DIAGNOSTIC MANUAL

2015 N13 Engine

Navistar, Inc.

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Foreword

Navistar, Inc. is committed to continuous research and development to improve products and introduce technological advances. Procedures, specifications, and parts defined in published technical service literature may be altered.

NOTE: Photo illustrations identify specific parts or assemblies that support text and procedures; other areas in a photo illustration may not be exact.

This manual includes necessary information and specifications for technicians to maintain Navistar® diesel engines. See vehicle manuals and Technical Service Information (TSI) bulletins for additional information.

Technical Service Literature

Navistar® N13 with SCR *Engine Operation and Maintenance Manual*

Navistar® N13 with SCR *Engine Service Manual*

Navistar® N13 with SCR *Engine and Aftertreatment Wiring Schematic Form*

Technical Service Literature is revised periodically. If a technical publication is ordered, the latest revision will be supplied.

NOTE: To order technical service literature, contact your International dealer.

Service Diagnosis

Service diagnosis is an investigative procedure that must be followed to find and correct an engine application problem or an engine problem.

If the problem is engine application, see specific vehicle manuals for further diagnostic information.

If the problem is the engine, see specific *Engine Diagnostic Manual* for further diagnostic information.

Prerequisites for Effective Diagnosis

- Availability of gauges and diagnostic test equipment
- Availability of current information for engine application and engine systems
- Knowledge of the principles of operation for engine application and engine systems
- Knowledge to understand and do procedures in diagnostic and service publications

Technical Service Literature required for Effective Diagnosis

- *Engine Service Manual*
- *Engine Diagnostic Manual*
- Diagnostics Forms
- Engine Wiring Schematic Form
- Service Bulletins

Safety Information

This manual provides general and specific maintenance procedures essential for reliable engine operation and your safety. Since many variations in procedures, tools, and service parts are involved, advice for all possible safety conditions and hazards cannot be stated.

Read safety instructions before doing any service and test procedures for the engine or vehicle. See related application manuals for more information.

Disregard for Safety Instructions, Warnings, Cautions, and Notes in this manual can lead to injury, death or damage to the engine or vehicle.

Safety Terminology

Three terms are used to stress your safety and safe operation of the engine: Warning, Caution, and Note

Warning: A warning describes actions necessary to prevent or eliminate conditions, hazards, and unsafe practices that can cause personal injury or death.

Caution: A caution describes actions necessary to prevent or eliminate conditions that can cause damage to the engine or vehicle.

Note: A note describes actions necessary for correct, efficient engine operation.

Safety Instructions

Work Area

- Keep work area clean, dry, and organized.
- Keep tools and parts off the floor.
- Make sure the work area is ventilated and well lit.
- Make sure a First Aid Kit is available.

Safety Equipment

- Use correct lifting devices.
- Use safety blocks and stands.

Protective Measures

- Wear protective safety glasses and shoes.
- Wear correct hearing protection.
- Wear cotton work clothing.
- Wear sleeved heat protective gloves.
- Do not wear rings, watches or other jewelry.
- Restrain long hair.

Vehicle

- Make sure the vehicle is in neutral, the parking brake is set, and the wheels are blocked before servicing engine.

- Clear the area before starting the engine.

Engine

- The engine should be operated or serviced only by qualified individuals.
- Provide necessary ventilation when operating engine in a closed area.
- Keep combustible material away from engine exhaust system and exhaust manifolds.
- Install all shields, guards, and access covers before operating engine.
- Do not run engine with unprotected air inlets or exhaust openings. If unavoidable for service reasons, put protective screens over all openings before servicing engine.
- Shut engine off and relieve all pressure in the system before removing panels, housing covers, and caps.
- If an engine is not safe to operate, tag the engine and ignition key.

Fire Prevention

- Make sure charged fire extinguishers are in the work area.

NOTE: Check the classification of each fire extinguisher to ensure that the following fire types can be extinguished.

1. Type A — Wood, paper, textiles, and rubbish
2. Type B — Flammable liquids
3. Type C — Electrical equipment

Batteries

- Always disconnect the main negative battery cable first.
- Always connect the main negative battery cable last.
- Avoid leaning over batteries.
- Protect your eyes.
- Do not expose batteries to open flames or sparks.
- Do not smoke in workplace.

Compressed Air

- Use an OSHA approved blow gun rated at 30 psi.(207 kPa)
- Limit shop air pressure to 30 psi (207 kPa).
- Wear safety glasses or goggles.
- Wear hearing protection.
- Use shielding to protect others in the work area.
- Do not direct compressed air at body or clothing.

Tools

- Make sure all tools are in good condition.
- Make sure all standard electrical tools are grounded.

- Check for frayed power cords before using power tools.

Fluids Under Pressure

- Use extreme caution when working on systems under pressure.
- Follow approved procedures only.

Fuel

- Do not over fill the fuel tank. Over fill creates a fire hazard.
- Do not smoke in the work area.
- Do not refuel the tank when the engine is running.

Removal of Tools, Parts, and Equipment

- Reinstall all safety guards, shields, and covers after servicing the engine.
- Make sure all tools, parts, and service equipment are removed from the engine and vehicle after all work is done.

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DEF: SLH (Diesel Exhaust Fluid Suction Line Heater) Sensor 449
DEF: SM (Diesel Exhaust Fluid Supply Module) Sensor 462
DEF: SMH (Diesel Exhaust Fluid Supply Module Heater) Sensor 480
DEF: SP (Diesel Exhaust Fluid Supply Pump) Sensor 525
DEF: THC Sensor 540
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How To Use This Section

CONTENT
UNDER
DEVELOPMENT

0000305681

Diagnostic Trouble Code (DTC's) List

SPN	FMI	Sub-section	Condition Description
27	7	EGR (page 789)	EGRP does not agree with commanded position
27	10	EGR (page 789)	EGRP sensor feedback deviation during CSER
27	16	EGR (page 789)	Position error Position sensor feedback deviation from control command
27	18	EGR (page 789)	Position error Position sensor feedback deviation from control command
51	0	ETV (page 879)	ETP fault: over temperature
51	1	ETV (page 879)	ETP does not agree with commanded closed position
51	3	ETV (page 879)	ETP signal Out of Range HIGH
51	4	ETV (page 879)	ETP signal Out of Range LOW
51	7	ETV (page 879)	ETP does not agree with commanded position
51	10	ETV (page 879)	ETP sensor feedback deviation during CSER
84	2	EWPS (page 897)	Vehicle speed anti-tampering fault
91	2	APP (page 252)	APP1 and APP2 signal conflict
91	3	APP (page 252)	APP1 signal Out of Range HIGH
91	4	APP (page 252)	APP1 signal Out of Range LOW
94	0	FDP (page 964)	Fuel Delivery Pressure above maximum
94	3	FDP (page 964)	FDP signal Out of Range HIGH
94	4	FDP (page 964)	FDP signal Out of Range LOW
96	19	Fuel Level	Fuel Level not detected on J1939
98	3	EOL (page 848)	EOL signal Out-of-Range HIGH
98	4	EOL (page 848)	EOL signal Out-of-Range LOW
100	1	EWPS (page 897)	Engine Oil System below Critical Pressure
100	3	EOP (page 858)	EOP signal Out of Range HIGH
100	4	EOP (page 858)	EOP signal Out of Range LOW
100	11	EWPS (page 897)	Engine oil pressure below dealer programmed engine RPM value
100	17	EWPS (page 897)	Low Oil Pressure vehicle event fault
100	18	EWPS (page 897)	Engine Oil System below Warning Pressure
102	2	IMP (page 1054)	IMP signal does not agree with BARO
102	3	IMP (page 1054)	IMP signal Out of Range HIGH
102	4	IMP (page 1054)	IMP signal Out of Range LOW
102	10	AMS (page 241)	IMP Boost slow response
102	16	AMS (page 241)	Intake Manifold Pressure Overboost

SPN	FMI	Sub-section	Condition Description
102	18	AMS (page 241)	Intake Manifold Pressure Underboost
105	2	IMT (page 1062)	IMT signal erratic, intermittent or incorrect
105	3	IMT (page 1062)	IMT signal Out of Range HIGH
105	4	IMT (page 1062)	IMT signal Out of Range LOW
108	3	BARO (page 268)	BARO signal Out of Range HIGH
108	4	BARO (page 268)	BARO signal Out of Range LOW
110	0	EWPS (page 897)	Engine Coolant System above Critical Temperature
110	2	ECT1 (page 751)	ECT1 signal erratic, intermittent, or incorrect
110	3	ECT1 (page 751)	ECT1 signal Out of Range HIGH
110	4	ECT1 (page 751)	ECT1 signal Out of Range LOW
110	11	EWPS (page 897)	Event logger, coolant temperature hot, extreme
110	15	EWPS (page 897)	Engine Coolant System above Warning temperature
110	16	EWPS (page 897)	Engine Coolant System above OBD maximum temperature
110	17	EWPS (page 897)	Engine Coolant System below OBD maximum temperature
110	18	EWPS (page 897)	Engine Coolant System below closed loop minimum Temperature
111	1	ECL (page 713)	Low Engine Coolant Level
111	31	ECL (page 713)	Engine Coolant Level Low Repeated Occurrence
157	0	FRP (page 1019)	FRP relief valve opening fault
157	3	FRP (page 983)	FRP signal Out of Range HIGH
157	4	FRP (page 983)	FRP signal Out of Range LOW
157	14	FRP (page 983)	FRP Relief Valve failure
157	20	FRP (page 983)	FRP signal Drifted HIGH
157	21	FRP (page 983)	FRP signal Drifted LOW
157	31	FRP (page 983)	Pressure Linearization Monitor
158	15	ECM (page 720)	ECM Switched voltage too HIGH
158	17	ECM (page 720)	ECM Switched voltage too LOW
171	2	AAT (page 102)	AAT signal erratic, intermittent or incorrect
171	3	AAT (page 102)	AAT signal Out of Range HIGH (Body mounted sensor)
171	4	AAT (page 102)	AAT signal Out of Range LOW (Body mounted sensor)
175	0	EWPS (page 897)	Engine Oil System above Critical Temperature
175	3	EOT (page 869)	EOT signal Out of Range HIGH
175	4	EOT (page 869)	EOT signal Out of Range LOW

SPN	FMI	Sub-section	Condition Description
175	11	EWPS (page 897)	Oil Temperature Exceeds limit by large amount
175	15	EWPS (page 897)	Engine Oil System above warning temperature
188	0	EWPS (page 897)	Engine unable to achieve desired idle speed (too high)
188	1	EWPS (page 897)	Engine unable to achieve desired idle speed (too low)
188	16	EWPS (page 897)	Engine unable to achieve desired speed: secondary fuel detected
190	0	EWPS (page 897)	Engine overspeed most severe level
190	11	EWPS (page 897)	Engine overspeed vehicle event fault
190	15	EWPS (page 897)	Engine overspeed detected
191	1	TOSS (page 1453)	TOSS not detected with vehicle moving
191	2	TOSS (page 1453)	TOSS signal erratic, intermittent or incorrect
191	3	TOSS (page 1453)	TOSS signal Out of Range HIGH
191	4	TOSS (page 1453)	TOSS signal Out of Range LOW
191	16	TOSS (page 1453)	Hard wired vehicle speed reading higher than limit
412	1	EGRT (page 825)	EGRT signal stuck low, not warming up
412	2	EGRT (page 825)	EGRT signal erratic, intermittent or incorrect
412	3	EGRT (page 825)	EGRT signal Out of Range HIGH
412	4	EGRT (page 825)	EGRT signal Out of Range LOW
560	19	J1939 (page 1211)	Transmission Driveline Engaged not detected on J1939
609	19	J1939 (page 1211)	ACM not detected on J1939
626	3	Inlet Air Heater Fuel Solenoid (page 1049)	CSFS short to PWR
626	4	Inlet Air Heater Fuel Solenoid (page 1049)	CSFS short to GND
626	5	Inlet Air Heater Fuel Solenoid (page 1049)	CSFS open load/circuit
626	18	Inlet Air Heater Fuel Solenoid (page 1049) Inlet Air Heater Fuel Igniter (page 1027)	Cold Start Assist fault: Lack of heat in the Intake Manifold
628	12	ECM (page 720)	ECM Memory Error
629	0	ECM (page 720)	ECM Error - CPU Load Excessively HIGH
629	2	ECM (page 720)	ECM Error – Level 2 Monitoring
629	8	ECM (page 720)	Engine Off timer fault
629	12	ECM (page 720)	ECM Internal chip Error
629	14	ECM (page 720)	ECM Internal component overtemperature

SPN	FMI	Sub-section	Condition Description
633	3	FPCV (page 978)	FPCV short to PWR
633	4	FPCV (page 978)	FPCV short to GND
633	5	FPCV (page 978)	FPCV open load/circuit
636	2	CMP (page 303)	CMP and CKP Synchronization Error
636	8	CMP (page 303)	CMP signal noise
636	10	CMP (page 303)	CMP signal missing
637	8	CKP (page 293)	CKP signal noise
637	10	CKP (page 293)	CKP signal inactive
639	14	J1939 (page 1211)	J1939 Data Link Error (ECM unable to transmit)
639	19	J1939 (page 1211)	J1939 Data Link Error (ECM unable to transmit or receive)
647	3	EFC (page 782)	EFC short to PWR
647	4	EFC (page 782)	EFC short to GND
647	5	EFC (page 782)	EFC open load/circuit
651	3	INJ (page 1077)	Injector 1 short to PWR
651	4	INJ (page 1077)	INJ short circuit
651	5	INJ (page 1077)	INJ open circuit
651	13	CYL Balance (page 317)	Injector 1 programmable parameter error
651	16	CYL Balance (page 317)	Injector 1 Fuel quantity/timing high error
651	18	CYL Balance (page 317)	Injector 1 Fuel quantity/timing low error
652	3	INJ (page 1077)	Injector 2 short to PWR
652	4	INJ (page 1077)	Injector 2 short circuit
652	5	INJ (page 1077)	Injector 2 open circuit
652	13	CYL Balance (page 317)	Injector 2 programmable parameter error
652	16	CYL Balance (page 317)	Injector 2 Fuel quantity/timing high error
652	18	CYL Balance (page 317)	Injector 2 Fuel quantity/timing low error
653	3	INJ (page 1077)	Injector 3 short to PWR
653	4	INJ (page 1077)	Injector 3 short circuit
653	5	INJ (page 1077)	Injector 3 open circuit
653	13	CYL Balance (page 317)	Injector 3 programmable parameter error
653	16	CYL Balance (page 317)	Injector 3 Fuel quantity/timing high error
653	18	CYL Balance (page 317)	Injector 3 Fuel quantity/timing low error
654	3	INJ (page 1077)	Injector 4 short to PWR
654	4	INJ (page 1077)	Injector 4 short circuit
654	5	INJ (page 1077)	Injector 4 open circuit

SPN	FMI	Sub-section	Condition Description
654	13	CYL Balance (page 317)	Injector 4 programmable parameter error
654	16	CYL Balance (page 317)	Injector 4 Fuel quantity/timing high error
654	18	CYL Balance (page 317)	Injector 4 Fuel quantity/timing low error
655	3	INJ (page 1077)	Injector 5 short to PWR
655	4	INJ (page 1077)	Injector 5 short circuit
655	5	INJ (page 1077)	Injector 5 open circuit
655	13	CYL Balance (page 317)	Injector 5 programmable parameter error
655	16	CYL Balance (page 317)	Injector 5 Fuel quantity/timing high error
655	18	CYL Balance (page 317)	Injector 5 Fuel quantity/timing low error
656	3	INJ (page 1077)	Injector 6 short to PWR
656	4	INJ (page 1077)	Injector 6 short circuit
656	5	INJ (page 1077)	Injector 6 open circuit
656	13	CYL Balance (page 317)	Injector 6 programmable parameter error
656	16	CYL Balance (page 317)	Injector 6 Fuel quantity/timing high error
656	18	CYL Balance (page 317)	Injector 6 Fuel quantity/timing low error
724	2	O2S (page 1297)	O_2S Slow response detecting fueling to non-fueling
724	3	O2S (page 1297)	O_2S Circuit Fault: Open or short to PWR
724	4	O2S (page 1297)	O_2S Circuit Fault: Short to GND
724	5	O2S (page 1297)	O_2S Circuit Fault: Open circuit
724	20	O2S (page 1297)	O_2S adaptation above maximum limit
724	21	O2S (page 1297)	O_2S adaptation below minimum limit
731	16	EWPS (page 897)	Knock detected: Cylinder Acceleration Above Normal
731	18	EWPS (page 897)	Knock Detected: Unexpected Fueling without Demand
837	14	Body (page 273)	Speedometer Drive Output Error
			Refer to the *Chassis Electrical Circuit Diagram Manual*
974	3	RAPP (page 1328)	Remote APP signal Out of Range HIGH
974	4	RAPP (page 1328)	Remote APP signal Out of Range LOW
1072	3	ECB1 (page 708)	ECB1 Control short to PWR
1072	4	ECB1 (page 708)	ECB1 Control short to GND
1072	5	ECB1 (page 708)	ECB1 Control open load/circuit
1073	3	ECB2	ECB2 Control short to PWR
1073	4	ECB2	ECB2 Control short to GND
1073	5	ECB2	ECB2 Control open load/circuit
1081	3	WTSL (page 1518)	WTSL short to PWR

SPN	FMI	Sub-section	Condition Description
1081	4	WTSL (page 1518)	WTSL short to GND
1081	5	WTSL (page 1518)	WTSL open load/circuit
1110	31	ECM (page 720)	ECM detects fueling without demand
1135	3	EOL (page 848)	EOT2 signal Out of Range HIGH
1135	4	EOL (page 848)	EOT2 signal Out of Range LOW
1173	2	TC2CIS (page 1415)	TC2CIT signal does not agree with other sensors
1173	3	TC2CIS (page 1415)	TC2CIT signal Out of Range HIGH
1173	4	TC2CIS (page 1415)	TC2CIT signal Out of Range LOW
1173	16	TC2CIS (page 1415)	TC2CIT signal above desired (interstage CAC under cooling)
1177	2	TC2CIS (page 1415)	TC2CIP Underdevelopment
1177	3	TC2CIS (page 1415)	TC2CIP signal Out of Range HIGH
1177	4	TC2CIS (page 1415)	TC2CIP signal Out of Range LOW
1189	3	TC2WC (page 1447)	TC2WC short to PWR
1189	4	TC2WC (page 1447)	TC2WC short to GND
1189	5	TC2WC (page 1447)	TC2WC open load/circuit
1213	3	MIL (page 1235)	MIL circuit short to PWR
1213	4	MIL (page 1235)	MIL circuit short to GND
1213	5	MIL (page 1235)	MIL open load/circuit
1322	31	CYL Balance (page 317)	Misfire - Multiple Cylinders
1323	31	CYL Balance (page 317)	Misfire - Cylinder 1
1324	31	CYL Balance (page 317)	Misfire - Cylinder 2
1325	31	CYL Balance (page 317)	Misfire - Cylinder 3
1326	31	CYL Balance (page 317)	Misfire - Cylinder 4
1327	31	CYL Balance (page 317)	Misfire - Cylinder 5
1328	31	CYL Balance (page 317)	Misfire - Cylinder 6
1378	31	Service (page 1402)	Change Engine Oil Service Interval
1569	31	SCR (page 1331)	SCR Tamperproof Warning & Protection System Inducement Severe
1590	19	Body (page 273)	Adaptive Cruise Control not detected on J1939
1659	20	ECS (page 1231)	ECT1 below expected: Check Thermostat
1761	1	DEFTL (page 554)	DEF Tank Level sensor Inducement (Level 3 - 5)
1761	3	DEFTL (page 554)	DEFTL signal Out of Range HIGH
1761	4	DEFTL (page 554)	DEFTL signal Out of Range LOW
1761	10	DEFTL (page 554)	DEF Level abnormal rate of change

SPN	FMI	Sub-section	Condition Description
1761	11	DEFTL (page 554)	DEFTL Signal erratic, intermittent, or incorrect
1761	17	DEFTL (page 554)	DEFTL Inducement Level 1
1761	18	DEFTL (page 554)	DEFTL Inducement Level 2
1761	19	DEFTL (page 554)	DEFTL not detected on J1939
1810	0	Hard Brake Monitor (page 847)	Hard Brake monitor, event log, extreme
1810	15	Hard Brake Monitor (page 847)	Hard Brake monitor, event log, non-extreme
2588	0	EWPS (page 897)	Vehicle overspeed 1, event log, extreme
2588	15	EWPS (page 897)	Vehicle overspeed 1, event log, non-extreme
2589	0	EWPS (page 897)	Vehicle overspeed 2, event log, extreme
2589	15	EWPS (page 897)	Vehicle overspeed 2, event log, non-extreme
2623	3	APP (page 252)	APP2 signal Out of Range HIGH
2623	4	APP (page 252)	APP2 signal Out of Range LOW
2630	2	CACOT (page 275)	CACOT signal erratic, intermittent, or incorrect
2630	3	CACOT (page 275)	CACOT signal Out of Range HIGH
2630	4	CACOT (page 275)	CACOT signal Out of Range LOW
2630	16	CACOT (page 275)	CACOT undercooling
2659	10	AMS (page 241)	EGR slow response
2659	20	AMS (page 241)	EGR High Flow Rate detected
2659	21	AMS (page 241)	EGR Low Flow Rate detected
2791	0	EGR (page 789)	EGRV Overtemperature
2791	2	EGR (page 789)	EGR Feedback Communication Fault
2791	3	EGR (page 789)	EGRC short to PWR
2791	4	EGR (page 789)	EGRV supply voltage is too LOW
2791	5	EGR (page 789)	EGRC open load/circuit
2791	6	EGR (page 789)	EGR Valve Control current above normal or grounded
2791	7	EGR (page 789)	EGR Valve unable to achieve commanded position
2791	8	EGR (page 789)	EGR valve not receiving ECM PWM signal
2791	12	EGR (page 789)	EGR Valve Internal self test fault
2791	14	EGR (page 789)	EGRV Error: Internal Processor failure
2791	19	EGR (page 789)	EGR Valve Control not detected on J1939
2797	11	INJ (page 1077)	Injector Control Group 1 short circuit (INJ 1, 3, 5)
2798	11	INJ (page 1077)	Injector Control Group 2 short circuit (INJ 2, 4, 6)
3031	2	DEFTLT (page 577)	DEFTT signal erratic, intermittent or incorrect
3031	3	DEFTLT (page 577)	DEFTT signal Out of Range HIGH

SPN	FMI	Sub-section	Condition Description
3031	4	DEFTLT (page 577)	DEFTT signal Out of Range LOW
3055	0	FRPS (page 998)	FRP exceeded maximum
3055	1	FRPS (page 998)	No start due to low rail fuel pressure
3055	15	FRPS (page 998)	FRP below minimum with maximum command
3055	17	FRPS (page 998)	FRP above maximum with minimum command
3058	10	EGR (page 789)	EGR did not go into Closed loop EGR control when expected
3061	31	Inlet Air Heater Fuel Igniter (page 1027)	Cold start system warm-up fault during CSER
3216	2	NOx IN sensor module (page 1237)	NOx IN signal erratic, intermittent or incorrect
3216	4	NOx IN sensor module (page 1237)	NOx IN signal drifted LOW
3216	10	NOx IN sensor module (page 1237)	NOx IN signal abnormal rate of change
3216	13	NOx IN sensor module (page 1237)	NOx IN Out of Calibration
3216	19	NOx IN sensor module (page 1237)	NOx IN not detected on J1939
3216	20	NOx IN sensor module (page 1237)	NOx IN signal drifted HIGH
3216	21	NOx IN sensor module (page 1237)	NOx IN signal drifted LOW
3218	2	NOx IN sensor module (page 1237)	NOx IN power supply signal erratic, intermittent or incorrect
3223	0	O_2S (page 1297)	O2S heater temperature above maximum
3223	1	O_2S (page 1297)	O_2S heater temperature below minimum
3223	3	O_2S (page 1297)	O_2S heater short to PWR
3223	4	O_2S (page 1297)	O_2S heater short to GND
3223	5	O_2S (page 1297)	O_2S heater open load/circuit
3223	17	O_2S (page 1297)	O_2S heater temperature below minimum at low battery PWR
3226	2	NOx OUT Sensor Module (page 1268)	NOx OUT signal erratic, intermittent or incorrect
3226	4	NOx OUT Sensor Module (page 1268)	NOx OUT signal Out of Range LOW
3226	10	NOx OUT Sensor Module (page 1268)	Aftertreatment Outlet NOx Sensor — abnormal rate of change

SPN	FMI	Sub-section	Condition Description
3226	13	NOx OUT Sensor Module (page 1268)	NOx OUT Out of Calibration
3226	19	NOx OUT Sensor Module (page 1268)	NOx OUT not detected on J1939
3226	20	NOx OUT Sensor Module (page 1268)	NOx OUT signal drifted HIGH
3226	21	NOx OUT Sensor Module (page 1268)	NOx OUT signal drifted LOW
3228	2	NOx OUT Sensor Module (page 1268)	NOx OUT power supply signal erratic, intermittent or incorrect
3242	0	DPFIT (page 645)	DPFIT above Critical
3242	2	DPFIT (page 645)	DPFIT signal erratic, intermittent, or incorrect
3242	3	DPFIT (page 645)	DPFIT Signal Out of Range HIGH
3242	4	DPFIT (page 645)	DPFIT signal Out of Range LOW
3242	16	DPFIT (page 645)	DPFIT above Maximum Temperature
3246	0	DPFOT (page 675)	DPFOT above Critical
3246	2	DPFOT (page 675)	DPFOT signal erratic, intermittent, or incorrect
3246	3	DPFOT (page 675)	DPFOT signal Out of Range HIGH
3246	4	DPFOT (page 675)	DPFOT signal Out of Range LOW
3246	16	DPFOT (page 675)	DPFOT Above Maximum Temperature
3251	2	DPFDP / Outlet Pressure Sensor (page 658)	DPFDP signal erratic, intermittent, or incorrect
3251	3	DPFDP / Outlet Pressure Sensor (page 658)	DPFDP signal Out of Range HIGH
3251	4	DPFDP / Outlet Pressure Sensor (page 658)	DPFDP signal Out of Range LOW
3361	2	DEFSP (page 525)	DEFSP signal erratic, intermittent or incorrect
3361	3	DEFSP (page 525)	DEFSP signal Out of Range HIGH
3361	4	DEFSP (page 525)	DEFSP signal Out of Range LOW
3362	31	DEFSP (page 525)	DEF dosing unable to prime
3363	3	DEFTHC (page 540)	DEFTHC short to PWR
3363	4	DEFTHC (page 540)	DEFTHC short to GND
3363	7	DEFTHC (page 540)	DEFTHC Mechanical system not responding or out of adjustment
3363	16	DEFTHC (page 540)	DEFTHC stuck on fault
3363	18	DEFTHC (page 540)	DEFTHC unable to thaw frozen DEF
3464	3	ETV (page 879)	ETC short to PWR

SPN	FMI	Sub-section	Condition Description
3464	4	ETV (page 879)	ETV short to GND
3464	5	ETV (page 879)	ETC open load/circuit
3480	2	AFTFP1 (page 162)	AFTFP1 signal erratic, intermittent, or incorrect
3480	3	AFTFP1 (page 162)	AFTFP1 signal Out of Range HIGH
3480	4	AFTFP1 (page 162)	AFTFP1 signal Out of Range LOW
3480	17	AFTFP1 (page 162)	AFTFP1 below normal operating range
3482	2	AFTFSV (page 183)	AFT Fuel Shutoff Valve signal erratic, intermittent or incorrect
3482	3	AFTFSV (page 183)	AFT Fuel Shutoff Valve short to PWR
3482	4	AFTFSV (page 183)	AFT Fuel Shutoff Valve short to GND
3482	7	AFTFSV (page 183)	AFT Fuel Shutoff Valve Mechanical system not responding or out of adjustment
3482	16	AFTFSV (page 183)	AFT Fuel Shutoff Valve Plugged
3490	3	AFTPAV (page 205)	AFTPAV short to PWR
3490	4	AFTPAV (page 205)	AFTPAV short to GND
3490	7	AFTPAV (page 205)	AFTPAV Mechanical system not responding or out of adjustment
3509	14	VREF (page 1499)	VREF1 voltage deviation ECM pins: C1-36
3510	14	VREF (page 1499)	VREF2 voltage deviation ECM pins: E1-85 and E1-86
3511	14	VREF (page 1499)	VREF3 voltage deviation ECM pins: E1-89
3512	14	VREF (page 1499)	VREF4 voltage deviation ECM pins: C1-37, C1-49, C2-08, and E1-58
3513	14	VREF (page 1499)	VREF5 voltage deviation ECM pins: C1-50, E1-81, and E1-82
3514	14	VREF (page 1499)	VREF6 voltage deviation ECM pin: E1-88
3556	2	AFTFI (page 218)	AFT Fuel Injector signal erratic, intermittent or incorrect
3556	5	AFTFI (page 218)	AFT Fuel Injector open load/circuit
3556	18	AFTFI (page 218)	AFT Fuel Pressure 2 below Warning Pressure
3597	4	ECM (page 720)	ECM Power Output 1 below normal ECM Pins: C1-31, C1-33, C1-54, C2-51, E1-01 and E1-51
3598	4	ECM (page 720)	ECM Power Output 2 below normal ECM Pins: C1-42, C2-06, E1-05, E1-28, E1-29 and E1-54
3599	4	ECM (page 720)	ECM Power Output 3 below normal ECM Pins: C1-30, C2-03, E1-24, E1-26 and E1-27
3610	2	DPFDP / Outlet Pressure Sensor (page 658)	DPFOP signal erratic, intermittent or incorrect

SPN	FMI	Sub-section	Condition Description
3610	3	DPFDP / Outlet Pressure Sensor (page 658)	DPFOP signal Out of Range HIGH
3610	4	DPFDP / Outlet Pressure Sensor (page 658)	DPFOP signal Out of Range LOW
3695	2	AFT System (page 120)	DPF Regen Inhibit Switch erratic, intermittent or incorrect
3703	31	AFT System (page 120)	DPF Active Regeneration Inhibited Due to Inhibit Switch
3713	31	AFT System (page 120)	DPF Active Regeneration Inhibited Due to System Timeout
3719	0	DPF System (page 598)	DPF Soot Load - Highest (level 3/3)
3719	15	DPF System (page 598)	DPF Soot Load - Lowest (level 1/3)
3719	16	DPF System (page 598)	DPF Soot Load - Moderate (level 2/3)
3750	31	AFT System (page 120)	DPF Regen inhibited due to low exhaust temperatures
3826	18	SCR (page 1331)	DEF Reagent Consumption below setpoint
3936	0	DPF System (page 598)	DPF Soot Load - Severe De-Rate
3936	7	DPF System (page 598)	DPF System - DPF exceeded maximum temperature threshold - replace DPF
3936	14	DOC / DPF Temperature Sensor Module	Part # Mismatch (What's stored in ACM vs Reading from Smart Sensor Assembly)
3936	15	DPF System (page 598)	DPF System above Warning Pressure
4076	0	EWPS (page 897)	ECT2 above Critical (EWPS programmable limit)
4076	2	ECT2 (page 767)	ECT2 signal erratic, intermittent, or incorrect
4076	3	ECT2 (page 767)	ECT2 signal Out of Range HIGH
4076	4	ECT2 (page 767)	ECT2 signal Out of Range LOW
4076	15	EWPS (page 897)	ECT2 above Warning (EWPS programmable limit)
4076	17	ECT2 (page 767)	ECT2 signal stuck low, not warming up
4192	3	WIF (page 1514)	WIF signal Out of Range HIGH
4192	4	WIF (page 1514)	WIF signal Out of Range LOW
4227	7	CCOSS (page 291)	CC Oil Separator Speed: Not spinning
4334	2	DEFLP Sensor (page 406)	DEFLP signal erratic, intermittent or incorrect
4334	3	DEFLP Sensor (page 406)	DEFLP signal Out of Range HIGH
4334	4	DEFLP Sensor (page 406)	DEFLP signal Out of Range LOW
4334	16	DEFLP Sensor (page 406)	DEFLP above Maximum Pressure
4334	18	DEFLP Sensor (page 406)	DEFLP below normal operating range
4337	2	DEFSM (page 462)	DEF Supply Module Temperature erratic, intermittent or incorrect
4337	10	DEFSM (page 462)	DEF Supply Module Temperature abnormal rate of change

SPN	FMI	Sub-section	Condition Description
4340	3	DEFPLH (page 423)	DEFL1HC short to PWR
4340	5	DEFPLH (page 423)	DEFL1HC open load/circuit
4342	3	DEFRLH (page 436)	DEFL2HC short to PWR
4342	5	DEFRLH (page 436)	DEFL2HC open load/circuit
4344	3	DEFSLH (page 449)	DEFL3HC short to PWR
4344	5	DEFSLH (page 449)	DEFL3HC open load/circuit
4360	0	SCRIT Senor (page 1367)	SCRIT above Critical Temperature
4360	2	SCRIT Senor (page 1367)	SCRIT signal erratic, intermittent or incorrect
4360	3	SCRIT Senor (page 1367)	SCRIT signal Out of Range HIGH
4360	4	SCRIT Senor (page 1367)	SCRIT signal Out of Range LOW
4360	16	SCRIT Senor (page 1367)	SCRIT Above Maximum Temperature
4360	19	SCRIT Senor (page 1367)	SCRIT signal not detected on J1939
4363	0	SCROT (page 1384)	SCROT above Critical Temperature
4363	2	SCROT (page 1384)	SCROT signal erratic, intermittent or incorrect
4363	3	SCROT (page 1384)	SCROT signal Out of Range HIGH
4363	4	SCROT (page 1384)	SCROT signal Out of Range LOW
4363	16	SCROT (page 1384)	SCROT above Maximum Temperature
4363	19	SCROT (page 1384)	SCROT signal not detected on J1939
4364	18	SCR (page 1331)	Low NOx Conversion Detected
4376	3	DEFSM (page 462)	DEF Return Valve short to PWR
4376	4	DEFSM (page 462)	DEF Return Valve short to GND
4376	7	DEFSM (page 462)	DEF Return Valve - Mechanical system not responding or out of adjustment
4752	4	EGR (page 789)	EGR Cooler Efficiency: EGR outlet Temperature above expected
4765	0	DOCIT (page 586)	DOCIT above Critical Temperature
4765	2	DOCIT (page 586)	DOCIT signal erratic, intermittent, or incorrect
4765	3	DOCIT (page 586)	DOCIT signal Out of Range HIGH
4765	4	DOCIT (page 586)	DOCIT signal Out of Range LOW
4765	16	DOCIT (page 586)	DOCIT Above Maximum Temperature
4792	7	SCR (page 1331)	SCR Catalyst System - Mechanical system not responding or out of adjustment
4792	10	SCR (page 1331)	Aftertreatment 1 SCR System abnormal rate of change
4792	14	SCR (page 1331)	SCR Catalyst System - Out of Calibration
4792	31	SCR (page 1331)	Improper Reductant in DEF Tank

SPN	FMI	Sub-section	Condition Description
4794	31	AFT System (page 120)	SCR Catalyst System Missing
4795	31	AFT System (page 598)	DPFDP excessively LOW (sensor/circuit fault or missing DPF)
5024	10	NOx IN sensor module (page 1237)	NOx IN Sensor Heater abnormal rate of change
5031	10	NOx OUT Sensor Module (page 1268)	NOx OUT Sensor Heater not reading correctly
5125	14	VREF (page 1499)	VREF 7 voltage above or below normal
5126	14	VREF (page 1499)	VREF 8 voltage above or below normal
5127	14	VREF (page 1499)	VREF 9 voltage above or below normal
5246	15	SCR (page 1331)	SCR Tamper Proof Inducement Level 1 status
5298	17	AFT System (page 120)	DOC Conversion Efficiency below minimum
5298	18	AFT System (page 120)	DOC Conversion Efficiency below Warning Pressure
5319	31	DPF System (page 598)	DPF incomplete Regeneration
5394	5	DEFDV (page 389)	DEFDC open load/circuit
5394	7	DEFDV (page 389)	DEF Dosing Valve - Mechanical system not responding
5395	0	EWPS (page 897)	Engine unable to achieve desired idle torque (too high)
5395	1	EWPS (page 897)	Engine unable to achieve desired idle torque (too low)
5397	31	DPF System (page 598)	DPF regenerations are occurring too frequently
5491	3	DEFLHR (page 396)	DEFLHR short to PWR
5491	4	DEFLHR (page 396)	DEFLHR short to GND
5541	2	TC1TOP (page 1403)	TC1TOP does not agree with BARO
5541	3	TC1TOP (page 1403)	TC1TOP signal Out of Range HIGH
5541	4	TC1TOP (page 1403)	TC1TOP signal Out of Range LOW
5542	15	TC1TOP (page 1403)	TC1TOP above desired
5542	16	EBPV (page 689)	EBP Above Desired during CSER
5542	17	TC1TOP (page 1403)	TC1TOP below desired - Check Exhaust Back Pressure Valve
5542	18	EBPV (page 689)	EBP Below Desired during CSER
5543	3	EBPV (page 689)	EBPC short to PWR
5543	4	EBPV (page 689)	EBPC short to GND
5543	5	EBPV (page 689)	EBPC open load/circuit
5548	3	Inlet Air Heater Fuel Igniter (page 1027)	IAHFI short to PWR
5548	4	Inlet Air Heater Fuel Igniter (page 1027)	IAHFI short to GND

SPN	FMI	Sub-section	Condition Description
5548	5	Inlet Air Heater Fuel Igniter (page 1027)	IAHFI open load/circuit
5548	7	Inlet Air Heater Fuel Igniter (page 1027)	Inlet Air Heater Relay return (relay, or igniter, or circuit failure)
5742	3	DOC / DPF Temperature Sensor Module	DPF Thermocouple Controller Out of Range HIGH
5742	4	DOC / DPF Temperature Sensor Module	DPF Thermocouple Controller Out of Range LOW
5742	11	DOC / DPF Temperature Sensor Module	DPF Thermocouple Controller signal erratic, intermittent, or incorrect
5742	16	DOC / DPF Temperature Sensor Module	DPF Thermocouple Controller above Maximum Temperature
5742	19	DOC / DPF Temperature Sensor Module	DPF Thermocouple Controller signal not detect on J1939
5743	3	SCR Temperature Sensor Module Assembly (page 1351)	SCR Thermocouple Controller Out of Range HIGH
5743	4	SCR Temperature Sensor Module Assembly (page 1351)	SCR Thermocouple Controller Out of Range LOW
5743	11	SCR Temperature Sensor Module Assembly (page 1351)	SCR Thermocouple Controller signal erratic, intermittent, or incorrect
5743	16	SCR Temperature Sensor Module Assembly (page 1351)	SCR Thermocouple Controller above Maximum Temperature
5743	19	SCR Temperature Sensor Module Assembly (page 1351)	SCR Thermocouple Controller signal not detect on J1939
5745	3	DEFSMH (page 480)	DEF Dosing Unit Heater Out of Range HIGH
5745	4	DEFSMH (page 480)	DEF Dosing Unit Heater Out of Range LOW
5745	18	DEFSMH (page 480)	DEF Dosing Unit Heater below Warning Temperature
5746	3	DEFSMH (page 480)	DEF Dosing Unit Heater Relay short to PWR
5746	4	DEFSMH (page 480)	DEF Dosing Unit Heater Relay short to GND
5798	2	DEFSMH (page 480)	DEF Dosing Unit Heater Temperature erratic, intermittent or incorrect
5798	10	DEFSMH (page 480)	DEF Dosing Unit Heater Temperature abnormal rate of change
7424	3	SCR (page 1331)	DEF Lamp circuit short to PWR
7424	4	SCR (page 1331)	DEF Lamp circuit short to GND
7424	5	SCR (page 1331)	DEF Lamp circuit open load / circuit

Operational Checkout Procedures

1.0 - Preliminary Vehicle Operational Checkout Procedure

Step 1	Inspect fuel level, quality, and fuel system.	Decision
Perform Fuel Level Inspection (page 1775), Fuel System Inspection (page 1774), and Fuel Quality Inspection . Are fuel level and quality to specification, and did fuel system pass inspection?		Yes: Go to Step 2.
		No: Repair fuel system fault. After repairs are complete, retest for original problem.

Step 2	Inspect batteries, electrical system, and connections.	Decision
	Perform Batteries and Electrical System Inspection (page 1710). Are batteries, electrical system, and connections in good condition, tight, not corroded, and is battery voltage in specification?	Yes: Go to Step 3.
		No: Repair broken, loose, or corroded electrical system connections or components. Charge batteries to 12.6 V. After repairs are complete, retest for original problem.

Step 3	Inspect air intake system for damage or restrictions.	Decision
	Inspect Charge Air Cooler (CAC), Engine Throttle Valve (ETV), Mass Air Flow (MAF) sensor, air filter, intake piping, clamps, and connections for damage or restrictions. Are air intake system components damaged or restricted?	Yes: Repair air intake system damage or restrictions. After repairs are complete, retest for original problem.
		No: Go to Step 4.

Step 4	Inspect exhaust system for damage or restrictions.	Decision
	Inspect Diesel Oxidation Catalyst (DOC), Diesel Particulate Filter (DPF), Selective Catalyst Reduction (SCR) catalyst, exhaust back pressure valve, and exhaust piping for damage or restrictions. Are exhaust system components damaged or restricted?	Yes: Repair exhaust system damage or restrictions. After repairs are complete, retest for original problem.
		No: Go to Step 5.

Step 5	Inspect engine oil level.	Decision
	Perform Engine Oil Level Inspection (page 1784). Is engine oil level to specification?	Yes: Go to Step 6.
		No: Correct engine oil level problem. After repairs are complete, retest for original problem.

Step 6	Inspect engine coolant level and quality.	Decision
	Perform Coolant Level Inspection (page 1786) and Coolant Quality Inspection (page 1788) procedures. Are coolant level and quality to specification?	Yes: Go to Step 7.
		No: Fill engine coolant to specification. If coolant is contaminated, go to Coolant Contamination . After repairs are complete, retest for original problem.

Step 7	Verify Engine Control Module (ECM) communicates with Electronic Service Tool (EST), obtain vehicle health report, and check for current Engine Control Module (ECM) calibration.	Decision
	A. Connect EST with ServiceMaxx software and log-in. B. Perform Obtain Vehicle Health Report (page 1540). Is EST communicating with the ECM, and is ECM calibration current?	Yes: Go to Step 8.
		No, EST not communicating with ECM: Go to 11.0 ECM Loss of Communication (page 41).
		No, ECM calibration not current: Ensure vehicle has latest ECM calibration. After repairs are complete, retest for original problem.

Step 8	Review Repair Order (RO) and operator complaint.

Go to operational checkout procedure for specific symptom:

- 2.0 Engine Does Not Start Operational Checkout Procedure (page 29)
- 3.0 Engine Hard to Start Operational Checkout Procedure (page 31)
- 4.0 Engine Performance Problem Operational Checkout Procedure (page 32)
- 5.0 Cooling System Operational Checkout Procedure (page 34)
- 6.0 Engine Oil System Operational Checkout Procedure (page 37)
- Go to 7.0 Fuel System Operational Checkout Procedure (page 38)
- 8.0 Engine Brake Operational Checkout Procedure (page 39)
- 9.0 SCR Aftertreatment Operational Checkout Procedure (page 40)

2.0 - Engine Does Not Start Operational Checkout Procedure

Overview

The following steps direct technicians to systematically troubleshoot engine no start conditions and avoid unnecessary repairs.

Step 1	Perform preliminary operational checkout procedure.	Decision
	Did you perform 1.0 Preliminary Vehicle Operational Checkout Procedure?	Yes: Go to Step 2.
		No: Go to 1.0 Preliminary Vehicle Operational Checkout Procedure (page 26).

Step 2	Check for no start related Diagnostic Trouble Codes (DTC).	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check DTC list for: • SPN 94 Fuel Delivery Pressure (FDP) • SPN 636 Camshaft Position (CMP) • SPN 637 Crankshaft Position (CKP) • SPN 108, 158, 628, 629, 1136, 1387 Engine Control Module (ECM) • SPN 5541, 5542 Turbocharger 1 Turbine Outlet Pressure (TC1TOP) • SPN 3251 Diesel Particulate Filter Differential Pressure (TC1TOP) • SPN 3610 Diesel Particulate Filter Outlet Pressure (DPFOP) • SPN 51, 3464, Engine Throttle Valve (ETV) • SPN 102 Intake Manifold Pressure (IMP) • SPN 2797, 2789 Injector • SPN 157, 3055 Fuel Rail Pressure (FRP) • SPN 633 Fuel Pressure Control Valve (FPCV) Does EST DTC list have any active fault codes listed above?		Yes: Go to Fault Code Diagnostics for no start related SPN.
		No: Go to Step 3.

Step 3	Record snapshot of engine cranking data.	Decision
	Perform Engine Cranking Test (page 1711). Is Engine Speed (rpm) within Engine cranking specification? ?	Yes: Go to 2.2 Engine Cranks But Does Not Start (page 46).
		No: Engine Speed (rpm) out of specification: Go to 2.1 Engine Cranks Fast, Slow or Does Not Crank (page 42).

3.0 - Engine Hard to Start Operational Checkout Procedure

CONTENT
UNDER
DEVELOPMENT

0000305681

4.0 - Engine Performance Problem Operational Checkout Procedure

Overview

The following steps direct technicians to systematically troubleshoot engine running problems while under a load.

Step 1	Perform preliminary operational checkout procedure.	Decision
	Did you Perform 1.0 Preliminary Vehicle Operational Checkout Procedure (page 26)?	Yes: Go to Step 2.
		No: Go to 1.0 Preliminary Vehicle Operational Checkout Procedure (page 26).

Step 2	Check for related Diagnostic Trouble Codes (DTCs).	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check DTC list for fault codes. Does EST DTC list have fault codes active?		Yes: Go to Fault Code Diagnostics for appropriate SPN (page 101).
		No: Go to Step 3.

Step 3	Determine if engine has a misfire, rough idle, and / or runs rough.	Decision
	Does vehicle have a misfire, rough idle, and / or runs rough?	Yes: Go to 4.1 Misfire / Rough Idle / Runs Rough (page 50).
		No: Go to Step 4.

Step 4	Determine if engine has popping noises coming from the engine intake.	Decision
	Does vehicle have popping noises coming from the engine intake?	Yes: Go to 4.2 Popping Noise from Intake (page 57).
		No: Go to Step 5.

Step 5	Determine if engine has low power or slow acceleration.	Decision
	Does vehicle have low power or slow acceleration?	Yes: Go to 4.3 Low Power (Slow Acceleartion) (page 52).
		No: Go to Step 6.

Step 6	Determine if engine has a stumble or hesitation during acceleration.	Decision
	Does engine have a stumble or hesitation during acceleration?	Yes: Go to 4.4 Stumble (Hesitation on Acceleration) (page 56).
		No: Go to Step 7.

Step 7	Determine if engine has a surge or inconsistent RPM during steady state.	Decision
	Does engine surge or is engine speed (RPM) inconsistent during steady state?	Yes: Go to 4.5 Surge (Inconsistent Engine RPM During Steady State) (page 56).
		No: Review operator complaint.

5.0 - Cooling System Operational Checkout Procedure

Overview

The following steps direct technicians to systematically troubleshoot engine cooling system problems and avoid unnecessary repairs.

Step 1	Perform preliminary operational checkout procedure.	Decision
	Did you perform 1.0 Preliminary Vehicle Operational Checkout Procedure?	Yes: Go to Step 2.
		No: Go to 1.0 Preliminary Vehicle Operational Checkout Procedure (page 26).

Step 2	Determine if air flow thru cooling package is restricted or cooling system components are damaged.	Decision
A. Inspect for restrictions and debris in front of and between radiators and other cooling package components. B. Inspect cooling fan blades, fan shroud, accessory drive belt(s), drive belt tensioner(s), cooling package, and other cooling system components for damage. Were restrictions or debris found, or are cooling system components damaged?		Yes: Clear restrictions and clean debris from cooling package. Repair damaged cooling system components. After repairs are complete, retest for original problem.
		No: Go to Step 3.

Step 3	Determine if deaeration tank cap holds to rated pressure.	Decision
A. Remove deaeration tank cap. B. Attach deration cap to Coolant Cap Pressure Tester 09-0400-01. C. Pressurize deaeration cap to rated pressure. Does deaeration cap hold to rated pressure?		Yes: Go to Step 4.
		No: Replace deaeration tank cap. After repairs are complete, retest for original problem.

Step 4	Determine if engine or cooling system components are leaking externally or internally.	Decision
A. Fill deaeration tank with coolant to proper level. B. Inspect cooling package, hoses, water pump, and engine for coolant leaks. C. Install Radiator Pressure Testing Kit ZTSE2384 on deaeration tank. D. Pressurize cooling system to 117 kPa (17 psi) for a minimum of 15 minutes. Does cooling system holding pressure for 15 minutes?		Yes: Go to Step 5. No, external leaks: Repair external cooling system leaks. After repairs are complete, retest for original problem. No, internal leaks: Go to Step 7.

Step 5	Determine if cooling system overflows.	Decision
A. Fill deaeration tank with coolant to proper level using Coolant Management System tool KL5007NAV. B. Install deaeration tank cap. C. Start engine. Turn engine Off before any over temperature or overheating occurs. D. Run engine to operating temperature at high idle. Does deaeration cap hold to rated pressure?		Yes: Go 5.1 Coolant Overflow (page 58). No: Go to Step 6.

Step 6	Determine if vehicle cooling system goes over temperature or overheats.	Decision
NOTE: Do not run vehicle on a dyno to duplicate over temperature or over heat concern. False results will occur due to lack of proper air flow across the cooling package. Does vehicle cooling system go over temperature or overheat (220 F)?		Yes: Go 5.2 Coolant Over Temperature (page 61). No: Go to Step 7.

Step 7	Determine if coolant is in the engine oil.	Decision
Remove engine oil level gauge (dipstick) and inspect for coolant contamination. Oil contaminated with coolant usually causes the oil to thicken and turn light gray. Is engine oil contaminated with coolant?		Yes: Go 5.3 Coolant in Engine Oil (page 64). No: Go to Step 7.

Step 8	Determine if coolant is in the engine intake.	Decision
A. Disconnect Charge Air Cooler (CAC) pipe at the Engine Throttle Valve (ETV). B. Inspect CAC pipe for white coolant residue. C. Inspect inside ETV and air intake throttle duct for signs of coolant. Is coolant and / or white coolant residue present in the engine intake?		Yes: Go 5.4 Coolant in Intake (page 66). No: Go to Step 7.

WARNING: To prevent personal injury or death, allow engine to cool before working with components.

Step 9	Determine if coolant is in the exhaust.	Decision
A. Allow engine to cool for 15 minutes or more. B. Remove deaertion tank cap. C. Install Radiator Pressure Test Kit on the deaeration tank. D. Pressurize cooling system to 117 kPa (17 psi) for a minimum of 15 minutes. E. Disconnect turbocharger down pipe and inspect for coolant. Is coolant or white residue visible in the exhaust system?		Yes: Go 5.5 Coolant in Exhaust (page 68). No: Review operator complaint.

6.0 - Engine Oil System Operational Checkout Procedure

CONTENT
UNDER
DEVELOPMENT

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7.0 - Fuel System Operational Checkout Procedure

CONTENT
UNDER
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8.0 - Engine Brake Operational Checkout Procedure

CONTENT
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9.0 - SCR Aftertreatment Operational Checkout Procedure

CONTENT
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DEVELOPMENT

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10.0 - ECM Loss of Communication

CONTENT
UNDER
DEVELOPMENT

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Engine Does Not Start Symptoms

2.1 - Engine Cranks Fast, Slow or Does Not Crank

Overview

Determine reason engine cranks too fast, will not crank, or will not crank fast enough to start the engine.

Possible Causes

- Failed batteries or low charge
- Corroded or loose battery cables
- Master battery switch turned Off, or Open battery cable circuit
- Starting system faults
- Crank inhibit fault
- Charging system faults
- Internal engine damage
- Starter or flywheel gear binding or not engaging properly
- Power Take Off (PTO) or engine drive engaged

NOTE: See appropriate Truck Electrical System Troubleshooting Guide for additional starting and charging system information.

Test Procedure

Step 1	Perform operational checkout procedure.	Decision
Did you perform 2.0 Engine Does Not Start Operational Checkout Procedure?		Yes: Go to Step 2.
		No: Go to 2.0 Engine Does Not Start Operational Checkout Procedure (page 29).

WARNING: To prevent personal injury or death when working with batteries, always wear face or eye protection, have water supply available, ensure good ventilation, and be sure no flames or sparks are present.

Step 2	Determine if each vehicle battery is fully charged.	Decision
Measure batteries voltage with a Digital Multimeter (DMM). Is voltage of each battery 12.5 volts or more?		Yes: Go to Step 3.
		No: Charge batteries. Test charging system. After repairs are complete, retest for original problem.

Step 3	Determine if engine cranks too fast.	Decision
Crank engine while observing engine rpm. Does engine crank too fast?		Yes: Go to Step 4.
		No: Go to Step 5.

Step 4	Determine if valves, valve bridges, or engine timing problems are present.	Decision
A. Remove valve cover (see *Engine Service Manual*) B. Inspect valves and valve bridges. C. Check engine timing. Are any valves sitting too low or valve bridges damaged? Is engine timing out of specification?		Yes: Repair engine damage. After repairs are complete, retest for original problem.
		No: Go to 2.2 Engine Cranks But Does Not Start (page 46).

Step 5	Determine if master battery switch is Off or battery cable circuit has high resistance.	Decision
Turn ignition key to the Run position and observe instrument panel lights and listen for injector pre-cycle. Do instrument panel lights come on?		Yes: Go to Step 6.
		No: Turn master battery switch On or fix battery cable circuit. After repairs are complete, retest for original problem.

CAUTION: Follow instructions and safety procedures suggested by test equipment manufacturers.

NOTE: Cold batteries deliver less current.

Step 6	Determine if batteries are able to deliver appropriate current to start engine.	Decision
Using Midtronics – inTELLECT EXP HD – Battery and Electrical System tester (EXP1000HD), test fully charged batteries. Follow directions in tester instruction manual. Do batteries pass test?		Yes: Go to Step 7. No: Slow charge or replace each battery that fails test. After repairs are complete, retest for original problem.

Step 7	Determine if PTO or engine drive is engaged.	Decision
Are PTO or engine drive engaged?		Yes: Disengage PTO accessories and engine drives. After repairs are complete, retest for original problem. No: Go to Step 8.

Step 8	Determine if engine has internal damage or starter / flywheel gears are binding.	Decision
Using torque wrench set to 162 N-m (120 lb-ft) rotate crankshaft (see Engine Service Manual “Crankshaft Rotation Procedure”) by hand to determine if starter / flywheel gears are binding or engine has internal damage. Does crankshaft rotate appropriately?		Yes: Go to Step 9. No: Repair starter / flywheel binding or internal engine damage. See *Engine Service Manual*.

Step 9	Determine if starting system is operating properly.	Decision
Using Midtronics – inTELLECT EXP HD – Battery and Electrical System Tester (EXP1000HD), test starting system. Follow directions in tester instruction manual. Does starting system pass the test?		Yes: End Diagnostic Steps No, low current draw: Perform voltage drop test on main positive and negative battery cables. If voltage drop is 0.5 volts

	or more, clean or replace cable. After repairs are complete, retest for original problem.
	No, zero current draw: Check for crank inhibit faults, starter solenoid or circuit faults, failed starter, and ignition switch. After repairs are complete, retest for original problem.
	No, high current draw: Check for faulty starter or internal engine damage. After repairs are complete, retest for original problem.

End Diagnostic Steps
After performing all diagnostic steps, if fault remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

2.2 - Engine Cranks But Does Not Start

Overview

Determine reason engine will not start.

Possible Causes

- Exhaust restriction
- Low Fuel Delivery Pressure (FDP)
- Fuel Rail Pressure (FRP) internal leak
- Piston overflow valve (KUEV)
- High-pressure fuel pump
- Air Intake restriction

Test Procedure

Step 1	Perform operational checkout procedure	Decision
Did you perform 2.0 Engine Does Not Start Operational Checkout Procedure?		Yes: Go to Step 2.
		No: Go to 2.0 Engine Does Not Start Operational Checkout Procedure (page 29).

Step 2	Determine if exhaust is restricted.	Decision
Review Engine Cranking Test (page 1711) data. Are Turbocharger 1 Turbine Outlet Pressure (TC1TOP) within cranking specification?		Yes: Go to Step 3.
		No: Go to Exhaust Restriction. After repairs are complete, retest for original problem.

Step 3	Determine if engine is able to build Fuel Delivery Pressure (FDP).	Decision
Review Engine Cranking Test (page 1711) data. Is FDP in specification during cranking test?		Yes: Go to Step 4.
		No: Go to Fuel Delivery Pressure.

Step 4	Determine if engine is able to build Fuel Rail Pressure (FRP).	Decision
Review Engine Cranking Test (page 1711) data. Is FRP in specification?		Yes: End diagnostic steps.
		No: Go to High-pressure Fuel System.

End Diagnostic Steps
After performing all diagnostic steps, if fault remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Engine Hard to Start Symptoms

3.1 - Engine Hard to Start (Long Crank Time)

CONTENT
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DEVELOPMENT

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3.2 - Engine Starts, Then Stalls

CONTENT
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DEVELOPMENT

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Engine Performance Problems Symptoms

4.1 - Misfire / Rough Idle / Runs Rough

CONTENT
UNDER
DEVELOPMENT

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4.2 - Popping Noise from Intake

CONTENT
UNDER
DEVELOPMENT

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4.3 - Low Power (Slow Acceleartion)

Overview

Vehicle or engine is not able to accelerate properly while under a load.

Possible Causes

- High-pressure fuel system
- Exhaust restriction
- Low boost (turbocharger, wastegate, intake restriction or leak)
- Engine Coolant Temperature 2 (ECT2) over temp (de-rate)

Test Procedure

Step 1	Perform operational checkout procedure.	Decision
Did you perform 4.0 Engine Performance Problem Operational Checkout Procedure?		Yes: Go to Step 2.
		No: Go to 4.0 Engine Performance Problem Operational Checkout Procedure (page 32).

Step 2	Record snapshot of engine performance data and determine if engine has low fuel rail pressure.	Decision
A. Connect Electronic Service Tool (EST) with ServiceMaxx software and log in. B. Run engine to operating temperature. C. Perform Lug Down Test (page 1657) while symptom is occurring. D. Use the playback feature to graph the following signals from the Lug Down Test: • Engine Speed (RPM) • Fuel Rail Pressure (FRP) • Fuel Rail Pressure Desired (FRPD) E. Compare snapshot to Lug Down Test (RPM, FRP, and FRP Desired) Graph (page 1659). Is FRP signal operating per Lug Down Test (RPM, FRP, and FRP Desired) Graph?		Yes: Go to Step 3.
		No: Go to High-Pressure Fuel System (page 1693).

Step 3	Determine if exhaust is restricted.	Decision
A. Use the EST playback feature to graph the following signals from the Lug Down Test: • Engine Speed (RPM) • Turbocharger 1 Turbine Outlet Pressure (TC1TOP) • Diesel Particulate Filter Outlet Pressure (DPFOP) B. Compare snapshot to Lug Down Test (RPM, TC1TOP, DPFOP) Graph (page 1663). Is TC1TOP signal operating per Lug Down Test (RPM, TC1TOP, DPFOP) Graph?		Yes: Go to Step 4. No: Repair exhaust system restriction. After repairs are complete, retest for original problem.

Step 4	Determine if engine has low boost.	Decision
A. Use the EST playback feature to graph the following signals from the Lug Down Test: • Engine Speed (RPM) • Accelerator Pedal Position 1 (APP1) • Vehicle Speed • Intake Manifold Pressure (IMP) B. Compare snapshot to Lug Down Test (RPM, APP1, Vehicle Speed, and IMP) Graph. Is IMP signal operating per Lug Down Test (RPM, APP1, Vehicle Speed, and IMP) Graph?		Yes: Go to Step 5. No: Go to Step 7.

Step 5	Determine if air flow thru cooling package is restricted or cooling system components are damaged.	Decision
A. Inspect for restrictions and debris in front of and between radiators and other cooling package components. B. Inspect cooling fan blades, fan shroud, accessory drive belt(s), drive belt tensioner(s), cooling package, and other cooling system components for damage. Were restrictions or debris found, or are cooling system components damaged?		Yes: Clear restrictions and clean debris from cooling package. Repair damaged cooling system components. After repairs are complete, retest for original problem. No: Go to Step 6.

Step 6	Determine if Low Temperature Radiator (LTR) internal flow is restricted.	Decision
A. Remove inlet and outlet to the LTR. B. Put a garden water hoses at the LTR inlet and turn water valve to full flow. Is water flow coming out of the LTR consistent with flow going in?		Yes: Diagnosis and repair LTR thermostat. After repairs are complete, retest for original problem.
		No: Replace LTR. Add phosphate conditioner in cooling system. After repairs are complete, retest for original problem.

Step 7	Determine if turbocharger wastegate is operating properly.	Decision
A. Using Electronic Service Tool (EST) with ServiceMaxx software, select Tests > KOEO Tests > Actuator Test. B. Visually inspect wastegate movement during Actuator Test. C. From the Actuator drop down, select TC2 Wastegate Control. Did wastegate move properly and pass the Actuator Test?		Yes: Go to Step 10.
		No: Go to Step 8.

Step 8	Determine if Air Control Valve (ACV) is operating properly.	Decision
A. Remove air hose from the turbocharger wastegate actuator. B. Using EST with ServiceMaxx software, select Tests > KOEO Tests > Actuator Test. C. Monitoring air flow out of wastegate air hose. No air should flow until wastegate is commanded. Air should flow when wastegate is commanded. D. From the Actuator drop down, select TC2 Wastegate Control. Does air flow thru wastegate air hose only when commanded?		Yes: Go to Step 9.
		No: Replace ACV. After repairs are complete, retest for original problem.

Step 9	Determine if turbocharger wastegate is seized.	Decision
A. Remove wastegate actuator from turbocharger. B. Open and close turbocharger wastegate by hand to determine if it is seized. Is turbocharger wastegate seized?		Yes: Replace turbocharger. After repairs are complete, retest for original problem. No: Replace turbocharger wastegate actuator. After repairs are complete, retest for original problem.

Step 10	Inspect for engine air intake (boost) leaks or restrictions.	Decision
A. Inspect air intake system from air filter to engine intake manifold for air leaks, damage, or restrictions. B. Remove air inlet duct from low-pressure turbocharger and inspect for restrictions. C. Pressurize the Charge Are Cooler (CAC) system to 30 psi using Charge Air Cooler (CAC)Tester and Interstage Cooler Test Kit. D. Inspect hoses and clamps, interstage cooler, and Charge Air Cooler (CAC). Use Leak Locator 19-700-01 to help find leaks. Is the air intake system and CAC system free of restrictions, leaks, and physical damage?		Yes: Go to Step 11. No: Repair air intake system leaks, damage, or restrictions. After repairs are complete, retest for original problem.

Step 11	Determine if turbochargers are visibly damaged.	Decision
A. Inspect turbochargers for damage, cracks and leaks. B. Turn each turbocharger turbine shaft by hand and check for wheel rub in housing. C. Inspect each compressor impeller and turbine wheels. Is either turbocharger damaged, cracked or leaking; turbine wheel rubbing in the housing; or are either compressor impeller or turbine wheel blades bent, broken, or eroded?		Yes: Replace damaged turbocharger. After repairs are complete, retest for original problem. No: End Diagnostic Steps.

End Diagnostic Steps
After performing all diagnostic steps, if fault remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

4.4 - Stumble (Hesitation on Acceleration)

CONTENT
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4.5 - Surge (Inconsistent Engine RPM During Steady State)

CONTENT
UNDER
DEVELOPMENT

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Engine Coolant Symptoms

5.1 - Coolant Overflow

Overview

Determine reason coolant overflows out of deaeration tank with the deaeration tank cap installed.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

Possible Causes

- Air compressor
- Exhaust Gas Recirculation (EGR) cooler
- Cracked cylinder sleeve
- Cylinder head cracked or leaking
- Incorrect cylinder sleeve protrusion

Test Procedure

Step 1	Perform operational checkout procedure.	Decision
Did you perform 5.0 Cooling System Operational Checkout Procedure?		Yes: Go to Step 2.
		No: Go to 5.0 Cooling System Operational Checkout Procedure (page 34).

Step 2	Verify coolant overflow occurs before coolant over temperature.	Decision
Does coolant overflow occur before cooling system goes over temperature?		Yes: Go to Step 3.
		No: Go to 5.2 Coolant Over Temperature (page 61).

Step 3	Determine if air compressor is causing coolant overflow.	Decision
A. Fill deaeration tank with coolant to proper level. B. Install deaeration tank cap. C. Drain air tanks. D. Open air tank drain valves and prop them open. E. Run engine to recreate overflow. Does coolant overflow occur with air tanks drained and valves open?		Yes: Go to Step 4.
		No: Repair or replace air compressor. After repairs are complete, retest for original problem.

Step 4	Determine if Exhaust Gas Recirculation (EGR) cooler is leaking.	Decision
Pressure test EGR cooler using EGR Cooler Pressure Test Kit 12-892-07. Is EGR cooler leaking coolant?		Yes: Repair or replace EGR cooler. After repairs are complete, retest for original problem.
		No: Go to Step 5.

CAUTION: To prevent engine damage, when replacing cylinder sleeves inspect piston cooling jets for damage or obstructions.

NOTE: Some cylinder head cracks between intake-to-intake or exhaust-to-exhaust valves are normal and acceptable.

Step 5	Inspect cylinder sleeves for leaks, staining, pinholes, and cracks.	Decision
A. Remove cylinder head (see *Engine Service Manual*). B. Using torque wrench set to 162 N-m (120 lb-ft) rotate crankshaft (see *Engine Service Manual "Crankshaft Rotation Procedure"*) to put one cylinder to Bottom Dead Center (BDC). C. Inspect for coolant, coolant staining, pinholes, and cracks in cylinder sleeve. D. Repeat steps B and C for all 6 cylinders. Are all cylinder sleeves free of coolant leaks, coolant staining, pinholes, and cracks?		Yes: Go to Step 6.
		No: Replace leaking or cracked cylinder sleeves. After repairs are complete, retest for original problem.

Step 6	Determine if cylinder sleeve protrusion is in specification for each cylinder.	Decision
Measure cylinder sleeve protrusion using Sleeve Protrusion Hold Down Clamps ZTSE4825 and a dial indicator with magnetic base. See *Engine Service Manual*. Is Sleeve protrusion in specification for all 6 cylinders?		Yes: Go to Step 8.
		No: Go to Step 7.

Step 7	Determine if cylinder sleeve or crankcase counter bore is out of specification.	Decision
A. Remove cylinder sleeve(s) with incorrect sleeve protrusion. See *Engine Service Manual*. B. Install / swap known good cylinder sleeve. Is sleeve protrusion now within specification?		Yes: Replace out of specification cylinder sleeves. After repairs are complete, retest for original problem. No: Counter bore issue. Notify supervisor for further action.

Step 8	Determine if cylinder liner(s) are leaking.	Decision
A. Remove all cylinder sleeves. See *Engine Service Manual*. B. Inspect cylinder sleeves inside and out for pin holes, cracks, and damage. Are all cylinder sleeves free of pin holes, cracks, and damage?		Yes: Replace cylinder head. After repairs are complete, retest for original problem. No: Replace leaking or cracked cylinder sleeves. After repairs are complete, retest for original problem.

End Diagnostic Steps
After performing all diagnostic steps, if fault remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

5.2 - Coolant Over Temperature

Overview

Determine reason engine cooling system goes over temperature or over heats.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

Possible Causes

- Cooling package debris clogging
- Damaged fan belt
- Accessory belt tensioner failure
- Inoperative / slipping fan clutch
- Inoperative / damaged cooling fan or shroud
- Damaged water pump impeller
- Stuck closed thermostats

Test Procedure

Step 1	Perform operational checkout procedure.	Decision
Did you perform 5.0 Cooling System Operational Checkout Procedure?		Yes: Go to Step 2.
		No: Go to 5.0 Cooling System Operational Checkout Procedure (page 34).

Step 2	Determine if coolant is flowing in the deareation tank and coolant lines.	Decision
A. Fill deaeration tank with coolant to proper level. B. Run engine. C. Observe deareation tank and coolant lines for coolant flow. Is coolant circulating in the deaeration tank?		Go to Step 3.
		No: Go to Step 6.

Step 3	Determine if fan clutch is operating properly.	Decision
Determine if fan turns On and operates properly. Does fan clutch operate properly?		Yes: Go to Step 4.
		No: Repair fan clutch. After repairs are complete, retest for original problem.

Step 4	Determine if thermostats are stuck closed.	Decision
A. Connect Electronic Service Tool (EST) with ServiceMaxx software and log-in. B. Run engine to operating temperature. C. Using EST monitor Engine Coolant Temperature 1 (ECT1). D. Using Infrared Thermometer ZTSE4799 target the upper radiator hose and record temperature. E. Calculate temperature difference (ECT1 – upper radiator hose temp). With engine at operating temperature, is the upper radiator within 25 F of ECT1?		Yes: Go to Step 5.
		No: Replace thermostats. After repairs are complete, retest for original problem.

Step 5	Determine if radiator will not dissipate heat properly.	Decision
A. Run engine to operating temperature at high idle. B. Using an Infrared Thermometer, target the upper radiator hose, and record reading. C. Using an Infrared Thermometer, target the lower radiator hose, and record reading. D. Calculate the temperature difference (upper radiator temp – lower radiator temp). Is the lower radiator hose temperature within 40 to 60 F of the upper radiator hose temperature?		Yes: Go to Step 6. No: Clean or replace radiator. After repairs are complete, retest for original problem.

Step 6	Determine if water pump and water distribution housing are operating properly	Decision
A. Remove water pump pulley. See *Engine Service Manual*. B. Remove water pump. C. Inspect water pump and water distribution housing for damage / cavitation. See *Engine Service Manual*. Does the water pump or water distribution housing have damage or excess cavitation / wear?		Yes: Replace water pump and / or water distribution housing. After repairs are complete, retest for original problem. No: End Diagnostic Steps.

End Diagnostic Steps
After performing all diagnostic steps, if fault remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

5.3 - Coolant in Engine Oil

Overview

Determine what component is causing engine coolant to leak into the engine oil.

Possible Causes

- Cracked cylinder liner
- Leaking cylinder liner o-ring(s)
- Leaking rear gear train freeze plug
- Failed air compressor
- Leaking oil cooler module or gaskets

NOTE: White condensation under the oil filler cap is normal.

Test Procedure

Step 1	Perform operational checkout procedure.	Decision
Did you perform 5.0 Cooling System Operational Checkout Procedure?		Yes: Go to Step 2.
		No: Go to 5.0 Cooling System Operational Checkout Procedure (page 34).

Step 2	Determine if coolant is leaking from the cylinder liners.	Decision
A. Remove engine oil pan. See *Engine Service Manual*. B. Remove deaeration tank cap. C. Install Radiator Pressure Testing Kit ZTSE2384 on deaeration tank. D. Pressurize cooling system to 117 kPa (17 psi) for a minimum of 15 minutes. E. Inspect for coolant leaking between cylinder liner and piston. F. Inspect for coolant leakage between cylinder liner and crankcase. Is coolant leaking between piston and liner, or between cylinder liner and crankcase?		Yes, coolant leaking between cylinder liner and crankcase: Replace failed cylinder liner o-ring(s). After repairs are complete, retest for original problem. Change engine oil and filter.
		Yes, coolant leaking between piston and cylinder liner: Replace leaking cylinder liner(s). After repairs are complete, retest for original problem. Change engine oil and filter.
		No: Go to Step 3.

Step 3	Determine where coolant is leaking into the crankcase.	Decision
A. With cooling system pressurized to 117 kPa (17 psi). B. Inspect for coolant at the rear gear train area. C. Inspect for coolant at the air compressor drain. D. Inspect for coolant at the oil cooler drain. Is coolant leaking in the gear train area, air compressor drain, or oil cooler drain?		Yes, rear gear train area leaking: Inspect and repair cylinder head freeze plug leaks. After repairs are complete, retest for original problem. Change engine oil and filter.
		Yes, leaking from air compressor drain: Replace air compressor. After repairs are complete, retest for original problem. Change engine oil and filter.
		Yes, leaking from oil cooler drain: Inspect and repair leaking oil cooler module and / or gasket. After repairs are complete, retest for original problem. Change engine oil and filter.
		No: Verify complaint.

End Diagnostic Steps
After performing all diagnostic steps, if fault remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

5.4 - Coolant in Intake

Overview

Determine what component is causing engine coolant to leak into the engine air intake.

Possible Causes

- Failed Exhaust Gas Recirculation (EGR) cooler.
- Failed high-pressure turbocharger air inlet duct.
- Failed Low-Pressure Charge Air Cooler (LPCAC).

Test Procedure

Step 1	Perform operational checkout procedure.	Decision
Did you perform 5.0 Cooling System Operational Checkout Procedure?		Yes: Go to Step 2.
		No: Go to 5.0 Cooling System Operational Checkout Procedure (page 34).

Step 2	Determine if coolant or white coolant residue is coming from the EGR cooler.	Decision
A. Disconnect Charge Air Cooler (CAC) pipe from the Engine Throttle Valve (ETV). B. Inspect inside ETV and air intake throttle duct for coolant coming from the EGR cooler. C. Inspect for coolant or white coolant residue in the CAC piping and High Pressure Charge Air Cooler (HPCAC). **NOTE:** There may only be white coolant residue in the CAC piping if the HP turbocharger air inlet duct or LPCAC are leaking coolant. Is coolant or white coolant residue present?		Yes, inside ETV or air intake throttle duct: Go to Step 3.
		Yes, inside CAC piping or HPCAC: Go to Step 4.
		No: Review operator complaint.

Step 3	Determine if Exhaust Gas Recirculation (EGR) cooler is leaking.	Decision
Pressure test EGR cooler using EGR Cooler Pressure Test Kit 12-892-07. Is EGR cooler leaking coolant?		Yes: Repair or replace EGR cooler. After repairs are complete, retest for original problem. Do O2 Calibration (page 1568). Change engine oil and oil filter.
		No: Review complaint.

Step 4	Determine if the High-Pressure (HP) turbocharger air inlet duct is leaking.	Decision
A. Remove HP turbocharger air inlet duct. See *Engine Service Manual*. B. Inspect HP turbocharger air inlet duct for coolant and / or coolant residue. Inspect for coolant seeping through the casting (porosity). Is HP turbocharger air inlet duct leaking?		Yes: Replace HP turbocharger air inlet duct. After repairs are complete, retest for original problem. Do O2 Calibration (page 1568). Change engine oil and oil filter.
		No: Go to Step 5.

Step 5	Determine if Low Pressure Charge Air Cooler (LPCAC) is leaking.	Decision
A. Remove LPCAC. See *Engine Service Manual*. B. Pressure test LPCAC using LPCAC Pressure Test Tool ZTSE6042. Is the LPCAC leaking?		Yes: Replace LPCAC. After repairs are complete, retest for original problem. Do O2 Calibration (page 1568). Change engine oil and oil filter.
		No: End diagnostic steps.

End Diagnostic Steps
After performing all diagnostic steps, if fault remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

5.5 - Coolant in Exhaust

Overview

Determine why engine coolant is leaking into the exhaust.

Possible Causes

- Failed Exhaust Gas Recirculation (EGR) cooler

Test Procedure

Step 1	Perform operational checkout procedure.	Decision
Did you perform 5.0 Cooling System Operational Checkout Procedure?		Yes: Go to Step 2.
		No: Go to 5.0 Cooling System Operational Checkout Procedure (page 34).

Step 3	Determine if Exhaust Gas Recirculation (EGR) cooler is leaking.	Decision
Pressure test EGR cooler using EGR Cooler Pressure Test Kit 12-892-07. Is EGR cooler leaking coolant?		Yes: Repair or replace EGR cooler. After repairs are complete, retest for original problem. Do O2 Calibration (page 1568). Change engine oil and oil filter.
		No: End diagnostic steps

End Diagnostic Steps
After performing all diagnostic steps, if fault remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Engine Lubrication Symptoms

6.1 - Engine Oil Contamination

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DEVELOPMENT

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6.2 - Engine Oil to Coolant

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DEVELOPMENT

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6.3 - Engine Oil to Intake

CONTENT
UNDER
DEVELOPMENT

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6.4 - Engine Oil to Exhaust

CONTENT
UNDER
DEVELOPMENT

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6.5 - Power Steering Fluid Leak to Engine Oil

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6.6 - Low Oil Pressure

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DEVELOPMENT

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6.7 - High Oil Pressure

CONTENT
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DEVELOPMENT

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6.8 - Excessive Oil Consumption

CONTENT
UNDER
DEVELOPMENT

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Fuel System Symptoms

7.1 - Low Fuel Delivery Pressure

CONTENT
UNDER
DEVELOPMENT

0000305681

7.2 - High-Pressure Fuel System

CONTENT
UNDER
DEVELOPMENT

0000305681

7.3 - Fuel Pressure and Aeration

CONTENT
UNDER
DEVELOPMENT

0000305681

7.4 - Fuel in Coolant

CONTENT
UNDER
DEVELOPMENT

0000305681

7.5 - Fuel in Engine Oil

CONTENT
UNDER
DEVELOPMENT

0000305681

7.6 - Fuel in Intake

CONTENT
UNDER
DEVELOPMENT

0000305681

7.7 - Fuel in exhaust

CONTENT
UNDER
DEVELOPMENT

0000305681

7.8 - Water in Fuel

CONTENT
UNDER
DEVELOPMENT

0000305681

7.9 - Excessive Fuel Consumption

CONTENT
UNDER
DEVELOPMENT

0000305681

Engine Brake Symptoms

8.1 - Low Engine Braking Power

CONTENT
UNDER
DEVELOPMENT

0000305681

8.2 - Engine Brake Inoperative

CONTENT
UNDER
DEVELOPMENT

0000305681

8.3 - Engine stalls

CONTENT
UNDER
DEVELOPMENT

0000305681

8.4 - Engine Miss

CONTENT
UNDER
DEVELOPMENT

0000305681

8.5 - Engine Brake Does Not Turn Off, Slow to Turn Off, or Engine Does Not Start

CONTENT
UNDER
DEVELOPMENT

0000305681

8.6 - Engine Brake Slow To Operate

CONTENT
UNDER
DEVELOPMENT

0000305681

8.7 - Low Oil Pressure For Proper Engine Brake Operation

CONTENT
UNDER
DEVELOPMENT

0000305681

8.8 - One or More Cylinders Fail To Stop Braking or Engine Stalls

CONTENT
UNDER
DEVELOPMENT

0000305681

Aftertreatment Symptoms

9.1 - Frequent Parked Regens (More than 1 Parked Regen Per Day)

CONTENT
UNDER
DEVELOPMENT

0000305681

9.2 - SPN 3719 Active Only or Frequent Regens

CONTENT
UNDER
DEVELOPMENT

0000305681

9.3 - SPN 3719 and Other Active Fault Codes

CONTENT
UNDER
DEVELOPMENT

0000305681

9.4 - White Smoke

CONTENT
UNDER
DEVELOPMENT

0000305681

9.5 - Black Smoke

CONTENT
UNDER
DEVELOPMENT

0000305681

9.6 - Excessive DEF Consumption

CONTENT
UNDER
DEVELOPMENT

0000305681

9.7 - Engine No Start

CONTENT
UNDER
DEVELOPMENT

0000305681

Fault Code Diagnostics

Section Information

All electrical faults in the engine control system can be diagnosed in this section. All components are divided into separate test procedures and contain the following information:

- SPN / FMI with possible cause
- Circuit diagram
- Component function
- Circuit operation
- Component location
- Diagnostic tool list
- Sensor End Diagnostics (with ServiceMaxx™ software)
- Pin-point Diagnostics (without ServiceMaxx™ software)
- Step Based Diagnostics
- Harness resistance check
- Operational voltage check (most components)

AAT (Ambient Air Temperature) Sensor

Overview of AAT Sensor Group

SPN	FMI	Description
171	2	AAT Signal Erratic, Intermittent, or Incorrect (page 103)
171	3	AAT Signal Out of Range HIGH (page 109)
171	4	AAT Signal Out of Range LOW (page 116)

Overview

The Ambient Air Temperature (AAT) measures the outside air temperature where the engine is operating. AAT represents the air temperature for engine cooling performance.

SPN 171 FMI 2 - AAT Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Ambient Air Temperature (AAT) does not agree with other sensors.	AAT sensor temperature differs from Intake Manifold Temperature (IMT), CAC Outlet Temperature (CACOT) > 27°F (15°C).	Key ON Engine is cold soaked Engine speed > 1000 RPM Vehicle speed > 24.85 mph Engine speed and vehicle speed conditions met for > 2 seconds

Fault Overview

Fault code sets when Ambient Air Temperature (AAT) sensor temperature differs from Intake Manifold Temperature (IMT), CAC Outlet Temperature (CACOT) by greater than 27°F (15°C) after a cold soak.

Lamp Reaction

MIL will immediately illuminate when this fault is detected.

Associated Faults

SPN 171 FMI 3 and 4 (AAT)

Fault Facts

Diagnostic runs at initial Key ON after a minimum of an 8 hour cold soak.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed AAT sensor
- High resistance in AAT circuit
- High resistance in SIG GND circuit

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 171 FMI 3 and 4 (AAT). Is EST DTC list free of SPN 171 FMI 3 and 4?		Yes: Go to Step 2. No: Repair SPN 171 FMI 3 and 4. After repairs are complete, retest for SPN 171 FMI 2.

Step 2	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 171 FMI 2. Is EST DTC list SPN 171 FMI 2 active or pending?		Yes: Go to Step 3. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 3	Inspect connections at Ambient Air Temperature (AAT) connector.	Decision
A. Key OFF. B. Disconnect AAT connector. C. Check AAT and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are AAT connector, harness, and terminals clean and undamaged?		Yes: Perform Pin Point Test (page 105). No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 171 FMI 2.

Pin-Point Test SPN 171 FMI 2

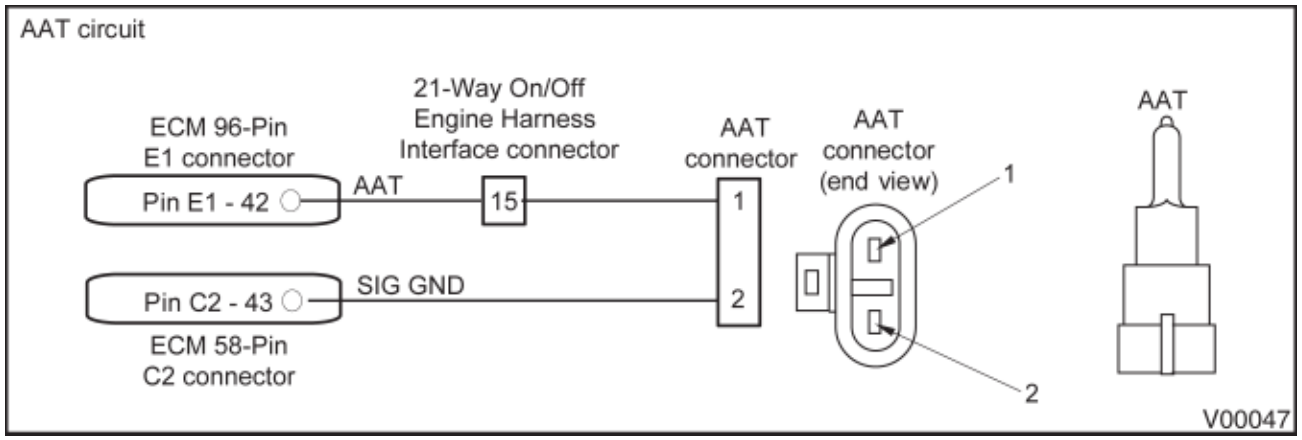
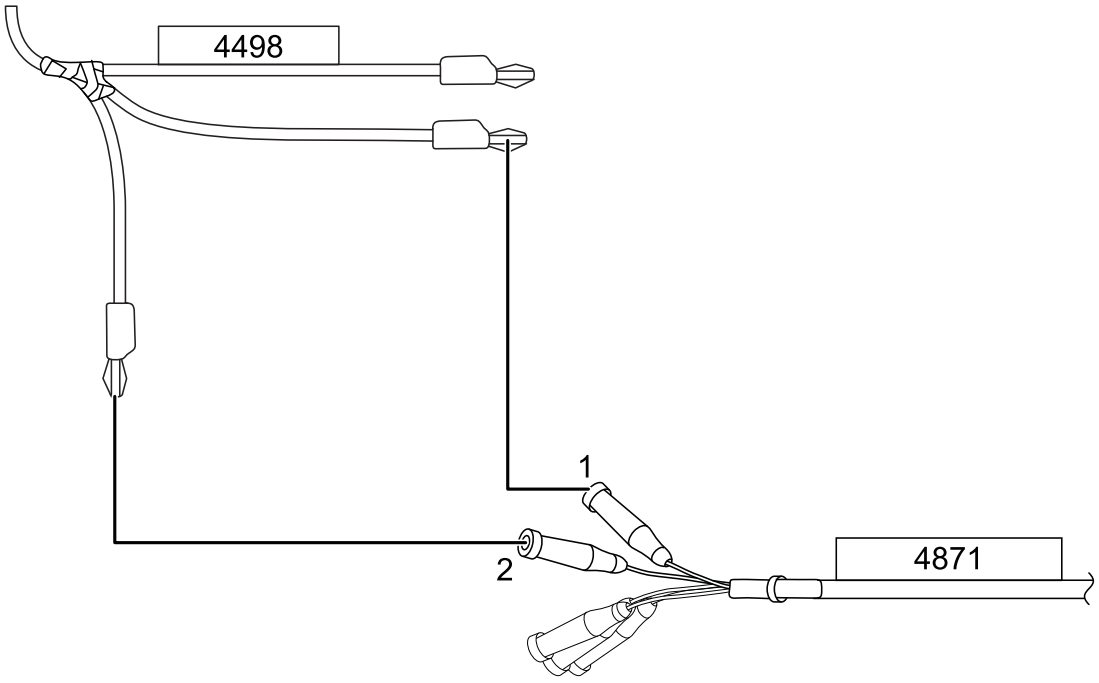


Figure 46 Ambient Air Temperature (AAT) Sensor Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4871
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)



0000304403

Figure 47 AAT Sensor Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4871 to vehicle harness and leave Ambient Air Temperature (AAT) sensor disconnected. C. Using Breakout Harness ZTSE4498 short pin-1 and pin-2 of Breakout Harness ZTSE4871 together. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON, log into ServiceMaxx™ software.

Test 1	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor AAT voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Replace Ambient Air Temperature (AAT) sensor. After repairs are complete, retest for SPN 171 FMI 2.
	No: Go to Test 2.

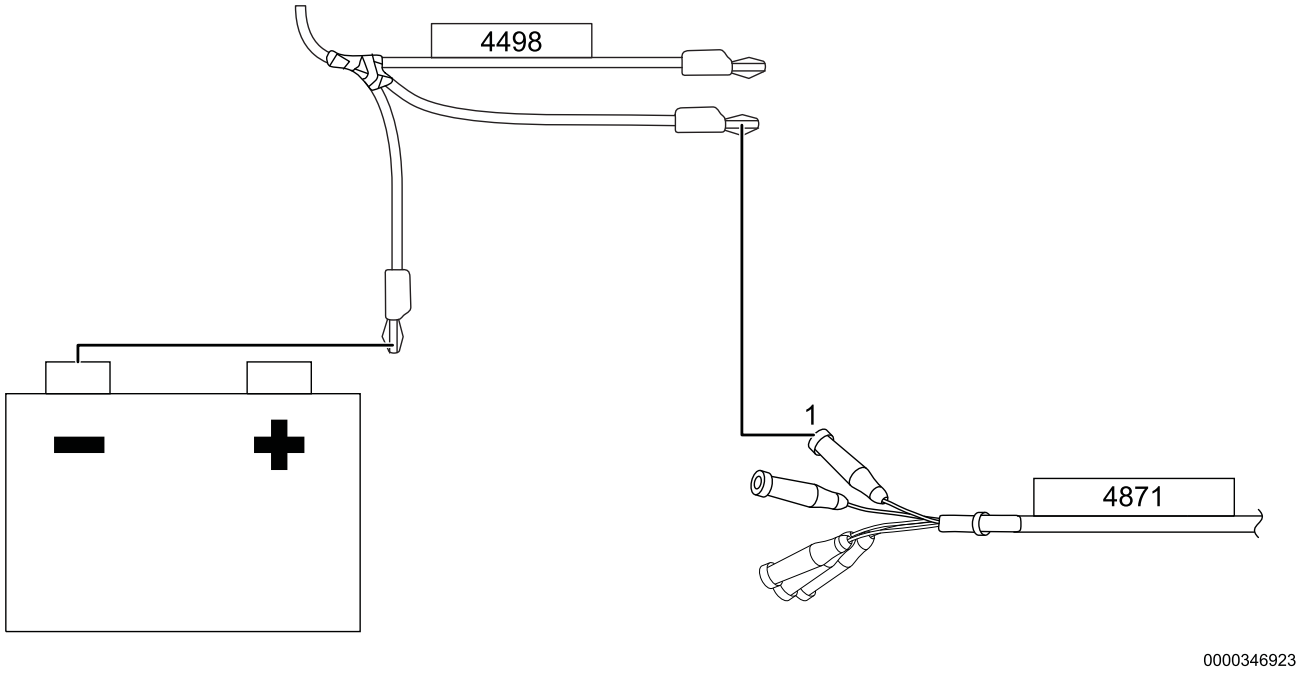


Figure 48 AAT Sensor Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4871 to vehicle harness and leave AAT sensor disconnected. C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4871 pin-1 to GND. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector. E. Key ON, log in to ServiceMaxx™ software.

Test 2 Clear DTC fault list.	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor AAT voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Repair Open between AAT pin-2 and Engine Control Module (ECM) pin C2-43. After repairs are complete, retest for SPN 171 FMI 2.
	No: Repair Open between AAT pin-1 and ECM pin E1-42. After repairs are complete, retest for SPN 171 FMI 2.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 171 FMI 2 fault code diagnostics.

SPN 171 FMI 3 - AAT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Ambient Air Temperature (AAT) value greater than expected.	AAT sensor voltage > 4.5 volts.	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Ambient Air Temperature (AAT) voltage is greater than 4.5 volts.

Lamp Reaction

MIL will immediately illuminate when this fault is detected.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- SIG GND circuit Open or High resistance
- AAT circuit Open or high resistance
- AAT circuit short to PWR
- Failed AAT sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 171 FMI 3. Is EST DTC list SPN 171 FMI 3 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Ambient Air Temperature (AAT) connector.	Decision
A. Key OFF. B. Disconnect AAT connector. C. Check AAT and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are AAT connector, harness, and terminals clean and undamaged?		Yes: Perform Pin Point Test (page 110). No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 171 FMI 3.

Pin-Point Test SPN 171 FMI 3

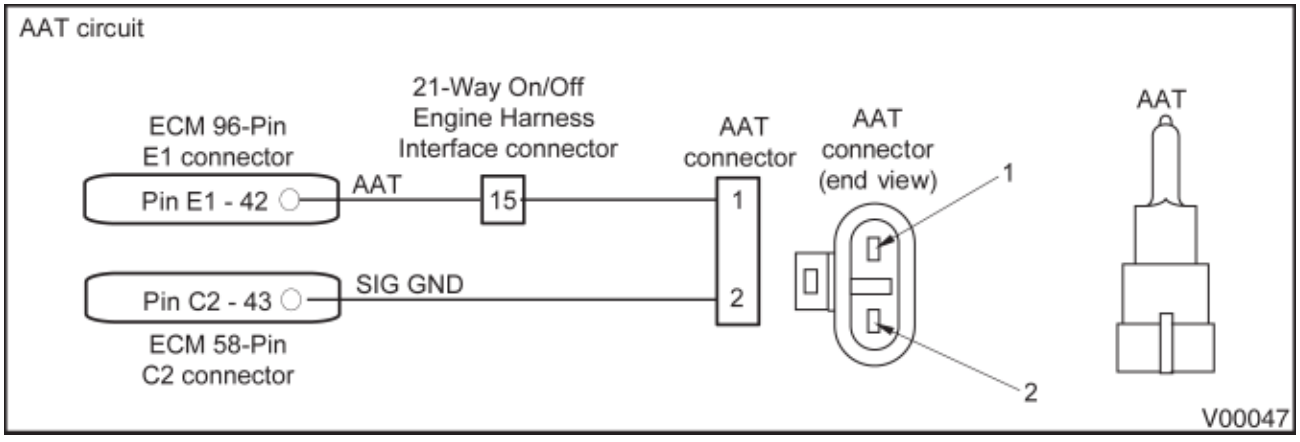


Figure 49 Ambient Air Temperature (AAT) Sensor Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4871
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

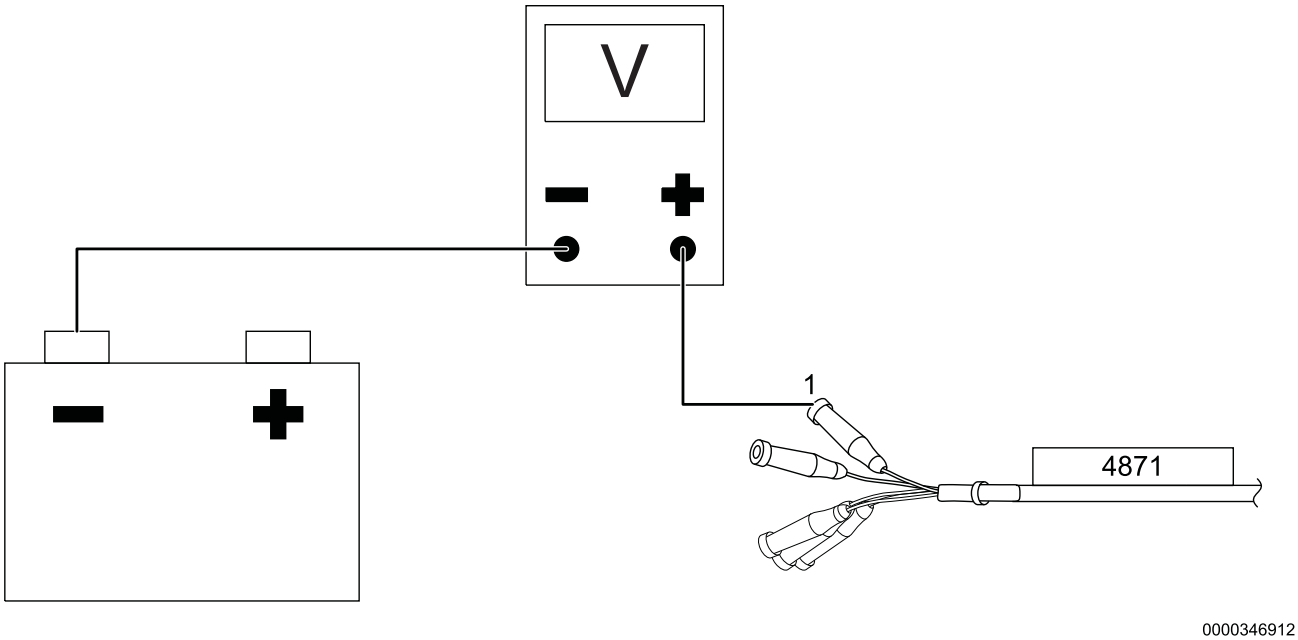
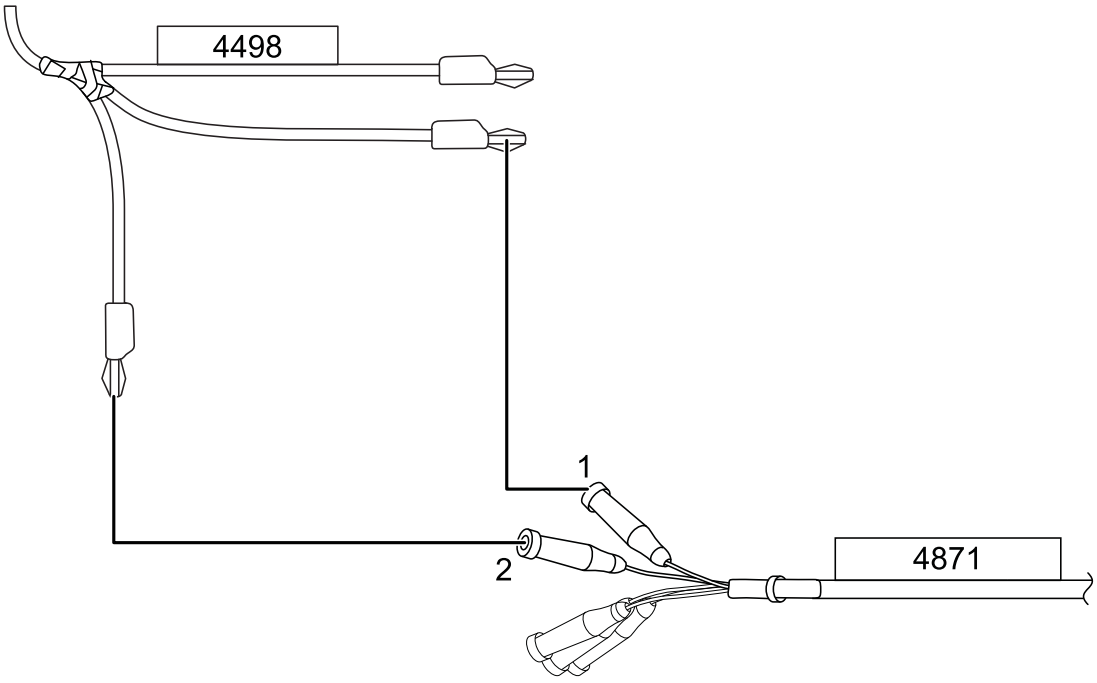


Figure 50 AAT Circuit Voltage Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4871 to vehicle harness and leave Ambient Air Temperature (AAT) sensor disconnected. C. Key ON.

Test 1	Specification
Use a Digital Multimeter (DMM) to measure voltage between Breakout Harness ZTSE 4871 pin-1 and a known good ground.	Greater than 5 volts
Decision	
Is voltage greater than 5 volts?	Yes: Repair short to PWR between AAT pin-1 and Engine Control Module (ECM) pin C2-43. After repairs are complete, retest for SPN 171 FMI 3.
	No: Go to Test 2.



0000304403

Figure 51 AAT Sensor Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4871 to vehicle harness and leave AAT sensor disconnected. C. Using Breakout Harness ZTSE4498 short pin-1 and pin-2 of Breakout Harness ZTSE4871 together. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON, log into ServiceMaxx™ software.

Test 2	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor AAT voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Replace AAT sensor. After repairs are complete, retest for SPN 171 FMI 3.
	No: Go to Test 3.

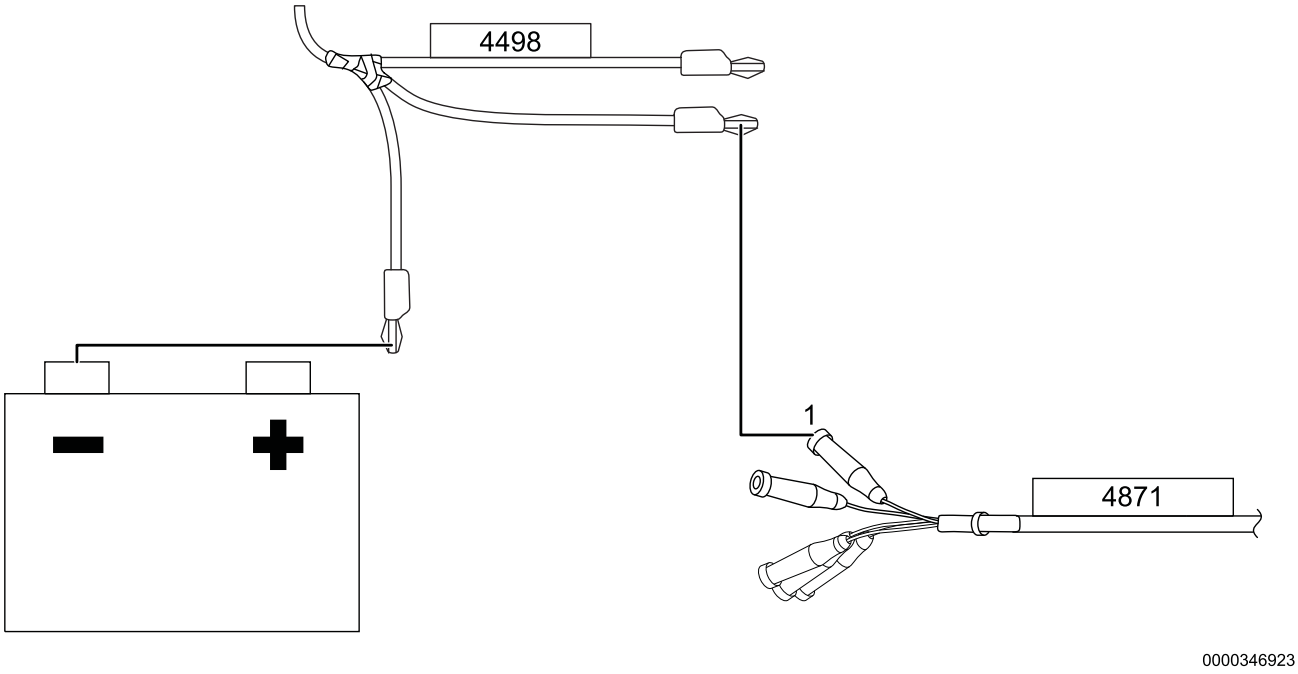


Figure 52 AAT sensor circuit check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4871 to vehicle harness and leave AAT sensor disconnected. C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4871 pin-1 to a known good GND. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector. E. Key ON, log in to ServiceMaxx™ software.

Test 3	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor AAT voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Repair Open between AAT pin-2 and ECM pin C2-43. After repairs are complete, retest for SPN 171 FMI 3.
	No: Repair Open between AAT pin-1 and ECM pin E1-42. After repairs are complete, retest for SPN 171 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 171 FMI 3 fault code diagnostics.

SPN 171 FMI 4 - AAT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Ambient Air Temperature (AAT) sensor reading less than expected.	AAT sensor voltage < 0.25 volts.	Key ON

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects that the Ambient Air Temperature (AAT) signal voltage is less than expends.

Lamp Reaction

MIL will immediately illuminate when this fault is detected.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- AAT circuit short to GND
- Failed AAT sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 171 FMI 4. Is EST DTC list SPN 171 FMI 4 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Ambient Air Temperature (AAT) connector.	Decision
A. Key OFF. B. Disconnect AAT connector. C. Check AAT and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are AAT connector, harness, and terminals clean and undamaged?		Yes: Perform Pin Point Test (page 117). No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 171 FMI 4.

Pin-Point Test SPN 171 FMI 4

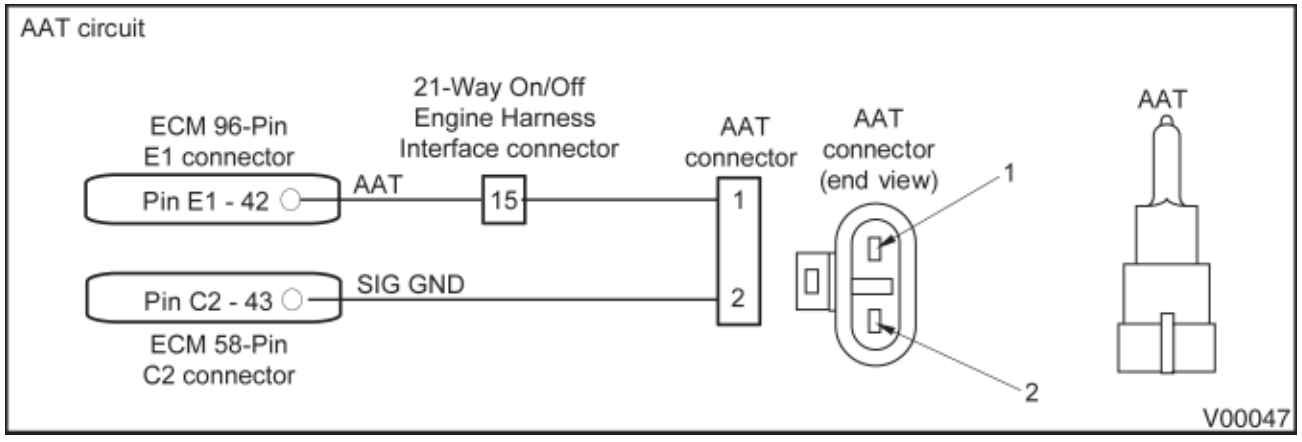


Figure 53 Ambient Air Temperature (AAT) Sensor Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF. B. Disconnect Ambient Air Temperature (AAT) sensor C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). D. Key ON, log into ServiceMaxx™ software.

Test 1	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor AAT voltage.	4.85 volts ± 0.1 volts
Decision	
Is voltage 4.85 volts ± 0.05 volts?	Yes: Replace AAT sensor. After repairs are complete, retest for SPN 171 FMI 4.
	No: Repair short to GND between AAT pin-1 and Engine Control Module pin E1-42. After repairs are complete, retest for SPN 171 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 171 FMI 4 fault code diagnostics.

AFT (Aftertreatment) System

Overview of AFT Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
3695	2	DPF Regen Inhibit Switch erratic, intermittent or incorrect	• DPF regen inhibit switch On • Failed DPF regen inhibit switch	Step-Based Diagnostics (page 141)
3703	31	DPF Active Regeneration Inhibited Due to Inhibit Switch	• Regen Inhibit Switch enabled when active regeneration is needed	Step-Based Diagnostics (page 142)
3713	31	DPF Active Regeneration Inhibited Due to System Timeout	• Fault present which prohibits regeneration	Step-Based Diagnostics (page 143)
3750	31	DPF Regen inhibited due to low exhaust temperatures	• Degraded Diesel Oxidation Catalyst (DOC) • Exhaust leak • Damaged or missing Diesel Particulate Filter (DPF) • Failed DOC / DPF temperature sensor module	Step-Based Diagnostics (page 146)
4794	31	SCR Catalyst System Missing (Low NOx Conversion)	• Missing SCR Catalyst • Contaminated, damaged, or cracked SCR Catalyst • Contaminated DEF • Failed DEF: DV	Step-Based Diagnostics(page 149)
5298	17	DOC Conversion Efficiency below minimum	• Damaged or failed DOC • Restricted DOC (soot accumulation) • Exhaust system leak between turbocharger and DOC • Failed Aftertreatment Fuel Injector (AFTFI)	Step-Based Diagnostics(page 151)

			• Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)	
5298	18	DOC Conversion Efficiency below Warning Pressure	• Damaged or failed DOC • Restricted DOC (soot accumulation) • Exhaust system leak between turbocharger and DOC • Failed Aftertreatment Fuel Injector (AFTFI) • Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)	Step-Based Diagnostics(page 154)
5397	31	DPF regenerations are occurring too frequently	• Low engine performance • Failed fuel injector • Engine mechanical • Failed Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor • Restricted DPFDP / outlet pressure sensor hose(s) • DPF restricted, damaged, or contaminated • Diesel Oxidation Catalyst (DOC) restricted, damaged, or contaminated	Step-Based Diagnostics (page 157)

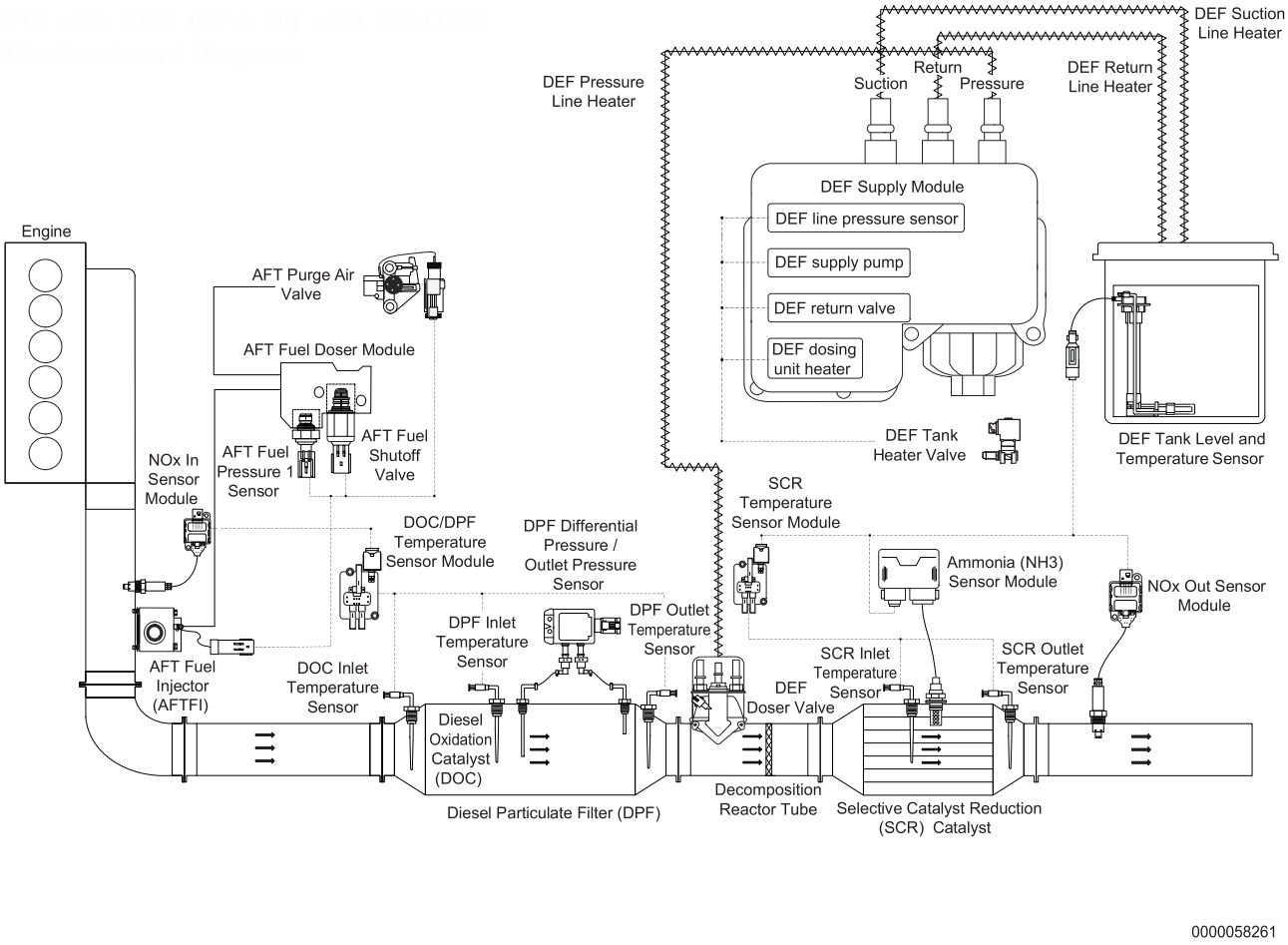


Figure 54 Functional Diagram of AFT system

NOTE: Note: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Aftertreatment (AFT) System catalyzes carbon monoxide (CO), Oxides of Nitrogen (NOx), and Hydrocarbons (HC), and has three main components: the Diesel Oxidation Catalyst (DOC) and Diesel Particulate Filter (DPF), decomposition reactor tube, and Selective Catalyst Reduction (SCR) catalyst.

The DPF captures soot and other particulates exiting the engine. Typically a good running engine will have 99% soot to 1% ash.

Soot is captured by the DPF. Although the DOC should not require regular maintenance, the DPF does require occasional off-board cleaning to remove ash.

Soot is converted to carbon dioxide by a process of regeneration (Regen). The temperature at the face of the DPF is raised to approximately 1000°F (538°C), for a period of time, depending on the amount of soot that accumulated within the DPF. Regen time is calculated by the DPF Differential Pressure (DPFDP) feedback.

The Regen may take place as the vehicle is in operation under a steady state heavy engine loading condition, or by commanding a Parked Regen.

During a Parked Regen, engine speed is increased, while the Engine Control Module (ECM) controls Post-Injection, Exhaust Gas Recirculation (EGR), and Engine Throttle Valve (ETV) to increase heat going into the exhaust system. The Inlet Air Heater (IAH) may also cycle on and off, not just to increase the Inlet Air Temperature (IAT), but to add extra load on the engine.

The health of the system and the Regen processes are monitored by the DOC Inlet Temperature (DOCIT), DPF Inlet Temperature (DPFIT), DPF Outlet Temperature (DPFOT), and the Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor. The DPFDP / outlet pressure sensor measures the pressure difference across the DPF. The DOCIT, DPFIT, and DPFOT sensors measure the temperature differences across the DOC and DPF and are part of the DOC / DPF temperature sensor module.

The DPF and / or the DOC may fail or become restricted prematurely for a number of reasons. It is important to pinpoint the root cause and repair the failure before replacing the DOC or DPF. Failure to do so could result in destroying a newly replaced component.

NOTE: Any time the DPF is replaced or removed for cleaning, record DPF serial number and use ServiceMaxx™ software to run the Diesel Particulate Filter Servicing procedure. Follow on-screen instructions. See DPF Servicing in "DIAGNOSTIC SOFTWARE OPERATION" for additional information.

The aftertreatment system reduces NOx by injecting Diesel Exhaust Fluid (DEF) through the Diesel Exhaust Fluid Doser Valve (DEF: DV), and into the decomposition reactor tube. Exhaust heat in the decomposition reactor tube causes the DEF to break down and convert to ammonia and CO2.

The final component of the aftertreatment system is the SCR catalyst. The SCR catalyst completes the break down of DEF into ammonia and CO2, and then converts ammonia and NOx into Nitrogen gas and water.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Compucheck fitting ZTSE4526
- Fuel Pressure Gauge ZTSE4681
- Fuel Inlet Restriction / Aeration Tool ZTSE4886
- Fuel Line Coupler ZTSE4906
- DEF Refractometer 5025

AFT System Overview

AFT System Indicators

Fault codes that require a Regen are better understood as Alert codes. This is a normal condition used to alert the operator or technician that soot level in the DPF has reached a set point and the system is running or needs to run a DPF Regen.

Types of Regens

Passive – Not initiated by operator or by control system. Occurs when exhaust gas temperatures are hot enough to ignite soot particles in the aftertreatment system.

Active – Initiated by control system. Occurs when exhaust gas temperatures are too low to ignite soot particles. The ACM will command the Aftertreatment Fuel Injector ON causing extra fuel to be injected into the aftertreatment system increasing exhaust gas temperatures.

Parked – Initiated by operator. Occurs when soot levels are too high for Passive or Active regen methods. During a Parked regen, engine RPM is raised, fuel is injected into the exhaust, and the Engine Throttle Valve (ETV) is positioned to restrict air flow. If equipped with an Exhaust Back Pressure Valve (EBPV), the valve is positioned to restrict exhaust gas flow.

Hot Exhaust Temperature (HET) Lamp

Figure 55 HET Lamp

Hot Exhaust System Temperature lamp indicates exhaust temperature is above 400 °C (752 °F) and vehicle speed is below 5 mph.

Operator Action: Beware of surroundings, the exhaust is very hot.

Technician Action: None

Diesel Particulate Filter (DPF) Lamp

Figure 56 DPF Lamp

DPF lamp on solid. This notifies the operator the Aftertreatment System is cleaning the DPF.

Operator Action: Drive at highway speed, until lamp goes out, or perform a Parked Regen.

Technician Action: None

If system is unable to finish the cleaning process due to driving conditions (Low load, short trip) or if there's a problem with the system, the soot level will continue to build in the DPF and trigger the next soot level DTC.

SPN 3719 FMI 15 – DPF Soot Load - Lowest (level 1/3)

Figure 57 DPF Lamp Flashing

DPF soot level 1, DPF lamp flashing. This notifies the operator the Aftertreatment System is cleaning the DPF.

Operator Action: Perform a Parked Regen.

Technician Action: Verify the system is working without fault. See below procedure.

DPF soot level 1, DPF lamp flashing. This notifies the operator the soot level is reaching a much higher level and the system is not completing a Regen through the operators current drive cycle. If this is ignored, the soot level will continue to build to setting the next level DTC.

SPN 3719 FMI 16 – DPF Soot Load - Moderate (level 2/3)

Figure 58 DPF Lamp Flashing, Amber Warning Lamp On Solid

Operator Action: Perform a Parked Regen.

Technician Action: Verify the system is working without fault. See below procedure.

DPF soot level 2, DPF lamp flashing and the buzzer sounding. This notifies the operator the soot level has reached a critical level and the engine now de-rated engine is de-rated by 15% of normal engine power.

SPN 3719 FMI 0 DPF Soot Load - Highest (level 3/3)

Figure 59 DPF Lamp Flashing and Buzzer Sounding

Operator Action: Tow vehicle in for service.

Technician Action: The DPF must be replaced at soot level 3, when the DPF lamp is flashing and the buzzer sounding. This notifies the operator the soot level has reached a critical level and the engine is engine is de-rated by 85% of normal power.

Regen Inhibitors

A DPF Regen can be inhibited by disabling switches, or the entry conditions have not yet been met to start the regeneration process.

Fault Code Regen Inhibitors

Fault codes that can inhibit a Regen will not allow a Regen process to take place. The ECM continuously monitors for system faults. If a fault is detected the Malfunction Indicator Lamp (MIL) lamp will illuminate and a DTC will set.

Entry Conditions for an Active Regen

When the ECM determines the soot level threshold is reached, the system triggers DPF Regen.

NOTE: Short trips or stop and go driving could prevent a successful Regen.

The following conditions are required for an Active Regen:

- DPF Status signal displaying: Regen Needed
- Red stop engine lamp not on
- Engine Coolant Temperature is above or at least 75 ºC (170 ºF)
- Inhibiting DTCs must not be active (See Fault Code Regen Inhibitors (page 126)
- Regen Inhibit switch not active (switch must be off)
- PTO not active (switch must be off)
- Exhaust Temperature sensors below safe thresholds
  - DOCIT below 500 °C (932 °F)
  - DOCOT below 650 °C (120 °F)
  - DPFOT below 750 °C (1382 °F)

If DPF Status displays "Regen needed" and vehicle is unable to perform an Active Regen, perform the Diagnostic Test Procedure .

Entry Conditions for a Parked Regen

A Parked Regen can only be performed when the DPF soot level threshold is reached. The DPF lamp will flash or stay on solid, signaling the need for Regen.

The following conditions are required for a Parked Regen:

- Engine Running
- DPF lamp is on
- Parked Regen switch on
- DPF Status signal displaying: Regen Needed
- Red stop engine lamp not on
- Engine Coolant Temperature is above or at least 75 ºC (170 ºF)
- Vehicle speed not rolling
- Inhibiting DTCs must not be active (See Fault Code Regen Inhibitors (page 126)
- Regen Inhibit switch not active (switch must be off)
- PTO not active (switch must be off)
- Exhaust Temperature sensors below safe thresholds
  - DOCIT below 500 °C (932 °F)
  - DOCOT below 650 °C (1202 °F)
  - DPFOT below 750 °C (1382 °F)

Onboard Filter Cleanliness Test. DPF Status displays “Regen needed” and vehicle is unable to perform an Active Regen, perform Diagnostic Test Procedure .

DPF Regeneration

This test checks the status of the DPF if the Soot level is within a Regen Needed limit. The test will automatically start a Parked Regen.

This test will perform a complete Parked Regen.

Engine speed is ramped up to increase exhaust flow through the DPF while the DPFDP sensor monitors the pressure difference across the DPF. The test runs for about 15 minutes. If a Regen is needed, the engine ramps up for another 15 minutes, but this time to run DPF Regen cycle.

The following conditions are required for a Onboard Filter Cleanliness Test.

- Engine Running
- Engine Coolant Temperature is above or at least 75 ºC (170 ºF)
- Vehicle stationary
- Inhibit DTCs must not be active: Refer to Fault Code Regen Inhibitors (page 126)
- PTO not active (switch must be off)
- Regen inhibit switch not active (switch must be off)
- Parking brake must be applied
- Brake pedal not depressed
- Accelerator pedal not depressed
- Driveline disengaged

- If the Soot level is within normal range, the test completes and displays “Test Completed Successful.” No further action is required.
- If the test is aborted, perform the following Diagnostic Test Procedure.

Exhaust Restriction Test

Connect EST, open the Performance session, and select the All signals tab.

NOTE: Run engine at High Idle while monitoring DPF Differential Pressure and TC1 Turbine Outlet Pressure.

Checks	Specification	Comment – < Less than, > Greater than
DPFDP	< 1.5 psi	If > 1.5 psi, the DPF is restricted, go to Parked Regen.
TC1TOP	< 45 psi	If TC1TOP is > 45 psi and DPFDP is < 1.5 psi, remove DOC and inspect for face plugging.

If TC1TOP and DPFDP are within expected range, but the DPF Status reads “Regen Needed”, go to Parked Regen Checks (page 132).

Regen Inhibitors

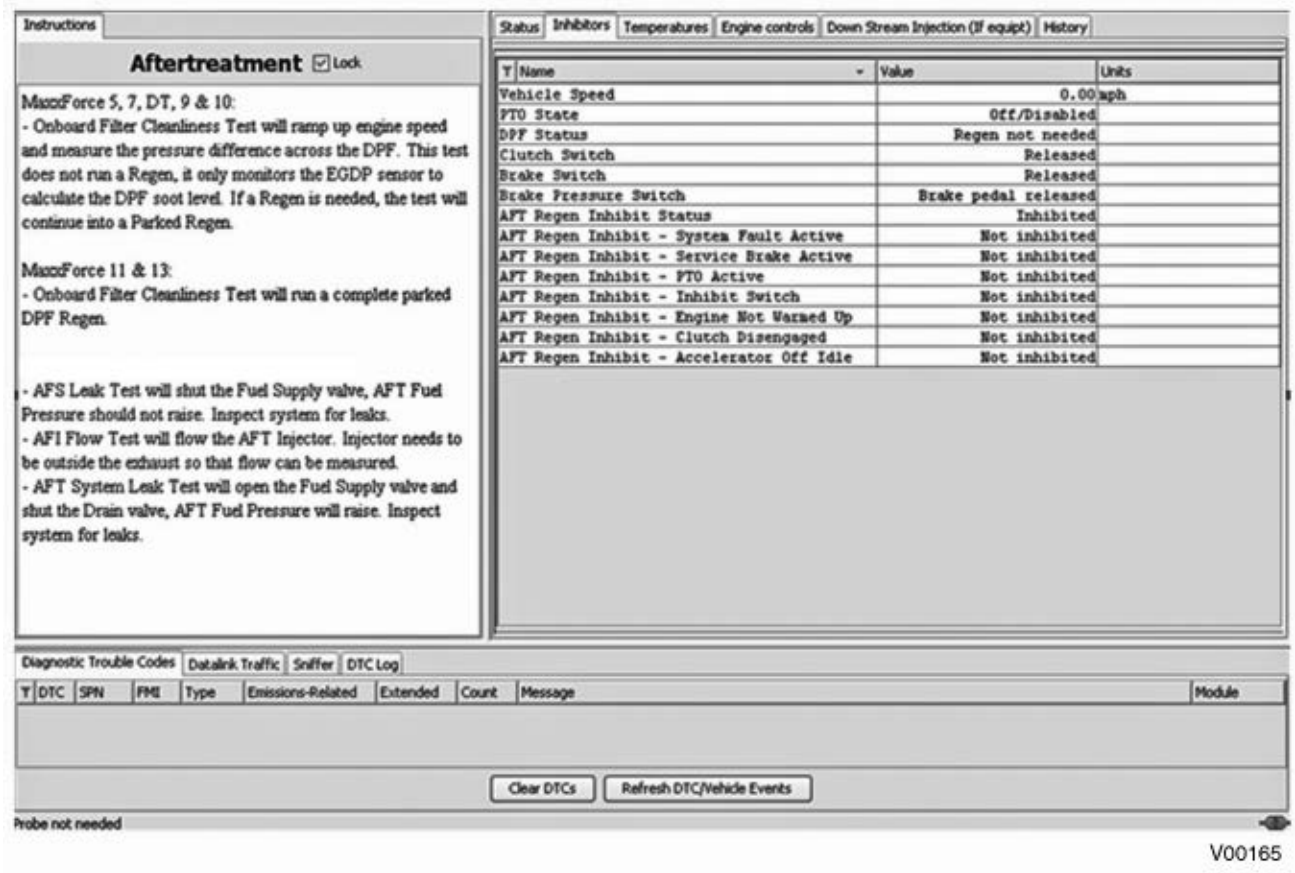


Figure 60 Aftertreatment session screen shot

Check Active Regen Inhibitors

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, load the Aftertreatment session.
3. Start engine and run vehicle speed above 5 mph.
4. Verify all listed inhibitors are displaying "Not Inhibited."

Check	Expected Results	Comment
AFT Regen Inhibit Status	Not Inhibited	If inhibited, correct the cause. Check switches and any DTC that may be causing the Regen inhibit.
Red Stop Alert Lamp	Off	If On, Regen can't be run. DPF must be replaced before continuing.
Regen Inhibit Switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO Enable Switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO Switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
If no inhibitors are active and Regen is needed, go to Parked Regen Checks (page 132).		

Check Parked Regen Inhibitors

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, load the Aftertreatment session.
3. Verify all listed Inhibitors are displaying "Not Inhibited."

Checks	Expected Results	Comment
AFT Regen Inhibit status	Not Inhibited	If inhibited, correct the cause. Check switches and any DTC that may be causing the Regen inhibit.
Red Stop Alert lamp	Off	If On, Regen can't be run. DPF must be replaced before continuing.
Regen inhibit switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO enable switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
PTO switch	Off	If On, turn switch Off. If switch does not turn Off, then diagnose circuit fault.
Parking brake switch	On	If Off, set parking brake, if switch does not turn On, then diagnose circuit fault.
Brake Pedal switch	Off	If On and foot is off pedal, then diagnose circuit fault.
Accelerator Pedal Position	0%	If above 0%, and foot is off pedal, then diagnose circuit fault.
Clutch Pedal Switch	Off	If On and foot is off pedal, then diagnose circuit fault.
Transmission Position	Park or Neutral	If engaged, disengage, or diagnose circuit fault.
If no inhibitors and a Regen is needed, go to the following Parked Regen Checks.		

Parked Regen Checks

During a Parked Regen the engine speed will ramp up to 1200-1800 rpm.

Typical readings:

- **ETV:** 80% (closed).
- **EGR Position:** 0% (closed)
- **DOCIT:** 482 - 572°F (250 - 300°C)
- **DOCOT:** 1022 - 1112°F (550 - 600°C) (after 5-10 minutes)
- **DPFOT:** 1112 - 1202°F (600 - 650°C) (after 10-15 minutes)
- **DPFDP:** Decreasing steadily once DPFIT and DPFOT are steady and above 1022°F (550 °C).

Connect the EST, open the Aftertreatment session. Start a Parked Regen and monitor signals.

Parked Regen Checks

Connect EST, open the Aftertreatment session. Open the inhibitors tab and check for Inhibitors.

Checks	Expected Results	Comment
Engine condition	Smooth, not stumbling	If engine does not run smoothly, diagnose engine performance problem. See “PERFORMANCE DIAGNOSTICS."
DPF Status	Regen Needed	If signal reads “Not needed”, than a Regen cannot be commanded to run.
Engine Coolant Temp	Above 66 ºC (150 ºF)	If below 66 ºC (150 ºF), warm engine above set point.
AFT Regen Status	Active	If signal reads “Not Active”, check for fault codes and Parked Regen Inhibitors.
EGR Position	Closed	If not closed, see EGR Valve (page 789).
ETV Position	80% ±5%	If not within specifications, see ETV (page 879).
DOCIT	250 ºC (482 ºF) to 300ºC (572 ºF)	If below 250 ºC (482 ºF), using Electronic Service Tool (EST) with ServiceMaxx™ software, run the KOER Air Management Test. If above 300 ºC (572 ºF), check for proper ETV operation, and if engine is over fueling.
DOCOT	After 5-10 minutes above 530 ºC (986 ºF)	If below 530 ºC (986 ºF), replace DOC, and inspect DPF for soot leaking through the filter.
DPFOT	Below 700 ºC (1292 ºF)	If above 700 ºC (1292 ºF), replace DPF
DPFDP	Below 0.5 psi	If above 0.5 psi, after the system completes a full Parked Regen, replace the DPF.
If the DPF is face plugged, measure the distance between the filter and outlet. If not within specification, the filter cannot be cleaned and must be replaced.		

DPF Filter Inspection

Normal DPF Inlet

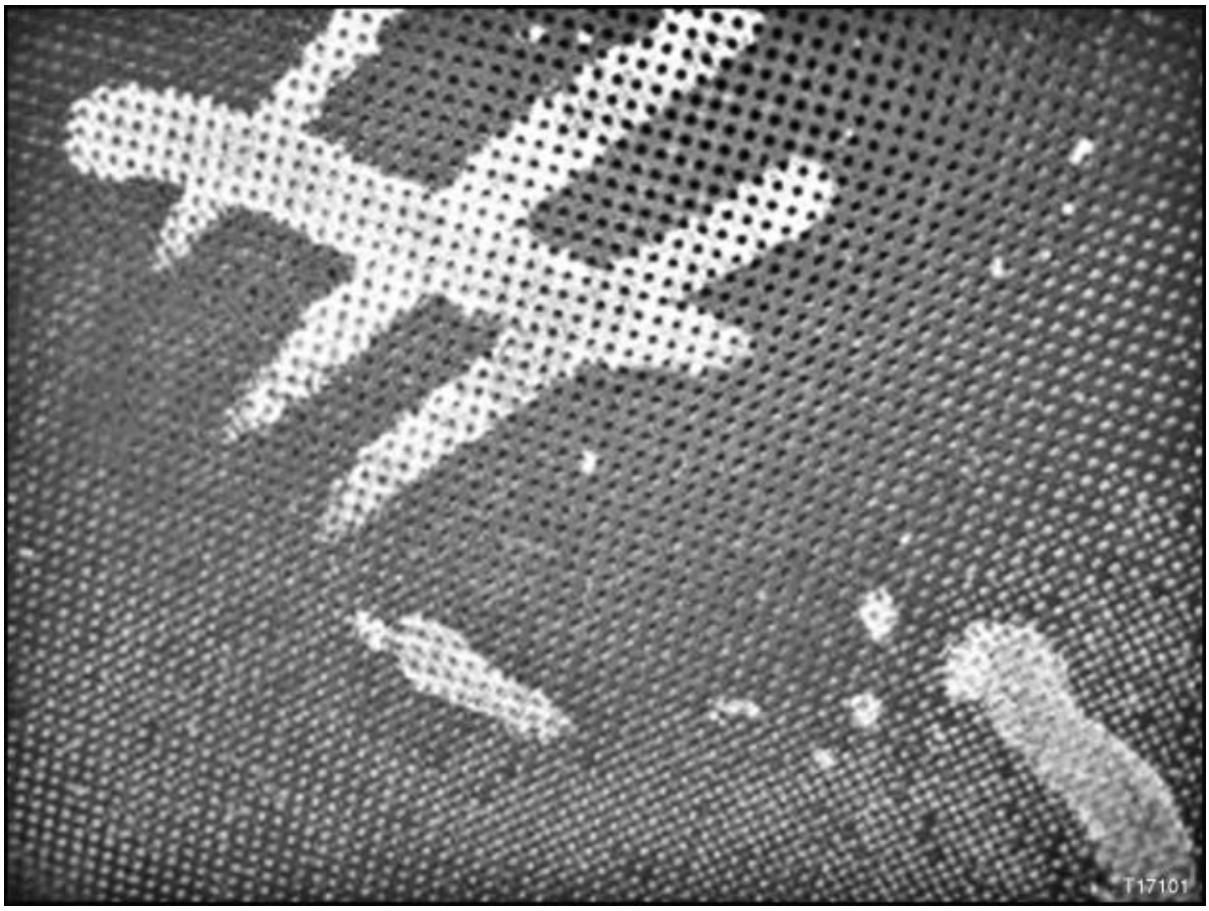


Figure 61 DPF Inlet (Normal)

Normal DPF Outlet

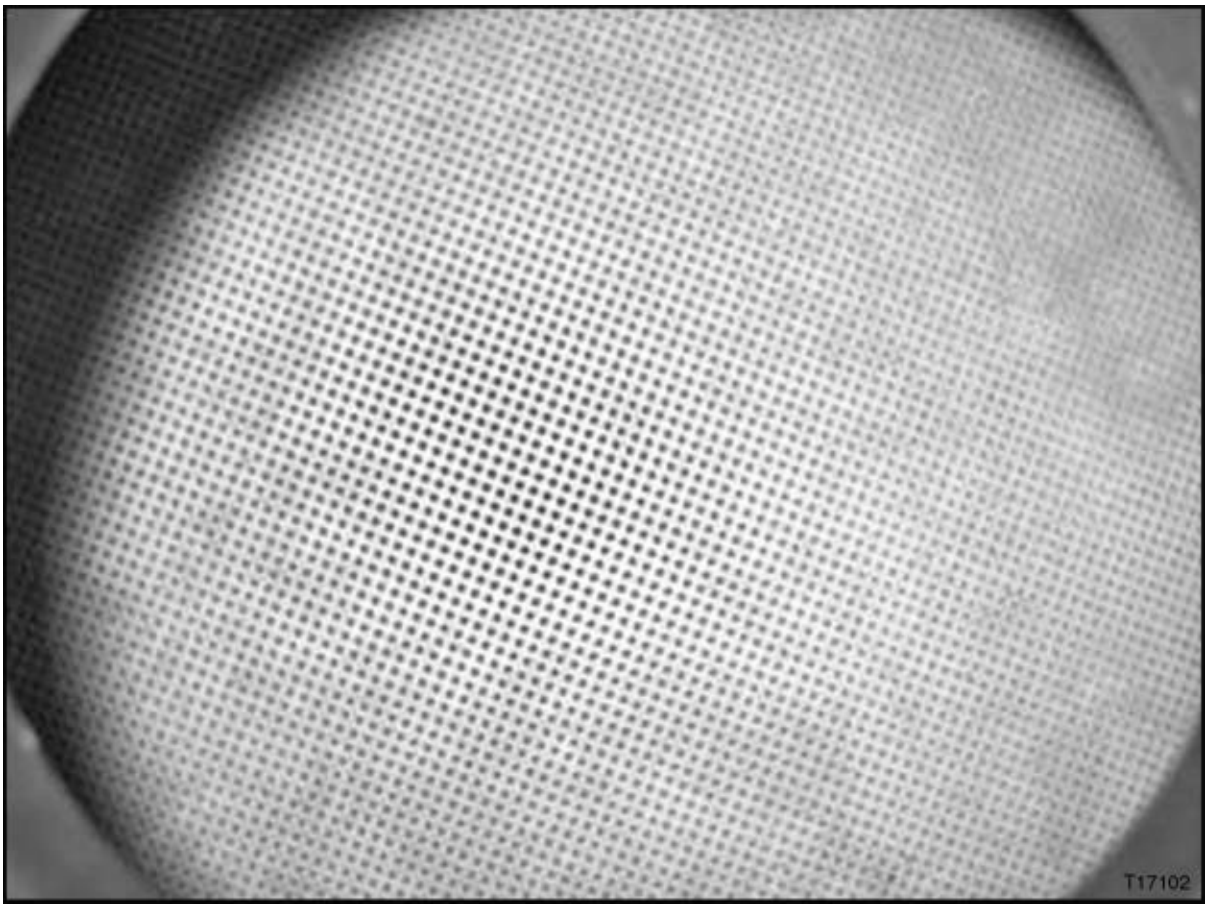


Figure 62 DPF Outlet (Normal)

Inspect the inlet and outlet of the DPF.

Insure all inlet channels are visible and the light soot coating over the whole inlet face easily wiped away with a finger. Soot amount on face may vary depending on the time since last DPF regeneration, but should be less than 1/8."

Possible Causes	Action
System is working correctly	None.

Restricted DPF Inlet

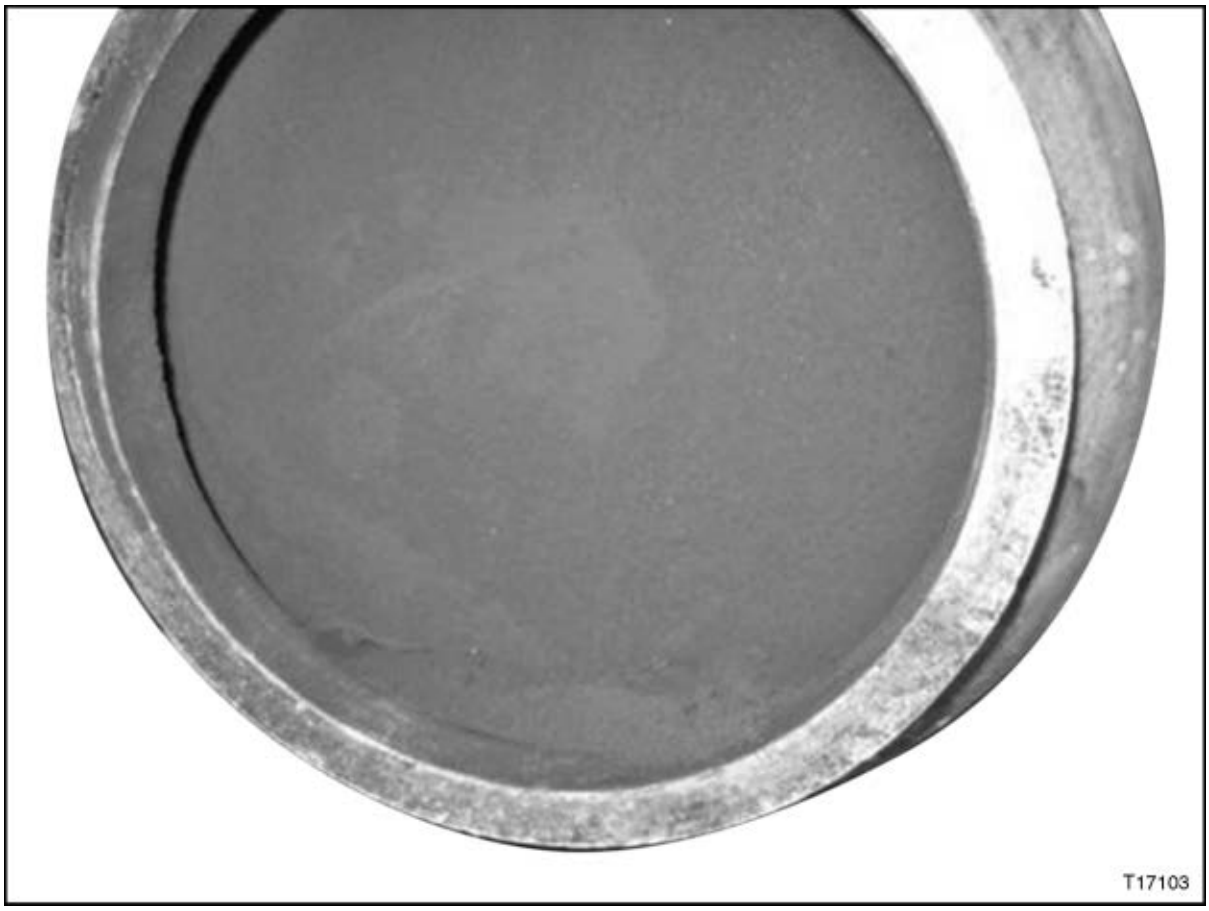


Figure 63 DPF Face Plugged

Inspect Inlet of the DPF.

If no channels are visible and the face of the DPF has a deep cake of soot greater than 1/8”, remove DPF for external cleaning.

Possible Causes	Action
• Drive cycle (Unable to complete Regen) • Engine over fueling • Boost problem • Intake throttle problem	1. Interview the operator about his drive cycle. 2. Verify there are no inhibitors (DTCs or switches). 3. Replace the DPF.

DPF Contaminated with Coolant

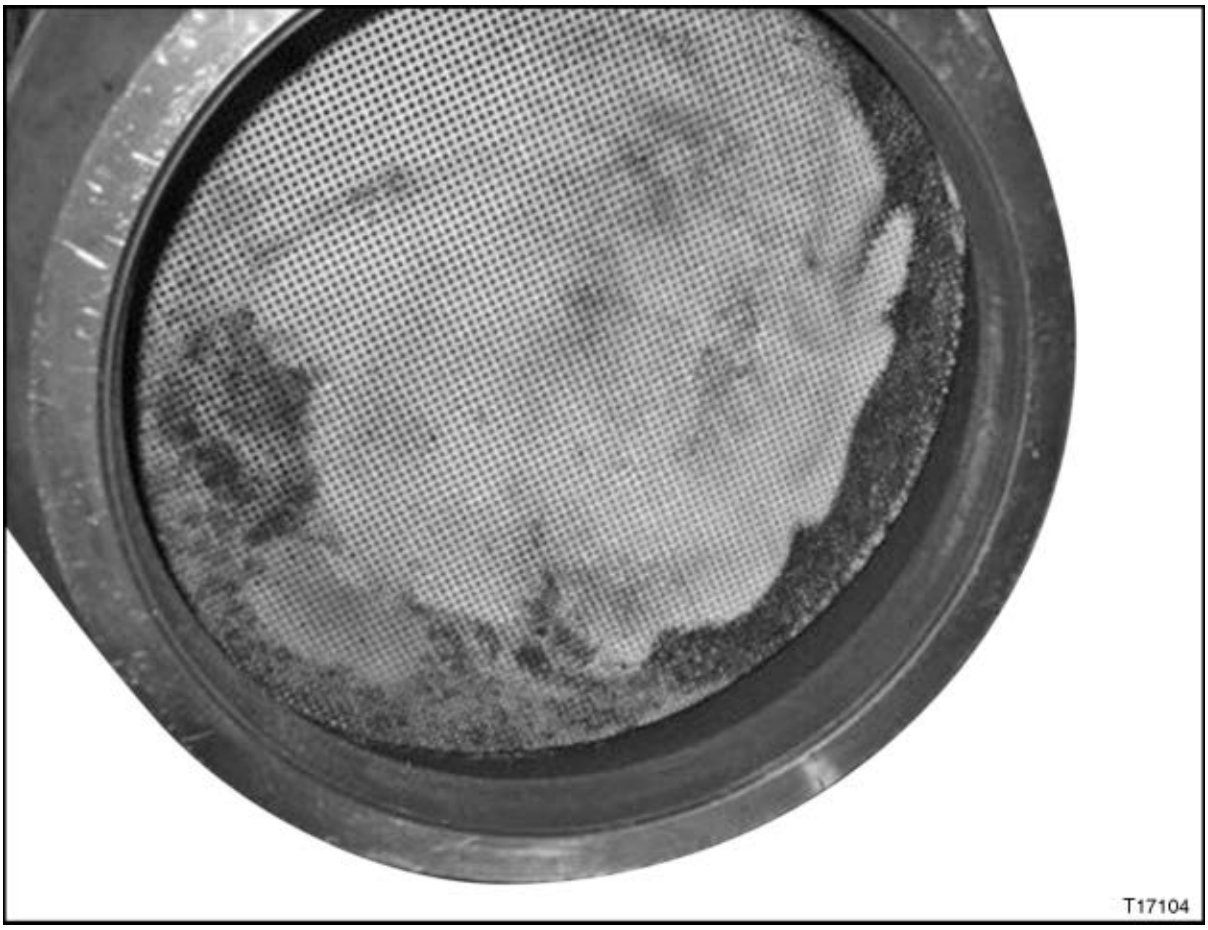


Figure 64 Coolant Contamination

Inspect the inlet and outlet of the DPF.

DPF will show signs of coolant flowing through exhaust system and contaminating the DPF.

Possible Causes	Action
• Coolant is flowing through exhaust • Failed Interstage cooler • Failed EGR cooler • Failed injector sleeve • Leaking cylinder head cup plugs • Cylinder head porosity	1. Repair coolant problem. 2. The DPF cannot be cleaned, it must be replaced.

DPF Contaminated with Oil

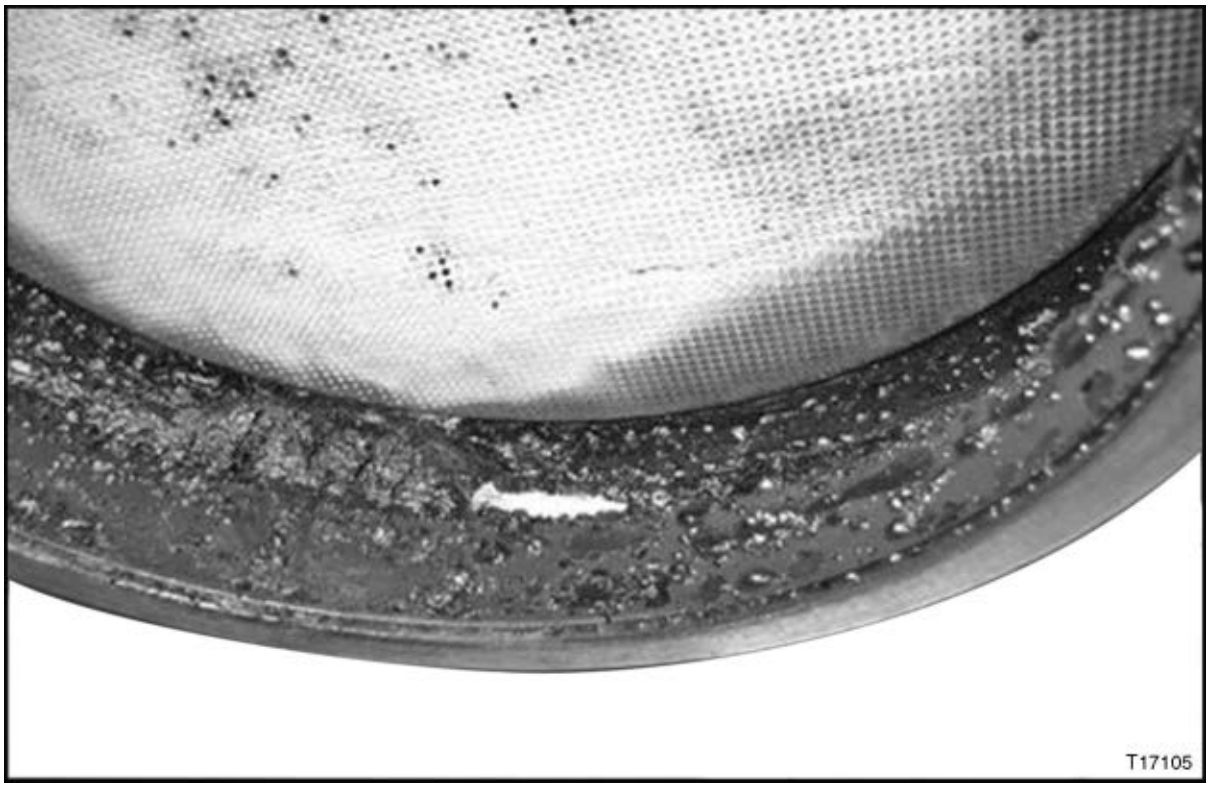


Figure 65 Engine Oil Contamination, Soot Leakage

Inspect the inlet and outlet of the DPF.

DPF will show signs of soot leakage and oil.

Possible Causes	Action
• Failed turbocharger • Failed piston rings • Failed cylinder sleeves • Failed valve guides	1. Repair engine oil to exhaust problem. 2. The DPF cannot be cleaned, it must be replaced. 3. Inspect the DOC for damage and replace if necessary.

DPF Outlet Leaking Soot

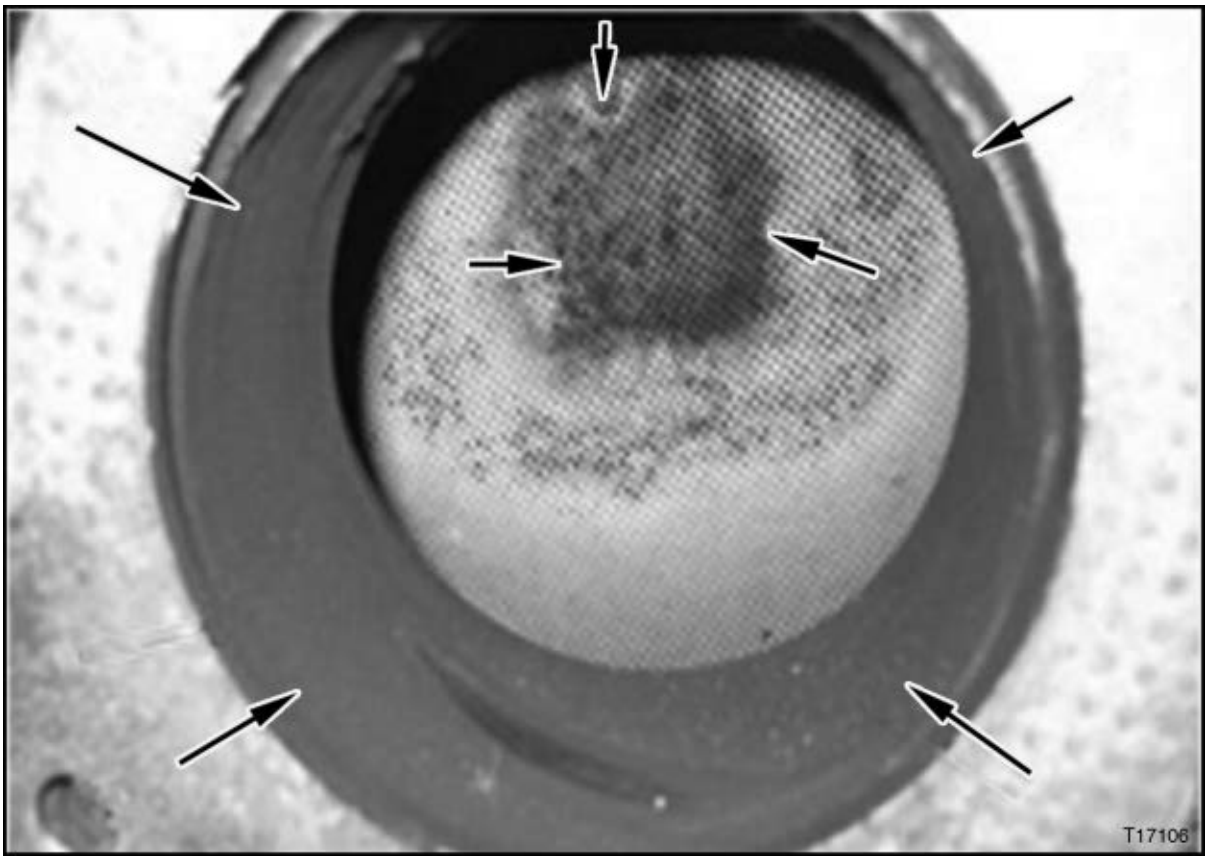


Figure 66 DPF Filter Damage, Soot Leakage

Inspect the outlet of the DPF.

DPF will show signs of soot leakage as indicated by the arrows in figure.

Possible Causes	Action
• DPF is damaged	1. The DPF cannot be cleaned, it must be replaced. 2. Inspect the DOC for damage and replace if necessary.

External Damage to DPF

Figure 67 DPF Filter, Can Damage

Inspect the exterior of the DPF.

DPF will show signs of damage such as dents or cracks.

Possible Causes	Action
• Road debris • Vehicle accident	1. The DPF cannot be cleaned, it must be replaced.

DPF Ceramic Filter Brick Measurement

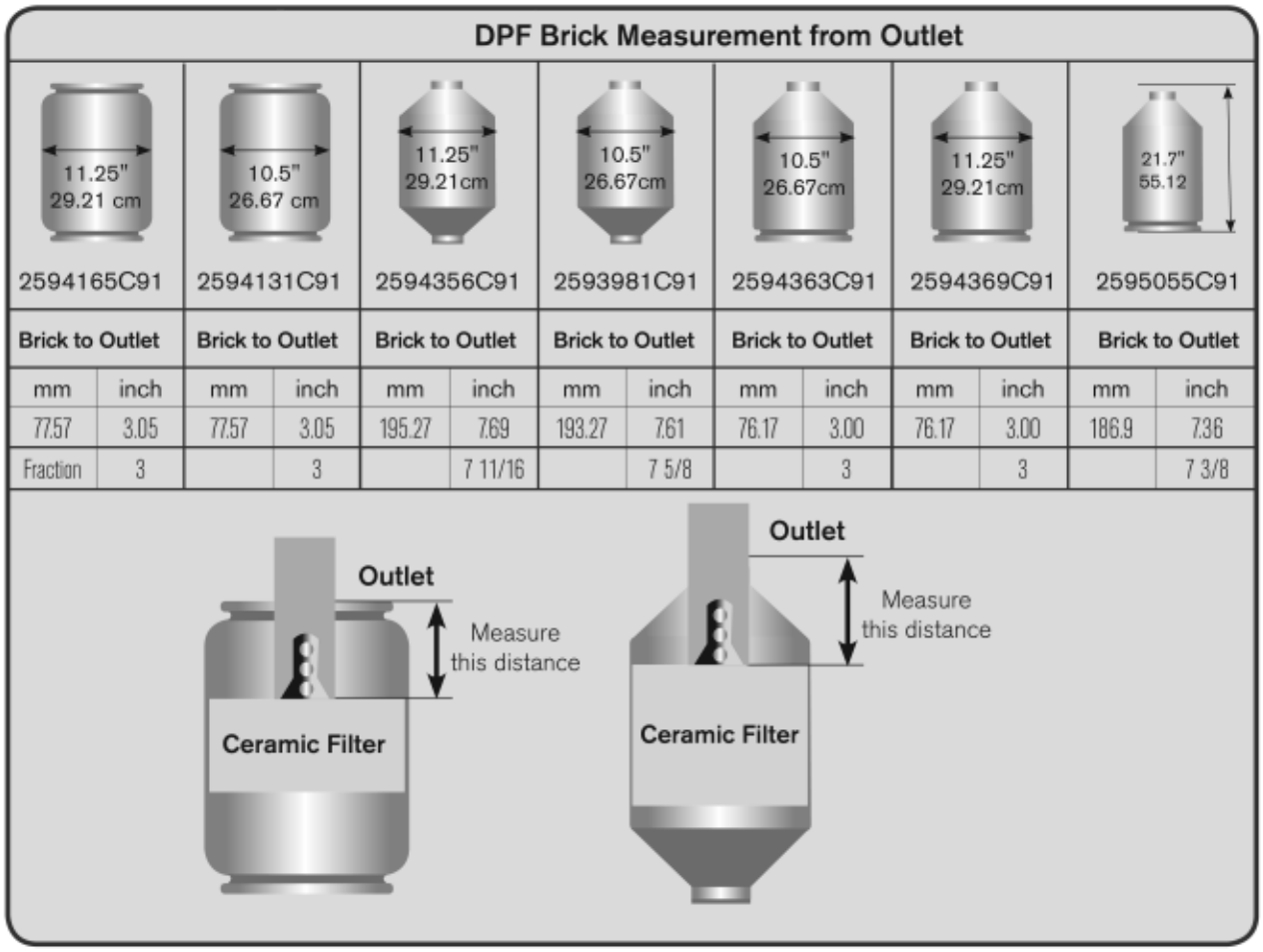


Figure 68 DPF Ceramic Filter Brick Measurement

Measure the distance between the ceramic filter brick and the outlet. If the distance is greater then the specification, the ceramic filter brick has moved out of its correct location. Replace the DPF Filter.

Possible Causes	Action
Face plugged	If the distance is greater then the specification, the DPF cannot be cleaned. It must be replaced.

SPN 3695 FMI 2 - DPF Regen Inhibit Switch Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Active regeneration of the aftertreatment system inhibited due to DPF regen inhibit switch left ON.	Active regeneration needed and DPF regen inhibit switch active.	DPF regen inhibit switch On Key-On Engine-Running (KOER)	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the DPF regen inhibit switch is On, and active regeneration of the aftertreatment system is needed.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3695 FMI 19 (J1939)

Drive Cycle to Determine Fault Status

Drive cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- DPF regen inhibit switch On
- Failed DPF regen inhibit switch

Step 1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3695 FMI 19 (J1939).	Decision
Is EST DTC list free of SPN 3695 FMI 19?		Yes: Go to step 2.
		No: Repair SPN 3695 FMI 19. After repairs are complete, retest for SPN 3695 FMI 2.

Step 2	Verify DPF regen inhibit switch is in the correct position.	Decision
Is the DPF regen inhibit switch Off allowing for active regenerations of the aftertreatment system?		Yes: Replace the DPF regen inhibit switch. After repairs are complete, retest for SPN 3695 FMI 2.
		No: Turn DPF regen inhibit switch Off and perform a parked regeneration of the aftertreatment system. After repairs are complete, retest for SPN 3695 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3695 FMI 2 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3703 FMI 31 - DPF Active Regeneration Inhibited Due to Inhibit Switch

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Active regeneration of the aftertreatment system inhibited due to inhibit switch.	SPN 3719 FMI 0, 15, or 16 active OR active regeneration requested	Key-ON Engine-Running (KOER) Regen inhibit switch enabled	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the regen inhibit switch is enabled when any of the following occur:

- SPN 3719 FMI 0, 15, or 16 (DPF soot load) active.
- Active regeneration of the aftertreatment system is needed.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 3695 FMI 2 and 19 (Regen Inhibit Switch).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

This fault can indicate the reason high soot load faults have been logged.

Possible Causes

- Regen Inhibit Switch enabled when active regeneration is needed.

Step 1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3695 FMI 2 and 19 (regen inhibit switch).	Decision
Is EST DTC list free of SPN 3695 FMI 2 and 19?		Yes: Go to step 2.
		No: Repair SPN 3695 FMI 2 and 19. After repairs are complete, retest for SPN 3703 FMI 31.

Step 2	Verify regen inhibit switch is in the correct position.	Decision
Is the regen inhibit switch disabled allowing for active regenerations of the aftertreatment system?		Yes: Run a parked regeneration of the aftertreatment system, and retest for SPN 3703 FMI 31.
		No: Disable regen inhibit switch and perform a parked regeneration of the aftertreatment system. Retest for SPN 3703 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 3703 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3713 FMI 31 - DPF Active Regeneration Inhibited Due to System Timeout

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Active regeneration of the aftertreatment system is needed, but a fault that inhibits regeneration is present.	Regen inhibit fault present	Key ON	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects active regeneration is needed, but a fault that inhibits regeneration is present.

Lamp Reaction

This fault will not illuminate the MIL.

Associated Faults

SPN 3242 FMI 0, 2, 3, 4, 15, 16 (DPFIT); SPN 3246 FMI 0, 2, 3, 4, 15, 16 (DPFOT); SPN 3251 FMI 2, 3, 4 (DPFDP); SPN 3610 FMI 2, 3, 4 (DPFDP); SPN 3695 FMI 2, 19 (DPF); SPN 3936 FMI 7, 14, 15 (DPF System); SPN 4765 FMI 2, 3, 4, 16 (DOCIT); SPN 5742 FMI 11, 16 (DOC / DPF Temperature Sensor Module);

SPN 3480 FMI 2, 3, 4, 17 (AFT: FP1); SPN 3482 FMI 2, 3, 4, 7, 16 (AFTFSV); SPN 3490 FMI 3, 4, 7 (AFT: PAV); SPN 3556 FMI 2, 5 (AFTFI);

SPN 3703 FMI 31 (AFT); SPN 3719 FMI 0, 16 (AFT); SPN 3750 FMI 31 (AFT); SPN 4792 FMI 14 (AFT); SPN 4794 FMI 31 (AFT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT); SPN 5298 FMI 17, 18 (AFT); SPN 5397 FMI 31 (AFT);

SPN 4360 FMI 2 (SCRIT); SPN 4363 FMI 16 (SCROT); SPN 5743 FMI 11, 16 (SCR Temp sensor module).

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Fact

This fault can indicate the reason high soot load faults have been logged.

Possible Causes

- Regen inhibit faults present when active regeneration is needed.

<table>
<tr><td>Step 1</td><td>Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 0, 2, 3, 4, 15, 16 (DPFIT); SPN 3246 FMI 0, 2, 3, 4, 15, 16 (DPFOT); SPN 3251 FMI 2, 3, 4 (DPFDP); SPN 3610 FMI 2, 3, 4 (DPFDP); SPN 3695 FMI 2, 19 (DPF); SPN 3936 FMI 7, 14, 15 (DPF System); SPN 4765 FMI 2, 3, 4, 16 (DOCIT); SPN 5742 FMI 11, 16 (DOC / DPF Temperature Sensor Module)</td><td>Decision</td></tr>
<tr><td colspan="2" rowspan="2">Is EST DTC list free of SPN 3242 FMI 0, 2, 3, 4, 15, 16; SPN 3246 FMI 0, 2, 3, 4, 15, 16; SPN 3251 FMI 2, 3, 4; SPN 3610 FMI 2, 3, 4; SPN 3695 FMI 2, 19; SPN 3936 FMI 7, 14, 15; SPN 4765 FMI 2, 3, 4, 16; SPN 5742 FMI 11, 16?</td><td>Yes: Go to step 2.</td></tr>
<tr><td>No: Repair SPN 3242 FMI 0, 2, 3, 4, 15, 16; SPN 3246 FMI 0, 2, 3, 4, 15, 16; SPN 3251 FMI 2, 3, 4; SPN 3610 FMI 2, 3, 4; SPN 3695 FMI 2, 19; SPN 3936 FMI 7, 14, 15; SPN 4765 FMI 2, 3, 4, 16; SPN 5742 FMI 11, 16. After repairs are complete, retest for SPN 3713 FMI 31.</td></tr>
</table>

Step 2	Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 2, 3, 4, 17 (AFT: FP1); SPN 3482 FMI 2, 3, 4, 7, 16 (AFTFSV); SPN 3490 FMI 3, 4, 7 (AFT: PAV); SPN 3556 FMI 2, 5 (AFTFI).	Decision
Is EST DTC list free of SPN 3480 FMI 2, 3, 4, 17; SPN 3482 FMI 2, 3, 4, 7, 16; SPN 3490 FMI 3, 4, 7; SPN 3556 FMI 2, 5?		Yes: Go to step 3.
		No: Repair SPN 3480 FMI 2, 3, 4, 17; SPN 3482 FMI 2, 3, 4, 7, 16; SPN 3490 FMI 3, 4, 7; SPN 3556 FMI 2, 5. After repairs are complete, retest for SPN 3713 FMI 31.

Step 3	Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3703 FMI 31 (AFT); SPN 3719 FMI 0, 16 (AFT); SPN 3750 FMI 31 (AFT); SPN 4792 FMI 14 (AFT); SPN 4794 FMI 31 (AFT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT); SPN 5298 FMI 17, 18 (AFT); SPN 5397 FMI 31 (AFT).	Decision
Is EST DTC list free of SPN 3703 FMI 31; SPN 3719 FMI 0, 16; SPN 3750 FMI 31; SPN 4792 FMI 14; SPN 4794 FMI 31; SPN 4795 FMI 31; SPN 4796 FMI 31; SPN 5298 FMI 17, 18; SPN 5397 FMI 31?		Yes: Go to step 4.
		No: Repair SPN 3703 FMI 31; SPN 3719 FMI 0, 16; SPN 3750 FMI 31; SPN 4792 FMI 14; SPN 4794 FMI 31; SPN 4795 FMI 31; SPN 4796 FMI 31; SPN 5298 FMI 17, 18; SPN 5397 FMI 31. After repairs are complete, retest for SPN 3713 FMI 31.

Step 4	Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4360 FMI 2 (SCRIT); SPN 4363 FMI 16 (SCROT); SPN 5743 FMI 11, 16 (SCR Temp sensor module).	Decision
Is EST DTC list free of SPN 4360 FMI 2; SPN 4363 FMI 16; SPN 5743 FMI 11, 16?		Yes: Run a parked regeneration of the aftertreatment system, and retest for SPN 3713 FMI 31.
		No: Repair SPN 4360 FMI 2; SPN 4363 FMI 16; SPN 5743 FMI 11, 16. After repairs are complete, retest for SPN 3713 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 3713 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3750 FMI 31 - DPF Regen Inhibited Due to Low Exhaust Temperatures

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Unable to begin closed loop control of active regeneration of Diesel Particulate Filter (DPF) due to low DOC temperature.	Diesel Particulate Filter Inlet Temperature (DPFIT) < 500°F (260°C)	Engine speed > 800 RPM for 200 seconds Barometric Pressure (BARO) ≥ 10.9 psi (75 kPa) Ambient Air Temperature (AAT) ≥ -4°F (-20°C) Active regeneration of DPF has been requested more than 200 seconds. Inactive: SPN 3242 FMI 3 and 4; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3 and 4.	90 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) is unable to achieve closed loop control of active regeneration of the aftertreatment system due to low Diesel Oxidation Catalyst (DOC) temperature.

Lamp Reaction

This fault does not illuminate the MIL when active.

Associated Faults

SPN 27 (EGR); SPN 51 (ETV); SPN 2659 (AMS); SPN 2791 (EGR); SPN 3058 FMI 10 (EGR System Monitor); SPN 3251 FMI 2, 3, and 4 (DPFDP);SPN 3242 (DPFIT); SPN 3246 (DPFOT); and SPN 4796 FMI 31 (DOC)

Drive Cycle to Determine Fault Status

Drive Cycle 13 then 3 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

This fault code may indicate exhaust temperature is not high enough to actively regenerate the aftertreatment system. Driving the vehicle with long-term increased load may increase exhaust temperatures and decrease aftertreatment regeneration frequency.

Possible Causes

- Degraded Diesel Oxidation Catalyst (DOC)
- Exhaust leak
- Damaged or missing Diesel Particulate Filter (DPF)
- Failed DOC / DPF temperature sensor module

Step 1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 27 (EGR); SPN 51 (ETV); SPN 2659 (AMS); SPN 2791 (EGR); SPN 3058 FMI 10 (EGR System Monitor); SPN 3251 FMI 2, 3, and 4 (DPFDP); SPN 3242 (DPFIT); SPN 3246 (DPFOT); and SPN 4796 FMI 31 (DOC).	Decision
Is EST DTC list free of SPN 27; SPN 51; SPN 2659; SPN 2791; SPN 3058 FMI 10; SPN 3251 FMI 2, 3, and 4; SPN 3242; SPN 3246; and SPN 4796 FMI 31?		Yes: Go to step 2.
		No: Repair SPN 27; SPN 51; SPN 2659; SPN 2791; SPN 3058 FMI 10; SPN 3251 FMI 2, 3, and 4; SPN 3242; SPN 3246; and SPN 4796 FMI 31. After repairs are complete, retest for SPN 3750 FMI 31.

Step 2	Inspect exhaust system for leaks and physical damage.	Decision
Is exhaust system free of leaks and physical damage?		Yes: Go to step 3.
		No: Repair or replace leaking or damaged exhaust components. After repairs are complete, retest for SPN 3750 FMI 31.

Step 3	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT), Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) temperatures. Perform Hot Run Sensor Comparison Test .	Decision
Are the DOCIT, DPFIT, and DPFOT temperatures within 77°F (25°C) of each other?		Yes: Go to step 3.
		No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3750 FMI 31.

Step 4	Check the exhaust system for an installed and undamaged Diesel Particulate Filter (DPF).	Decision
Is a DPF installed in the exhaust system and free damage?		Yes: Inspect DOC for damage and replace if damaged. After repairs are complete, retest for SPN 3750 FMI 31.
		No: Install correct DPF. After repairs are complete, retest for SPN 3750 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 3750 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4794 FMI 31 - SCR Catalyst System Missing

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Selective Catalyst Reduction (SCR) catalyst has low NOx conversion.	SCR catalyst conversion efficiency < 20% (NOx IN sensor module compared to NOx OUT sensor module)	Inactive: SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3480 FMI 2, 3, 4, and 17 (AFT: FP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3 and 4 (AFT: PAV); SPN 3556 FMI 2 and 5 (AFT); SPN 3610 FMI 2, 3, and 4 (DPFDP / outlet pressure); SPN 4363 FMI 0 (SCROT); SPN 4377 FMI 20 and 21 (NH_3); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 12 (DOC / DPF temp sensor module) EGR Off Engine Protection is not active. Estimated SCR catalyst bed temperature from 356 °F (180°C) to 842°F (450°C) Exhaust Flow rate 100 g/s to 440 g/s NOx IN 100 ppm to 826 ppm NOx OUT 0 ppm to 766 ppm DEF injection rate > 0.07 ml/sec Ambient pressure (absolute) 12 psi (80 kPa) to 23 psi (160 kPa) Ambient air temperature ≥ 19.9°F (-6.7°C) Rate of change of NOx IN < 40 ppm/sec Rate of change of estimated SCR bed temperature ≤ 32.9°F (0.5°C) /sec Rate of change of estimated exhaust mass flow < 10 g/sec	7 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Nitrogen Oxides (NOx) conversion efficiency of the Selective Catalyst Reduction (SCR) catalyst is critically low. The ACM compares NOx IN sensor value, to the NOx OUT sensor value. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced and vehicle speed limited if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3226 (NOx OUT); SPN 3228 (NOx OUT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT)

Drive Cycle to Determine Fault Status

Drive Cycle 1 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Missing SCR Catalyst
- Contaminated, damaged, or cracked SCR Catalyst
- Contaminated DEF
- Failed DEF: DV

Step 1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 (NOx Out); SPN 3228 (NOx OUT); SPN 4360 FMI 2, 3, and 4 (SCRIT); and SPN 4363 FMI 2, 3, and 4 (SCROT).	Decision
Is EST DTC list free of SPN 3226; SPN 3228; SPN 4360 FMI 2, 3, and 4; and SPN 4363 FMI 2, 3, and 4?		Yes: Go to step 2.
		No: Repair SPN 3226; SPN 3228; SPN 4360 FMI 2, 3, and 4; and SPN 4363 FMI 2, 3, and 4. After repairs are complete, retest for SPN 4794 FMI 31.

Step 2	Check exhaust system for an installed Selective Catalyst Reduction (SCR) catalyst.	Decision
Is an SCR catalyst installed in the exhaust system?		Yes: Go to step 3.
		No: Install proper SCR. After repairs are complete, retest for SPN 4794 FMI 31.

Step 3	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF fluid.	Decision
Is urea concentration between 30 - 34 percent and Not contaminated?		Yes: Do DEF Doser Pump Override Test . After repairs are complete, retest for SPN 4794 FMI 31.
		No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4794 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 4794 FMI 31 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5298 FMI 17 - DOC Conversion Efficiency Below Minimum

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Active regeneration of the Diesel Particulate Filter (DPF) aborted due to the system detecting a malfunction with the closed loop temperature controller, using up all of the adjustment allowed.	Three occurrences of the following conditions during an active regeneration of the DPF, with each lasting for a minimum of 60 seconds: • Desired Diesel Particulate Filter Inlet Temperature (DPFIT) compared to actual DPFIT > 59 °F (15 °C) • Allowed Aftertreatment Fuel Injector (AFTFI) injection compared to desired AFTFI injection greater then expected.	Key-On Engine-Running (KOER) Rate of active / intrusive injection of HC's into exhaust > 0.1 g/sec Ambient air temperature > 19 °F (-7 °C) Active regeneration running Inactive: SPN 3242 FMI 2, 3, and 4; SPN 3480 FMI 2, 3, 4, and 17; SPN 3482 FMI 2, 3, 4, and 7; SPN 3490 FMI 3 and 4; SPN 3556 FMI 2 and 5; SPN 4765 FMI 2, 3, and 4; SPN 5742 FMI 3, 4, 11, and 12	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the temperature differential across the Diesel Oxidation Catalyst (DOC) during active regeneration of the aftertreatment system is Not matching expected temperature increase. Active and parked regeneration of the DPF will be disabled. The Exhaust Gas Recirculation (EGR) valve will be closed, and engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 4765 FMI 2, 3, and 4 (DOCIT)

Drive Cycle to Determine Fault Status

Drive Cycle 1 in the 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

Possible Causes

- Damaged or failed DOC
- Restricted DOC (soot accumulation)
- Exhaust system leak between turbocharger and DOC
- Failed Aftertreatment Fuel Injector (AFTFI)
- Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)

Possible Causes

- Damaged or failed DOC
- Restricted DOC (soot accumulation)
- Exhaust system leak between turbocharger and DOC
- Failed Aftertreatment Fuel Injector (AFTFI)
- Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)

Step 1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); and SPN 4765 FMI 2, 3, and 4 (DOCIT).	Decision
Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; and SPN 4765 FMI 2, 3, and 4?		Yes: Go to step 2.
		No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 5298 FMI 17.

Step 2	Inspect exhaust system for leaks between the turbocharger outlet and Diesel Oxidation Catalyst (DOC) inlet. Key-On Engine-Running (KOER), check for cracked exhaust system welds, leaking exhaust system seams, or other damage.	Decision
Is the exhaust system between the turbocharger outlet and DOC inlet sealed and undamaged?		Yes: Go to step 3.
		No: Repair or replace damaged exhaust system components. After repairs are complete, retest for SPN 5298 FMI 17.

Step 3	Inspect for a restricted or damaged DOC. Remove the DOC (see appropriate Exhaust System Service Manual). Check DOC for restrictions from soot or oil contamination, cracks or damage to cells in the DOC, and soot restrictions at the front face of the DOC.	Decision
Is the DOC unrestricted and free of damage?		Yes: Go to step 4.
		No: Clean or replace DOC. Refer to fault facts. After repairs are complete, retest for SPN 5298 FMI 17.

Step 4	Check for failed Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650).	Decision
Is the Aftertreatment Fuel Injector (AFTFI) dry and free of fuel?		Yes: Go to step 5.
		No: Replace AFTFSV. After repairs are complete, retest for SPN 5298 FMI 17.

Step 5	Check for failed AFTFI. Perform AFT Fuel Injector Leak Test (page 1652).	Decision
Is the AFTFI dry and free of fuel?		Yes: Go to step 6.
		No: Replace AFTFI. After repairs are complete, retest for SPN 5298 FMI 17.

Step 6	Check for failed AFT fuel flow (AFTFI). Perform AFT Dosing System Test (page 1648).	Decision
Was between 225 ml - 500 ml of fuel dispensed within 2.5 minutes?		Yes: Replace DOC. After repairs are complete, retest for SPN 5298 FMI 17.
		No: Replace AFTFI. After repairs are complete, retest for SPN 5298 FMI 17.

NOTE: After performing all diagnostic steps, if SPN 5298 FMI 17 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5298 FMI 18 - DOC Conversion Efficiency below Warning Pressure

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Decrease in conversion capability of the Diesel Oxidation Catalyst (DOC) that would cause tailpipe out emissions to exceed the applicable OBD threshold.	Filtered value of Hydrocarbon (HC) dosing efficiency < 57 %, where HC dosing efficiency is defined as DOC Heat / DOC Dosing Heat	Key-On Engine-Running (KOER) Active regeneration running	225 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the temperature differential across the Diesel Oxidation Catalyst (DOC) during active regeneration does not indicate a temperature increase.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3556 FMI 18 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT)

Drive Cycle to Determine Fault Status

Drive Cycle 32 in the 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

Possible Causes

- Damaged or failed DOC
- Restricted DOC (soot accumulation)
- Exhaust system leak between turbocharger and DOC
- Failed Aftertreatment Fuel Injector (AFTFI)
- Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)

Step 1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3556 FMI 18 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT).	Decision
Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3556 FMI 18; and SPN 4765 FMI 2, 3, and 4?		Yes: Go to step 2.
		No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3556 FMI 18; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 5298 FMI 18.

Step 2	Inspect exhaust system for leaks between the turbocharger outlet and Diesel Oxidation Catalyst (DOC) inlet. Key-On Engine-Running (KOER), check for cracked exhaust system welds, leaking exhaust system seams, or other damage.	Decision
Is the exhaust system between the turbocharger outlet and DOC inlet sealed and undamaged?		Yes: Go to step 3.
		No: Repair or replace damaged exhaust system components. After repairs are complete, retest for SPN 5298 FMI 18.

Step 3	Inspect for a restricted or damaged DOC. Remove the DOC (see appropriate Exhaust System Service Manual). Check DOC for restrictions from soot or oil contamination, cracks or damage to cells in the DOC, and soot restrictions at the front face of the DOC.	Decision
Is the DOC unrestricted and free of damage?		Yes: Go to step 4.
		No: Clean or replace DOC. Refer to fault facts. After repairs are complete, retest for SPN 5298 FMI 18.

Step 4	Check for failed Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650).	Decision
Is the Aftertreatment Fuel Injector (AFTFI) dry and free of fuel?		Yes: Go to step 5.
		No: Replace AFTFSV. After repairs are complete, retest for SPN 5298 FMI 18.

Step 5	Check for failed AFTFI. Perform AFT Fuel Injector Leak Test (page 1652).	Decision
Is the AFTFI dry and free of fuel?		Yes: Go to step 6.
		No: Replace AFTFI. After repairs are complete, retest for SPN 5298 FMI 18.

Step 6	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648).	Decision
Was between 225 ml - 500 ml of fuel dispensed within 2.5 minutes?		Yes: Replace DOC. After repairs are complete, retest for SPN 5298 FMI 18.
		No: Replace AFTFI. After repairs are complete, retest for SPN 5298 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 5298 FMI 18 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5397 FMI 31 - DPF Regenerations Occurring Too Frequently

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF system active regeneration occurring more frequently than intended.	Time since last active regeneration of the DPF completed and the next active regeneration is requested < 5 hrs. Number of failed decisions out of the last 3 updates made >=2	Inactive: SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3251 FMI 0, 2, 3, 4 (DPFDP / outlet pressure); SPN 3480 FMI 2, 3, 4,17 (AFT: FP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFT: PAV); SPN 3556 FMI 2, 5, 18 (AFT); SPN 3597 2 (ECM); SPN 3610 FMI 2, 3, 4 (DPFDP / outlet pressure); SPN 3936 FMI 7, 15 (DPF System); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4796 FMI 31 (DOC); SPN 5298 FMI 17, 18 (DOC); SPN 5319 FMI 31 (DPF); SPN 5742 FMI 3, 4, 11, 12 (DOC / DPF Temperature Sensor Module) Engine speed > 200 RPM Last active regeneration did not abort due to detection of malfunction with Aftertreatment system The system detects the DPF is no longer new	Immediate

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects the time between the completion of a successful active regeneration and the request for another active regeneration is less than 5 hours.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3251 FMI 2, 3, 4 (DPFDP)

Fault Facts

An excessive ash accumulation condition reduces the soot holding capability of the Diesel Particulate Filter (DPF) and will cause frequent aftertreatment regenerations.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low engine performance
- Failed fuel injector
- Engine mechanical
- Failed Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor
- Restricted DPFDP / outlet pressure sensor hose(s)
- DPF restricted, damaged, or contaminated
- Diesel Oxidation Catalyst (DOC) restricted, damaged, or contaminated

Step 1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3251 FMI 2, 3, and 4 (DPFDP / outlet pressure).	Decision
Is EST DTC list free of SPN 3251 FMI 2, 3, and 4?		Yes: Go to step 2.
		No: Repair SPN 3251 FMI 2, 3, and 4. After repairs are complete, retest for SPN 5397 FMI 31.

Step 2	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing.	Decision
Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?		Yes: Go to step 3.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5397 FMI 31.

Step 3	Monitor DPFDP signal. Key-On Engine-Running (KOER), using EST with ServiceMaxx software, load the Signals session and monitor DPFDP. Bring engine to high idle.	Decision
Is DPFDP below 0.5 psi?		Yes: Go to step 5.
		No: Go to step 4.

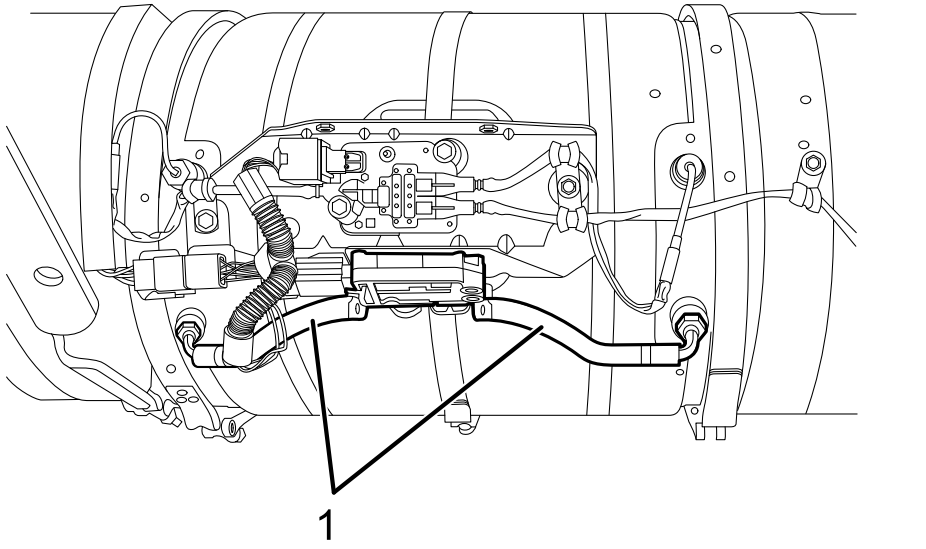


Figure 69 DPFDP / Outlet Pressure Sensor Hose(s) Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hose(s)

Step 4	Check DPFDP sensor hoses for correct routing and restrictions. Inspect the DPFDP sensor hoses for kinks, improper hose routing, restrictions, or damage.	Decision
Are the DPFDP sensor hoses routed correctly, free of damage, and unrestricted?		Yes: Replace DPF Differential Pressure / Outlet Pressure sensor. After repairs are complete, retest for SPN 5397 FMI 31.
		No: Repair or replace DPFDP sensor hose(s). After repairs are complete, retest for SPN 5397 FMI 31.

Step 5	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725).	Decision
5	Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 5397 FMI 31.
		No: Go to step 6

Step 6	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636).	Decision
Did one or more cylinders have significant speed difference(s) than the others?		Yes: Go to step 7.
		No: Go to step 8.

Step 7	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment.	Decision
Is valve train free of failed valve train components?		Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 5397 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 5397 FMI 31.

Step 8	Inspect Diesel Oxidation Catalyst (DOC) for restrictions, damage, or contamination. Remove the DOC (see Exhaust System Service Manual). Check DOC for restrictions; oil and coolant contamination; and cracks or damage to cells in the DOC.	Decision
Is the DOC unrestricted, free of damage, and free of contamination?		Yes: Go to step 9.
		No: Clean or replace DOC. After repairs are complete, retest for SPN 5397 FMI 31.

Step 9	Inspect Diesel Particulate Filter (DPF) for restrictions, damage, or contamination. Remove the DPF (see Exhaust System Service Manual). Check DPF for restrictions; oil and coolant contamination; and cracks or damage.	
Is the DPF unrestricted, free of damage, and free of contamination?		Yes: Retest for SPN 5397 FMI 31.
		No: Clean or replace DPF. After repairs are complete, retest for SPN 5397 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 5397 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

AFTFP (Aftertreatment Fuel Pressure 1) Sensor

Overview of AFTFP Sensor Group

SPN	FMI	Description
3480	2	AFTFP pressure sensor plausibility error (page 163)
3480	3	AFTFP signal Out of Range HIGH (page 167)
3480	4	AFTFP signal Out of Range LOW (page 173)
3480	17	AFTFP below normal operating range (page 180)

Overview

The Aftertreatment Control Module (ACM) monitors the Aftertreatment Fuel Pressure 1 (AFTFP) signal voltage to calculate fuel pressure in the aftertreatment system feeding the Aftertreatment Fuel Injector (AFTFI). This is used during active and parked regeneration only.

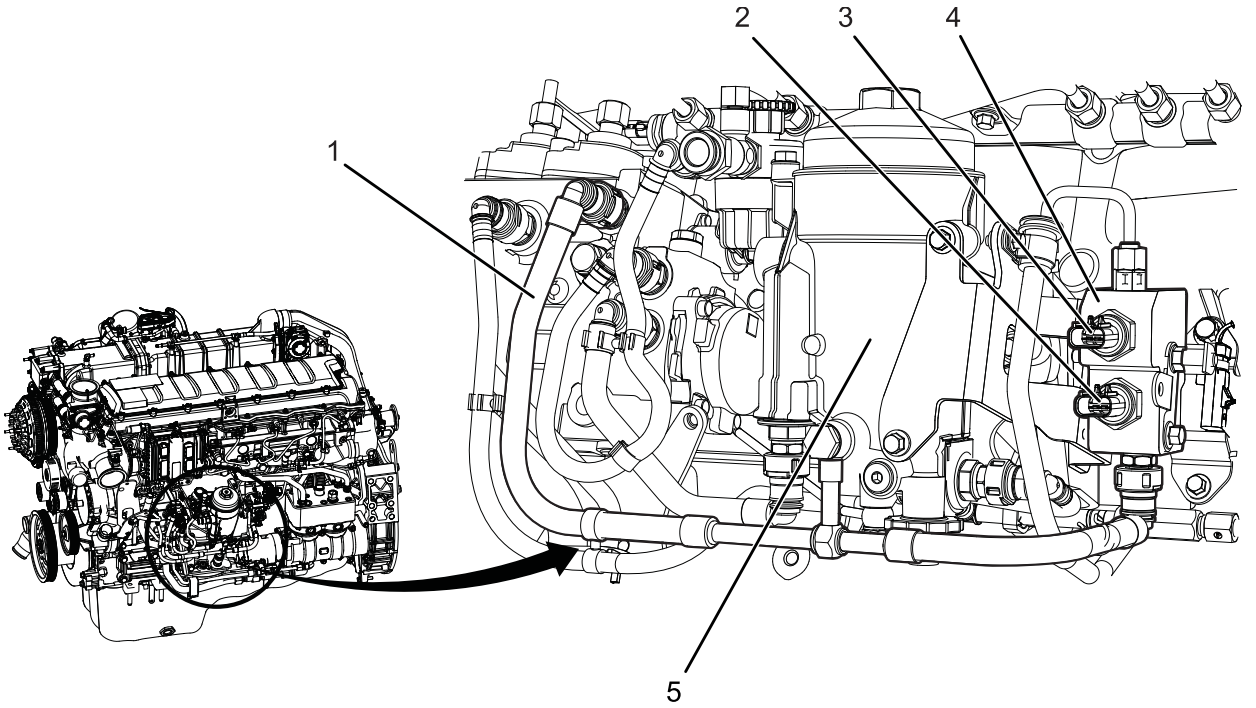


Figure 70 AFTFP Location.

1. AFT Fuel Doser Module fuel supply line
2. AFT Fuel Shutoff Valve (AFTFSV)
3. AFT Fuel Pressure 1 (AFTFP)
4. AFT Fuel Doser Module

SPN 3480 FMI 2 - AFTFP Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Aftertreatment Fuel Pressure 1 (AFTFP) sensor is in range, but not rational.	[(Aftertreatment Fuel Pressure 1 (AFTFP) pressure at Ambient pressure state < -7.3 psi (-50 kPa) or > 61.6 psi (425 kPa)) OR (AFTFP pressure at Air Supply state < 49.9 psi (344 kPa) or > 159 psi (1,100 kPa)) OR (AFTFP pressure at Fuel pressure state < 79.8 psi (550 kPa) or > 246 psi (1,700 kPa)) AND SPN 3490 FMI 7 (AFT: PAV)] OR [(AFTFP pressure with the Aftertreatment Fuel Shutoff Valve (AFTFSV) commanded open) - (AFTFP pressure when the AFT Fuel Injector (AFTFI) is open and the AFT Purge Air Valve (AFT: PAV) and AFTFSV are closed) < 50.7 psi (350 kPa)] AND [(AFTFP pressure with the AFT: PAV commanded open) - (AFTFP pressure when the AFTFI is open and the AFT: PAV and AFTFSV are closed) < 50.7 psi (350 kPa)]	Key ON Inactive: SPN 168 FMI 18 (ACM Power); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 3, 4, 17 (AFTFP); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFT: PAV); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT System); SPN 5742 FMI 3, 4, 11, 12 (DOC/DPF Temp Sensor Module)

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects Aftertreatment Fuel Pressure 1 (AFTFP) sensor is stuck in-range. Diagnostics are only performed prior to starting an active regeneration of the DPF, or at Key ON if the active regeneration is continuing across key cycles. If the diagnostics fail, then the regeneration request is aborted. Active regeneration of the aftertreatment diesel particulate filter will be disabled until the next key cycle. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 108 (BARO); SPN 157 (FRP); SPN 168 FMI 18 (ACM Power); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3480 FMI 3, 4, 17 (AFTFP); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFT: PAV); SPN 3512 FMI 14 (VREF-4); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT System); SPN 5742 FMI 3, 4, 11, 19 (DOC/DPF Temp Sensor Module)

Fault Facts

This fault is detected by comparing measured pressure at three pressure reference states to see if the measured pressures are unique in all cases. The reference pressure states are 1): Ambient, 2) Air Supply Pressure, and 3) Fuel Pressure.

- 1: An ambient pressure (BARO) reading is taken when the AFTFI is open AND the AFT: PAV and AFTFSV are closed.
- 2: An air supply pressure reading is taken when the AFT: PAV is open AND the AFTFSV and AFTFI are closed.
- 3: A fuel pressure reading is taken when the AFTFSV is open AND the AFTFI and AFT: PAV are closed.

Also, the individual measured pressures at each state are checked against their expected pressure range. A fault is set if any measured value is outside the expected range.

Drive Cycle to Determine Fault Status

Road Test

Possible Causes

- Aftertreatment Fuel Doser Module or AFT Fuel Injector (AFTFI) fuel lines or connections loose, leaking, restricted, or damaged.
- Failed AFTFP

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 3. Is EST DTC list SPN 3480 FMI 3 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Check for Associated Fault Codes	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 108 (BARO); SPN 157 (FRP); SPN 168 FMI 18 (ACM Power); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3480 FMI 3, 4, 17 (AFTFP); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFT: PAV); SPN 3512 FMI 14 (VREF-4); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT System); SPN 5742 FMI 3, 4, 11, 19 (DOC/DPF Temp Sensor Module). Is EST DTC list free of SPN 94; SPN 108; SPN 157; SPN 168 FMI 18; SPN 3242 FMI 2, 3, 4; SPN 3246 FMI 2, 3, 4; SPN 3480 FMI 3, 4, 17; SPN 3482 FMI 2, 3, 4, 7; SPN 3490 FMI 3, 4; SPN 3512 FMI 14; SPN 3556 FMI 2, 5; SPN 3936 FMI 7, 15; SPN 4363 FMI 0; SPN 4765 FMI 2, 3, 4; SPN 4795 FMI 31; SPN 4796 FMI 31; SPN 5742 FMI 3, 4, 11, 19?		Yes: Go to Step 3. No: Repair SPN 94; SPN 108; SPN 157; SPN 168 FMI 18; SPN 3242 FMI 2, 3, 4; SPN 3246 FMI 2, 3, 4; SPN 3480 FMI 3, 4, 17; SPN 3482 FMI 2, 3, 4, 7; SPN 3490 FMI 3, 4; SPN 3512 FMI 14; SPN 3556 FMI 2, 5; SPN 3936 FMI 7, 15; SPN 4363 FMI 0; SPN 4765 FMI 2, 3, 4; SPN 4795 FMI 31; SPN 4796 FMI 31; SPN 5742 FMI 3, 4, 11, 19. After repairs are complete, retest for SPN 3480 FMI 2.

Step 3	Check for leaks restriction and damage.	Decision
Check AFT fuel doser module and AFT Fuel Injector (AFTFI) fuel lines and connections for: loose connections, leaks, restrictions, or damage. Are the AFT fuel doser module and AFTFI fuel lines and connections leaking, restricted, or damaged?		Yes: Repair or replace leaking, restricted, or damaged fuel line or connection. After repairs are complete, retest for SPN 3480 FMI 2.
		No: Install new AFTFP sensor. After repairs are complete, retest for SPN 3480 FMI 2.

SPN 3480 FMI 3 - AFTFP Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
AFTFP sensor circuit voltage above normal or shorted to high source.	AFTFP sensor value > 4.75 V for more than 2 seconds	Key ON

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects Aftertreatment Fuel Pressure (AFTFP) signal voltage is more than 4.75 volts for more than 2 seconds. Engine torque may be reduced if the engine is operated for an extended period of time with this fault active. Active regeneration of the aftertreatment system may be disabled until the next key cycle.

Lamp Status

MIL will illuminate when this fault is detected during 1 drive cycle.

Associated Faults

SPN 3512 FMI 14 (VREF-7)

Fault Facts

The (ACM) monitors the (AFTFP) signal voltage to calculate fuel pressure in the aftertreatment system.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- AFTFP circuit short to power
- SIG GND circuit Open or high resistance
- Failed AFTFP

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 3. Is EST DTC list SPN 3480 FMI 3 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Check for Associated Fault Codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-7). Is EST DTC list free of SPN 3512 FMI 14?		Yes: Go to Step 3. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 3480 FMI 3.

Step 3	AFTFP sensor inspection	Decision
Inspect connections at AFT Fuel Pressure (AFTFP) sensor. Key OFF, disconnect AFTFP connector. Check AFTFP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFP sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests (SPN 3480 FMI 3). No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3480 FMI 3.

Pin-Point Tests SPN 3480 FMI 3

AFTFP circuit

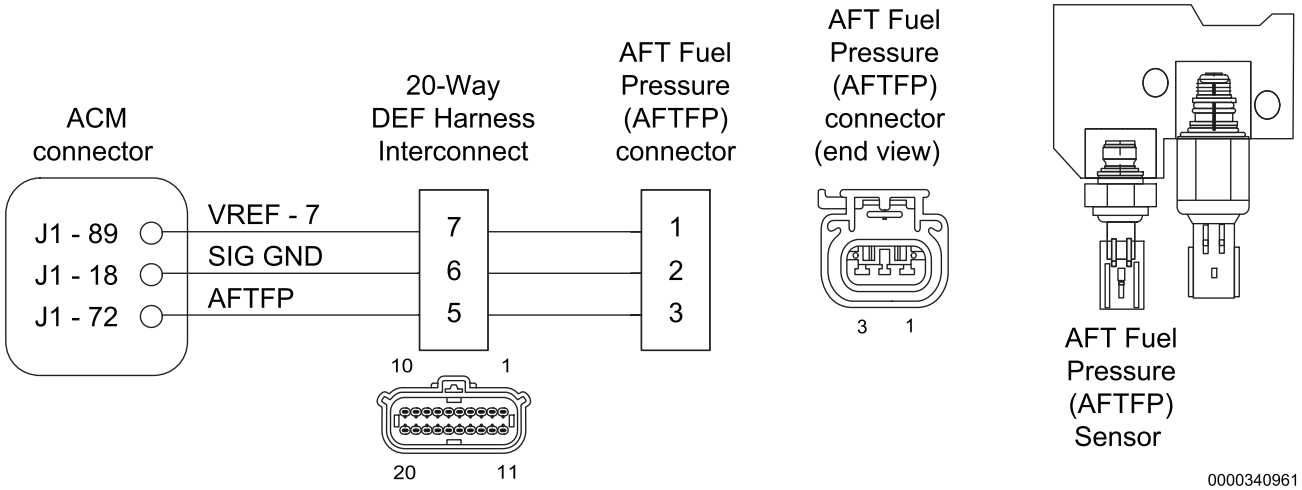


Figure 71 Aftertreatment Fuel Pressure 1 (AFTFP) Sensor Circuit Diagram.

See latest version of Navistar® N13 Engine Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4845
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

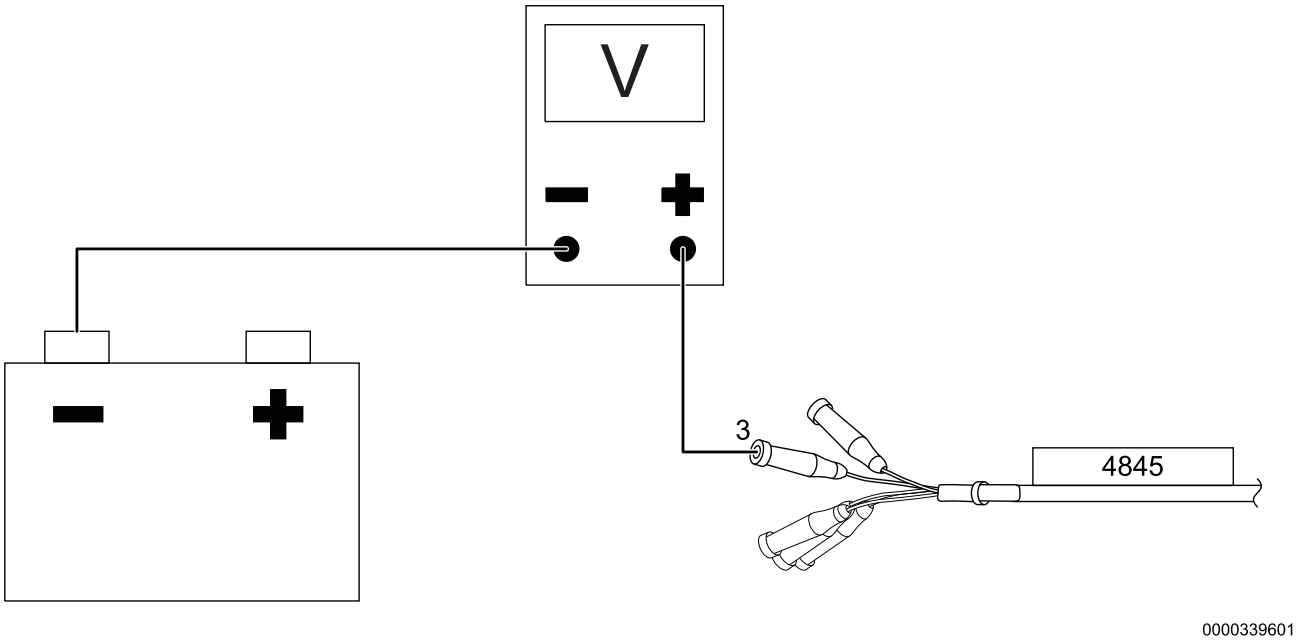


Figure 72 AFTFP1 Voltage Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4845 to vehicle harness and leave Aftertreatment Fuel Pressure 1 (AFTFP) disconnected. C. Key ON.

Test 1	Specification
Use Digital Multimeter (DMM) to measure voltage between Breakout Harness ZTSE4845 pin-3 and known good ground.	Less than 0.5 volts
Decision	
Is voltage less than 0.5 volts?	Yes: Go to Test 2.
	No: Repair short to power between AFTFP pin-3 and Aftertreatment Control Module (ACM) pin J1–72. After repairs are complete, retest for SPN 3480 FMI 3.

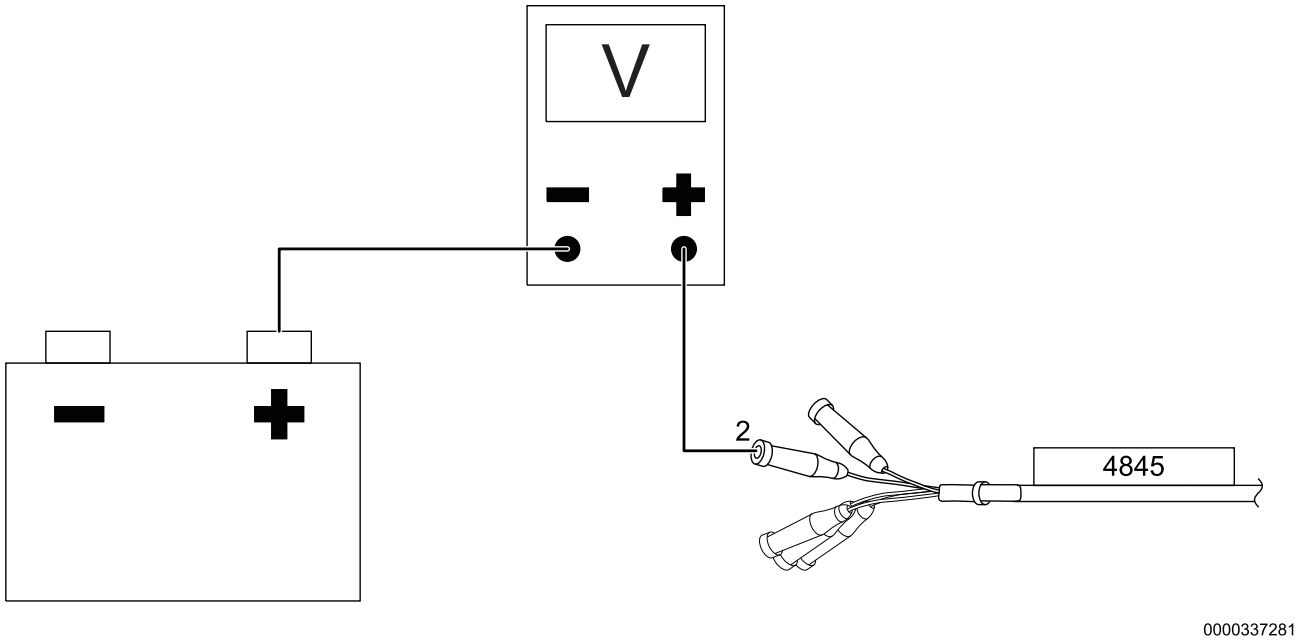


Figure 73 SIG GND Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4845 to vehicle harness and leave AFTFP disconnected. C. Key ON.

Test 2	Specification
Use DMM to measure voltage between Breakout Harness ZTSE4845 pin-2 and PWR.	Less than 0.5 volts
Decision	
Is voltage less than 0.5 volts?	Yes: Replace AFTFP sensor. After repairs are complete, retest for SPN 3480 FMI 3.
	No: Repair Open between AFTFP pin-2 and ACM pin J1–18. After repairs are complete, retest for SPN 3480 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and proper decision was made. Return to SPN 3480 FMI 3 fault code diagnostics.

SPN 3480 FM 4 - AFTFP Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Aftertreatment Fuel Pressure (AFTFP) sensor circuit - Voltage below normal or shorted to low source.	AFTFP < 0.25 volts	Key ON

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects signal from Aftertreatment Fuel Pressure Fuel Pressure (AFTFP) sensor is less than 0.25 volts for 2 seconds. Active aftertreatment regeneration disabled until the next key cycle. Engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during 1 drive cycle.

Associated Faults

SPN 3512 FMI 14 (VREF-7)

Fault Facts

The (ACM) monitors the (AFTFP) signal voltage to calculate fuel pressure in the aftertreatment system.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- AFTFP signal circuit short to GND
- AFTFP signal circuit Open or high resistance
- VREF-7 circuit Open or high resistance
- Failed AFTFP

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 3. Is EST DTC list SPN 3480 FMI 3 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Check for Associated Fault Codes..	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-7). Is EST DTC list free of SPN 3512 FMI 14?		Yes: Go to Step 3. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 3480 FMI 3.

Step 3	AFTFP sensor inspection	Decision
Inspect connections at AFT Fuel Pressure (AFTFP) sensor. Key OFF, disconnect AFTFP connector. Check AFTFP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFP sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests (SPN 3480 FMI 3). No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3480 FMI 3.

Pin-Point Tests SPN 3480 FMI 4

AFTFP circuit

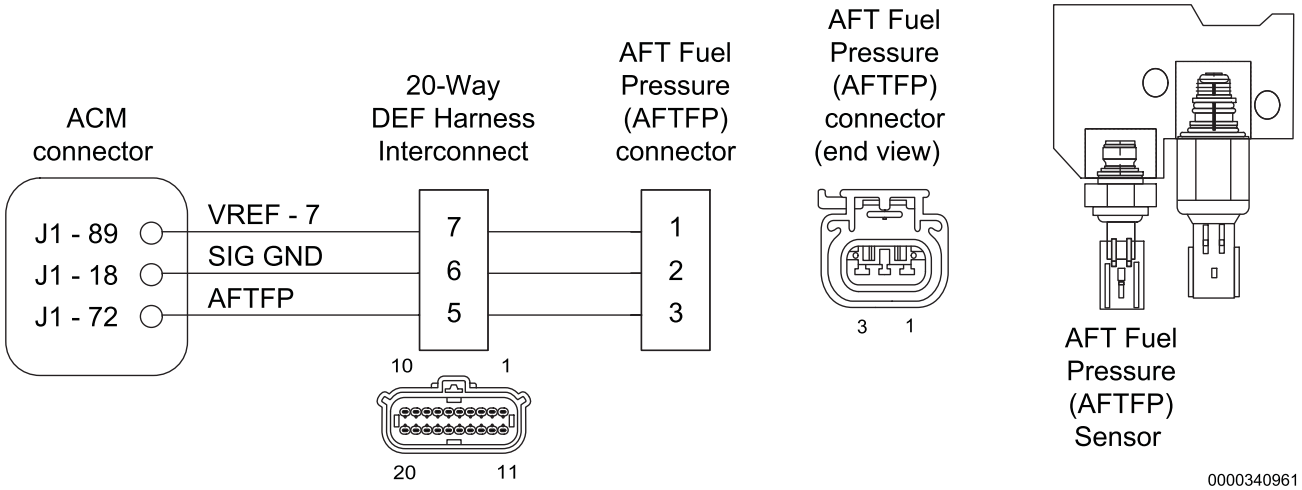


Figure 74 Aftertreatment Fuel Pressure (AFTFP) Sensor Circuit Diagram.

See latest version of Navistar® N13 Engine Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4845
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

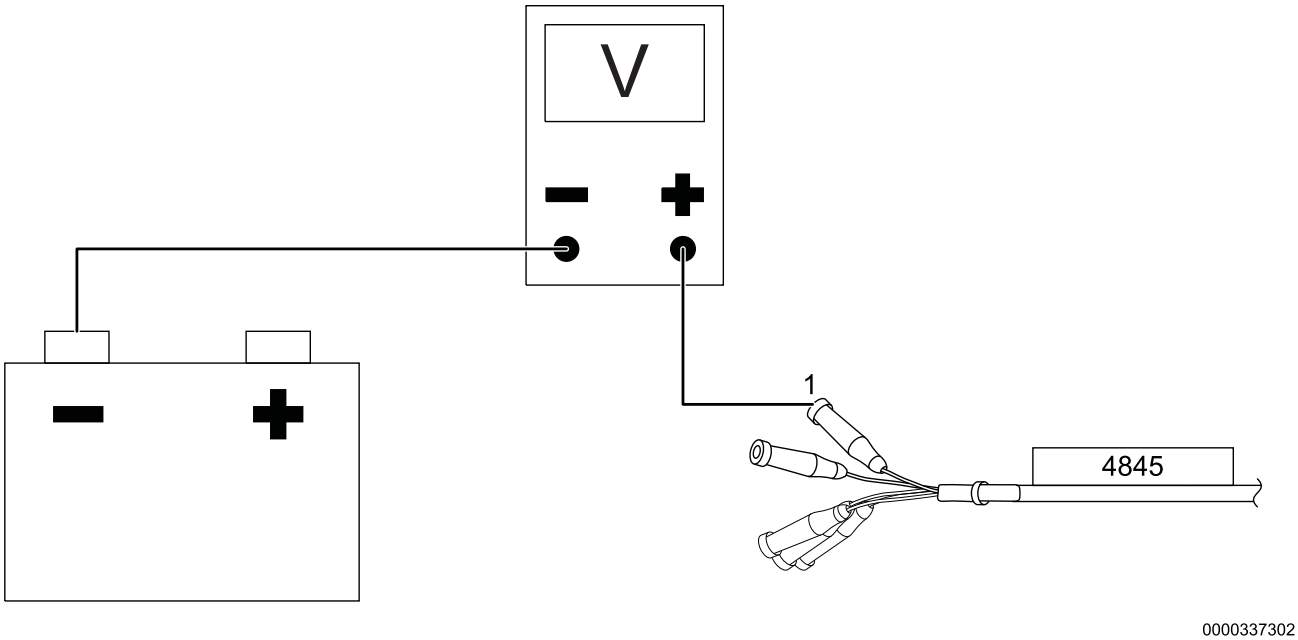


Figure 75 VREF Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4845 to vehicle harness and leave Aftertreatment Fuel Pressure (AFTFP) disconnected. C. Key ON.

Test 1	Specification
Use Digital Multimeter (DMM) to measure voltage between Breakout Harness ZTSE4845 pin-1 and known good ground.	5 volts ± 0.5 volts
Decision	
Is voltage 5 volts ± 0.5 volts?	Yes: Go to Test 2.
	No: Repair Open or short to GND between AFTFP pin-1 and Aftertreatment Control Module (ACM) pin J1-89. After repairs are complete, retest for SPN 3480 FMI 4.

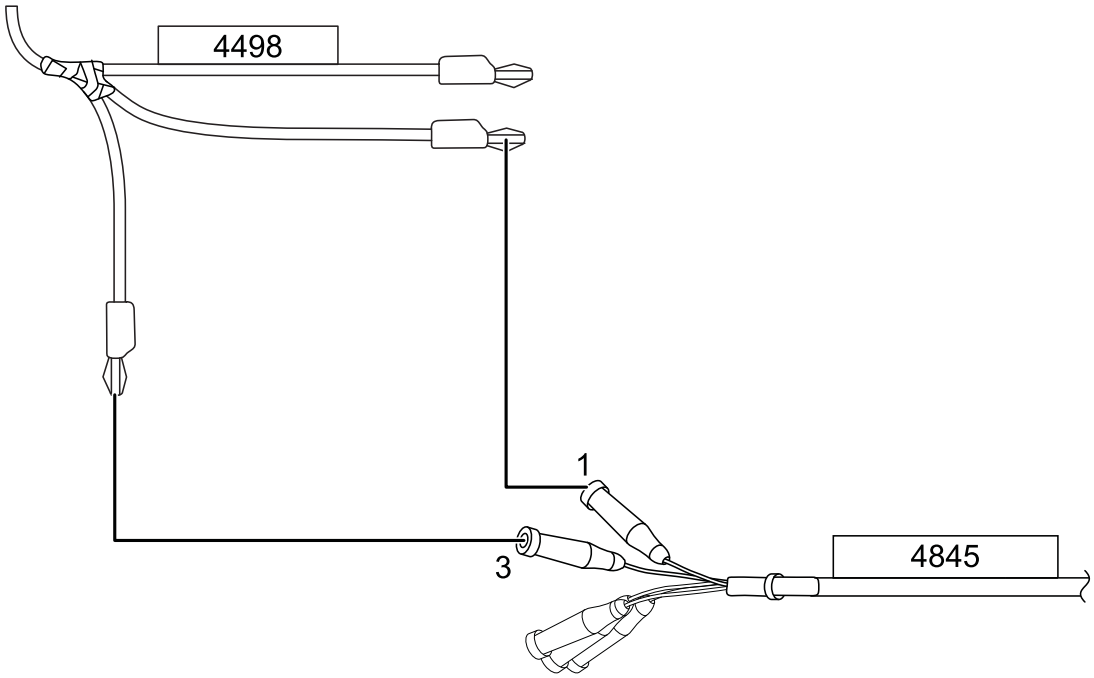


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Figure 76 AFTFP Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4845 to vehicle harness and leave AFTFP disconnected. C. Using Breakout Harness ZTSE4498 short Breakout Harness ZTSE4845 pin-1 and pin-3 together. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON. Log in to ServiceMaxx™ software.

Test 2	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test, monitor AFTFP voltage.	5 volts ± 0.5 volts
Decision	
Is voltage less than 5 volts ± 0.5 volts?	Yes: Replace AFTFP sensor. After repairs are complete, retest for SPN 3480 FMI 4.
	No: Go to test 3.

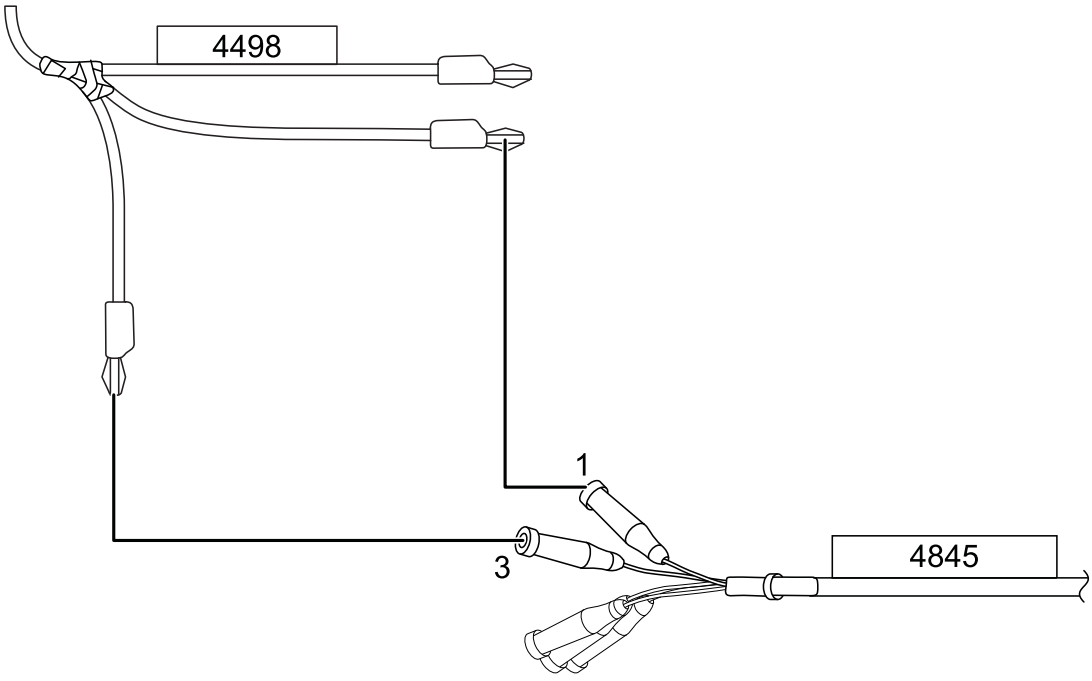

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Figure 77 AFTFP1 Circuit Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4845 to vehicle harness and leave AFTFP disconnected. C. Using Breakout Harness ZTSE4498 short Breakout Harness ZTSE4845 pin-1 and pin-3 together. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON. Log in to ServiceMaxx™ software.

Test 3	Specification
Using EST with ServiceMaxx™ software, clear Diagnostic Trouble Code (DTC) list.	SPN 3480 FMI 3 sets
Decision	
Does SPN 5125 FMI 14 sets in DTC list?	Yes: Repair short to GND between AFTFP pin 3 and ACM pin J1-72. After repairs are complete, retest for SPN 3480 FMI 4.
	No: Repair Open between AFTFP pin 3 and ACM pin J1-72. After repairs are complete, retest for SPN 3480 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and proper decision was made. Return to SPN 3480 FMI 4 fault code diagnostics.

SPN 3480 FM 17 - AFTFP Below Normal Operating Range

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Aftertreatment Fuel Pressure (AFTFP) sensor signal is valid but below normal operating range.	Aftertreatment Fuel Pressure (AFTFP) sensor signal is below 300 kPa (gauge) (43.5 psi) for greater than 15 seconds.	Rate of active / intrusive injection of fuel in exhaust > 0.1 g/sec Inactive: SPN 168 FMI 18 (ACM Power); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 2, 3, 4 (AFTFP); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFT: PAV); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (AFT System); SPN 4796 FMI 31 (AFT System); SPN 5742 FMI 3, 4, 11, 19 (DOC/DPF Temp Sensor Module)

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects Aftertreatment Fuel Pressure (AFTFP) sensor signal is valid but below normal operating range. This diagnostic runs during active regeneration of the aftertreatment diesel particulate filter. When this fault is active, active regeneration of the aftertreatment diesel particulate filter will be disabled until the next key cycle. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

None

Fault Facts

Fuel restriction diagnostic runs when Aftertreatment Fuel Injector (AFTFI) is open, Aftertreatment Fuel Shutoff Valve (AFTFPSO) is open, and Aftertreatment Purge Air Valve (AFTPAV) is closed. When enable conditions are met, a counter will count when fuel pressure is below the minimum to dose threshold. A fault will set when the failure monitor is triggered.

Drive Cycle to Determine Fault Status

Road Test

Possible Causes

- Restricted, damaged, or leaking fuel line to the aftertreatment fuel doser module

- Restricted, damaged, or leaking aftertreatment fuel doser module
- Low Fuel Delivery Pressure (FDP)

Step 1	Check FDP.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 85 psi or greater?		Yes: Go to step 2. No: Perform Fuel Delivery Pressure (FDP) Test (see page 165). After repairs are complete, retest for SPN 3480 FMI 17.

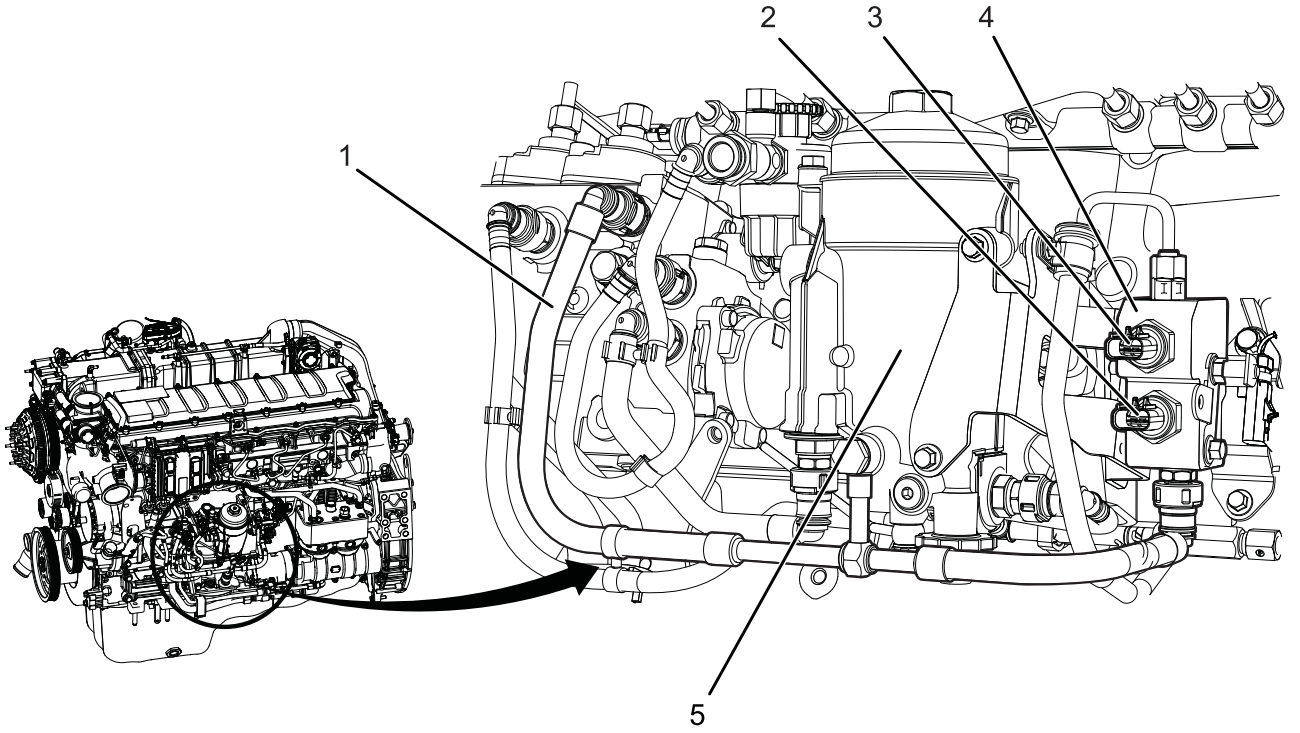

Figure 78 AFTFP Location.

1. Aftertreatment Fully Supply Module
2. Aftertreatment Fuel Pressure Shutoff (AFTFPSO)
3. AFT Fuel Pressure 1 (AFTFP)
4. Aftertreatment Fuel Supply Module (AFTFSM)
5. Secondary Fuel Filter

Step 2	Inspect AFT Fuel Doser Module for damage, restrictions, and leaks.	Decision
Check AFT Fuel Doser module fuel supply line from the secondary fuel filter assembly to Aftertreatment Fuel Supply Modulefor damage, restrictions or leaks. Is fuel supply line in good condition, not restricted or damaged?		Yes: Replace Aftertreatment Fuel Supply Module. After repairs are complete, retest for SPN 3480 FMI 17.
		No: Replace Aftertreatment Fuel Supply Module fuel supply line. After repairs are complete, retest for SPN 3480 FMI 17.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and proper decision was made. Return to SPN 3480 FMI 17 fault code diagnostics.

AFT: FSV (Aftertreatment Fuel Shutoff Valve) Sensor

Overview of AFT: FSV Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
3482	2	AFT Fuel Shutoff Valve signal erratic, intermittent, or incorrect	• Failed Aftertreatment Fuel Pressure 1 (AFTFP1) sensor • Failed Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed Aftertreatment Purge Air Valve (AFTPAV) • Aftertreatment Fuel Injector (AFTFI) missing poppet • Aftertreatment Fuel Injector (AFTFI) restricted • Restricted fuel line to AFTFI	Step-Based Diagnostics (page 186)
3482	3	AFT Fuel Shutoff Valve short to PWR (Open or high resistance)	• AFTFSV-H circuit short to PWR • AFTFSV-H circuit Open or high resistance • AFTFSV-L circuit Open or high resistance • Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)	Step-Based Diagnostics (page 188)
3482	4	AFT Fuel Shutoff Valve short to GND	• AFTFSV-H short to GND • AFTFSV-H shorted to AFTFSV-L • Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)	Step-Based Diagnostics (page 194)

3482	7	AFT Fuel Shutoff Valve Mechanical system not responding or out of adjustment	• Leaking fuel supply line to the AFT fuel doser module • Restricted fuel filter • Failed low-pressure fuel pump • Restricted Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed AFT Fuel Pressure 1 (AFTFP1)	Step-Based Diagnostics (page 199)
3482	16	AFT Fuel Shutoff Valve Plugged	• Missing, damaged, or leaking fuel supply hose to the AFT Fuel Doser Module • Restricted or stuck closed Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed AFT Fuel Pressure 1 (AFTFP1)	Step-Based Diagnostics (page 202)

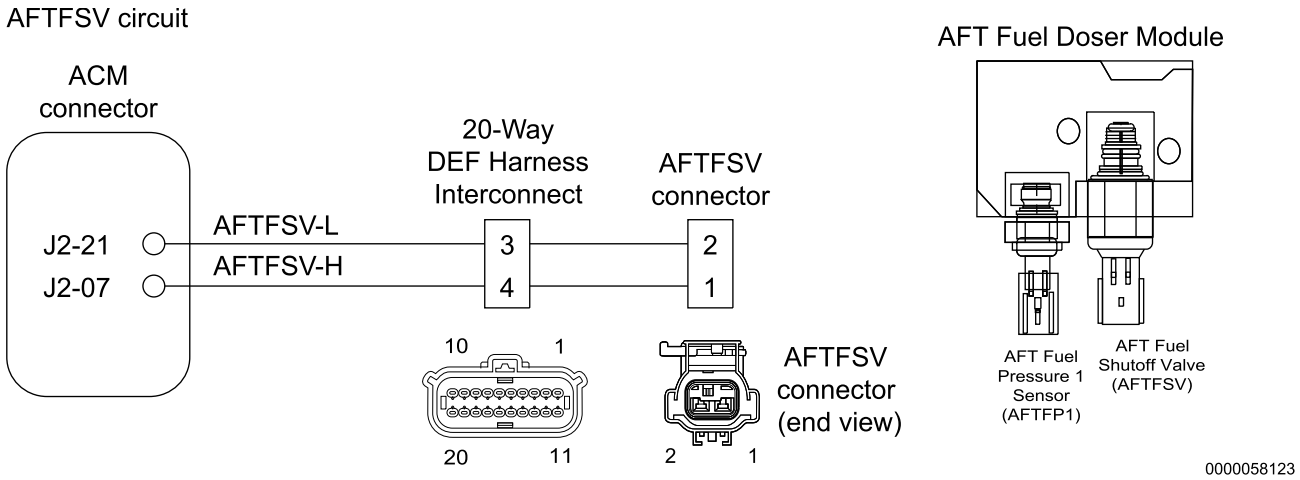

Figure 79 Aftertreatment Fuel Shutoff Valve Circuit Diagram

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Aftertreatment Fuel Shutoff Valve (AFTFSV) is used during active and parked regeneration of the aftertreatment system and is commanded open by the Aftertreatment Control Module (ACM). Diesel fuel is supplied to the AFTFSV from the low-pressure fuel pump which supplies the AFT fuel doser module.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- Breakout Harness ZTSE4760A
- Breakout Harness 18-050-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

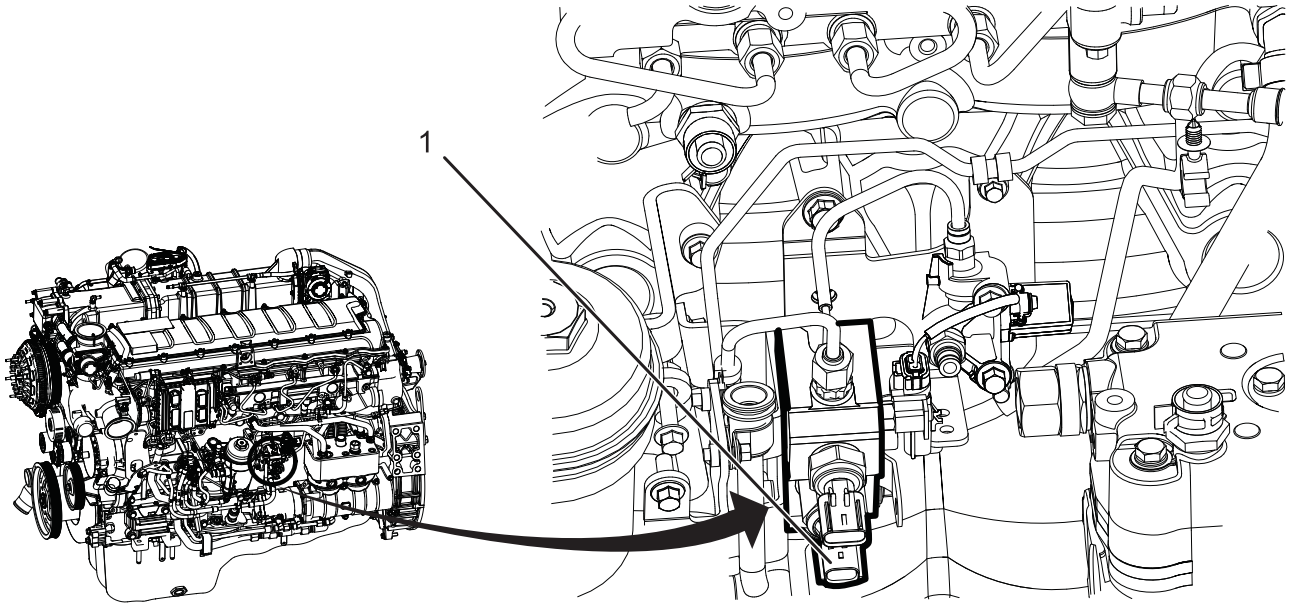

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Figure 80 Aftertreatment Shutoff Valve Location

1. Aftertreatment Fuel Shutoff Valve (AFTFSV)

SPN 3482 FMI 2 - AFT Fuel Shutoff Valve Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Pressure 1 (AFTFP1) has detected a leaking Aftertreatment Fuel Shutoff Valve (AFTFSV), leaking Aftertreatment Purge Air Valve (AFTPAV), or a stuck closed Aftertreatment Fuel Injector (AFTFI).	AFTFP1 pressure greater than 62 psi (425 kpa) when AFTFI is open AND the AFTPAV and AFTFSV are closed. OR (Pressure measured by the AFTFP1 with the AFTFI, AFTFSV and AFTPAV closed) - (pressure measured by AFTFP1 when the AFTFI is open AND the AFTPAV and AFTFSV are closed) > 58 psi (400 kPa).	Engine Running Engine run time > 180 sec Active regeneration Inactive: SPN 168 FMI 18 (ACM PWR); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3480 FMI 2, 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (DPFDP); SPN 4796 FMI 31 (DOC); SPN 5742 FMI 3, 4, 11, 12 (DOC/DPF Temp Sensor Module).	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects an internally leaking Aftertreatment Fuel Shutoff Valve (AFTFSV), Aftertreatment Purge Air Valve (AFTPAV), or a stuck closed Aftertreatment Fuel Injector (AFTFI). The AFTFI is commanded On at the start of the test. This will purge pressure in the fuel supply line. A pressure sample is then taken by the AFTFP1. An AFTFI restricted, stuck closed or missing the lower poppet, a leaking AFTFSV, or a leaking AFTPAV is detected if this pressure sample is above expected ambient pressure.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3480 FMI 2, 3, and 4 (AFTFP1); SPN 3482 FMI 3 and 4 (AFTFSV); SPN 3556 FMI 2 and 5 (AFTFI).

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed AFTFP1
- Failed AFTFSV
- Failed AFTPAV
- AFTFI missing lower poppet
- AFTFI failed or restricted

- Restricted fuel line to AFTFI

Step 1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 2, 3, and 4 (AFTFP1); SPN 3482 FMI 3 and 4 (AFTFSV); and SPN 3556 FMI 2 and 5 (AFTFI).	Decision
Is EST DTC list free of SPN 3480 FMI 2, 3, and 4; SPN 3482 FMI 3 and 4; and SPN 3556 FMI 2 and 5?		Yes: Go to step 2.
		No: Repair SPN 3480 FMI 2, 3, and 4; and SPN 3482 FMI 3 and 4; SPN 3556 FMI 2 and 5. After repairs are complete, retest for SPN 3482 FMI 2.

Step 2	Check for restricted or damaged fuel line between AFT fuel doser module and Aftertreatment Fuel Injector (AFTFI).	Decision
Is the fuel line unrestricted and in good condition?		Yes: Go to step 3.
		No: Repair or replace fuel line. After repairs are complete, retest for SPN 3482 FMI 2.

Step 3	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650).	Decision
Was 5 ml or less of fuel dispensed?		Yes: Go to step 4.
		No: Replace AFTFSV. After repairs are complete, retest for SPN 3482 FMI 2.

Step 4	Remove the Aftertreatment Fuel Injector (AFTFI) see *Engine Service Manual*. Inspect the AFTFI lower poppet.	Decision
Is the AFTFI missing the lower poppet?		Yes: Replace AFTFI. After repairs are complete, retest for SPN 3842 FMI 2.
		No: Go to step 5.

Step 5	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652).	Decision
Was 5 ml or less of fuel dispensed?		Yes: Go to step 6.
		No: Replace AFTFI. After repairs are complete, retest for SPN 3482 FMI 2.

Step 6	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648).	Decision
Was 225 to 500 ml of fuel dispensed within 2.5 minutes?		Yes: Go to step 7
		No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3482 FMI 2.

Step 7	Check for a leaking or stuck open Aftertreatment Purge Air Valve (AFTPAV). Using EST, command AFTFI ON and check for air flow from AFTFI tip.	Decision
Is the AFTFI Free of air flow?		Yes: Replace AFTFP1 sensor. After repairs are complete, retest for SPN 3482 FMI 2.
		No: Replace AFTPAV. After repairs are complete, retest for SPN 3482 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3482 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3482 FMI 3 - AFT Fuel Shutoff Valve Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Shutoff Valve (AFTFSV) circuit voltage above normal, shorted to high source, or open or high resistance. High signal voltage detected at the AFTFSV.	The resistance between AFTFSV-H circuit and AFTFSV-L circuit > 500,000 ohms	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Aftertreatment Fuel Shutoff Valve (AFTFSV) is high. Active regeneration of the aftertreatment system is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

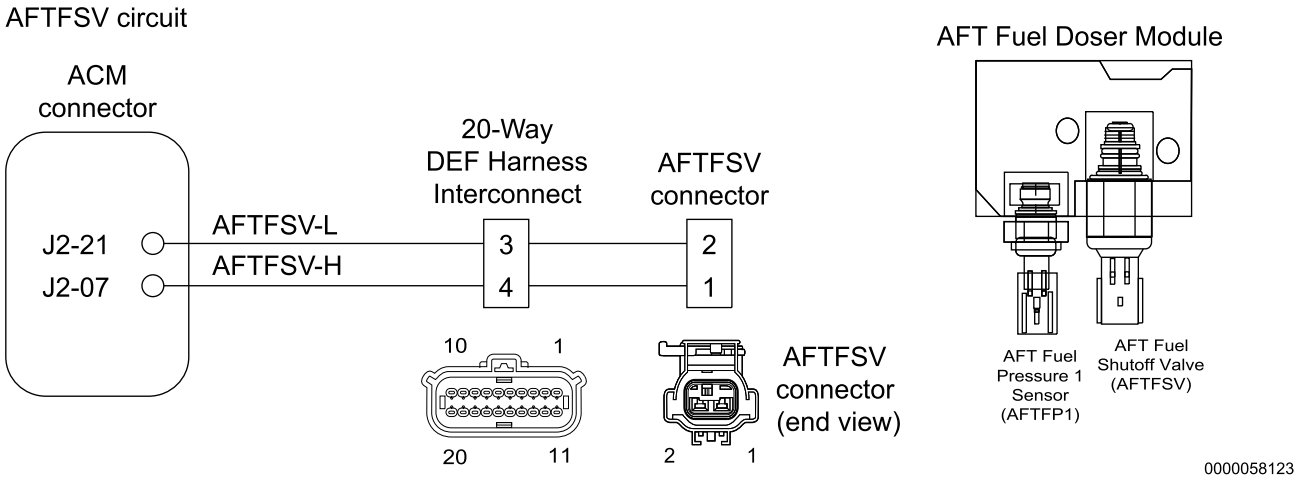

Figure 81 Aftertreatment Fuel Shutoff Valve Circuit Diagram

Possible Causes

- AFTFSV-H circuit short to PWR
- AFTFSV-H circuit Open or high resistance
- AFTFSV-L circuit Open or high resistance
- Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)

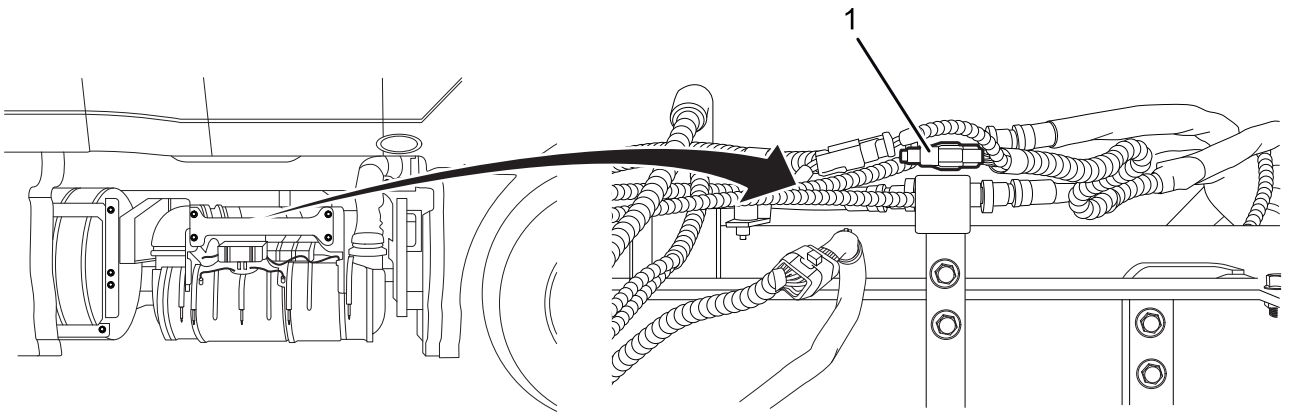

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Figure 82 20-Way DEF Harness Interconnect Location (Typical)

1. 20-Way DEF Harness Interconnect

Step 1	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing.	Decision
Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?		Yes: Go to step 2.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3482 FMI 3.

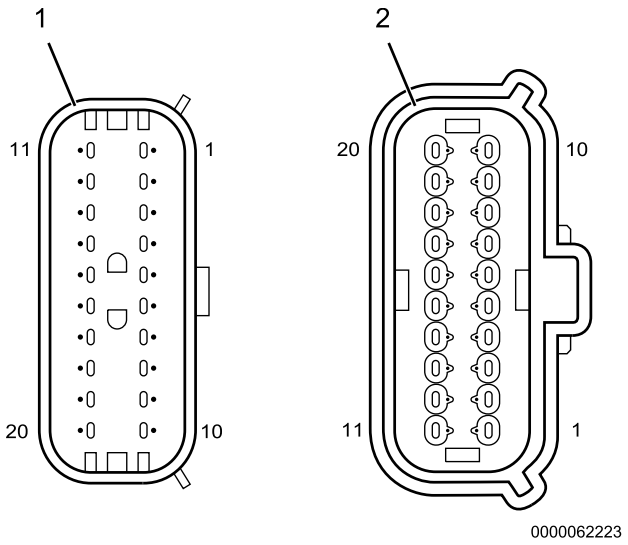

Figure 83 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step 2	Check Aftertreatment Fuel Shutoff Valve (AFTFSV-H) circuit for short to PWR. Connect Breakout Harness 18-050-01 to the female side of the 20-Way DEF harness interconnect and leave 20-Way disconnected. Key OFF, use a DMM to measure voltage between Breakout Harness pin-4 and a known good ground.	Decision
Is voltage less than 0.5 Volts?		Yes: Go to step 3.
		No: Repair short to PWR between 20-way DEF harness interconnect and AFTFSV. After repairs are complete, retest for SPN 3482 FMI 3.

Step 3	Check Aftertreatment Fuel Shutoff Valve (AFTFSV) circuit for Open or high resistance. Connect Breakout Harness 18-050-01 to the female side of the 20-Way DEF harness interconnect and leave 20-Way disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-3 and pin-4.	Decision
Is resistance less than 20 ohms?		Yes: Go to step 7.
		No: Go to step 4.

Step 4	Inspect connections at AFTFSV. Key OFF, disconnect AFTFSV. Check AFTFSV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing.	Decision
Are the AFTFSV connector, harness, and terminals clean and undamaged?		Yes: Go to step 5.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3482 FMI 3.

Step 5	Check AFTFSV-H circuit for Open or high resistance between the 20-way DEF harness interconnect and the AFTFSV. Connect Breakout Harness ZTSE4760A to AFTFSV connector and leave AFTFSV disconnected. Connect Breakout Harness 18-050-01 to 20-way DEF harness interconnect and leave disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and Breakout Harness 18-050-01 pin-4.	Decision
Is resistance less than 5 ohms?		Yes: Go to step 6.
		No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-4 and AFTFSV pin-1. After repairs are complete, retest for SPN 3482 FMI 3.

Step 6	Check AFTFSV-L circuit for Open or high resistance between the 20-way DEF harness interconnect and the AFTFSV. Connect Breakout Harness ZTSE4760A to AFTFSV connector and leave AFTFSV disconnected. Connect Breakout Harness 18-050-01 to 20-way DEF harness interconnect and leave disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-2 and Breakout Harness 18-050-01 pin-3.	Decision
Is resistance less than 5 ohms?		Yes: Replace AFTFSV. After repairs are complete, retest for SPN 3482 FMI 3
		No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-3 and AFTFSV pin-2. After repairs are complete, retest for SPN 3482 FMI 3.

Step 7	Check Aftertreatment Fuel Shutoff Valve (AFTFSV-H) circuit for short to PWR. Connect Breakout Harness 18-050-01 to the male side of the 20-Way DEF harness interconnect and leave 20-Way DEF harness interconnect disconnected. Key ON with ACM disconnected, use a DMM to measure voltage between Breakout Harness 18-050-01 pin-4 and a known good ground.	Decision
Is voltage less than 0.5 Volts?		Yes: Go to step 8.
		No: Repair short to PWR between 20-way connector pin-4 and ACM DEF harness interconnect J2-07. After repairs are complete, retest for SPN 3482 FMI 3.

Step 8	Check AFTFSV-H circuit for Open or high resistance between the 20-Way DEF harness interconnect and the ACM. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-4 and 180-pin Breakout Box pin J2-07.	Decision
Is resistance less than 5 ohms?		Yes: Repair Open or high resistance between 20-Way DEF harness interconnect pin-3 and ACM DEF harness interconnect J2-21. After repairs are complete, retest for SPN 3482 FMI 3.
		No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-4 and ACM DEF harness interconnect J2-07. After repairs are complete, retest for SPN 3482 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3482 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3482 FM 4 - AFT Fuel Shutoff Valve Short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Shutoff Valve (AFTFSV) driver control line is shorted to ground.	The resistance between the AFTFSV driver line and ground < 0.2 Ohms	Key ON The AFTFSV is commanded ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects a short to ground in the Aftertreatment Fuel Shutoff Valve (AFTFSV) circuit. Active regeneration of the Diesel Particulate Filter (DPF) is disabled until the next key cycle, and engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

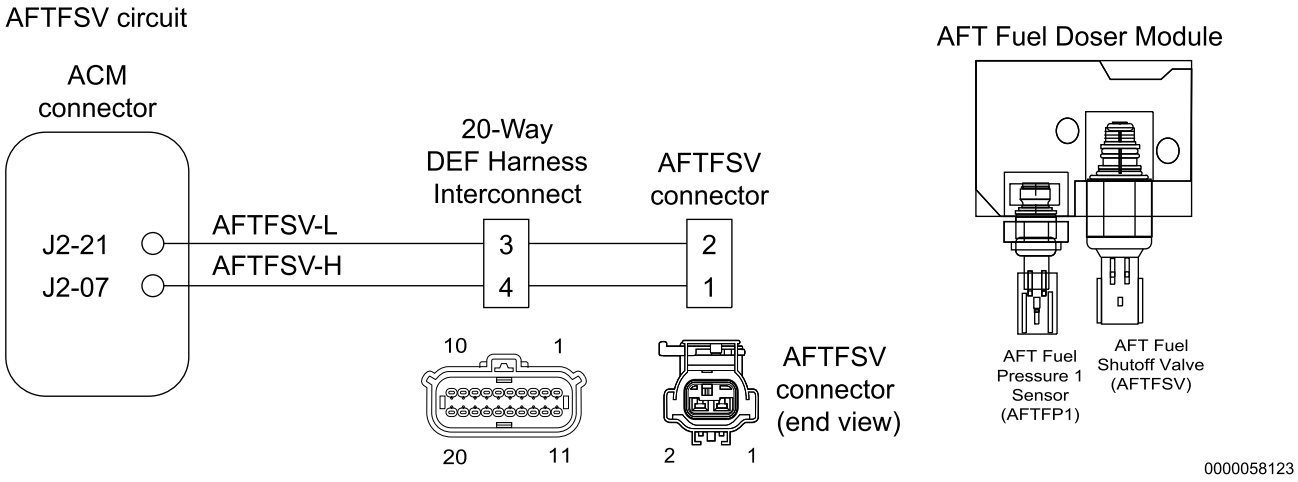

Figure 84 Aftertreatment Fuel Shutoff Valve Circuit Diagram

Possible Causes

- AFTFSV-H short to GND
- AFTFSV-H shorted to AFTFSV-L
- Failed Aftertreatment Fuel Shutoff Valve (AFTFSV)

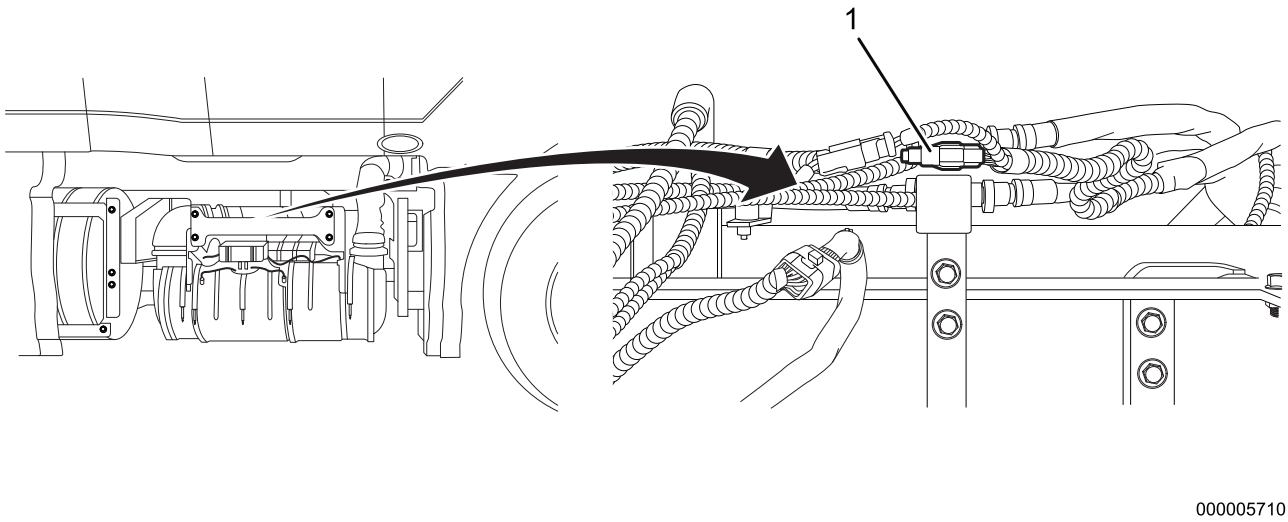

Figure 85 20-Way DEF Harness Interconnect Location (Typical)

1. 20-Way DEF Harness Interconnect

Step	Action	Decision
1	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 2.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3482 FMI 4.

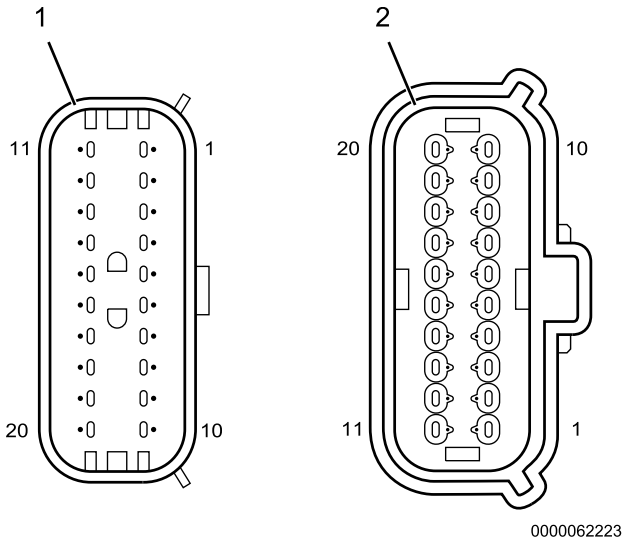

Figure 86 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
2	Check AFTFSV-H circuit for short to ground on male side of 20-Way DEF harness interconnect. Connect Breakout Harness 18-050-01 to the male side of the 20-Way DEF harness interconnect and leave 20-Way DEF harness interconnect disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-4 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3.
		No: Repair short to ground between 20-Way DEF harness interconnect pin-4 and ACM connector J2-07. After repairs are complete, retest for SPN 3482 FMI 4.

Step	Action	Decision
3	Determine if AFTFSV-H circuit is shorted to AFTFSV-L circuit between 20-Way DEF harness interconnect and Aftertreatment Control Module (ACM). Connect 180-Pin Breakout Box and ACM Breakout Harness 18-537-01 to ACM harness and leave ACM disconnected. Key OFF, with 20-Way DEF harness interconnect disconnected, measure resistance between Breakout Box pin J2-07 and pin J2-21. Is resistance greater than 1000 ohms?	Yes: Go to step 4.
		No: Repair short between AFTFSV-H circuit and AFTFSV-L circuit. After repairs are complete, retest for SPN 3482 FMI 4.

Step	Action	Decision
4	Inspect connections at Aftertreatment Fuel Shutoff Valve (AFTFSV). Key OFF, disconnect AFTFSV. Check AFTFSV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFSV connector, harness, and terminals clean and undamaged?	Yes: Go to step 5.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3482 FMI 4.

Step	Action	Decision
5	Check AFTFSV-H circuit for short to ground between 20-Way DEF harness interconnect and AFTFSV. Connect Breakout Harness ZTSE4760A to AFTFSV and leave AFTFSV disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6.
		No: Repair short to ground between AFTFSV connector pin-1 and 20-Way DEF harness interconnect pin-4. After repairs are complete, retest for SPN 3482 FMI 4.

Step	Action	Decision
6	Determine if AFTFSV-H circuit is shorted to AFTFSV-L circuit between 20-Way DEF harness interconnect and AFTFSV. Connect Breakout Harness ZTSE4760A to AFTFSV connector and leave AFTFSV disconnected. Key OFF, with 20-Way DEF harness interconnect disconnected, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Replace AFTFSV. After repairs are complete, retest for SPN 3482 FMI 4.
		No: Repair short between AFTFSV-H circuit and AFTFSV-L circuit, between 20-Way DEF harness interconnect and AFTFSV. After repairs are complete, retest for SPN 3482 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3482 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3482 FM 7 - AFT Fuel Shutoff Valve Mechanical System Not Responding or Out of Adjustment

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Pressure 1 (AFTFP1) pressure is too low when the Aftertreatment Fuel Shutoff Valve (AFTFSV) is commanded open.	(Pressure measured by AFTFP1 with the AFTFSV commanded open) - (ambient pressure reading taken when the Aftertreatment Fuel Injector (AFTFI) open AND the AFTPAV and AFTFSV are closed) < 65 psi (450 kPa) Pressure measured by the AFTFP1 sensor with the AFTFSV command open < 80 psi (550 kPa)	Engine Running Engine run time > 180 sec Diagnostic runs prior to regeneration of the Diesel Particulate Filter (DPF) Inactive: SPN 168 FMI 18 (ACM PWR); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2, 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 2, 3, 4, 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (DPFDP); SPN 4796 FMI 31 (DOC); SPN 5742 FMI 3, 4, 11, 12 (DOC/DPF Temp Sensor Module).	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Aftertreatment Fuel Pressure 1 sensor (AFTFP1) is reading lower than expected when the Aftertreatment Fuel Shutoff Valve (AFTFSV) is commanded open. This test closes the Aftertreatment Purge Air Valve (AFTPAV) and the AFTFI and then opens the AFTFSV. A pressure sample will be taken by AFTFP1, which is expected to be the fuel supply pressure. A stuck closed AFTFSV is detected if this pressure is not above a minimum threshold OR is too close to the ambient pressure reading.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3480 FMI 2, 3, and 4(AFTFP1); SPN 3482 FMI 3 and 4 (AFTFSV); SPN 3556 FMI 2 and 5 (AFTFI).

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

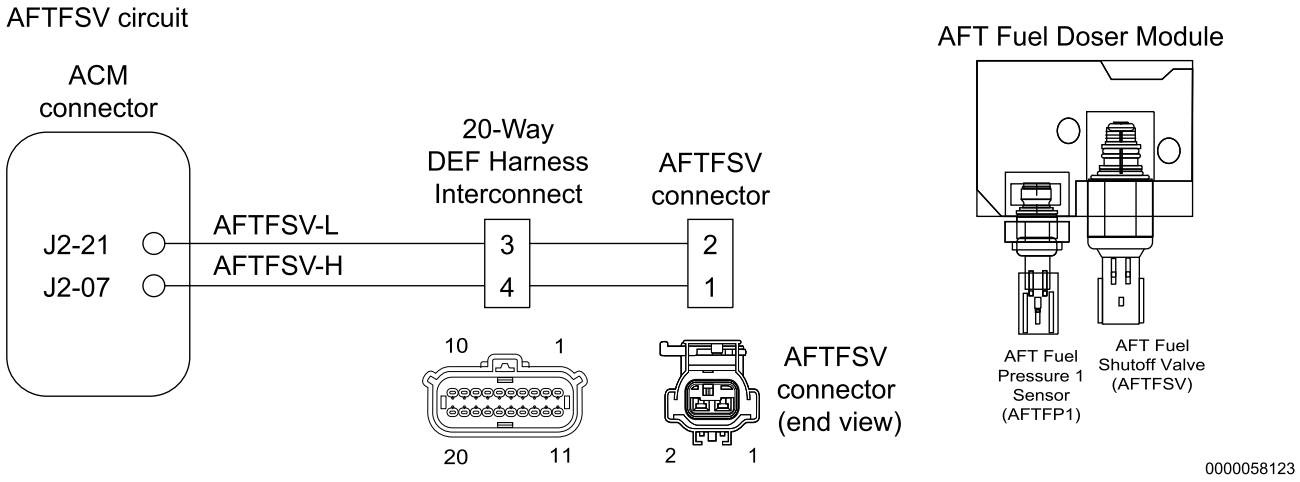

Figure 87 Aftertreatment Fuel Shutoff Valve Circuit Diagram

Possible Causes

- Leaking fuel supply line to the AFT fuel doser module
- Restricted fuel filter
- Failed low-pressure fuel pump
- Restricted Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed AFT Fuel Pressure 1 (AFTFP1)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 2, 3, and 4 (AFTFP1); SPN 3482 FMI 3 and 4 (AFTFSV); and SPN 3556 FMI 2 and 5 (AFTFI). Is EST DTC list free of SPN 3480 FMI 2, 3, and 4; SPN 3482 FMI 3 and 4; and SPN 3556 FMI 2 and 5?	Yes: Go to step 2.
		No: Repair SPN 3480 FMI 2, 3, and 4; SPN 3482 FMI 3 and 4; and SPN 3556 FMI 2 and 5. After repairs are complete, retest for SPN 3482 FMI 7.

NOTE: If engine performance symptoms are present, see Performance Diagnostics .

Step	Action	Decision
2	Check for missing, leaking, or damaged fuel supply line to AFTFSV. Key-On Engine-Running (KOER), inspect fuel supply line to AFTFSV for restrictions and leaks. Is the fuel supply line to the AFTFSV present and in good condition?	Yes: Go to step 3.
		No: Repair or replace fuel supply to AFTFSV. After repairs are complete, retest for SPN 3482 FMI 7.

Step	Action	Decision
3	Check Fuel Delivery Pressure (FDP). Using EST with ServiceMaxx™ software, Key-On Engine-Running (KOER), monitor FDP. Is FDP 85-120 psi	Yes: Go to step 4.
		No: Repair low-pressure fuel system. After repairs are complete, retest for SPN 3482 FMI 7.

Step	Action	Decision
4	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Replace AFTFP1 sensor. After repairs are complete, retest for SPN 3482 FMI 7.
		No: Replace AFTFSV. After repairs are complete, retest for SPN 3482 FMI 7.

NOTE: After performing all diagnostic steps, if SPN 3482 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3482 FM 16 - AFT Fuel Shutoff Valve Plugged

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Shutoff Valve (AFTFSV) mechanically stuck closed.	(Pressure measured by AFTFP1 with the AFTFSV commanded open) - (ambient pressure reading taken when AFTFI is open AND the AFTPAV and AFTFSV are closed) < 65 psi (450 kPa)(gauge) Pressure measured by the AFTFP1 with the AFTFSV command open < 80 psi (550 kPa)(gauge)	Engine Running Engine run time > 180 sec Diagnostic runs during active regeneration of the diesel particulate filter.	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the aftertreatment fuel pressure sensor (AFTFP1) is not reading a pressure increase when the aftertreatment fuel shutoff valve (AFTFSV) is commanded open.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 3480 FMI 2, 3, and 4 (AFTFP1); and SPN 3482 FMI 3 and 4 (AFTFSV).

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

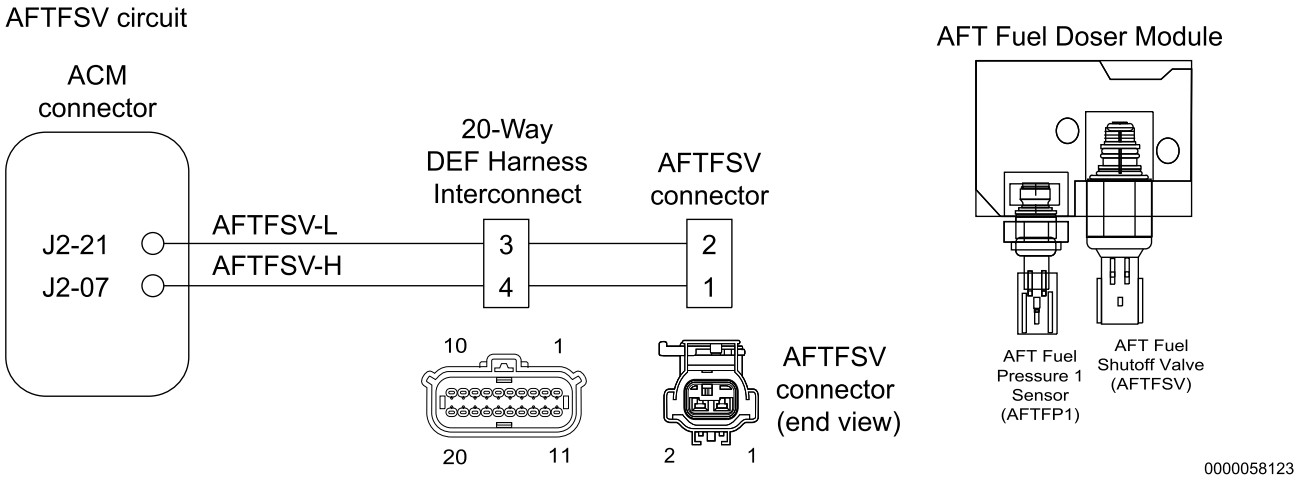

Figure 88 Aftertreatment Fuel Shutoff Valve Circuit Diagram

Possible Causes

- Missing, damaged, or leaking fuel supply hose to the AFT Fuel Doser Module
- Restricted or stuck closed Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed AFT Fuel Pressure 1 (AFTFP1)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 3480 FMI 2, 3, and 4 (AFTFP1); and SPN 3482 FMI 3 and 4 (AFTFSV). Is EST DTC list free of SPN 94; SPN 3480 FMI 2, 3, and 4; and SPN 3482 FMI 3 and 4?	Yes: Go to step 2.
		No: Repair SPN 94; SPN 3480 FMI 2, 3, and 4; and SPN 3482 FMI 3 and 4. After repairs are complete, retest for SPN 3482 FMI 16.

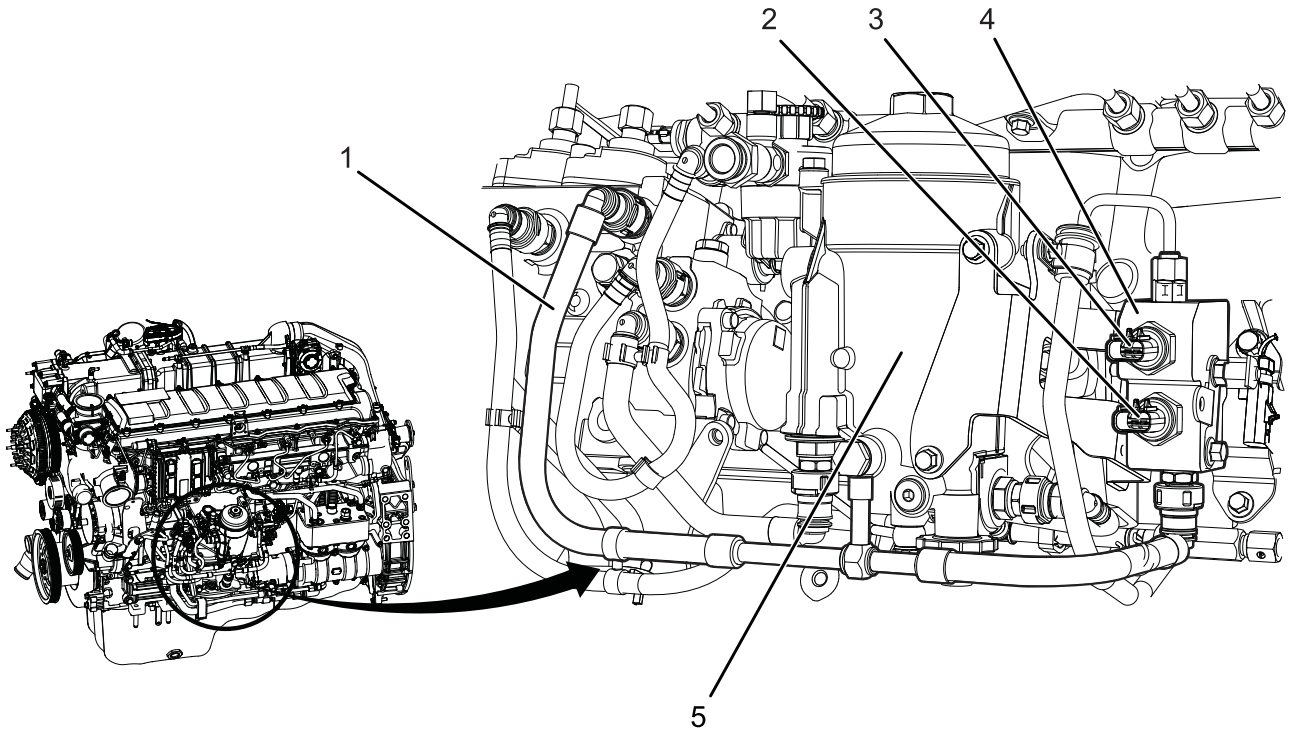

Figure 89 AFTFP1 Location.

1. AFT Fuel Doser Module fuel supply line
2. AFT Fuel Shutoff Valve (AFTFSV)
3. AFT Fuel Pressure 1 (AFTFP1)
4. AFT Fuel Doser Module

Step	Action	Decision
2	Check after-filter fuel supply hose from the secondary fuel filter assembly to the AFT fuel doser module for damage, restrictions, or leaks. Is fuel supply hose in good condition, not restricted, or damaged?	Yes: Replace AFTFSV. After repairs are complete, retest for SPN 3482 FMI 16.
		No: Repair fuel supply to AFTFSV. After repairs are complete, retest for SPN 3482 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 3482 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

AFT: PAV Sensor

Overview of AFT: PAV Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
3490	3	AFT: PAV short to PWR (Open or high resistance)	• AFT: PAV-1 circuit short to PWR • AFT: PAV-1 circuit Open or high resistance • AFT: PAV-2 circuit Open or high resistance • Failed Aftertreatment Purge Air Valve (AFT: PAV)	Step-Based Diagnostics (page 207)
3490	4	AFT: PAV short to GND	• AFT: PAV-1 shorted to AFT: PAV-2 • AFT: PAV-1 short to GND • Failed Aftertreatment Purge Air Valve (AFT: PAV)	Step-Based Diagnostics (page 211)
3490	7	AFT: PAV Mechanical system not responding or out of adjustment	• Missing or leaking air supply line to AFT: PAV • Missing or leaking air supply line to AFT Fuel Doser module • Failed AFT: PAV (stuck closed)	Step-Based Diagnostics (page 215)

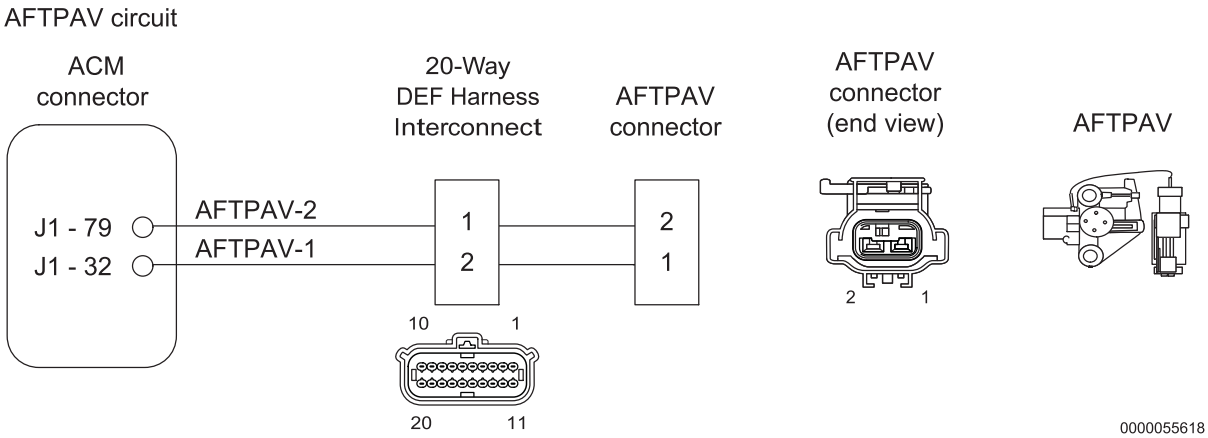

Figure 90 AFT: PAV Circuit Diagram

Overview

The Aftertreatment Purge Air Valve (AFT: PAV) is used to purge the Aftertreatment Fuel Injector (AFTFI) of fuel after active regeneration of the Aftertreatment system, and at Key Off. When purging is needed, the Aftertreatment Control Module (ACM) commands the AFT: PAV ON, and AFTFI open. The ACM does this by sending battery voltage through the AFT: PAV-1 circuit to open the AFT: PAV. This allows pressurized air to flow from the vehicle air tanks, to the AFT: PAV, through the AFT Fuel Doser module, and out the AFTFI.

Tools Required

- 00-00956-08 – 180-Pin Breakout Box
- SCR (ACM) Breakout Harness 18-537-01 (96-Pin)
- Breakout Harness ZTSE4760A
- Breakout Harness 18-050-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

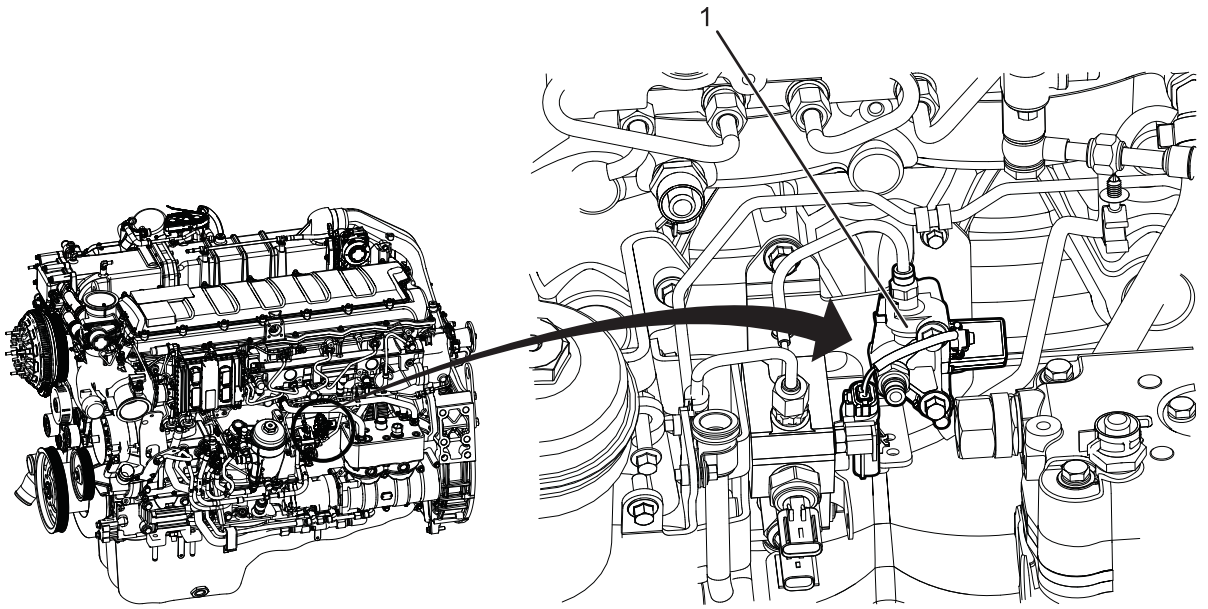

Figure 91 AFT: PAV Location

1. Aftertreatment Purge Air Valve (AFT: PAV)

SPN 3490 FMI 3 - AFT: PAV Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Purge Air Valve (AFT: PAV) circuit voltage above normal, shorted to high source, Open or High resistance. High signal voltage detected at the AFT: PAV	The resistance between AFT: PAV-1 circuit and ground > 500,000 ohms	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Aftertreatment Purge Air Valve (AFT: PAV) is high. Active regeneration of the Aftertreatment system is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

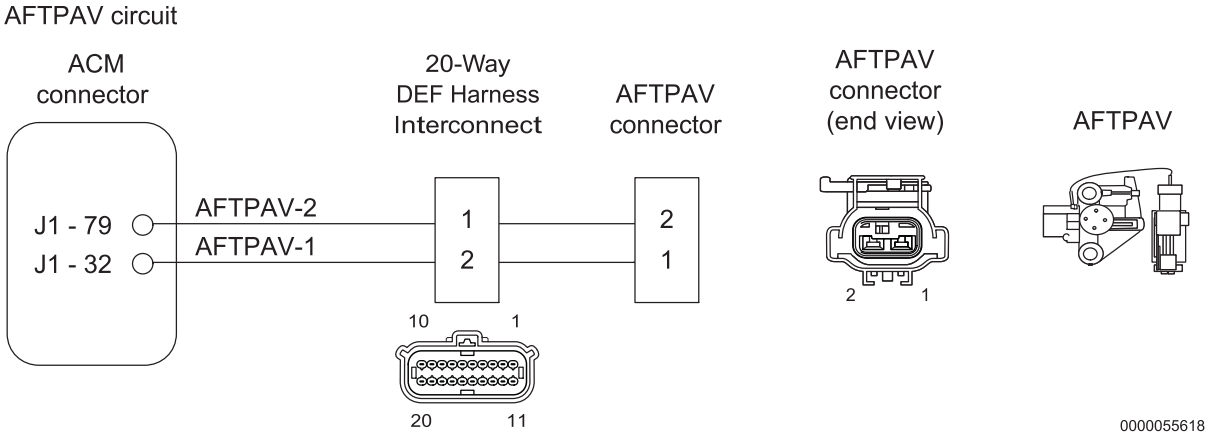

Figure 92 AFT: PAV Circuit Diagram

Possible Causes

- AFT: PAV-1 circuit short to PWR
- AFT: PAV-1 circuit Open or high resistance
- AFT: PAV-2 circuit Open or high resistance
- Failed Aftertreatment Purge Air Valve (AFT: PAV)

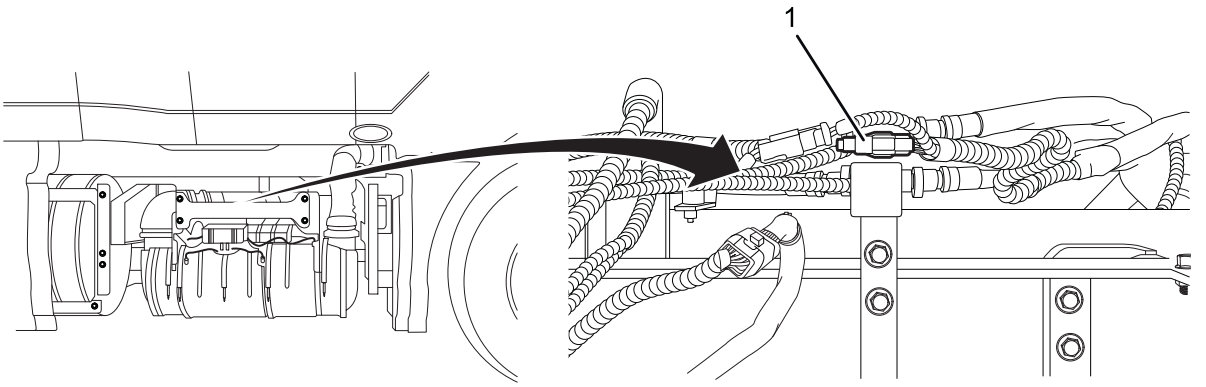

Figure 93 20-Way DEF Harness Interconnect Location (Typical)

1. 20-Way DEF harness interconnect

Step	Action	Decision
1	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After

		repairs are complete, retest for SPN 3490 FMI 3.

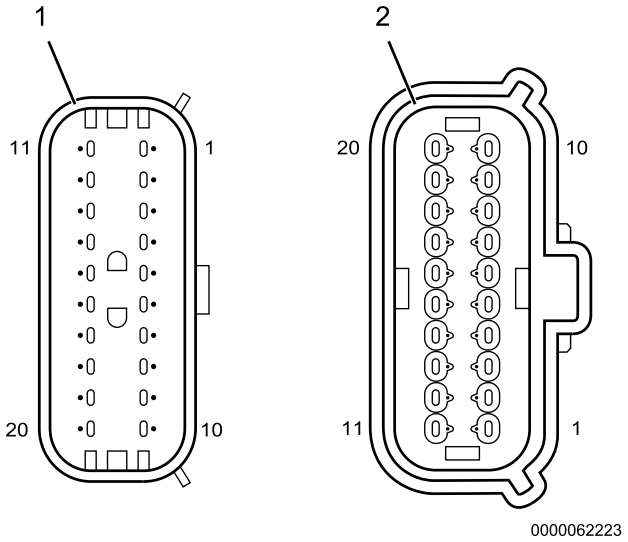

Figure 94 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
2	Check AFT: PAV circuit for Open or high resistance between the 20-Way DEF harness interconnect and AFT: PAV. Connect Breakout Harness 18-050-01 to the female side of the 20-Way DEF harness interconnect and leave male side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance less than 20 ohms (normal operation)?	Yes: Go to step 6. No: Go to step 3.

Step	Action	Decision
3	Inspect connections at Aftertreatment Purge Air Valve (AFT: PAV). Key OFF, disconnect AFT: PAV. Check AFT: PAV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFT: PAV connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3490 FMI 3.

Step	Action	Decision
4	Check AFT: PAV-1 circuit for Open or high resistance between the 20-way DEF harness interconnect and the AFT: PAV. Connect Breakout Harness ZTSE4760A to AFT: PAV vehicle harness connector and leave AFT: PAV disconnected. Connect Breakout Harness 18-050-01 to the female side of the 20-way DEF harness interconnect and leave male side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and Breakout Harness 18-050-01 pin-2. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-2 and AFT: PAV pin-1. After repairs are complete, retest for SPN 3490 FMI 3.

Step	Action	Decision
5	Check AFT: PAV-2 circuit for Open or high resistance between the 20-way DEF harness interconnect and the AFT: PAV. Connect Breakout Harness ZTSE4760A to AFT: PAV vehicle harness connector and leave AFT: PAV disconnected. Connect Breakout Harness 18-050-01 to the female side of the 20-way DEF harness interconnect and leave male side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-2 and Breakout Harness 18-050-01 pin-1. Is resistance less than 5 ohms?	Yes: Replace AFT: PAV. After repairs are complete, retest for SPN 3490 FMI 3. No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-1 and AFT: PAV pin-2. After repairs are complete, retest for SPN 3490 FMI 3.

Step	Action	Decision
6	Check AFT: PAV-1 circuit for Open or high resistance between the 20-Way DEF harness interconnect and the ACM. Connect Breakout Harness 18-050-01 to the male side of the 20-Way DEF harness interconnect and leave female side disconnected. Connect 180-Pin Breakout Box with SCR (ACM) Breakout Harness 18-537-01 (96-Pin) to Aftertreatment Control Module (ACM) vehicle harness and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-2 and Breakout Box pin J1-32.	Yes: Go to step 7.

	Is resistance less than 5 ohms?	
		No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-2 and ACM connector J1-32. After repairs are complete, retest for SPN 3490 FMI 3.

Step	Action	Decision
7	Check AFT: PAV-2 circuit for Open or high resistance between the 20-Way DEF harness interconnect and the ACM. Connect Breakout Harness 18-050-01 to the male side of the 20-Way DEF harness interconnect and leave female side disconnected. Connect 180-Pin Breakout Box with SCR (ACM) Breakout Harness 18-537-01 (96-Pin) to ACM vehicle harness and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-1 and Breakout Box pin J1-79. Is resistance less than 5 ohms?	Yes: Repair short to power between AFT: PAV pin-1 and Aftertreatment Control Module (ACM) connector J1-32. After repairs are complete, retest for SPN 3490 FMI 3.
		No: Repair Open or high resistance between 20-Way DEF harness interconnect pin-1 and ACM connector J1-79. After repairs are complete, retest for SPN 3490 FMI 3.

NOTE: After doing all diagnostic steps, if SPN 3490 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3490 FM 4 - AFT: PAV Short to GND

SPN 3490 FMI 4 - AFT: PAV short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Purge Air Valve (AFT: PAV) driver control line is shorted to ground.	The resistance between the AFT: PAV driver line and ground < 0.2 Ohms	Key ON AFT: PAV commanded OFF	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects a short to ground in the Aftertreatment Purge Air Valve (AFT: PAV) circuit. Active regeneration of the Diesel Particulate Filter (DPF) is disabled until the next key cycle, and engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

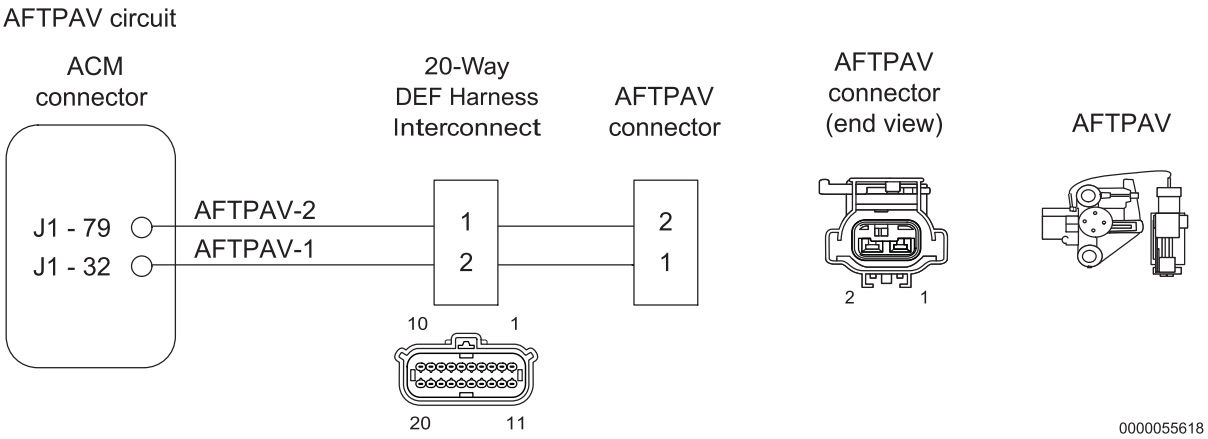

Figure 95 AFT: PAV Circuit Diagram

Possible Causes

- AFT: PAV-1 shorted to AFT: PAV-2
- AFT: PAV-1 short to GND
- Failed Aftertreatment Purge Air Valve (AFT: PAV)

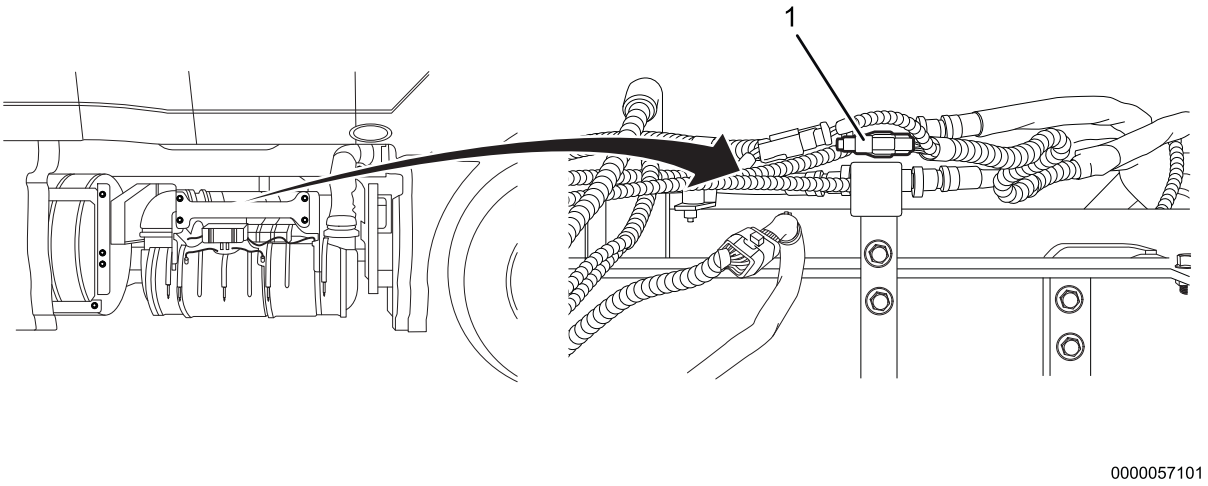

Figure 96 20–Way DEF Harness Interconnect Location (Typical)

1. 20–Way DEF harness interconnect

Step	Action	Decision
1	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 2.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3490 FMI 4.

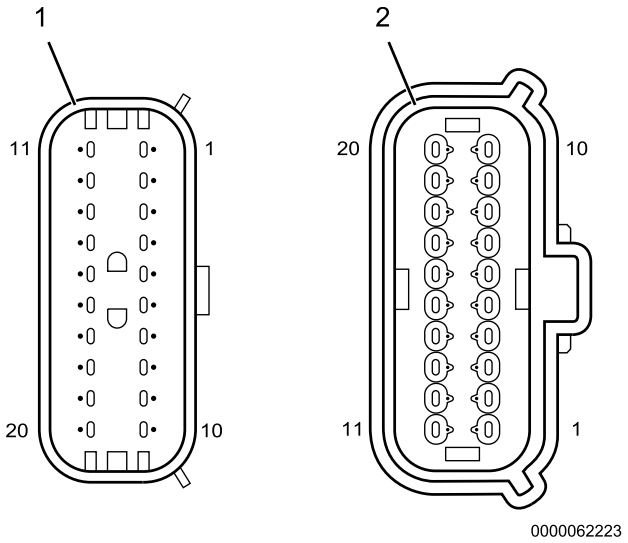

Figure 97 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
2	Check AFT: PAV-1 circuit for short to ground between 20-Way DEF harness interconnect and Aftertreatment Control Module (ACM). Connect Breakout Harness 18-050-01 to the male side of the 20-Way DEF harness interconnect and leave female side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3.
		No: Repair short to ground between 20-Way DEF harness interconnect pin-2 and ACM connector J1-32. After repairs are complete, retest for SPN 3490 FMI 4.

Step	Action	Decision
3	Determine if AFT: PAV-1 circuit is shorted to AFT: PAV-2 circuit between 20-Way DEF harness interconnect and ACM. Connect 180-Pin Breakout Box with ACM Breakout Harness 18-537-01 to ACM harness and leave ACM disconnected. Key OFF, with 20-Way DEF harness interconnect disconnected, measure resistance between Breakout Box pin J1-32 and pin J1-79. Is resistance greater than 1000 ohms?	Yes: Go to step 4.
		No: Repair AFT: PAV-1 circuit shorted to AFT: PAV-2 between 20-Way DEF harness interconnect and ACM. After repairs are complete, retest for SPN 3490 FMI 4.

Step	Action	Decision
4	Inspect connections at Aftertreatment Purge Air Valve (AFT: PAV). Key OFF, disconnect AFT: PAV. Check AFT: PAV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFT: PAV connector, harness, and terminals clean and undamaged?	Yes: Go to step 5.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3490 FMI 4.

Step	Action	Decision
5	Check AFT: PAV-1 circuit for short to ground between 20-Way DEF harness interconnect and AFT: PAV. Connect Breakout Harness ZTSE4760A to AFT: PAV vehicle harness connector and leave AFT: PAV disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6.
		No: Repair short to ground between AFT: PAV connector pin-1 and 20-Way DEF harness interconnect pin-2. After repairs are complete, retest for SPN 3490 FMI 4.

Step	Action	Decision
6	Determine if AFT: PAV-1 circuit is shorted to AFT: PAV-2 circuit between 20-Way DEF harness interconnect and AFT: PAV. Connect Breakout Harness ZTSE4760A to AFT: PAV vehicle harness connector and leave AFT: PAV disconnected. Key OFF, with 20-Way DEF harness interconnect disconnected, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Replace AFT: PAV. After repairs are complete, retest for SPN 3490 FMI 4.
		No: Repair AFT: PAV-1 circuit shorted to AFT: PAV-2 between 20-Way DEF harness interconnect and AFT: PAV. After repairs are complete, retest for SPN 3490 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 3490 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3490 FM 7 - AFT: PAV Mechanical System Not Responding or Out of Adjustment

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Purge Air Valve (AFT: PAV) not responding: OR air line leaking or restricted.	AFTFP1 with AFT: PAV commanded ON < 50 psi (344 kPa)	Key-On Engine-Running (KOER) Diagnostic runs during active regeneration of the diesel particulate filter	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal from the Aftertreatment Fuel Pressure 1 (AFTFP1) sensor is lower than expected when the Aftertreatment Purge Air Valve (AFT: PAV) is commanded ON.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

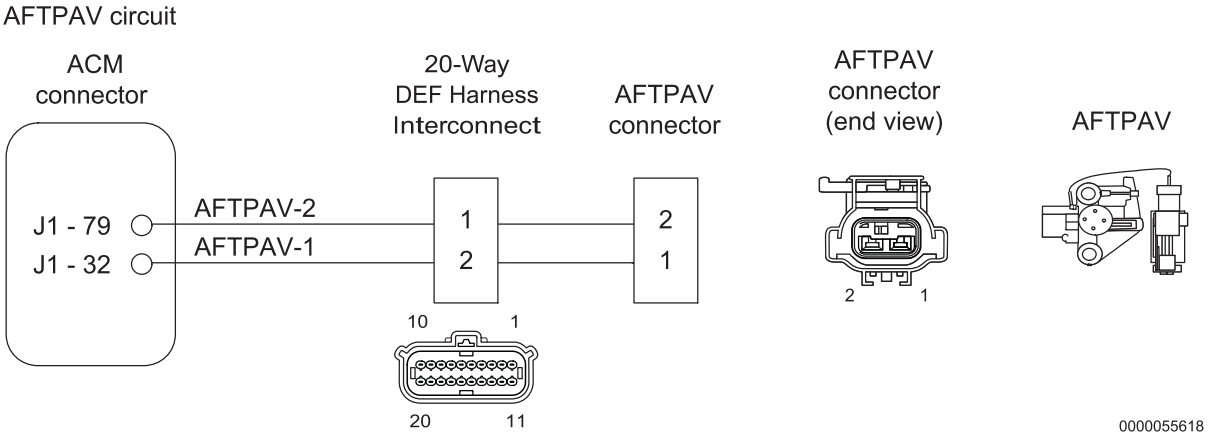

Figure 98 AFT: PAV Circuit Diagram

Possible Causes

- Missing or leaking air supply line to AFTPAV
- Missing or leaking air supply line to AFT Fuel Doser module
- Failed AFTPAV (stuck closed)
- Failed AFTFP1

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 2, 3, and 4 (AFTFP1); and SPN 3490 FMI 3 and 4 (AFT: PAV). Is EST DTC list free of SPN 3480 FMI 2, 3, and 4; and SPN 3490 FMI 3 and 4?	Yes: Go to step 2.
		No: Repair SPN 3480 FMI 2, 3, and 4; and SPN 3490 FMI 3 and 4. After repairs are complete, retest for SPN 3490 FMI 7.

Step	Action	Decision
2	Check for missing, leaking, or damaged air supply line to AFT: PAV. Verify vehicle air supply line to AFT: PAV is properly installed and not damaged. Key-On Engine-Running (KOER), inspect air supply line to AFT: PAV for restrictions and leaks. Is the air supply line to the AFT: PAV present and in good condition?	Yes: Go to step 3.
		No: Repair or replace air supply to AFT: PAV. After repairs are complete, retest for SPN 3490 FMI 7.

Step	Action	Decision
3	Check for missing, leaking, or damaged air supply line from AFT: PAV to AFT Fuel Doser module. Verify air supply line is properly installed and not damaged. Key-On Engine-Off (KOEO), inspect air supply line to AFT Fuel Doser Module for restrictions and leaks. Is the air supply line to the AFT Fuel Doser Module present and in good condition?	Yes: Replace AFT: PAV. After repairs are complete, retest for SPN 3490 FMI 7.
		No: Repair or replace air supply line to AFT Fuel Doser module. After repairs are complete, retest for SPN 3490 FMI 7.

NOTE: To verify proper operation of the AFT: PAV run AFT Purge Air Valve Test. Using EST with ServiceMaxx software go to KOEO Aftertreatment Tests > Actuator - AFT Purge Air Valve, run AFT Purge Air Valve TEST. If AFT: PAV is operating correctly an audible sound will be heard when AFT: PAV is activated.

NOTE: After doing all diagnostic steps, if SPN 3490 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

AFTFI (Aftertreatment Fuel Injector) Sensor

Overview of AFTFI Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
3556	2	AFT Fuel Injector signal erratic, intermittent or incorrect	• Leaking fuel line to AFTFI • Leaking AFT Fuel Doser Module • Failed Aftertreatment Fuel Injector (AFTFI)	Step-Based Diagnostics (page 220)
3556	5	AFT Fuel Injector open load/circuit	• AFTFI-1 circuit Open or high resistance • AFTFI-1 short to GND • AFTFI-1 short to power • AFTFI-2 circuit Open or high resistance • AFTFI-2 short to GND • AFTFI-2 short to power • AFTFI-1 short to AFTFI-2 • Failed Aftertreatment Fuel Injector (AFTFI)	Step-Based Diagnostics (page 222)
3556	18	AFT Fuel Pressure below Warning Pressure (AFTFI at high adaptation limit)	• Damaged or restricted supply line to AFTFI • Restricted AFTFI • Exhaust leak or restriction	Step-Based Diagnostics (page 237)

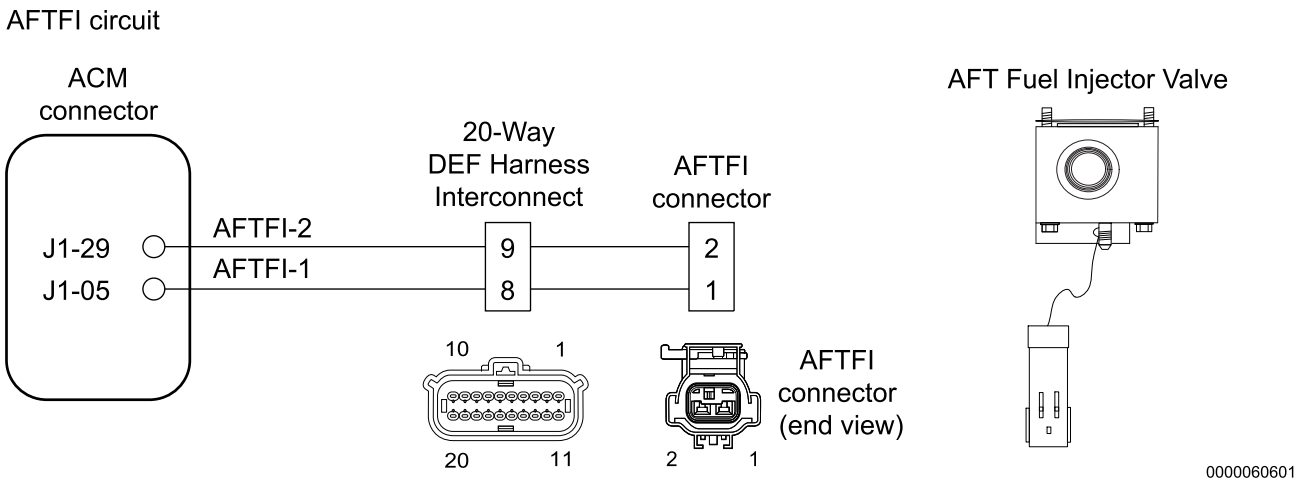

Figure 99 AFTFI Circuit Diagram

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Aftertreatment Fuel Injector (AFTFI) is controlled by the Aftertreatment Control Module (ACM) to dispense fuel into the aftertreatment system during active and parked regenerations of the aftertreatment system.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- Breakout Harness 18-537-01
- Breakout Harness 18-050-01
- Breakout Harness ZTSE4845
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 3556 FMI 2 - AFT Fuel Injector Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Leak detected in the aftertreatment fuel injection system.	(Pressure measured by AFT: FP1 with AFTFSV Open) - (Pressure measured by AFT: FP1 after AFTFSV closed for a predetermined time) > 87 psi (600 kPa)(gauge)	Key ON Active Regeneration requested. Inactive: SPN 168 FMI 18 (ACM); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 2, 3, 4, 17 (AFT: FP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFT: PAV); SPN 3556 FMI 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (DPFDP); SPN 4796 FMI 31 (DOC); SPN 5742 FMI 3 (DPF Temp Module); SPN 5742 FMI 4, 11, 12 (DPF Temp Module)	67 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects a leaking Aftertreatment Fuel Injector (AFTFI) or an external leak. Fuel pressure is building in the system as expected, but not holding.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3480 (AFT: FP1), SPN 3556 FMI 5 (AFTFI), SPN 3482 (AFTFSV), SPN 3490 (AFT: PAV)

Fault Facts

These diagnostics are only performed prior to starting an active regeneration of the DPF, or at Key ON if the active regeneration is continuing across key cycles.

Drive Cycle to Determine Fault Status

Drive cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel line to AFTFI
- Leaking AFT Fuel Doser Module
- Failed AFTFI

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 (AFT: FP1), SPN 3556 FMI 5 (AFTFI), SPN 3482 (AFTFSV), SPN 3490 (AFT: PAV). Is EST DTC list free of SPN 3480, SPN 3556 FMI 5, SPN 3482, or SPN 3490?	Yes: Go to step 2. No: Repair SPN 3480, SPN 3556 FMI 5, SPN 3482, or SPN 3490. After repairs are complete, retest for SPN 3556 FMI 2.

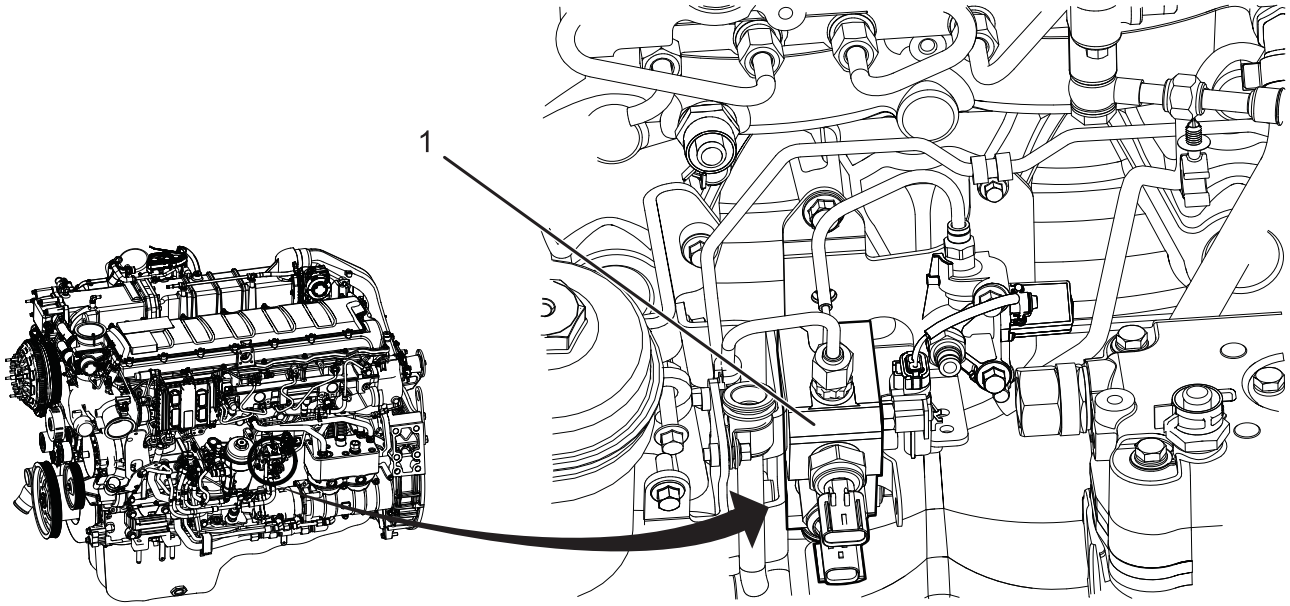

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Figure 100 AFT Fuel Doser Module Location

1. AFT fuel doser module

Step	Action	Decision
2	Inspect the AFT fuel doser module for leaks or damage. Is the AFT fuel doser module Not leaking or damaged?	Yes: Go to step 3. No: Replace AFT fuel doser module. After repairs are complete, retest for SPN 3556 FMI 2.

Step	Action	Decision
3	Check for leaking or damaged fuel supply line to Aftertreatment Fuel Injector (AFTFI). Key-On Engine-Running (KOER), inspect fuel supply line to AFTFI for leaks and damage. Is the fuel supply line to the AFTFI Not leaking or damaged?	Yes: Clean or replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 2. No: Repair or replace fuel supply line to AFTFI. After repairs are complete, retest for SPN 3556 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3556 FMI 2 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3556 FMI 5 - AFT Fuel Injector Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Fuel Injector (AFTFI) circuit electrical fault - shorted to battery, shorted to ground or open.	Resistance between the AFTFI high side and ground < 0.2 Ohms. Resistance between the AFTFI high side and ground, with AFTFI Off, > 1,000,000 Ohms. Resistance between the AFTFI low side and ground, with AFTFI Off, < 0.2 Ohms. Resistance between the AFTFI low side and ground, with AFTFI On, > 1,000,000 Ohms. Resistance between the AFTFI low side and ground, with AFTFI Off, > 1,000,000 Ohms.	Key ON	3 seconds

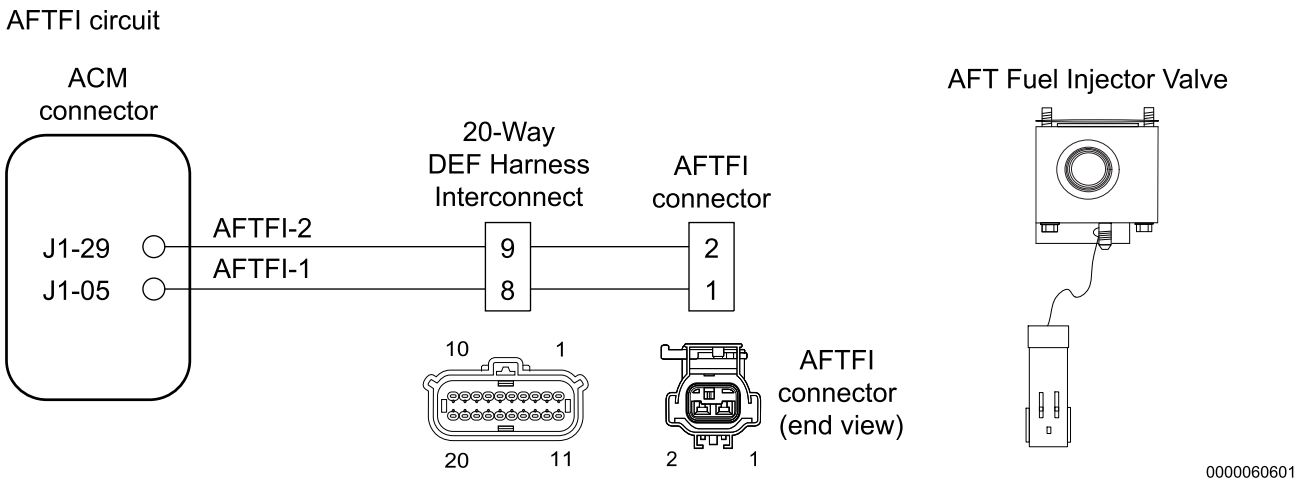

Figure 101 AFTFI Circuit Diagram

Fault Overview

Fault codes sets when the Aftertreatment Control Module (ACM) detects a fault in the Aftertreatment Fuel Injector (AFTFI) circuit. Active regeneration of the aftertreatment diesel particulate filter will be disabled until the next key cycle. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- AFTFI-1 circuit Open or high resistance
- AFTFI-1 short to GND
- AFTFI-1 short to power
- AFTFI-2 circuit Open or high resistance
- AFTFI-2 short to GND
- AFTFI-2 short to power
- AFTFI-1 short to AFTFI-2
- Failed Aftertreatment Fuel Injector (AFTFI)

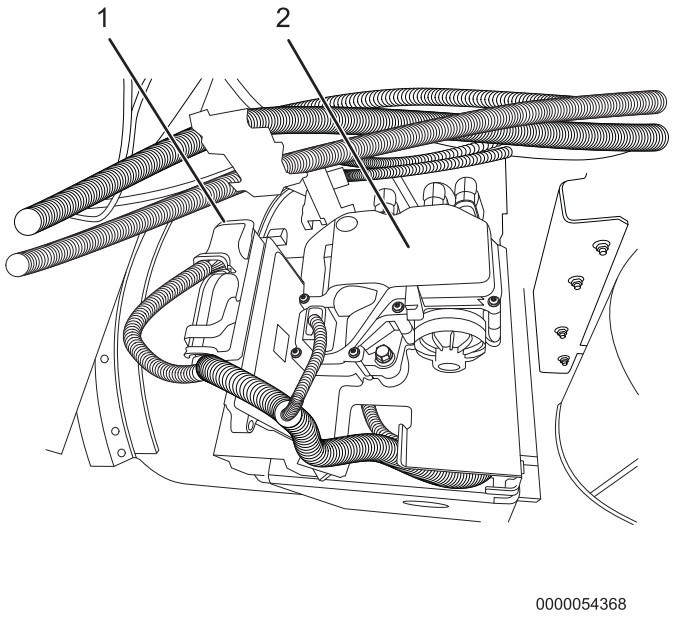

Figure 102 ACM Location (typical)

1. Aftertreatment Control Module (ACM)
2. DEF supply module

Step	Action	Decision
1	Inspect connections at ACM connector J1. Key OFF, disconnect ACM connector J1. Check ACM connector J1 and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector J1, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
2	Check AFTFI circuits for short to ground. Disconnect ACM and connect 180-Pin Breakout Box and SCR (ACM) Breakout Harness 18-537-01 (96-Pin) to ACM harness and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Box pin J1-05 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Go to step 5.

Step	Action	Decision
3	Check AFTFI circuits for short to power. With ACM disconnected, Key-On Engine-Off (KOEO), use a DMM to measure voltage between Breakout Box pin J1-05 and a known good ground. Is voltage less than 0.5 volts?	Yes: Go to step 4. No: Go to step 11.

Step	Action	Decision
4	Check AFTFI circuits for Open. With ACM disconnected, Key OFF, use a DMM to measure resistance from Breakout Box pin J1-05 and J1-29. Is resistance less than 10 ohms?	Yes: Go to step 23. No: Go to step 17.

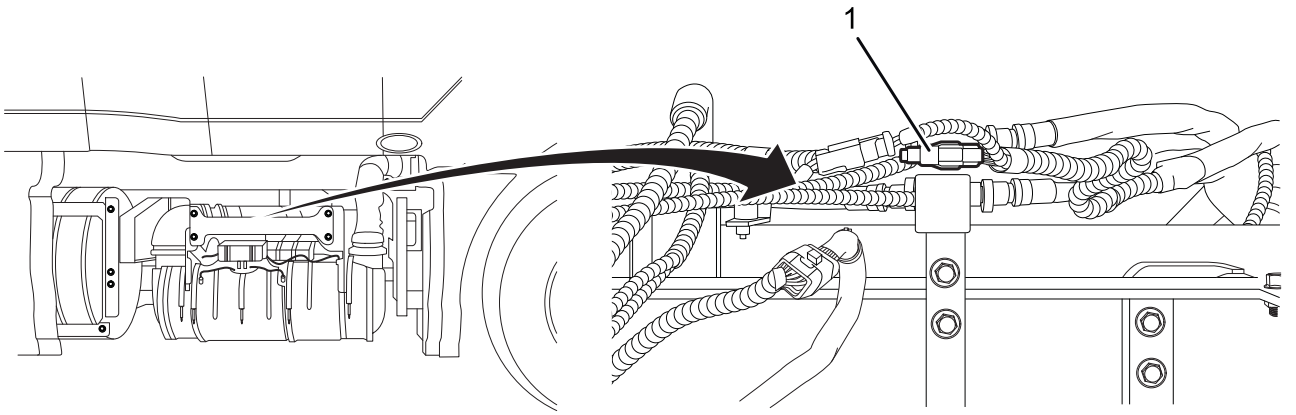

Figure 103 20-Way Connector Location

1. 20-way connector

Step	Action	Decision
5	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way. Check 20-Way and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 6. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

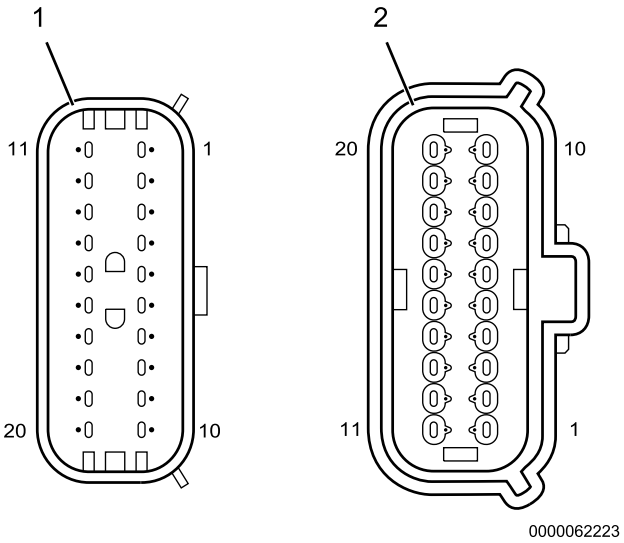

Figure 104 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
6	Check AFTFI-1 circuit for short to ground between ACM and 20-way DEF harness interconnect. With ACM disconnected, connect Breakout Harness 18-050-01 to the male side of the 20-way and leave female side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-050-01 pin-8 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Repair short to ground between 20-way connector pin-8 and Aftertreatment Control Module (ACM) connector pin J1-05. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
7	Check AFTFI-2 circuit for short to ground between ACM and 20-way DEF harness interconnect. Use a DMM to measure resistance between Breakout Harness 18-050-01 pin-9 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 8. No: Repair short to ground between 20-way connector pin-9 and Aftertreatment Control Module (ACM) connector pin J1-29. After repairs are complete, retest for SPN 3556 FMI 5.

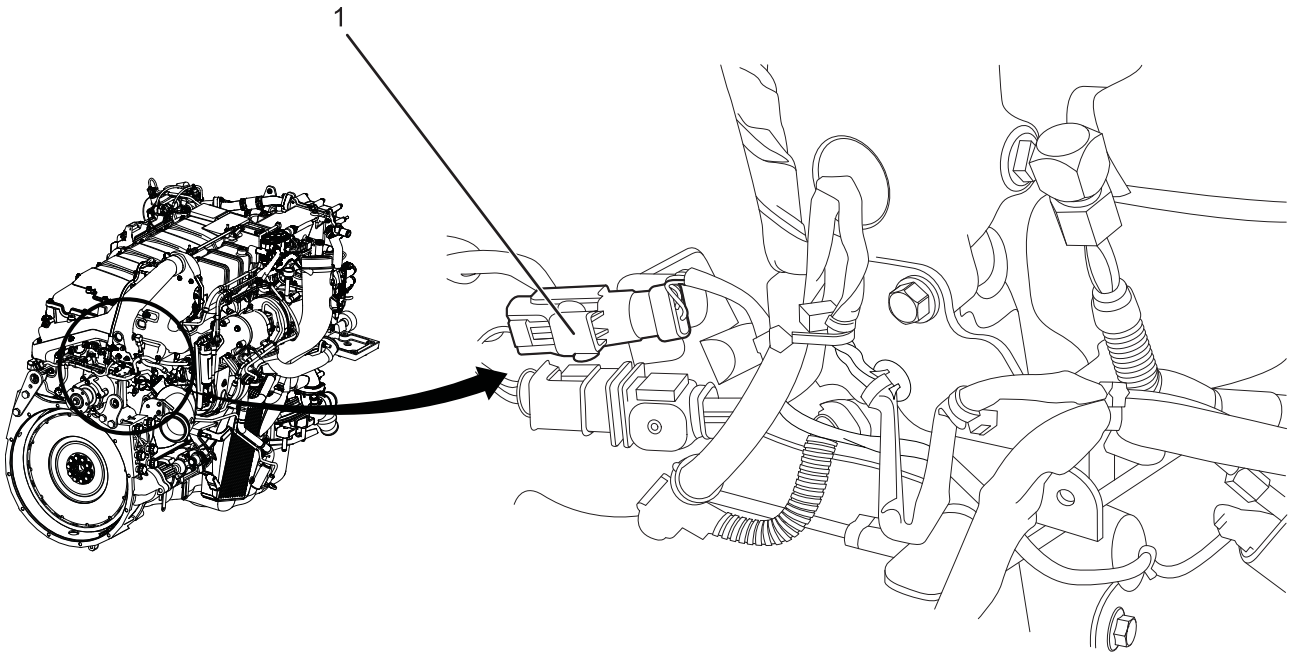

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Figure 105 AFTFI Connector Location

1. Aftertreatment Fuel Injector (AFTFI) connector

Step	Action	Decision
8	Inspect connections at Aftertreatment Fuel Injector (AFTFI). Key OFF, disconnect AFTFI. Check AFTFI connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFI connector, harness, and terminals clean and undamaged?	Yes: Go to step 9. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
9	Check AFTFI-1 circuit for short to ground between AFTFI and 20-way DEF harness interconnect. With 20-way disconnected, connect Breakout Harness ZTSE4760A to the vehicle harness and leave AFTFI disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 10. No: Repair short to ground between 20-way connector pin-8 and AFTFI pin-1. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
10	Check AFTFI-2 circuit for short to ground between AFTFI and 20-way DEF harness interconnect. Use a DMM to measure resistance between Breakout Harness ZTSE4760A pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 5. No: Repair short to ground between 20-way connector pin-9 and AFTFI pin-2. After repairs are complete, retest for SPN 3556 FMI 5.

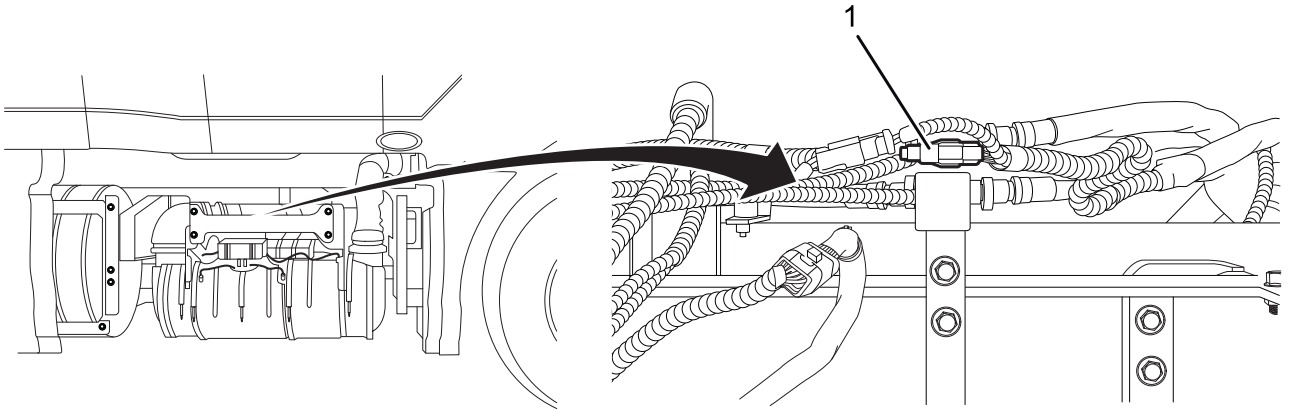

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Figure 106 20-Way Connector Location

1. 20-way connector

Step	Action	Decision
11	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 12. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

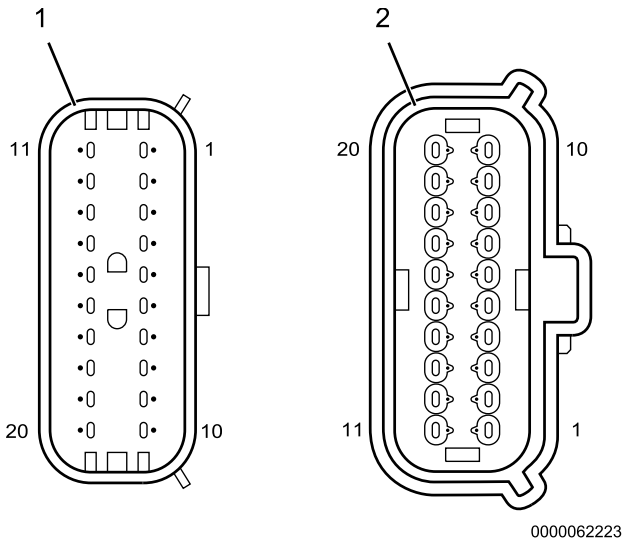

Figure 107 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
12	Check AFTFI-1 circuit for short to power between ACM and 20-way DEF harness interconnect. With ACM disconnected, connect Breakout Harness 18-050-01 to the male side of the 20-way and leave female side disconnected. KOEO, use a DMM to measure voltage between Breakout Harness 18-050-01 pin-8 and a known good ground. Is voltage less than 0.5 volts?	Yes: Go to step 13. No: Repair short to power between 20-way connector pin-8 and Aftertreatment Control Module (ACM) connector pin J1-05. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
13	Check AFTFI-2 circuit for short to power between ACM and 20-way DEF harness interconnect. KOEO, use a DMM to measure voltage between Breakout Harness 18-050-01 pin-9 and a known good ground. Is voltage less than 0.5 volts?	Yes: Go to step 14. No: Repair short to power between 20-way connector pin-9 and Aftertreatment Control Module (ACM) connector pin J1-29. After repairs are complete, retest for SPN 3556 FMI 5.

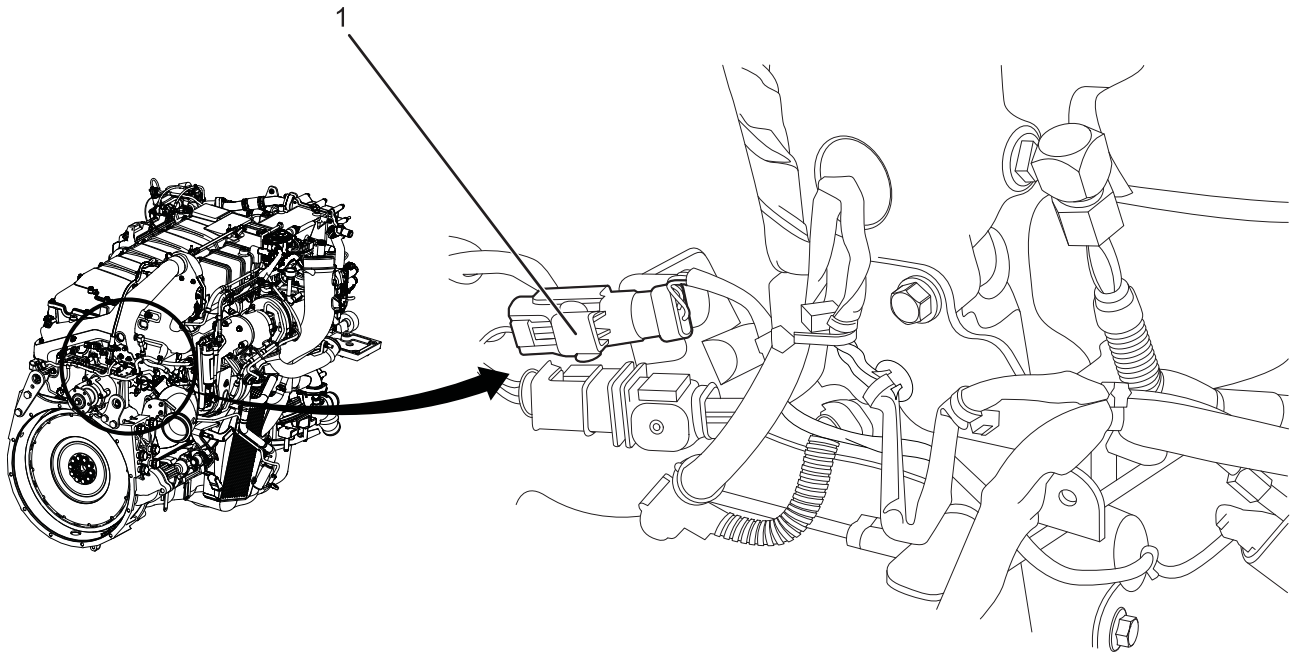

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Figure 108 AFTFI Connector Location

1. Aftertreatment Fuel Injector (AFTFI) connector

Step	Action	Decision
14	Inspect connections at AFTFI. Key OFF, disconnect AFTFI. Check AFTFI connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFI connector, harness, and terminals clean and undamaged?	Yes: Go to step 15. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
15	Check AFTFI-1 circuit for short to power between 20-way DEF harness interconnect and AFTFI. With 20-way disconnected, connect Breakout Harness ZTSE4760A to the AFTFI vehicle harness, and leave AFTFI disconnected. KOEO, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is voltage less than 0.5 volts?	Yes: Go to step 16. No: Repair short to power between 20-way connector pin-8 and AFTFI pin-1. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
16	Check AFTFI-2 circuit for short to power between 20-way DEF harness interconnect and AFTFI. KOEO, use a DMM to measure voltage between Breakout Harness ZTSE4760A pin-2 and a known good ground. Is voltage less than 0.5 volts?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 5. No: Repair short to power between 20-way connector pin-9 and AFTFI pin-2. After repairs are complete, retest for SPN 3556 FMI 5.

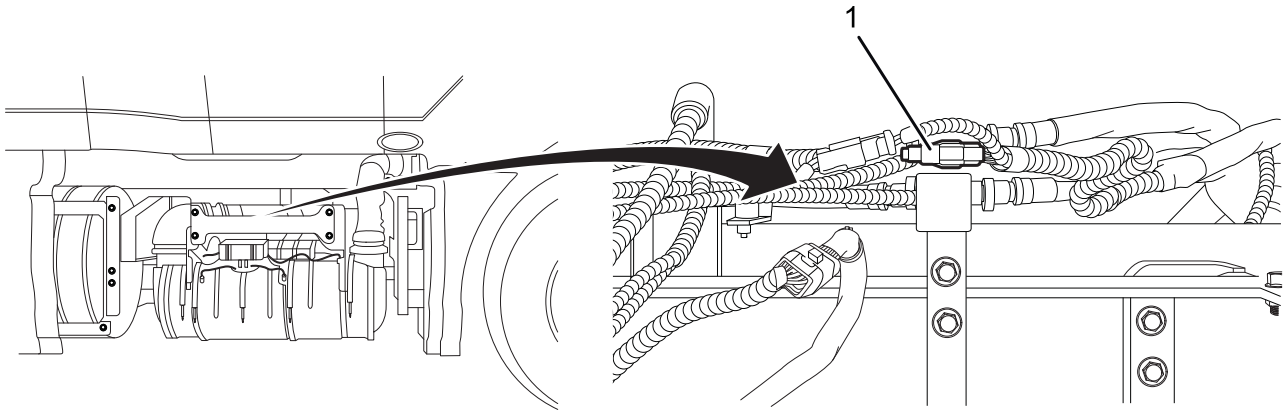

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Figure 109 20-Way Connector Location

1. 20-way connector

Step	Action	Decision
17	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 18. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

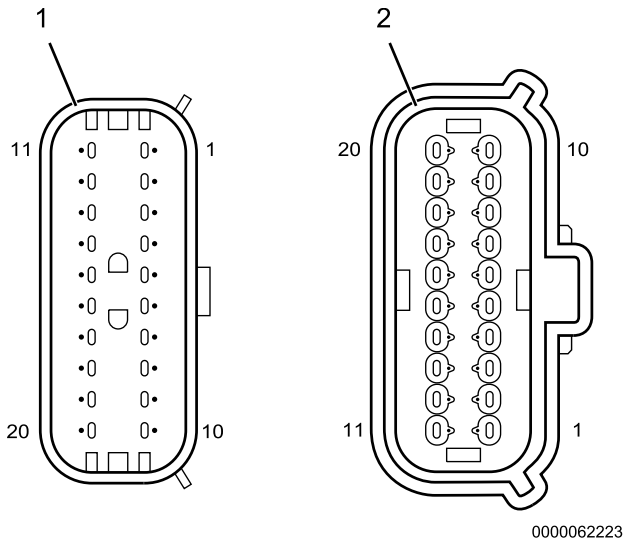

Figure 110 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
18	Check AFTFI-1 circuit for Open between ACM and 20-way DEF harness interconnect. With ACM disconnected, connect Breakout Harness 18-050-01 to the male side of the 20-way and leave female side disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness pin-8 and 180-pin Breakout Box pin J1-05. Is resistance less than 5 ohms?	Yes: Go to step 19. No: Repair Open between 20-way connector pin-8 and Aftertreatment Control Module (ACM) connector pin J1-05. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
19	Check AFTFI-2 circuit for Open between ACM and 20-way DEF harness interconnect. Key OFF, use a DMM to measure resistance from Breakout Harness 18-050-01 pin-9 and 180-pin Breakout Box pin J1-29. Is resistance less than 5 ohms?	Yes: Go to step 20. No: Repair Open between 20-way connector pin-9 and Aftertreatment Control Module (ACM) connector pin J1-29. After repairs are complete, retest for SPN 3556 FMI 5.

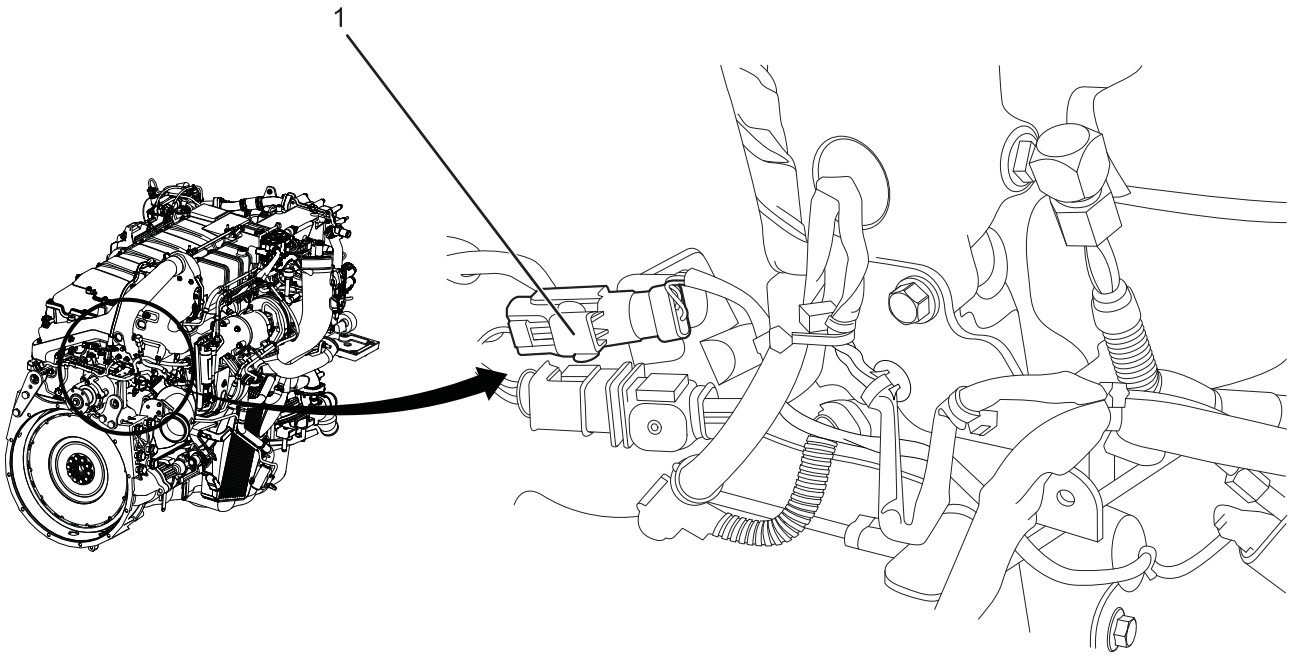

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Figure 111 AFTFI Connector Location

1. Aftertreatment Fuel Injector (AFTFI) connector

Step	Action	Decision
20	Inspect connections at AFTFI. Key OFF, disconnect AFTFI. Check AFTFI connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFI connector, harness, and terminals clean and undamaged?	Yes: Go to step 21. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

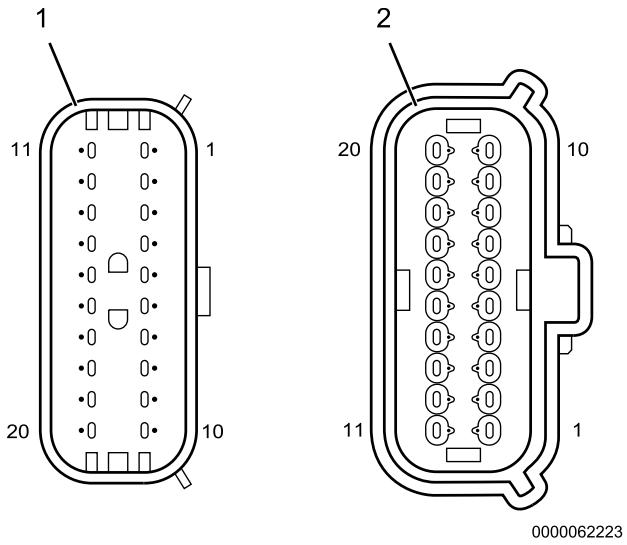

Figure 112 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
21	Check AFTFI-1 circuit for Open between 20-way DEF harness interconnect and AFTFI. Connect Breakout Harness 18-050-01 to the female side of the 20-way and leave male side disconnected. Connect Breakout Harness ZTSE4760A to the AFTFI vehicle harness and leave AFTFI disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness 18-050-01 pin-8 and Breakout Harness ZTSE4760A pin-1. Is resistance less than 5 ohms?	Yes: Go to step 22. No: Repair Open between 20-way connector pin-8 and AFTFI pin-1. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
22	Check AFTFI-2 circuit for Open between 20-way DEF harness interconnect and AFTFI. Key OFF, use a DMM to measure resistance from Breakout Harness 18-050-01 pin-9 and Breakout Harness ZTSE4760A pin-2. Is resistance less than 5 ohms?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 5. No: Repair Open between 20-way connector pin-9 and AFTFI pin-2. After repairs are complete, retest for SPN 3556 FMI 5.

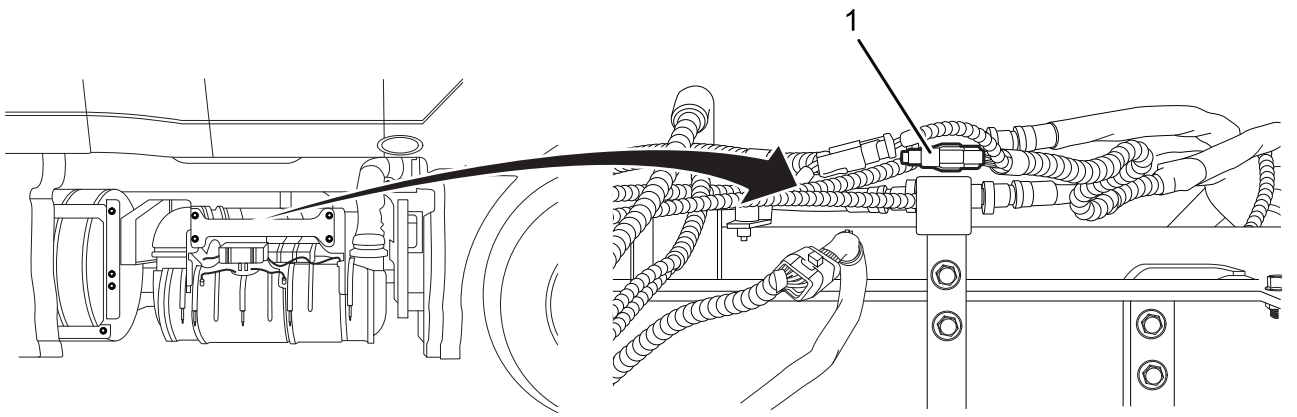

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Figure 113 20-Way Connector Location

1. 20-way connector

Step	Action	Decision
23	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way DEF harness interconnect. Check 20-Way DEF harness interconnect and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way DEF harness interconnect connector, harness, and terminals clean and undamaged?	Yes: Go to step 24. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
24	Check for AFTFI-1 shorted to AFTFI-2 between the 20-way DEF harness interconnect and ACM. With ACM disconnected, connect Breakout Harness 18-050-01 to the male side of the 20-way and leave female side disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-8 and pin-9. Is resistance greater than 1000 ohms?	Yes: Go to step 25. No: Repair AFTFI-1 shorted to AFTFI-2 between ACM and 20-way connector. After repairs are complete, retest for SPN 3556 FMI 5.

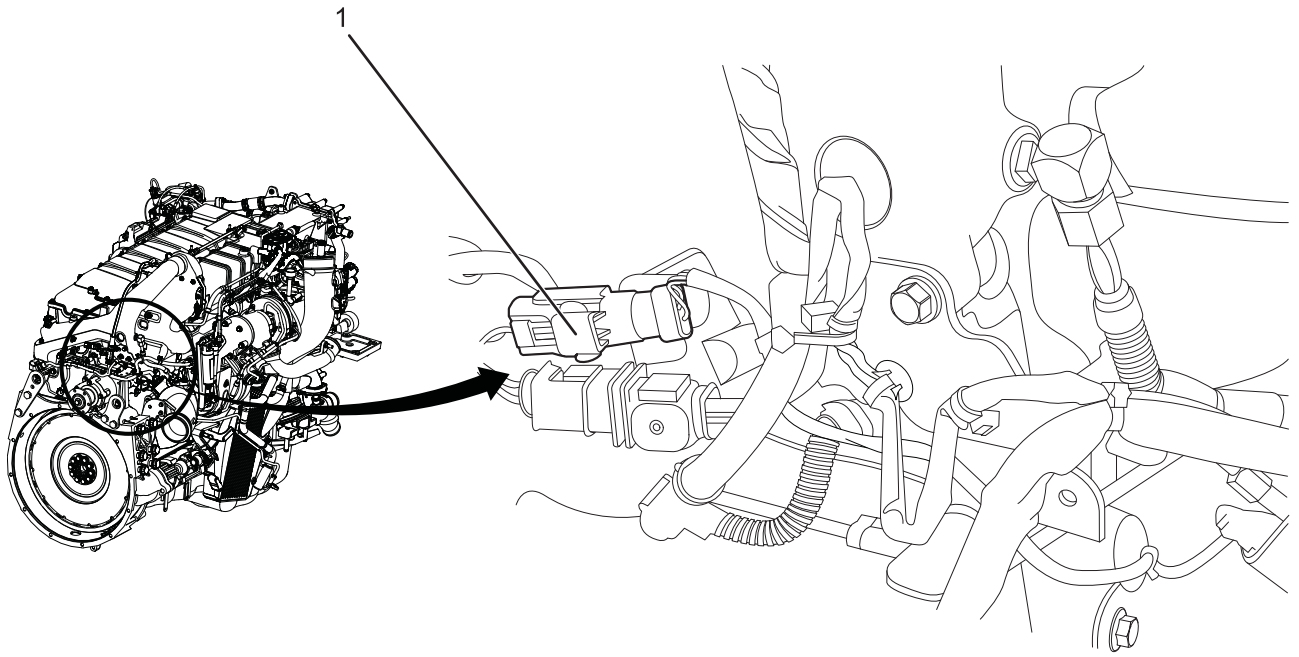

Figure 114 AFTFI Connector Location

1. Aftertreatment Fuel Injector (AFTFI) connector

Step	Action	Decision
25	Inspect connections at AFTFI. Key OFF, disconnect AFTFI. Check AFTFI connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the AFTFI connector, harness, and terminals clean and undamaged?	Yes: Go to step 19. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3556 FMI 5.

Step	Action	Decision
26	Check for AFTFI-1 shorted to AFTFI-2 between the 20-way DEF harness interconnect and AFTFI. With AFTFI disconnected, connect Breakout Harness 18-050-01 to the female side of the 20-way DEF Harness Interconnect and leave male side disconnected. Key OFF, use a DMM to measure resistance from 18-050-01 pin-8 and pin-9. Is resistance greater than 1000 ohms?	Yes: Replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 5. No: Repair AFTFI-1 shorted to AFTFI-2 between AFTFI and 20-way connector. After repairs are complete, retest for SPN 3556 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 3556 FMI 5 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3556 FM 18 - AFT Fuel Pressure 2 below Warning Pressure

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Unable to inject sufficient fuel through the Aftertreatment Fuel Injector (AFTFI) to achieve DPF regeneration.	DPF Inlet Temperature (DPFIT) below regeneration target temperature.	System test has run (Occurs before dosing). Key ON Inactive: SPN 168 FMI 18 (ACM); SPN 3242 FMI 2, 3, 4 (DPFIT); SPN 3246 FMI 2 3, 4 (DPFOT); SPN 3251 FMI 0 (DPFDP); SPN 3480 FMI 2, 3, 4, 17 (AFT: FP1); SPN 3482 FMI 2, 3, 4, 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFT: PAV); SPN 3556 FMI 2, 5 (AFTFI); SPN 3936 FMI 7, 15 (DPF System); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, 4 (DOCIT); SPN 4795 FMI 31 (DPFDP); SPN 4796 FMI 31 (DOC); SPN 5742 FMI 3 (DPF Temp Module); SPN 5742 FMI 4, 11, 12 (DPF Temp Module)	Minimum 30 seconds. Maximum 5000 seconds.

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Aftertreatment Fuel Injector (AFTFI) can not inject enough fuel for active regeneration of the aftertreatment Diesel Particulate Filter (DPF).

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 3242 (DPFIT); SPN 3246 (DPFOT); SPN 3480 (AFT: FP1); SPN 3556 FMI 2, 5 (AFTFI); SPN 3482 (AFTFSV); SPN 3490 (AFT: PAV); SPN 4765 (DOCIT); SPN 4796 (AFT); and SPN 5742 (DOC/DPF temp sensor module)

Drive Cycle to Determine Fault Status

Drive cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Damaged or restricted supply line to AFTFI
- Restricted AFTFI
- Exhaust leak or restriction

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 3242 (DPFIT); SPN 3246 (DPFOT); SPN 3480 (AFT: FP1); SPN 3556 FMI 2, 5 (AFTFI); SPN 3482 (AFTFSV); SPN 3490 (AFT: PAV); SPN 4765 (DOCIT); SPN 4796 (AFT); and SPN 5742 (DOC/DPF temp sensor module).	Yes: Go to step 2. No: Repair SPN 3242; SPN 3246; SPN 3480; SPN 3556 FMI 2, 5; SPN 3482; SPN 3490; SPN 4765; SPN 4796 (AFT); and SPN 5742. After repairs are

	Is EST DTC list free of SPN 3242; SPN 3246; SPN 3480; SPN 3556 FMI 2, 5; SPN 3482; SPN 3490; SPN 4765; and SPN 5742?	complete, retest for SPN 3556 FMI 18.

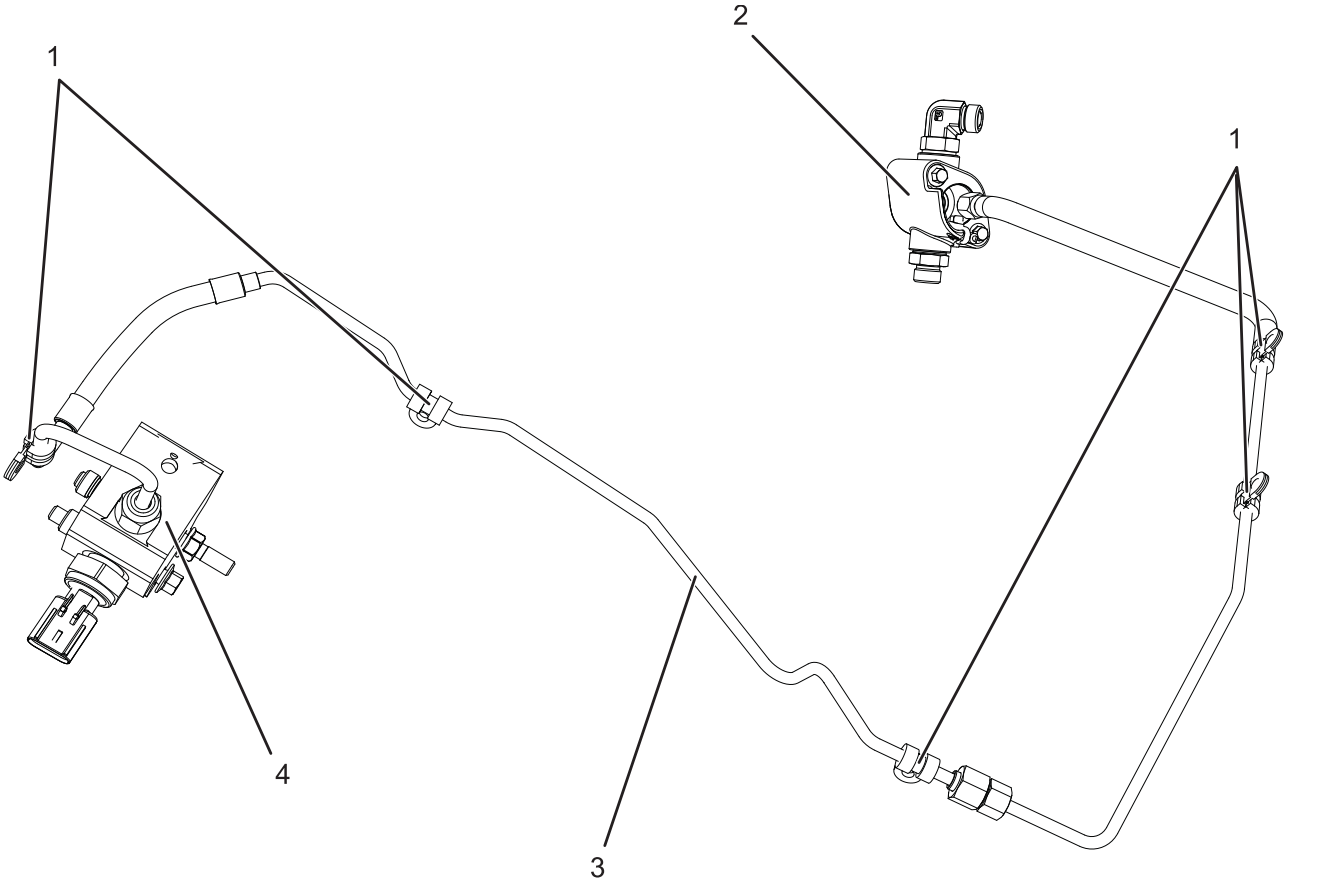

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Figure 115 Aftertreatment Fuel Injection Components (Top View)

1. Fuel line retainers (rear and left side of engine block)
2. Aftertreatment Fuel Injector (AFTFI)
3. AFTFI fuel pressure line
4. AFT fuel doser module

Step	Action	Decision
2	Check for restricted or damaged fuel supply line to Aftertreatment Fuel Injector (AFTFI). Key-On Engine-Running (KOER), inspect fuel supply line between AFT fuel doser module and AFTFI for restrictions and leaks. Is the fuel supply line between the AFT fuel doser module and the AFTFI in good condition and not restricted?	Yes: Go to step 3. No: Repair or replace the fuel line to AFTFI. After repairs are complete, retest for SPN 3556 FMI 18.

Step	Action	Decision
3	Inspect exhaust system for leaks and physical damage. Is exhaust system free of leaks and physical damage?	Yes: Go to step 4. No: Repair or replace leaking or damaged exhaust components. After repairs are complete, retest for SPN 3556 FMI 18.

Step	Action	Decision
4	Check for failed AFTFI fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2 minutes 30 seconds?	Yes: Retest for SPN 3556 FMI 18. No: Clean or replace AFTFI. After repairs are complete, retest for SPN 3556 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 3556 FMI 18 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

AMS (Air Management) System

Overview of AMS Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
102	10	IMP Boost slow response	• Turbocharger 2 (TC2) wastegate stuck open • Restricted intake air system • Charge Air Cooler (CAC) hose leaking • CAC leak • Failed turbocharger • Exhaust leak • Restricted exhaust • Exhaust Gas Recirculation (EGR) fault	Step Based Diagnostics (page 242)
102	16	Intake Manifold Pressure Overboost	• Turbocharger 2 (TC2) wastegate stuck closed	Pin-Point Diagnostics (page 246)
102	18	Intake Manifold Pressure Underboost	• TC2 wastegate stuck open • Restricted intake air system • Charge Air Cooler (CAC) hose leaking • CAC leak • Failed turbocharger	Pin-Point Diagnostics (page 247)
2659	10	EGR slow response	•	
2659	20	EGR High Flow Rate detected	• Biased O_2S or circuit • Biased Turbocharger 1 Turbo Outlet Pressure (TC1TOP) sensor or circuit • Exhaust Gas Recirculation (EGR) Valve stuck open • Low boost pressure	Step Based Diagnostics (page 248)
2659	21	EGR Low Flow Rate detected	• Biased O_2S or circuit • Biased TC1TOP sensor or circuit	Pin-Point Diagnostics (page 251)

- EGR Valve stuck closed
- Restricted EGR cooler
- Restricted Diesel Oxidation Catalyst (DOC) or Diesel Particulate Filter (DPF)

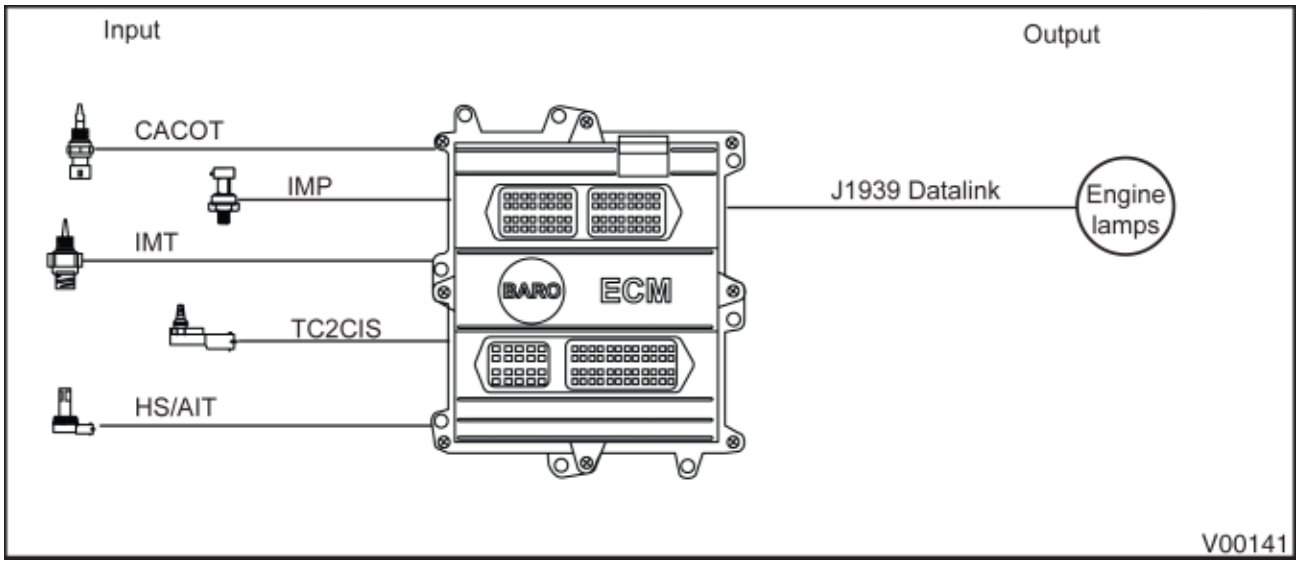


Figure 116 Functional diagram for the AMS

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 102 FMI 10 - Below Slow Response Fault

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Intake Manifold Pressure (IMP) accumulated deviation from boost.	Intake Manifold Pressure (IMP) does not maintain less than 80 psi (550 kPa) difference between actual and desired.	Rate of Change in Engine Speed > 100 rpm/s Key ON Engine Speed > 800 rpm Rate of Change in Injection Quantity > 50 mg Injection Quantity > 0 mg/stroke and < 500 mg/stroke	1 event

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN's 27 (EGR), 51 (ETV), 1189 (TC2WC), 2791 (EGR) and 3464 (ETV).

Drive Cycle

See 2013 HD-OBD Diagnostic Reference Manual.

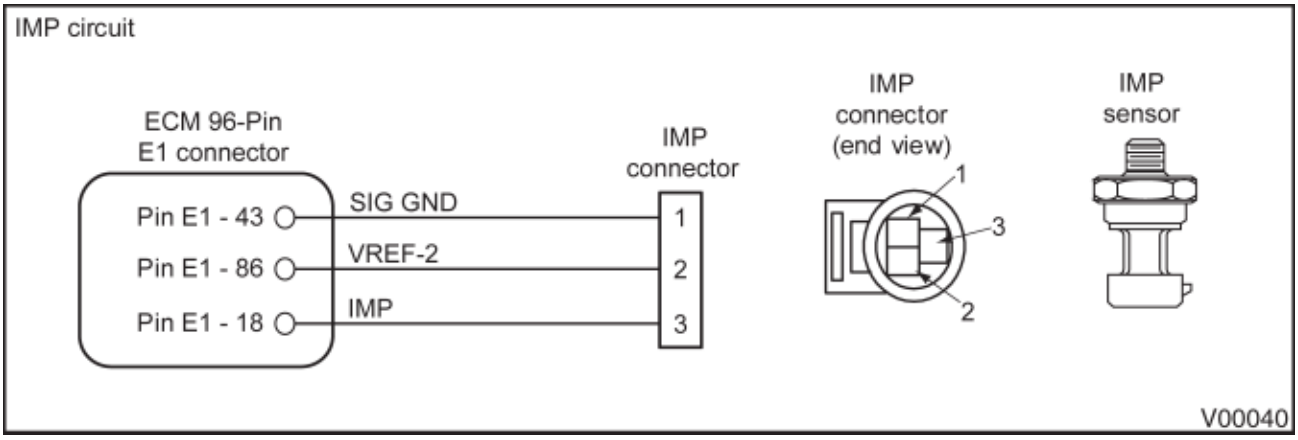


Figure 117 IMP Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 27 (EGR); SPN 51 (ETV); SPN 1189 (TC2WC); SPN 2791 (EGR); SPN 3464 (ETV). Is EST DTC list free of SPN 27; SPN 51; SPN 1189; SPN 2791; SPN 3464?	Yes: Go to step 2. No: Repair SPN 27; SPN 51; SPN 1189; SPN 2791; SPN 3464. After repairs are complete, retest for SPN 102 FMI 10.

Step	Action	Decision
2	Inspect air intake system, exhaust system, and air filter for restrictions, air leaks, or physical damage. Also, inspect the fuel system from fuel tank to AFTFI valve for leaks or physical damage. Is air intake system, exhaust system, fuel system and air filter free of restrictions, leaks, and physical damage?	Yes: Go to step 3. No: Repair restrictions, air leaks , fuel leaks or physical damage. After repairs are complete, retest for SPN 102 FMI 10.

Step	Action	Decision
3	Determine if Intake Manifold Pressure (IMP) sensor or circuit is out of specifications. Using EST with ServiceMaxx™ software, do IMP Biased Sensor or Circuit Check (page 1060). Is IMP sensor within specifications?	Yes: Go to step 4. No: Repair IMP sensor or circuit. After repairs are complete, retest for SPN 102 FMI 10.

Step	Action	Decision
4	Verify IMP changes when Turbocharger 2 Wastegate Control (TC2WC) and Exhaust Gas Recirculation (EGR) valve are commanded On. Key-On Engine-Running (KOER). Run Air Management Test while monitoring IMP sensor signal. Does IMP sensor signal change: • When TC2WC is commanded On? • When EGR valve is commanded On?	IMP signal change only when TC2WC is commanded On: Do EGR Pinpoint Diagnostics (page 808) and check for EGR issue. After repairs are complete, retest for SPN 102 FMI 10.
		IMP signal change only with EGR valve commanded On: Do TC2WC voltage and circuit checks (page 1451). After repairs are complete, retest for SPN 102 FMI 10.
		Neither change IMP signal when commanded On: Go to step 5.
		Both change IMP signal when commanded On: Go to step 7.

Step	Action	Decision
5	Verify IMP sensor and bore are not restricted due to carbon buildup. Remove and inspect IMP sensor and bore for carbon buildup. Is IMP sensor and bore free of carbon buildup?	Yes: Go to step 6.
		No: Clean IMP sensor bore of carbon deposits. After repairs are complete, retest for SPN 102 FMI 10. Go to step 6 if cleaning does not resolve fault code.

Step	Action	Decision
6	Determine if Charge Air Cooler is leaking. Do Charge Air Cooler (CAC) pressure test . Was CAC free of leaks?	Yes: Go to step 7.
		No: Correct air leak(s). After repairs are complete, retest for SPN 102 FMI 10.

Step	Action	Decision
7	Do a road test (100% throttle when safe to do so) while recording a snap shot of the following signals: • Diesel Particulate Filter Differential Pressure (DPFDP) = 0.5 – 0.8 psi • Turbocharger 1 Turbine Outlet Pressure (TC1TOP) = 2 – 3 psi Are DPFDP and TC1TOP within specification? **NOTE:** DPFDP and TC1TOP specifications only apply with soot load < 40%.	**Both** TC1TOP and DPFDP signals are above specification: Go to step 8.
		Only TC1TOP signal above specification: Remove Diesel Oxidation Catalyst (DOC) for inspection and clean or replace as necessary. After repairs are complete, retest for SPN 102 FMI 10.

		Neither signal above specification: Go to step 9.

Step	Action	Decision
8	Using EST with ServiceMaxx software, start an DPF Filter Regeneration procedure. Is DPF Filter Regeneration procedure running without an Abort Message in ServiceMaxx™?	Yes: Go to step 9. No: Correct Parked Regen Inhibitors (page 130) and restart DPF Filter Regeneration procedure.

Step	Action			Decision
9	While running DPF Filter Regeneration procedure, inspect for exhaust leaks and monitor following signals during test: Are Parked Regen Checks within specification during DPF Filter Regeneration procedure?			If Parked Regen Checks are within specification: Go to step 7.
	Parked Regen Checks	**Specifications**	**Pass / Fail**	
	Engine condition	Smooth, not stumbling		If AFTFP1 is below 110 psi: Do Fuel Delivery Pressure (FDP) Test (page 1680). Repair any FDP measurements out of specification. After repairs are complete, retest for SPN 102 FMI 10.
	Engine Coolant Temp (ECT)	Above 122°F (50°C) per ServiceMaxx		
	DOCIT	After 5 – 10 minutes above 500°F (260°C)		If AFTFP1 fuel pressure is below 40-70 psi at AFTFI opening: Clean AFTFI valve, housing, and bore. After cleaning procedure is complete, retest for SPN 102 FMI 10.
	DOCOT	After 5 – 10 minutes above 986°F (530°C)		
	DPFOT	Below 1292°F (700°C)		If Parked Regen Checks other than AFTFP1 is out of specifications: Repair Parked Regen Check (page 132). After repairs complete, retest for SPN 102 FMI 10.
	Aftertreatment Fuel Pressure 1 (AFTFP1)	> 110 psi during test		

Step	Action	Decision
10	After DPF Filter Regeneration procedure is complete, does Diesel Particulate Filter Differential Pressure (DPFDP) signal measure below 0.5 psi at high idle?	Yes: Go to step 11.
		No: Remove DPF and inspect for restrictions. If restricted, have the DPF cleaned using the appropriate DPF cleaning equipment. After repairs are complete, retest for SPN 102 FMI 10.

Step	Action	Decision
11	Inspect turbochargers for correct operation. Inspect for signs of wear on the turbocharger compressor wheel and air inlet. Look for chipping, scuffs, and rough finishes. Was anything determined to be malfunctioning or damaged?	Yes: Repair or replace turbocharger as necessary. After repairs are complete, retest for SPN 102 FMI 10.
		No: After doing all diagnostic steps, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

NOTE: After doing all diagnostic steps, if SPN 102 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 102 FMI 16 - Overboost

Pin-point AMS System Fault

1. Check for other active or inactive DTCs. Repair any electrical fault before continuing with this procedure.
2. Check for biased IMP sensor. Verify BAP and IMP are within KOEO specification. See applicable engine horsepower in “APPENDIX A: PERFORMANCE SPECIFICATIONS."
3. Run Air Management test while monitoring IMP sensor signal.
   - If IMP does not change state when TC2WC is cycled, proceed to TC2WC (page 1447) .

SPN 102 FMI 18 - Underboost

Pin-point AMS System Fault

1. Check for other active or inactive DTCs. Repair any electrical fault before continuing with this procedure.
2. Check for biased IMP sensor. Verify BAP and IMP are within KOEO specification. See applicable engine horsepower in “APPENDIX A: PERFORMANCE SPECIFICATIONS."
3. Run Air Management test while monitoring IMP sensor signal.
   - If IMP does not change state when TC2WC is cycled, proceed to TC2WC (page 1447).
4. Inspect for leaks in the intake air system.
5. Inspect turbochargers in the *Engine Service Manual*.

SPN 2659 FMI 10 - EGR Slow Response Detection

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 2659 FMI 20 - EGR High Flow Rate Detected

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
High flow by O_2 control error, valve closing.	O_2% in exhaust > 1.4%	Actual EGR Valve Position < 35% Desired EGR Valve Position < 27% Actual EGR Valve Position deviation limit (from set point) < 100% Key ON Limp Home Mode = Inactive DPF Regeneration = Inactive Power Takeoff (PTO) Mode = Inactive Engine Coolant Temperature 1 (ECT1) > -44°F (-7°C) and < 239°F (115°C) Ambient Air Temperature (AAT) > -44°F (-7°C) <131°F (55°C) Barometric pressure (BARO) > 11 psi (75 kPa) O_2 sensor at operating temp. > 1400°F (760°C) and < 1472°F (800°C) Engine operating in monitoring region Function of engine speed and load	2.4 seconds

Fault Overview

The Exhaust Gas Recirculation (EGR) valve is a variable position actuator used to control exhaust flow through the EGR cooler. The EGR valve contains an internal position sensor that monitors valve position. Valve position changes in response to Engine Control Module (ECM) signals.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 27, 91, 724, 2623, 2791, 3223, 5298, and 5541. If SPN 5298 is active, correct and then retest for SPN 2659 FMI 20.

Drive Cycle to Determine Fault Status

Drive Cycle 16 in 2013 HD-OBD Diagnostic Reference Manual.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 2659 FMI 20 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 2659 FMI 20.

Step	Action	Decision
2	Check for biased O^2 sensor. Do O^2 Biased Sensor or Circuit Check . Does O^2 sensor pass biased sensor or circuit check?	Yes: Go to step 3. No: Repair O^2 sensor or circuits. After repairs are complete, retest for SPN 2659 FMI 20.

Step	Action	Decision
3	Check for biased Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor or circuit. Using EST with ServiceMaxx™ software, run the Continuous Monitor test. Use the Key-On Engine-Off (KOEO) values found in “Appendix A: Performance Specifications”. Is TC1TOP within specifications?	Yes: Go to step 4. No: Do TC1TOP sensor circuit and voltage checks (page 1409). After repairs are complete, retest for SPN 2659 FMI 20.

Step	Action	Decision
4	Determine if Intake Manifold Pressure (IMP) sensor or circuit is out of specifications. Using EST with ServiceMaxx™ software, do IMP Biased Sensor Circuit Check (page 1060). Is IMP sensor within specifications?	Yes: Go to step 5. No: Repair IMP sensor or circuit. After repairs are complete, retest for SPN 2659 FMI 20.

Step	Action	Decision
5	Verify IMP changes when Turbocharger 2 Wastegate Control (TC2WC), Exhaust Gas Recirculation (EGR) valve, and Exhaust Back Pressure Valve (EBPV) are commanded On. Key-On Engine-Running (KOER), run Air Management Test while monitoring IMP sensor signal. While monitoring IMP signal: • Does IMP pressure decrease when EGR valve is commanded On? • Does IMP pressure decrease when TC2WC is commanded On? • Does IMP pressure decrease when EBPV is commanded On?	No IMP pressure decrease when EGR is commanded On: Do EGR Pinpoint Diagnostic (page 808) with ServiceMaxx. After repairs are complete, retest for SPN 2659 FMI 20. No IMP pressure decrease when TC2WC is commanded On: Do Air Control Valve (ACV) TC2WC test . After repairs are complete, retest for SPN 2659 FMI 20. No IMP pressure decrease when EBPV is commanded On: Do Air Control Valve (ACV) EBPV test . After repairs are complete, retest for SPN 2659 FMI 20.

		IMP signal does not change when any of the valves are commanded On: Go to step 6.

Step	Action	Decision
6	Verify IMP sensor and bore are not restricted due to carbon buildup. Remove and inspect IMP sensor and bore for carbon buildup. Is IMP sensor and bore free of carbon buildup?	Yes: After doing all diagnostic steps, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.
		No: Clean IMP sensor bore of carbon deposits. After repairs are complete, retest for SPN 2659 FMI 20.

NOTE: After doing all diagnostic steps, if SPN 2659 FMI 20 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2659 FMI 21 - EGR Low Flow Rate Detected

Pin-point AMS System Fault

1. Check for other active or inactive DTCs. Repair any electrical fault before continuing with this procedure. If SPN 5298 is active, correct and then retest for SPN 2659 FMI 21.
2. Check for biased TC1TOP or DPFDP sensor.
3. Run Air Management test while monitoring IMP, during EGR portion of test.
   - If IMP does not change state during EGR portion of Air Management test, proceed to EGR Valve (page 789) diagnostics.
4. See EGR Cooler Leak Inspection in “ENGINE SYMPTOM DIAGNOSTICS."

APP (Accelerator Pedal Position) Sensor

Overview of APP Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
91	2	APP1 and APP2 signal conflict	• APP1 and APP2 mismatched • Biased APP sensor or circuit	Pin-Point Diagnostics (page 264)
91	3	APP1 signal Out of Range HIGH	• APP1 signal circuit short to PWR • SIG GND circuit OPEN • Failed APP sensor	Pin-Point Diagnostics (page 264)
91	4	APP1 signal Out of Range LOW	• APP1 signal circuit OPEN or short to GND • VREF5 circuit OPEN • Failed APP sensor	Pin-Point Diagnostics (page 264)
2623	3	APP2 signal Out of Range HIGH	• APP2 signal circuit short to PWR • SIG GND circuit OPEN • Failed APP sensor	Pin-Point Diagnostics (page 264)
2623	4	APP2 signal Out of Range LOW	• APP2 signal circuit OPEN or short to GND • VREF1 circuit OPEN • Failed APP sensor	Pin-Point Diagnostics (page 264)

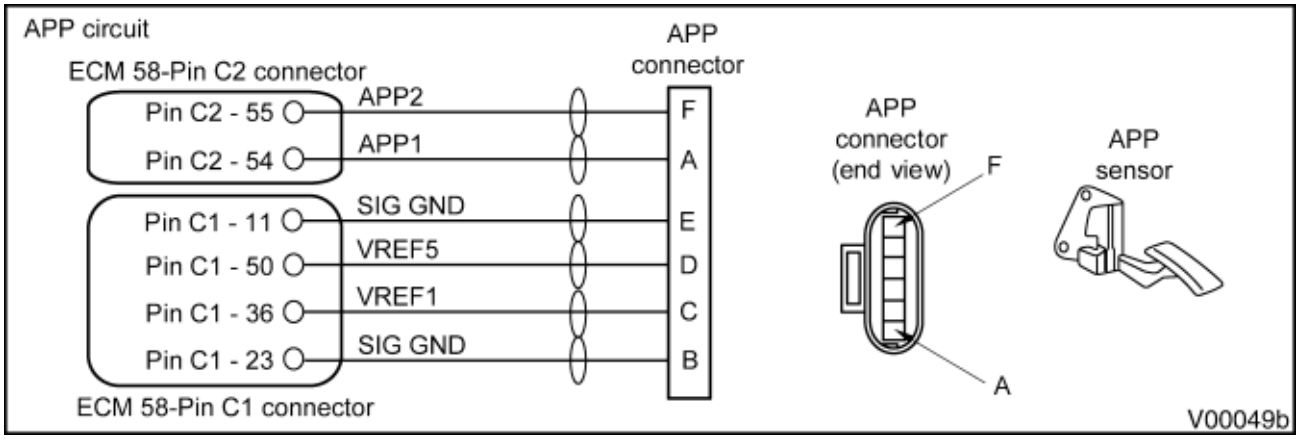


Figure 119 APP circuit diagram

Overview

The Accelerator Pedal Position (APP) sensor is a variable-resistance sensor that increases or decreases resistance as the accelerator pedal position changes. No mechanical attachment is present from the accelerator pedal to the engine. The ECM compares signals from two potentiometers to determine accelerator pedal position, APP1 and APP2. APP1 is supplied 5 volts while APP2 is supplied 2.5 volts. As the pedal is pressed, resistance decreases and change in voltage is interpreted by the ECM.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4485A (APP)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 91 FMI 2 - APP1 and APP2 signal conflict

Pinpoint Diagnostics With ServiceMaxx™ software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

The ECM determines accelerator pedal position by processing input signals from APP1 and APP2.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
    - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
    - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST - Monitor APP1v	0 V	If > 0.5 V, check APP1 circuit for short to PWR.
EST - Monitor APP2v	0 V	If > 0.5 V, check APP2 circuit for short to PWR.
DMM – Measure volts C to GND	5 V ± 0.5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND, go to Harness Resistance Check.
DMM – Measure volts D to GND	5 V ± 0.5 V	If > 5.5 V, check VREF1 for short to PWR. If < 4.5 V, check VREF1 for OPEN or short to GND, go to Harness Resistance Check.
EST - Monitor APP1v Short Pin A to C	5 V	If < 4.5 V, check APP1 circuit for OPEN, go to Harness Resistance check.
EST - Monitor APP2v Short Pin D to F	5 V	If is < 4.5 V, check APP2 circuit for OPEN, go to Harness Resistance Check.
DMM – Measure Volts B to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
DMM – Measure Volts E to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
If checks are within specification, connect sensor, clear DTCs, and cycle the accelerator pedal a few times. If active DTC returns, replace sensor.		

Pinpoint Diagnostics Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
A to B+	B+	If < B+, check APP1 for short to PWR.
B to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
C to GND	5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND.
D to GND	5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND.
E to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
F to B+	B+	If < B+, check APP2 for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
A to GND	> 1k Ω	If < 1k Ω, check for short circuit.
A to C2-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to C1-23	< 5 Ω	If > 5 Ω, check for OPEN circuit.
C to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C to C1-50	< 5 Ω	If > 5 Ω, check for OPEN circuit.
D to GND	> 1k Ω	If < 1k Ω, check for short circuit.
D to C1-36	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to C1-11	< 5 Ω	If > 5 Ω, check for OPEN circuit.
F to GND	> 1k Ω	If < 1k Ω, check for short circuit.
F to C2-55	< 5 Ω	If > 5 Ω, check for OPEN circuit.

Operational Voltage Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness between ECM C1 and C2 connectors and ECM. Connect Breakout Harness ZTSE4485A between APP vehicle harness and APP sensor. Turn ignition switch to ON. Use DMM to measure voltage or EST to read signal.

Test Point	Condition	DMM	EST Value
APP1	Foot off pedal	1.14 V ± 0.25V	0%
A to GND or C2-54 to GND	Pedal to floor	4.32 V ± 0.25V	99.6%
APP2	Foot off pedal	0.56 V ± 0.25 V	0%
F to GND or C2-55 to GND	Pedal to floor	2.16 V ± 0.25 V	99.6%

SPN 91 FMI 3 - APP1 signal Out of Range HIGH

Pinpoint Diagnostics With ServiceMaxx™ software

⚠ WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

The ECM determines accelerator pedal position by processing input signals from APP1 and APP2.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.

2. Monitor sensor voltage and verify an active DTC for this sensor.
    - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
    - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST - Monitor APP1v	0 V	If > 0.5 V, check APP1 circuit for short to PWR.
EST - Monitor APP2v	0 V	If > 0.5 V, check APP2 circuit for short to PWR.
DMM – Measure volts C to GND	5 V ± 0.5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND, go to Harness Resistance Check.
DMM – Measure volts D to GND	5 V ± 0.5 V	If > 5.5 V, check VREF1 for short to PWR. If < 4.5 V, check VREF1 for OPEN or short to GND, go to Harness Resistance Check.
EST - Monitor APP1v Short Pin A to C	5 V	If < 4.5 V, check APP1 circuit for OPEN, go to Harness Resistance check.
EST - Monitor APP2v Short Pin D to F	5 V	If is < 4.5 V, check APP2 circuit for OPEN, go to Harness Resistance Check.
DMM – Measure Volts B to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
DMM – Measure Volts E to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
If checks are within specification, connect sensor, clear DTCs, and cycle the accelerator pedal a few times. If active DTC returns, replace sensor.		

Pinpoint Diagnostics Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
A to B+	B+	If < B+, check APP1 for short to PWR.
B to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
C to GND	5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND.
D to GND	5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND.
E to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
F to B+	B+	If < B+, check APP2 for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
A to GND	> 1k Ω	If < 1k Ω, check for short circuit.
A to C2-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to C1-23	< 5 Ω	If > 5 Ω, check for OPEN circuit.
C to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C to C1-50	< 5 Ω	If > 5 Ω, check for OPEN circuit.
D to GND	> 1k Ω	If < 1k Ω, check for short circuit.
D to C1-36	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to C1-11	< 5 Ω	If > 5 Ω, check for OPEN circuit.
F to GND	> 1k Ω	If < 1k Ω, check for short circuit.
F to C2-55	< 5 Ω	If > 5 Ω, check for OPEN circuit.

Operational Voltage Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness between ECM C1 and C2 connectors and ECM. Connect Breakout Harness ZTSE4485A between APP vehicle harness and APP sensor. Turn ignition switch to ON. Use DMM to measure voltage or EST to read signal.

Test Point	Condition	DMM	EST Value
APP1	Foot off pedal	1.14 V ± 0.25V	0%
A to GND or C2-54 to GND	Pedal to floor	4.32 V ± 0.25V	99.6%
APP2	Foot off pedal	0.56 V ± 0.25 V	0%
F to GND or C2-55 to GND	Pedal to floor	2.16 V ± 0.25 V	99.6%

SPN 91 FMI 4 - APP1 signal Out of Range LOW

Pinpoint Diagnostics With ServiceMaxx™ software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

The ECM determines accelerator pedal position by processing input signals from APP1 and APP2.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.

2. Monitor sensor voltage and verify an active DTC for this sensor.
    - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
    - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST - Monitor APP1v	0 V	If > 0.5 V, check APP1 circuit for short to PWR.
EST - Monitor APP2v	0 V	If > 0.5 V, check APP2 circuit for short to PWR.
DMM – Measure volts C to GND	5 V ± 0.5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND, go to Harness Resistance Check.
DMM – Measure volts D to GND	5 V ± 0.5 V	If > 5.5 V, check VREF1 for short to PWR. If < 4.5 V, check VREF1 for OPEN or short to GND, go to Harness Resistance Check.
EST - Monitor APP1v Short Pin A to C	5 V	If < 4.5 V, check APP1 circuit for OPEN, go to Harness Resistance check.
EST - Monitor APP2v Short Pin D to F	5 V	If is < 4.5 V, check APP2 circuit for OPEN, go to Harness Resistance Check.
DMM – Measure Volts B to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
DMM – Measure Volts E to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
If checks are within specification, connect sensor, clear DTCs, and cycle the accelerator pedal a few times. If active DTC returns, replace sensor.		

Pinpoint Diagnostics Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
A to B+	B+	If < B+, check APP1 for short to PWR.
B to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
C to GND	5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND.
D to GND	5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND.
E to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
F to B+	B+	If < B+, check APP2 for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
A to GND	> 1k Ω	If < 1k Ω, check for short circuit.
A to C2-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to C1-23	< 5 Ω	If > 5 Ω, check for OPEN circuit.
C to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C to C1-50	< 5 Ω	If > 5 Ω, check for OPEN circuit.
D to GND	> 1k Ω	If < 1k Ω, check for short circuit.
D to C1-36	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to C1-11	< 5 Ω	If > 5 Ω, check for OPEN circuit.
F to GND	> 1k Ω	If < 1k Ω, check for short circuit.
F to C2-55	< 5 Ω	If > 5 Ω, check for OPEN circuit.

Operational Voltage Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness between ECM C1 and C2 connectors and ECM. Connect Breakout Harness ZTSE4485A between APP vehicle harness and APP sensor. Turn ignition switch to ON. Use DMM to measure voltage or EST to read signal.

Test Point	Condition	DMM	EST Value
APP1	Foot off pedal	1.14 V ± 0.25V	0%
A to GND or C2-54 to GND	Pedal to floor	4.32 V ± 0.25V	99.6%
APP2	Foot off pedal	0.56 V ± 0.25 V	0%
F to GND or C2-55 to GND	Pedal to floor	2.16 V ± 0.25 V	99.6%

SPN 2623 FMI 3 - APP2 signal Out of Range HIGH

Pinpoint Diagnostics With ServiceMaxx™ software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

The ECM determines accelerator pedal position by processing input signals from APP1 and APP2.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.

2. Monitor sensor voltage and verify an active DTC for this sensor.
    - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
    - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST - Monitor APP1v	0 V	If > 0.5 V, check APP1 circuit for short to PWR.
EST - Monitor APP2v	0 V	If > 0.5 V, check APP2 circuit for short to PWR.
DMM – Measure volts C to GND	5 V ± 0.5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND, go to Harness Resistance Check.
DMM – Measure volts D to GND	5 V ± 0.5 V	If > 5.5 V, check VREF1 for short to PWR. If < 4.5 V, check VREF1 for OPEN or short to GND, go to Harness Resistance Check.
EST - Monitor APP1v Short Pin A to C	5 V	If < 4.5 V, check APP1 circuit for OPEN, go to Harness Resistance check.
EST - Monitor APP2v Short Pin D to F	5 V	If is < 4.5 V, check APP2 circuit for OPEN, go to Harness Resistance Check.
DMM – Measure Volts B to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
DMM – Measure Volts E to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
If checks are within specification, connect sensor, clear DTCs, and cycle the accelerator pedal a few times. If active DTC returns, replace sensor.		

Pinpoint Diagnostics Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
A to B+	B+	If < B+, check APP1 for short to PWR.
B to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
C to GND	5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND.
D to GND	5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND.
E to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
F to B+	B+	If < B+, check APP2 for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
A to GND	> 1k Ω	If < 1k Ω, check for short circuit.
A to C2-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to C1-23	< 5 Ω	If > 5 Ω, check for OPEN circuit.
C to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C to C1-50	< 5 Ω	If > 5 Ω, check for OPEN circuit.
D to GND	> 1k Ω	If < 1k Ω, check for short circuit.
D to C1-36	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to C1-11	< 5 Ω	If > 5 Ω, check for OPEN circuit.
F to GND	> 1k Ω	If < 1k Ω, check for short circuit.
F to C2-55	< 5 Ω	If > 5 Ω, check for OPEN circuit.

Operational Voltage Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness between ECM C1 and C2 connectors and ECM. Connect Breakout Harness ZTSE4485A between APP vehicle harness and APP sensor. Turn ignition switch to ON. Use DMM to measure voltage or EST to read signal.

Test Point	Condition	DMM	EST Value
APP1	Foot off pedal	1.14 V ± 0.25V	0%
A to GND or C2-54 to GND	Pedal to floor	4.32 V ± 0.25V	99.6%
APP2	Foot off pedal	0.56 V ± 0.25 V	0%
F to GND or C2-55 to GND	Pedal to floor	2.16 V ± 0.25 V	99.6%

SPN 2623 FMI 4 - APP2 signal Out of Range LOW

Pinpoint Diagnostics With ServiceMaxx™ software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

The ECM determines accelerator pedal position by processing input signals from APP1 and APP2.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.

2. Monitor sensor voltage and verify an active DTC for this sensor.
    - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
    - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST - Monitor APP1v	0 V	If > 0.5 V, check APP1 circuit for short to PWR.
EST - Monitor APP2v	0 V	If > 0.5 V, check APP2 circuit for short to PWR.
DMM – Measure volts C to GND	5 V ± 0.5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND, go to Harness Resistance Check.
DMM – Measure volts D to GND	5 V ± 0.5 V	If > 5.5 V, check VREF1 for short to PWR. If < 4.5 V, check VREF1 for OPEN or short to GND, go to Harness Resistance Check.
EST - Monitor APP1v Short Pin A to C	5 V	If < 4.5 V, check APP1 circuit for OPEN, go to Harness Resistance check.
EST - Monitor APP2v Short Pin D to F	5 V	If is < 4.5 V, check APP2 circuit for OPEN, go to Harness Resistance Check.
DMM – Measure Volts B to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
DMM – Measure Volts E to Battery positive	B+	If < B+, check SIG GND for OPEN, go to Harness Resistance Check.
If checks are within specification, connect sensor, clear DTCs, and cycle the accelerator pedal a few times. If active DTC returns, replace sensor.		

Pinpoint Diagnostics Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
A to B+	B+	If < B+, check APP1 for short to PWR.
B to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
C to GND	5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND.
D to GND	5 V	If > 5.5 V, check VREF5 for short to PWR. If < 4.5 V, check VREF5 for OPEN or short to GND.
E to Battery positive	B+	If < B+, check SIG GND for OPEN circuit.
F to B+	B+	If < B+, check APP2 for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4485A to APP vehicle harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
A to GND	> 1k Ω	If < 1k Ω, check for short circuit.
A to C2-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
B to C1-23	< 5 Ω	If > 5 Ω, check for OPEN circuit.
C to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C to C1-50	< 5 Ω	If > 5 Ω, check for OPEN circuit.
D to GND	> 1k Ω	If < 1k Ω, check for short circuit.
D to C1-36	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E to C1-11	< 5 Ω	If > 5 Ω, check for OPEN circuit.
F to GND	> 1k Ω	If < 1k Ω, check for short circuit.
F to C2-55	< 5 Ω	If > 5 Ω, check for OPEN circuit.

Operational Voltage Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness between ECM C1 and C2 connectors and ECM. Connect Breakout Harness ZTSE4485A between APP vehicle harness and APP sensor. Turn ignition switch to ON. Use DMM to measure voltage or EST to read signal.

Test Point	Condition	DMM	EST Value
APP1	Foot off pedal	1.14 V ± 0.25V	0%
A to GND or C2-54 to GND	Pedal to floor	4.32 V ± 0.25V	99.6%
APP2	Foot off pedal	0.56 V ± 0.25 V	0%
F to GND or C2-55 to GND	Pedal to floor	2.16 V ± 0.25 V	99.6%

BARO Sensor

Overview of BARO Sensor Group

SPN	FMI	Description
108	3	BARO signal Out of Range HIGH (page 269)
108	4	BARO signal Out of Range LOW (page 271)

SPN 108 FMI 3 - BARO signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Barometric Pressure (BARO) Sensor signal Out of Range High	BARO sensor voltage > 4.72 Volts - 15.7 psi (108.1 kPa)	Key ON

Fault Overview

Fault Code sets when Barometric Pressure (BARO) sensor is above maximum threshold.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

BARO sensor is installed inside Engine Control Module (ECM).

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed ECM

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Code (DTC) list for SPN 108 FMI 3. Is EST DTC list SPN 108 FMI 3 active or pending?		Yes: Replace Engine Control Module (ECM) and perform CKP Relearn Procedure. After repairs are complete, retest for SPN 108 FMI 3.
		No. Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

End Diagnostic Steps
After performing all diagnostic steps, if SPN 108 FMI 3 remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 108 FMI 4 - BARO signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Barometric Pressure (BARO) Sensor signal Out of Range Low	BARO sensor voltage < 2.37 Volts - 8.70 psi (60.01 kPa)	Key ON

Fault Overview

Determines if Barometric Pressure (BARO) sensor is below minimum threshold.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

BARO sensor is installed inside Engine Control Module (ECM).

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed ECM

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Code (DTC) list for SPN 108 FMI 4. Is EST DTC list SPN 108 FMI 4 active or pending?		Yes: Replace Engine Control Module (ECM) and perform CKP Relearn Procedure. After repairs are complete, retest for SPN 108 FMI 4.
		No. Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

End Diagnostic Steps
After performing all diagnostic steps, if SPN 108 FMI 4 remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Body Sensor

Overview of Body Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
837	14	Speedometer Drive Output Error	•	
1590	19	Adaptive Cruise Control not detected on J1939	•	

SPN 837 FMI 14 - Speedometer Drive Output Error

Refer to the *Chassis Electrical Circuit Diagram Manual*

SPN 1590 FMI 19 - Adaptive Cruise Control Not Detected on J1939

Vehicle Diagnostic Connector Voltage Check

Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
B to GND	B+	If < B+, check B+ circuit to vehicle diagnostic connector for OPEN or short to GND, or blown fuse.
B to A	B+	If < B+, check GND circuit to vehicle diagnostic connector for OPEN.
C to GND	1 V to 4 V	The sum of C to GND and D to GND should = 4 V to 5 V.
D to GND	1 V to 4 V	The sum of C to GND and D to GND should = 4 V to 5 V.

EST Communication Check

Turn ignition switch to ON. Connect EST to vehicle diagnostic connector. If the EST is unable to communicate with the ECM, disconnect each module connected to the J1939 data link individually, until communication is established.

NOTE:

- If communication to ECM is established, check J1939 circuits to disconnected node for correct wiring. See truck *Electrical System Troubleshooting Guide*.
- If communication to ECM is not established, go to next test point.

Test Point	Comment
Disconnect Transmission Control Module (TCM)	See above note.
Disconnect Body Controller	See above note.
Disconnect instrument cluster	See above note.
Disconnect other nodes	See above note.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C to D	approximately 60 Ω	If not within specification, measure individual CAN terminating resistors.
Terminating Resistor Terminals	approximately 120 Ω	If not within specification, replace faulty terminating resistor(s).
C to C1-34	< 5 Ω	If > 5 Ω, check J1939-H for OPEN in circuit.
C to GND	> 1k Ω	If < 1k Ω, check J1939-H for short to GND.
D to C1-47	< 5 Ω	If > 5 Ω, check J1939-L for OPEN in circuit.
D to GND	> 1k Ω	If < 1k Ω, check J1939-L for short to GND.
A to GND	< 5 Ω	If > 5 Ω, check GND for OPEN in circuit.

Pinpoint Diagnostics With ServiceMaxx™ Software

SPN 1590 FMI 19 - Adaptive Cruise Control not detected on J1939

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the Parameters session and verify the correct Adaptive Cruise Control (ACC) system is selected under parameter ID 76102 Adaptive Cruise Control Enable (disable, Vorad, Wingman, or Wabco).

   Is the correct ACC system selected under parameter ID 76102?

   - Yes: Go to J1939 datalink circuit checks (page 1222).
   - No: Correct parameter ID 76102 and program engine. Retest for SPN 1590 FMI 19.

CACOT (Charge Air Cooler Outlet Temperature) Sensor

Overview of CACOT Sensor Group

SPN	FMI	Description
2630	2	CACOT signal erratic, intermittent, or incorrect
2630	3	CACOT signal Out of Range HIGH (page 278)
2630	4	CACOT signal Out of Range LOW (page 285)
2630	16	CACOT Undercooling (page 288)

Overview

The Charge Air Cooler Outlet Temperature (CACOT) is a thermistor sensor that measures charged-air temperature entering the Engine Throttle Valve (ETV). As temperature increases, resistance drops, causing the voltage signal interpreted by the Engine Control Module (ECM) to vary. The ECM monitors this signal for Exhaust Gas Recirculation (EGR) system control and CAC performance.

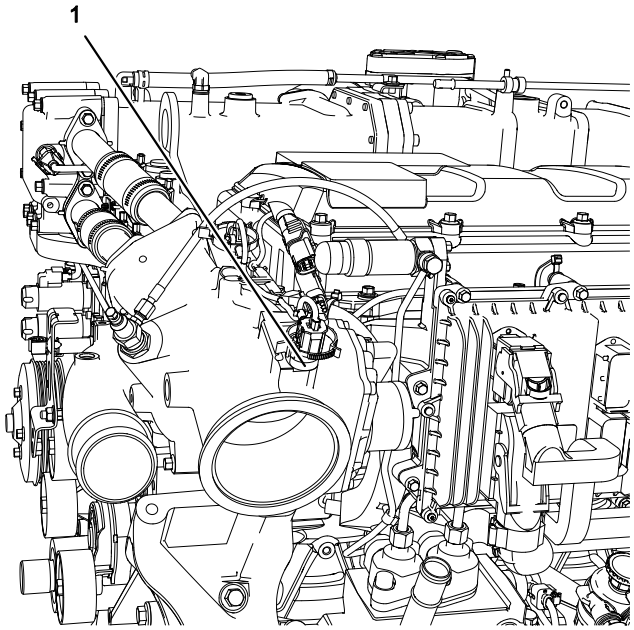


Figure 120 CACOT Sensor Location

1. Charge Air Cooler Outlet Temperature (CACOT) sensor

SPN 2630 FMI 2 - CACOT Signal Erratic, Intermittent, or Incorrect

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is pending or active, continue to Cold Soak Sensor Compare Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 2630 FMI 2 – CACOT signal erratic, intermittent or incorrect

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare CACOT to Ambient Air Temperature (AAT), Inlet Air Temperature (IAT), and Intake Manifold Temperature (IMT). Sensor temperatures should be within 5 °C (10 °F) of each other.
   - If CACOT is 5 °C (10 °F) above or below AAT, IAT, or IMT, check for poor circuitry going to the CACOT sensor.
   - If circuits are within specification, replace CACOT sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4993 to CACOT engine harness, and leave CACOT sensor disconnected. Turn ignition ON.

Test Point	Specifications	Comment– < Less than, > Greater than
EST – Monitor CACOTv	5 V	If <4.5 V, check CACOT signal circuit for short to GND.
EST – Monitor CACOTv Short pin 1 to 2	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check (page 277).
EST – Monitor CACOTv Short 500 Ω resistor across pins 1 and 2	< 1.0 V	If > 1.0 V, check CACOT signal circuit for short to PWR.
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace CACOT sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4993 to CACOT engine harness, and leave CACOT sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	4.5 V to 5 V	If < 4.5 V, check for OPEN or short to GND. Do Harness Resistance Check (page 277).
2 to B+	B+	If < B+, check for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4993 to CACOT engine harness, and leave CACOT sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-13	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-43	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 2630 FMI 3 - CACOT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Charge Air Cooler Outlet Temperature (CACOT) sensor voltage reading greater than expected.	CACOT sensor voltage < 4.80 volts	Key ON

Fault Overview

Fault Code sets when Engine Control Module (ECM) detects Charge Air Cooler Temperature (CACOT) sensor voltage is greater than 4.80 volts.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected after one bad trip.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- CACOT circuit short to PWR
- CACOT circuit Open
- SIG GND circuit Open
- Failed CACOT

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Codes (DTC) list for SPN 2630 FMI 3. Is EST DTC list SPN 2630 FMI 3 active?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at CACOT	Decision
A. Key OFF. B. Disconnect Charge Air Cooler Outlet Temperature (CACOT) sensor. C. Check CACOT sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CACOT sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 2630 FMI 3.

Pin-Point Tests (SPN 2630 FMI 3)

CACOT Circuit

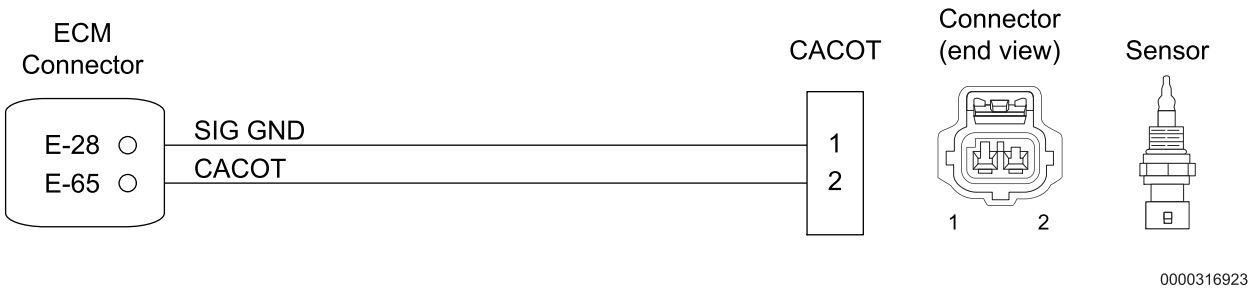


Figure 121 Charge Air Cooler Temperature (CACOT) Sensor Circuit Diagram

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Tools Required

- 3-Banana Plug Harness ZTSE4498
- Breakout Harness ZTSE4993
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

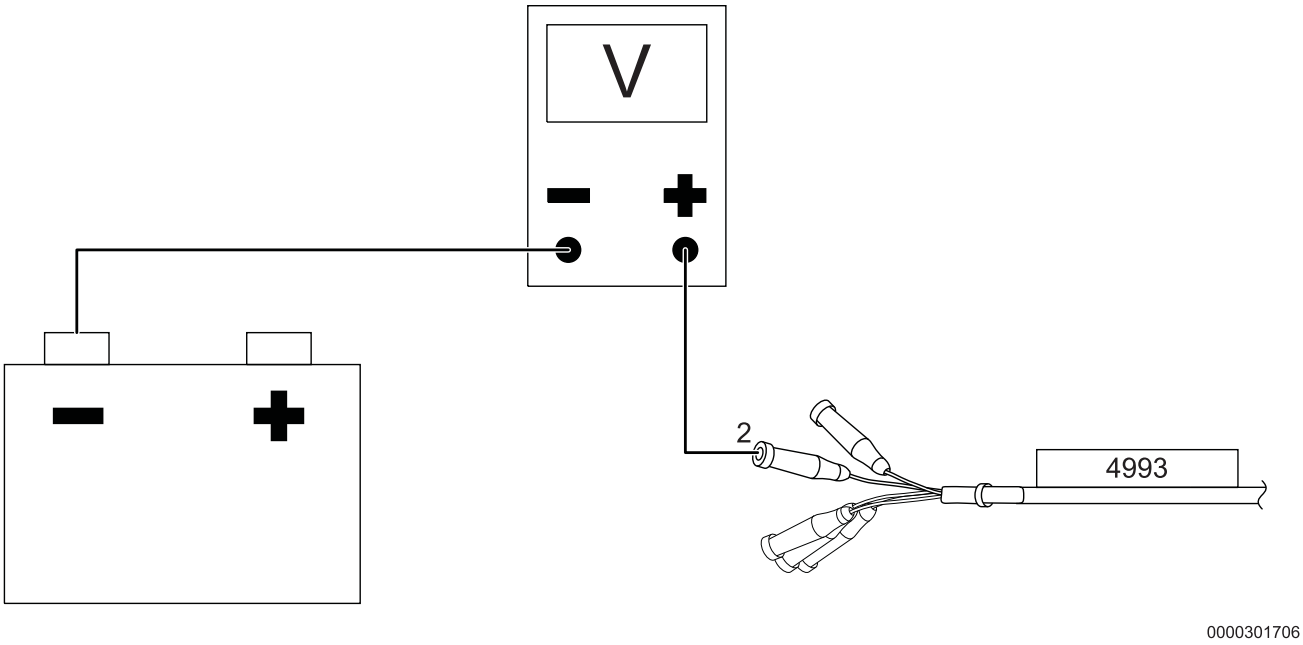
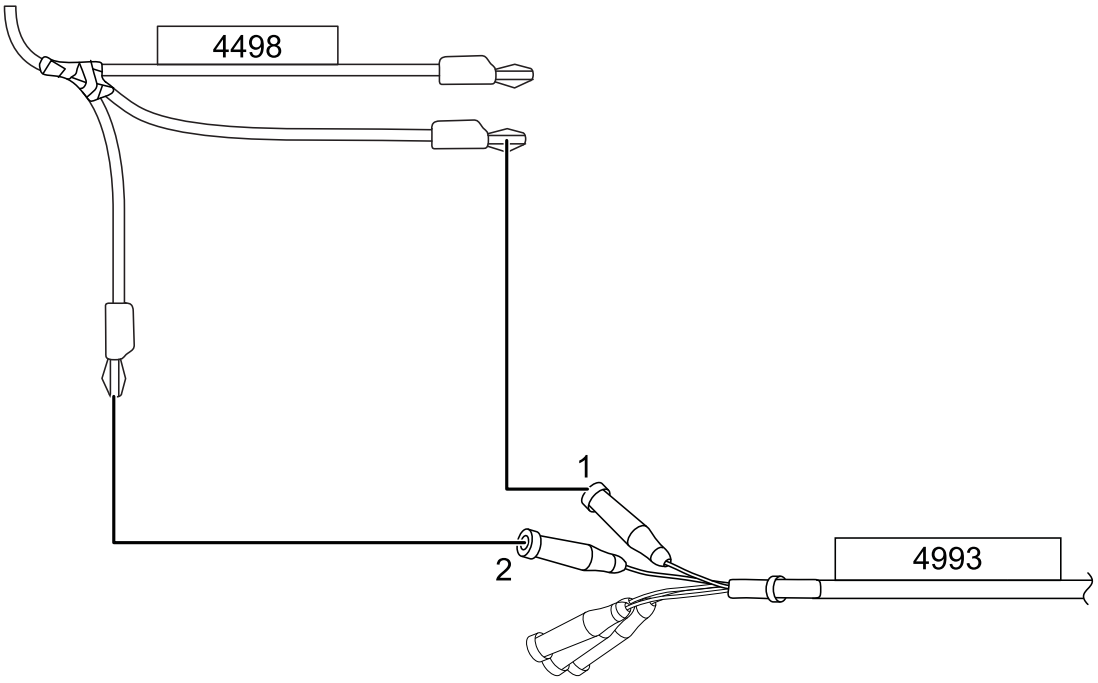


Figure 122 Test 1 CACOT Circuit Voltage Check

Test 1 Setup
A. Key OFF. B. Disconnect Charge Air Cooler Temperature (CACOT) sensor C. Connect Breakout Harness ZTSE4993 to vehicle harness connector and leave CACOT disconnected. D. Key ON.

Test 1	Specification
Use DMM to measure voltage between Breakout Harness ZTSE4993 pin-2 and known good GND.	Greater than 4.85 volts
Decision	
Is voltage greater than 4.85 volts?	Yes: Repair short to PWR between Engine Control Module (ECM) pin E1-13 and CACOT pin-2. After repairs are complete, retest for SPN 2630 FMI 3.
	No: Go to Test 2.



0000301703

Figure 123 Test 2 SIG GND Circuit Check

Test 2 Setup
A. Key OFF. B. Disconnect Charge Air Cooler Temperature (CACOT) sensor C. Connect Breakout Harness ZTSE4993 to vehicle harness connector and leave CACOT disconnected. D. Using 3-Banana Plug Harness ZTSE4498 short Breakout Harness ZTSE4993 pin-1 and pin-2 of together. E. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). F. Key ON. Log in to ServiceMaxx™ software.

Test 2	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor CACOT voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Replace CACOT sensor. After repairs are complete, retest for SPN 2630 FMI 3.
	No: Go to Test 3.

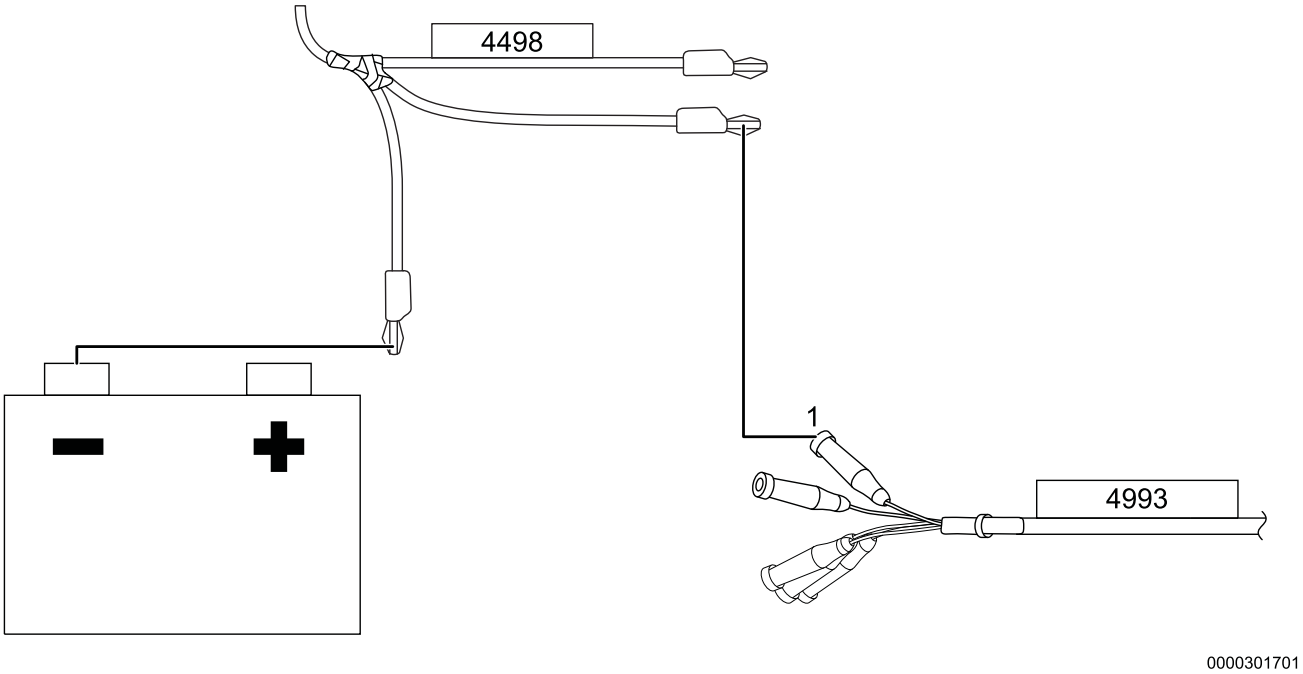


Figure 124 Test 3 CACOT Circuit Check

Test 3 Setup
A. Key OFF. B. Disconnect Charge Air Cooler Temperature (CACOT) sensor C. Connect Breakout Harness ZTSE4993 to vehicle harness connector and leave CACOT disconnected. D. Using 3-Banana Plug Harness ZTSE4498 short Breakout Harness ZTSE4993 pin-2 of to GND. E. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). F. Key ON. Log in to ServiceMaxx™ software.

Test 3	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor ECT1 voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Repair Open between CACOT pin-1 and ECM pin E1-43. After repairs are complete, retest for SPN 2630 FMI 3.
	No: Repair Open between CACOT pin-2 and ECM pin E1-13. After repairs are complete, retest for SPN 2630 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 2630 FMI 3 fault code diagnostics.

SPN 2630 FMI 4 - CACOT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Charge Air Cooler Outlet Temperature (CACOT) sensor signal is lower than expected.	CACOT sensor signal < 0.13 volts	Key ON

Fault Overview

Fault Code sets when Engine Control Module (ECM) detects Charge Air Cooler Outlet Temperature (CACOT) signal is less than 0.13 volts.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected after one trip.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- CACOT circuit short to GND
- Failed CACOT sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 2630 FMI 4. Is EST DTC list SPN 2630 FMI 4 active?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Charge Air Cooler Outlet Temperature (CACOT) sensor.	Decision
A. Key OFF. B. Disconnect CACOT electrical connector. C. Check CACOT sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent or broken pins; or broken connector housing. Are the CACOT sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests . No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 2630 FMI 4.

Pin-Point Tests (SPN 2630 FMI 4)

CACOT Circuit

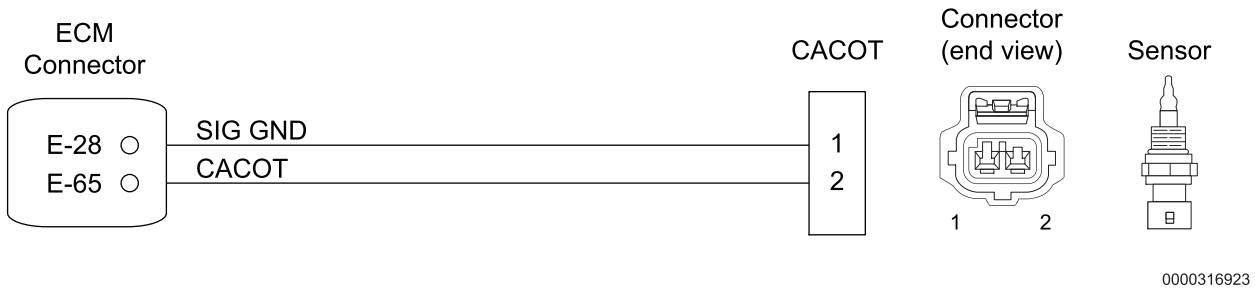


Figure 125 CACOT Sensor Circuit Diagram

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF. B. Disconnect Charge Air Cooler Outlet Temperature (CACOT) sensor. C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). D. Key ON. Log in to ServiceMaxx™ software.

Test 1	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor CACOT voltage.	SPN 2630 FMI 3 sets after DTC list is cleared
Decision	
Does SPN 2630 FMI 3 set after DTC list is cleared?	Yes: Replace CACOT sensor. After repairs are complete, retest for SPN 2630 FMI 4.
	No: Repair short to ground between CACOT pin-1 and Engine Control Module (ECM) pin E1-43. After repairs are complete, retest for SPN 2630 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 2630 FMI 4 fault code diagnostics.

SPN 2630 FMI 16 - CACOT Undercooling

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Comparison of Charge Air Cooler Outlet Temperature (CACOT) sensor reading to modeled value. Actual cooler effectiveness is less than the threshold effectiveness.	Function of engine speed and load, corrected for vehicle speed and ambient air temp	Function of engine speed and load > 0 Key ON Vehicle speed > 6.2 mph Limp Home Mode = Inactive DPF Regeneration = Inactive Power Takeoff (PTO) Mode = Inactive Ambient Air Temperature (AAT) >50°F (10°C) and <131°F (55°C) Barometric pressure (BARO) > 11 psi (75 kPa)	3 events

Fault Overview

Fault sets when the Engine Control Module (ECM) determines the Charge Air Cooler Outlet Temperature (CACOT) sensor reading is greater than a predetermined value. The ECM uses vehicle speed and Ambient Air Temperature (AAT) to determine CAC effectiveness.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 647

Drive Cycle to Determine Fault Status

Drive cycle 4 in 2013 HD-OBD Diagnostic Reference Manual.

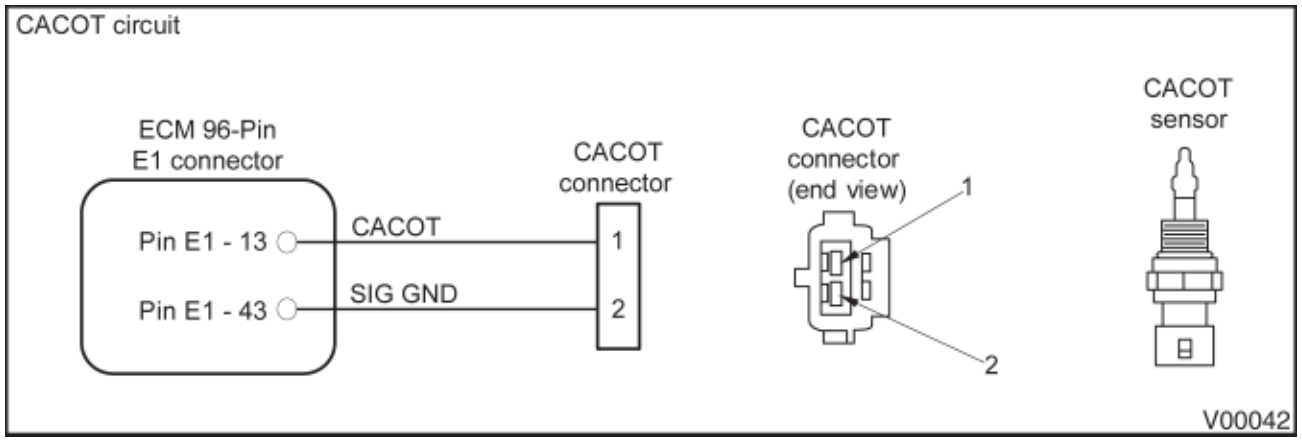


Figure 126 CACOT sensor circuit diagram

Possible Causes

- Restricted CAC
- Engine fan and/or engine fan shroud failure
- Inoperative engine fan
- Winter front installed outside recommended temperatures
- Failed Coolant Control Valve (CCV)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 2630 FMI 16 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 2630 FMI 16.

Step	Action	Decision
2	Determine if a winter front (grill cover) is installed during warm temperatures. Is winter front (grill cover) removed during warm temperatures outside the recommended range?	Yes: Go to step 3. No: Remove winter front. After repairs are complete, retest for SPN 2630 FMI 16.

Step	Action	Decision
3	Inspect Charge Air Cooler (CAC) for damage, blockage, or anything that could prevent proper air flow through the CAC. Is the CAC undamaged, not blocked, and is air able to flow through it properly?	Yes: Go to step 4. No: Repair CAC damage or blockage. After repairs are complete, retest for SPN 2630 FMI 16.

Step	Action	Decision
4	Inspect for damage to the engine cooling fan and shroud. Are the engine cooling fan and shroud in good condition and not damaged?	Yes: Go to step 5. No: Repair engine cooling fan or shroud damage. After repairs are made, retest for SPN 2630 FMI 16.

Step	Action	Decision
5	Determine if engine cooling fan is working when engine is hot. Using EST with ServiceMaxx go to: Tests > KOER Tests > Engine Fan Test. Does engine cooling fan come ON when the engine gets hot (approximately 205°F (96°C) to 225°F (107°C) and above)?	Yes: Go to step 6. No: Diagnosis and repair engine cooling fan or circuit. See EFC (Engine Fan Control) Voltage and Harness resistance checks (page 788). After repairs are complete, retest for SPN 2630 FMI 16.

Step	Action	Decision
6	Determine if Coolant Flow Valve (CFV) and Coolant Mixture Valve (CMV) are working correctly. Perform Coolant Control Valve (CCV) Test . Are the CFV and CMV operating correctly?	Yes: Verify each step was completed correctly and the proper decision was made. Notify supervisor for further action. No: Repair CCV. After repairs are complete, retest for SPN 2630 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 2630 FMI 16 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

CCOSS (Crankcase Oil Separator Speed) Sensor

Overview of CCOSS Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
4227	7	CC Oil Separator Speed: Not spinning	• Crankcase Oil Separator failure • Crankcase Oil Separator circuit or sensor fault	Pin-Point Diagnostics (page 292)

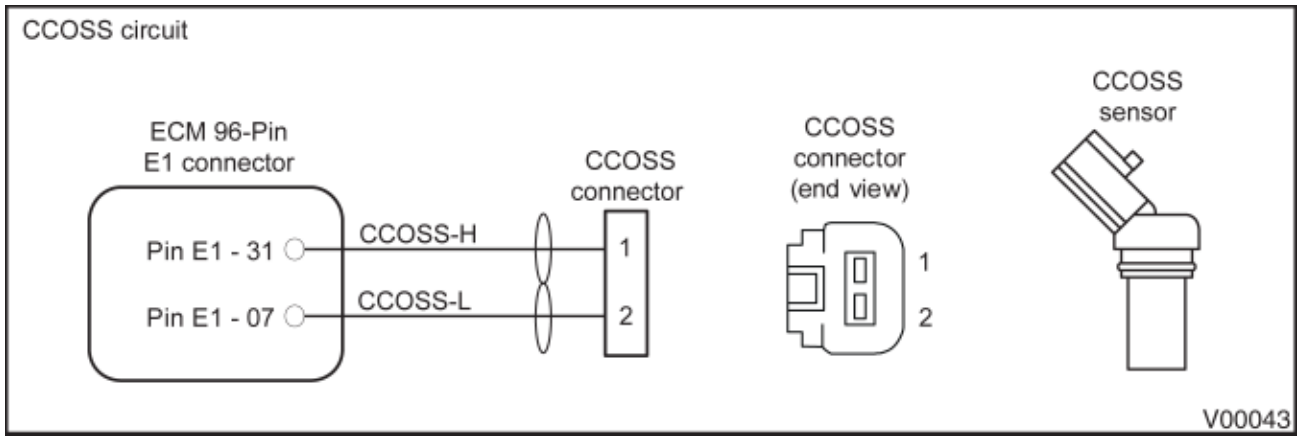


Figure 127 CCOSS circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4951 (CCOSS)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

SPN 4227 FMI 7 - CC Oil Separator: Not spinning

1. Using ServiceMaxx™ software, monitor Crankcase Oil Separator signal while running the engine.
   - If CC Oil Separator signal stays at 0 rpm, verify sensor and voltage to sensor are within specification, go to Connector Voltage Check and Sensor Resistance Check.
   - If sensor resistance and sensor connector voltage are within specification, go to Crankcase Oil Breather Separator Test in “PERFORMANCE DIAGNOSTICS."

Sensor Resistance Check

Turn ignition switch to OFF. Connect Breakout Harness ZTSE4951 to CCOSS sensor and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to 2	300 Ω to 400 Ω	If not within specification, replace CCOSS sensor.

Connector Voltage Check Without ServiceMaxx™ software

Connect Breakout Harness ZTSE4951 to CCOSS engine harness, and leave CCOSS sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	2.0 V – 2.5 V	If < 2.0 V, check for OPEN of short to GND. Do Harness Resistance Check.
2 to GND	2.0 V – 2.5 V	If < 2.0 V, check for OPEN of short to GND. Do Harness Resistance Check.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4951 to CCOSS engine harness, and leave CCOSS sensor disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
E1-07 to 2	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E1-07 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
E1-31 to 1	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E1-31 to GND	> 1k Ω	If < 1k Ω, check for short to GND.

CKP (Crankshaft Position) Sensor

Overview of CKP Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
637	8	CKP signal noise	• Debris accumulation on the Crankshaft Position (CKP) sensor • CKP-L circuit intermittent high resistance • CKP-H circuit intermittent high resistance • CKP-L circuit intermittent short to GND • CKP-H circuit intermittent short to GND • CKP-L circuit intermittent short to CKP-H circuit • Failed CKP sensor	Step-Based Diagnostics (page 295)
637	10	CKP signal inactive	• Debris accumulation on the Crankshaft Position (CKP) sensor • CKP-L circuit Open or high resistance • CKP-H circuit Open or high resistance • CKP-L circuit short to GND • CKP-H circuit short to GND • CKP-L circuit shorted to CKP-H circuit • Failed CKP sensor	Step-Based Diagnostics (page 299)

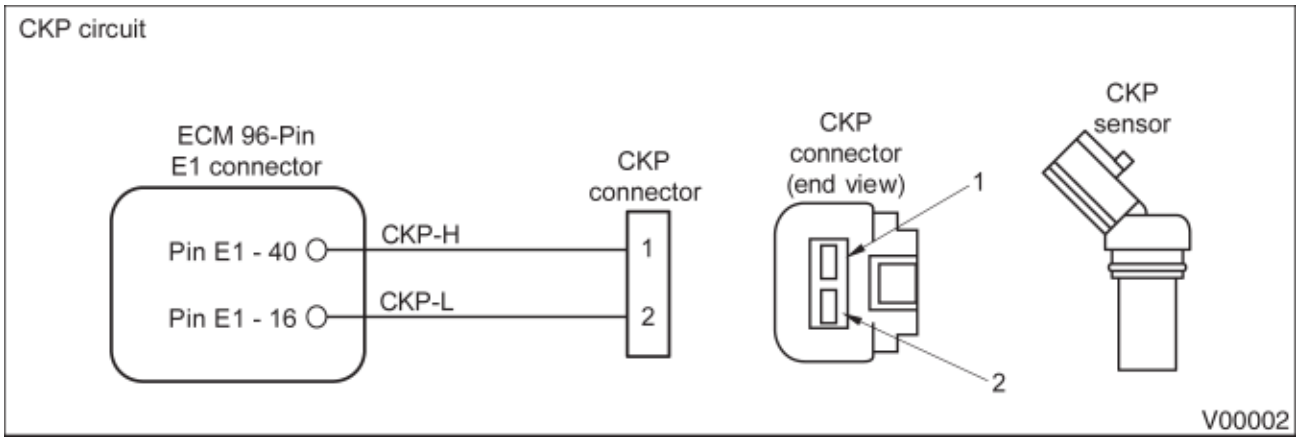


Figure 128 CKP sensor circuit diagram

Overview

The Crankshaft Position (CKP) sensor is a magnetic pickup sensor that indicates crankshaft speed and position. The CKP sensor is compared with the Camshaft Position (CMP) sensor by the Electronic Control Module (ECM) to calculate the RPM and timing of the engine. The engine will still start with a failed CKP or CMP sensor, but will have a longer crank time.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ECM Breakout Harness 00-01468-00
- Breakout Harness ZTSE6021 (CKP)
- International Electrical Engine. Terminal Test Kit ZTSE4435
- 500 Ohm Resistor Jumper Harness ZTSE4497
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

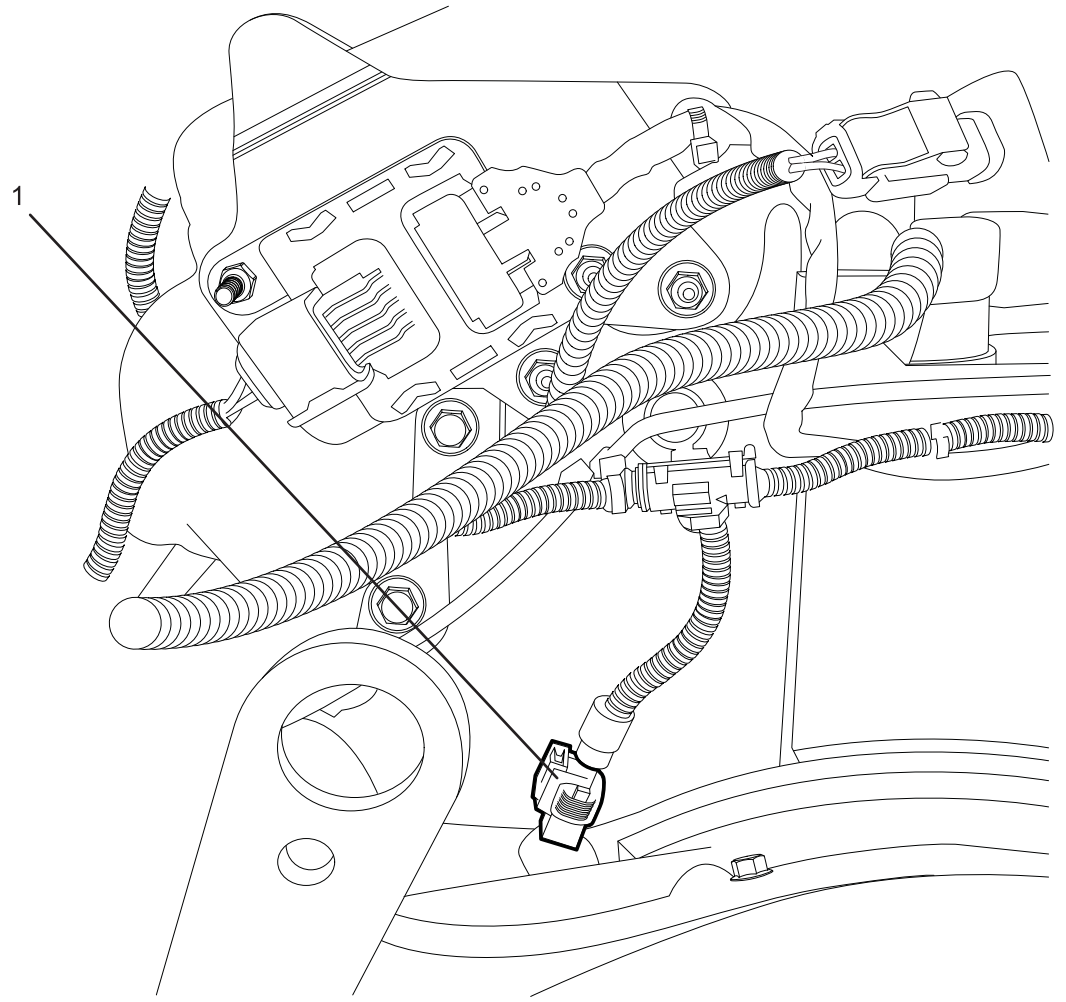


Figure 129 CKP Sensor Location (Back of Engine)

1. Crankshaft Position (CKP) sensor

SPN 637 FMI 8 - CKP signal noise

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft Position (CKP) sensor signal greater than expected.	CKP signal > 8000 rpm	Engine cranking OR Key-On Engine-Running (KOER)	8 engine revolutions (per cam signal)

Fault Overview

Fault Code sets when the Electronic Control Module (ECM) detects the signal from the Crankshaft Position (CKP) sensor indicates engine speed is greater than 8000 rpm.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

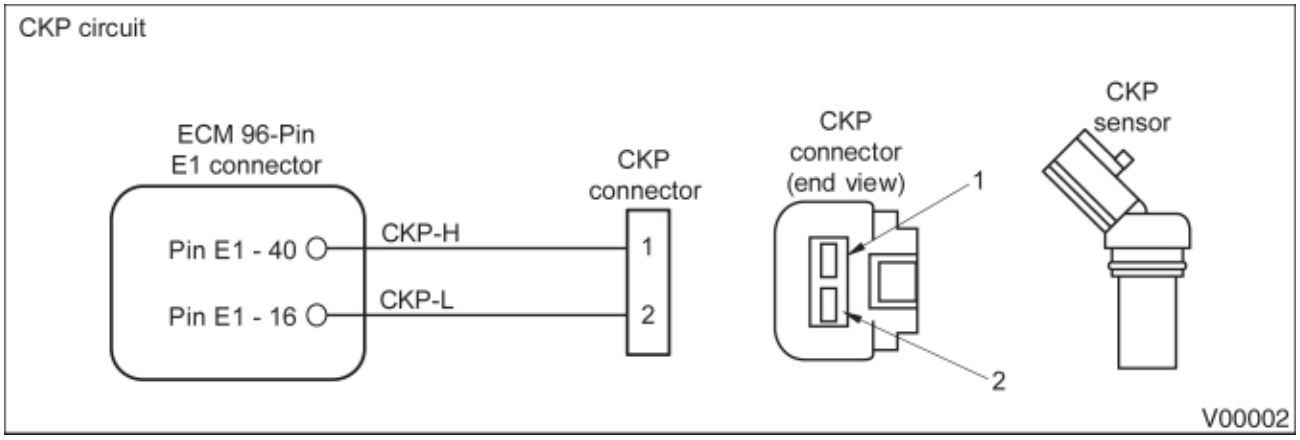


Figure 130 CKP sensor circuit diagram

Possible Causes

- Debris accumulation on the Crankshaft Position (CKP) sensor
- CKP-L circuit intermittent high resistance
- CKP-H circuit intermittent high resistance
- CKP-L circuit intermittent short to GND
- CKP-H circuit intermittent short to GND
- CKP-L circuit intermittent short to CKP-H circuit
- Failed CKP sensor

Step	Action	Decision
1	Inspect connections at Crankshaft Position (CKP) sensor. Key OFF, disconnect CKP sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CKP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 637 FMI 8.

CAUTION: To prevent damage, do not use chemical cleaners to clean crankshaft position sensor.

Step	Action	Decision
2	Remove CKP sensor. Inspect sensor for debris build up on the sensor. Is the sensor free of damage or debris on the sensor surface?	Yes: Go to step 3. No: Clean CKP sensor with a rag or towel. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
3	Check for a failed CKP sensor. Connect Breakout Harness ZTSE6021 to CKP sensor, and leave vehicle harness disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance 774 - 946 Ohms?	Yes: Go to step 4. No: Replace CKP sensor. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
4	Check for intermittent short to GND in CKP-H circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave CKP sensor disconnected. Key OFF Use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short to GND between CKP connector pin-1 and ECM pin E1-10. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
5	Check for intermittent short to GND in CKP-L circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave CKP sensor disconnected. Key OFF, Use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND between CKP connector pin-2 and ECM pin E1-16. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
6	Check CKP-H circuit for intermittent high resistance (voltage drop). 1. Key OFF, disconnect CKP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CKP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-1 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-40. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to pin previously installed, and the other end to PWR (use a jumper wire if needed).	Yes: Go to step 7. No: Repair intermittent high resistance between CKP connector pin-1 and ECM pin E1-40. After repairs are complete, retest for SPN 637 FMI 8.

	6. Using a DMM, measure voltage between Breakout Harness pin-1 and ECM pin E1-40. Is voltage less than 0.3 volts?	

Step	Action	Decision
7	Check CKP-L circuit for intermittent high resistance (voltage drop). 1. Key OFF, disconnect CKP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CKP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-2 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-16. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to pin previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-2 and ECM pin E1-16. Is voltage less than 0.3 volts?	Yes: Go to step 8. No: Repair intermittent high resistance between CKP connector pin-2 and ECM pin E1-16. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
8	Check for intermittent short CKP-L to CKP-H. With ECM Disconnected, connect Breakout Harness ZTSE6021 to vehicle harness, and leave CKP sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 to pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Repair short between CKP-L and CKP-H circuits. After repairs are complete, retest for SPN 637 FMI 8.

Step	Action	Decision
9	Check for incorrect output from the CKP sensor. With ECM connected, connect Breakout Harness ZTSE6021 between CMP sensor and vehicle harness. Using DMM set to AC Volts - RPM2. Measure RPM between pin-1 and pin-2 during cranking, low idle, and high idle. Is RPM measured 99 RPM to 250 RPM at cranking, 549 RPM to 700 RPM at low idle, and 1250 RPM to 1500 RPM at high idle?	Yes: Clear code and retest for SPN 637 FMI 8. No: Replace CKP sensor. After repairs are complete, retest for SPN 637 FMI 8.

NOTE: After performing all diagnostic steps, if SPN 637 FMI 8 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 637 FMI 10 - CKP signal inactive

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
No Crankshaft Position (CKP) signal	CKP circuit voltage < 0.40 volts	Engine cranking OR Key-On Engine-Running (KOER)	10 camshaft revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) receives no signal from the Crankshaft Position (CKP) sensor.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

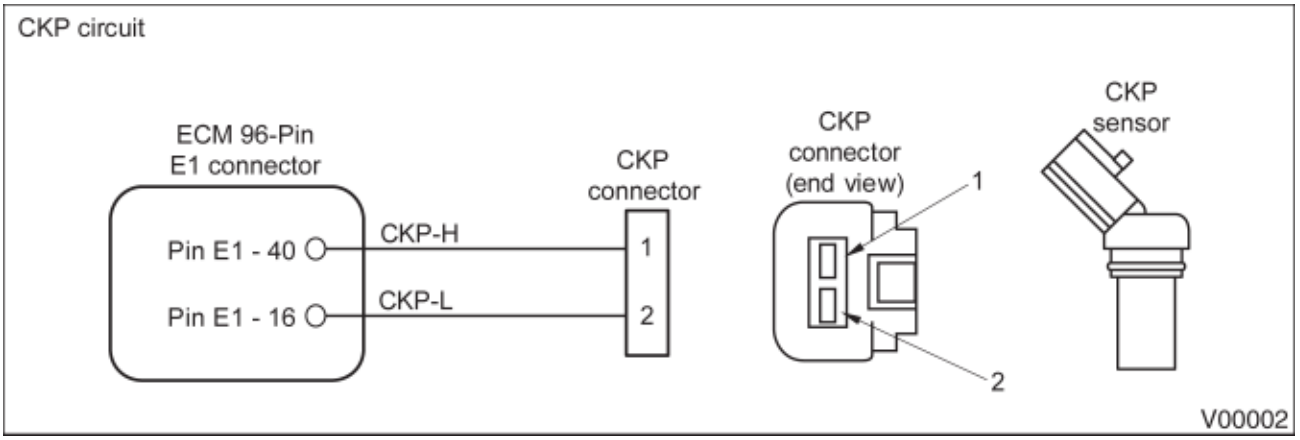


Figure 131 CKP sensor circuit diagram

Possible Causes

- Debris accumulation on the Crankshaft Position (CKP) sensor
- CKP-L circuit Open or high resistance
- CKP-H circuit Open or high resistance
- CKP-L circuit short to GND
- CKP-H circuit short to GND
- CKP-L circuit shorted to CKP-H circuit
- Failed CKP sensor

Step	Action	Decision
1	Inspect connections at Crankshaft Position (CKP) sensor. Key OFF, disconnect CKP sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CKP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 637 FMI 10.

CAUTION: To prevent damage, do not use chemical cleaners to clean crankshaft position sensor.

Step	Action	Decision
2	Remove CKP sensor. Inspect sensor for debris build up on the sensor. Is the sensor free of damage or debris on the sensor surface?	Yes: Go to step 3. No: Clean CKP sensor with a rag or towel. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
3	Check for a failed CKP sensor. Connect Breakout Harness ZTSE6021 to CKP sensor and leave Breakout Harness disconnected from vehicle. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance 774 – 946 Ohms?	Yes: Go to step 4. No: Replace CKP sensor. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
4	Check for short to GND in CKP-H circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave CKP sensor disconnected. Key OFF Use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short to GND between CKP connector pin-1 and ECM pin E1-10. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
5	Check for short to GND in CKP-L circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave CKP sensor disconnected. Key OFF, Use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND between CKP connector pin-2 and ECM pin E1-16. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
6	Check CKP-H circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect CKP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CKP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-1 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-40. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to pin previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-1 and ECM pin E1-40. Is voltage less than 0.3 volts?	Yes: Go to step 7. No: Repair Open or high resistance between CKP connector pin-1 and ECM pin E1-40. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
7	Check CKP-L circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect CKP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CKP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-2 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-16. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to pin previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-2 and ECM pin E1-16. Is voltage less than 0.3 volts?	Yes: Go to step 8. No: Repair Open or high resistance between CKP connector pin-2 and ECM pin E1-16. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
8	Check for CKP-H shorted to CKP-L. With ECM Disconnected, connect Breakout Harness ZTSE6021 to vehicle harness and leave CMP sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Repair short between CKP-H and CKP-L circuits. After repairs are complete, retest for SPN 637 FMI 10.

Step	Action	Decision
9	Check for a failed CKP sensor. Reconnect ECM. Connect Breakout Harness ZTSE6021 between CKP sensor and vehicle harness. Using a DMM set to measure AC frequency (Hz), measure the voltage of the sensor when cranking, low idle, and high idle (100-250 RPM). Is RPM measured 99 RPM to 250 RPM at cranking, 549 RPM to 700 RPM at low idle, and 1250 RPM to 1500 RPM at high idle?	Yes: Clear code and retest for SPN 637 FMI 10. No: Replace CKP sensor. After repairs are complete, retest for SPN 637 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 637 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

CMP (Camshaft Position) Sensor

Overview of CMP Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
636	2	CMP and CKP Synchronization Error	• Debris accumulation on the Camshaft Position (CMP) sensor • CMP-L high resistance • CMP-H high resistance • CMP-L short to GND • CMP-H short to GND • CMP-L shorted to CMP-H • Camshaft and Crankshaft not synchronized • Failed CMP	Step-Based Diagnostics (page 305)
636	8	CMP signal noise	• Debris accumulation on the Camshaft Position (CMP) sensor • CMP-L intermittent high resistance • CMP-H intermittent high resistance • CMP-L intermittent short to GND • CMP-H intermittent short to GND • CMP-L intermittent short to CMP-H • Failed CMP	Step-Based Diagnostics (page 309)
636	10	CMP signal inactive	• Debris accumulation on the Camshaft Position (CMP) sensor • CMP-L Open or high resistance	Step-Based Diagnostics (page 313)

- CMP-H Open or high resistance
- CMP-L short to GND
- CMP-H short to GND
- CMP-L shorted to CMP-H
- Failed CMP

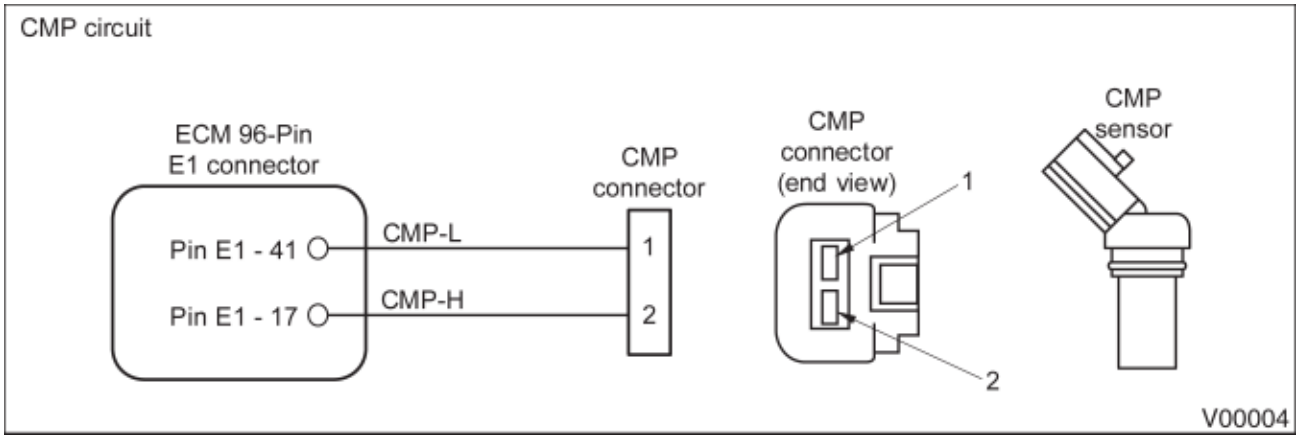


Figure 132 CMP sensor circuit diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Camshaft Position (CMP) sensor is a magnetic pickup sensor that indicates camshaft speed and position. The CMP sensor is compared with the Crankshaft Position (CKP) sensor by the Electronic Control Module (ECM) to calculate the RPM and timing of the engine. The engine will still start with a failed CMP or CKP sensor, but will have a longer crank time.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ECM Breakout Harness 00-01468-00
- Breakout Harness ZTSE6021
- International Electrical Engine. Terminal Test Kit ZTSE4435
- 500 Ohm Resistor Jumper Harness ZTSE4497
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

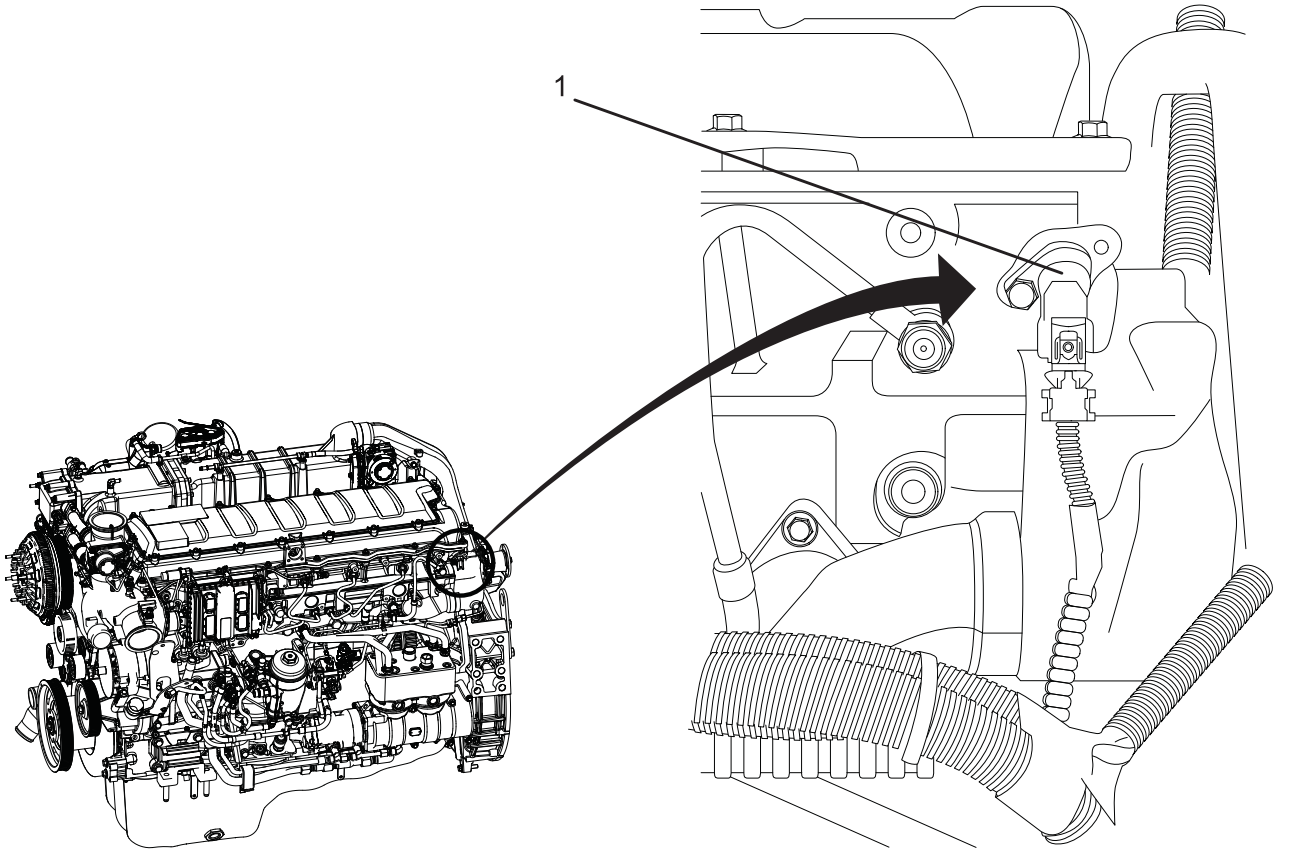


Figure 133 CMP Sensor Location

1. Camshaft Position (CMP) sensor

SPN 636 FMI 2 - CMP and CKP Synchronization Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Camshaft position signal error	Camshaft position signal error > 20 crank degrees OR < -20 crank degrees	Engine cranking OR Key-On Engine-Running (KOER)	2 consecutive camshaft revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects the difference between the camshaft and crankshaft position signals is > 20 degrees.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

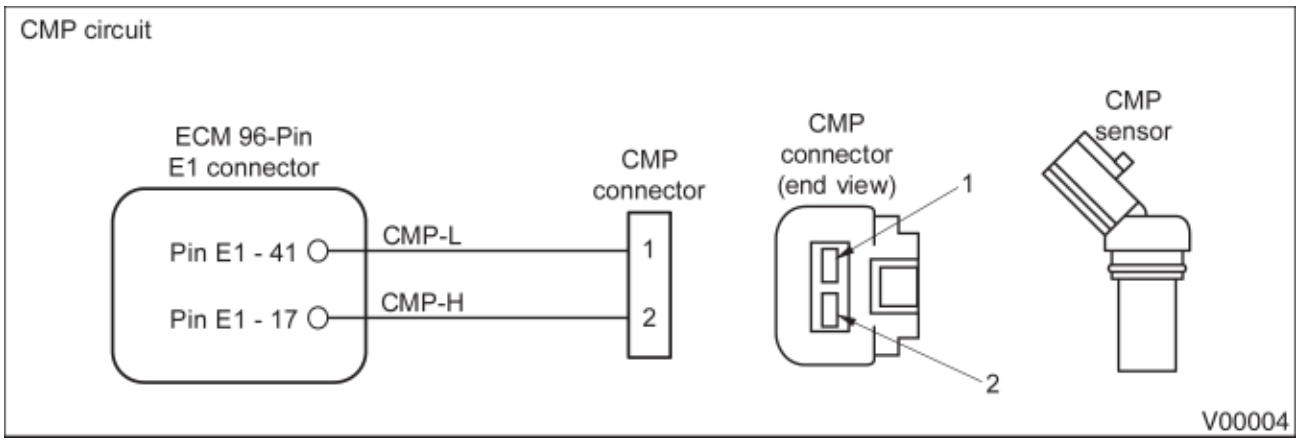


Figure 134 CMP sensor circuit diagram

Possible Causes

- Debris accumulation on the Camshaft Position (CMP) sensor
- CMP-L high resistance
- CMP-H high resistance
- CMP-L short to GND
- CMP-H short to GND
- CMP-L shorted to CMP-H
- Camshaft and Crankshaft not synchronized
- Failed CMP

Step	Action	Decision
1	Inspect connections at Camshaft Position (CMP) sensor. Key OFF, disconnect CMP sensor. Check CMP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CMP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 636 FMI 2.

CAUTION: To prevent damage, do not use chemical cleaners to clean camshaft position sensor.

Step	Action	Decision
2	Inspect CMP sensor and bore for damage or debris build up. Remove CMP sensor and inspect sensor and bore. Is the sensor and bore free of damage or debris?	Yes: Go to step 3. No: Clean or replace CMP sensor with a rag or towel and clean sensor bore. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
3	Check for a failed CMP sensor. Connect Breakout Harness ZTSE6021 to CMP sensor and leave Breakout Harness disconnected from vehicle harness. Key OFF, use a DMM to measure resistance between pin-1 and pin-2. Is CMP sensor resistance 774 to 946 ohms?	Yes: Go to step 4. No: Replace the CMP sensor. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
4	Check for short to GND in CMP-H circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short to GND between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
5	Check for short to GND in CMP-L circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
6	Check CMP-L circuit for high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-1 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-41.	Yes: Go to step 7. No: Repair high resistance between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 2.

	5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-1 and ECM pin E1-41. Is voltage less than 0.3 volts?	

Step	Action	Decision
7	Check CMP-H circuit for high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-2 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-17. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-2 and ECM pin E1-17. Is voltage less than 0.3 volts?	Yes: Go to step 8. No: Repair high resistance between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
8	Check for CMP-L shorted to CMP-H. With ECM Disconnected, connect Breakout Harness ZTSE6021 to vehicle harness and leave CMP sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Repair short between CMP-L and CMP-H. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
9	Check for incorrect output from the CMP sensor. With ECM connected, connect Breakout Harness ZTSE6021 between CMP sensor and vehicle harness. Using DMM set to AC Volts - RPM2. Measure RPM between pin-1 and pin-2 during cranking, low idle, and high idle. Is RPM measured 99 RPM to 250 RPM at cranking, 549 RPM to 700 RPM at low idle, and 1250 RPM to 1500 RPM at high idle?	Yes: Go to step 10. No: Replace the CMP sensor. After repairs are complete, retest for SPN 636 FMI 2.

Step	Action	Decision
10	Check for correct camshaft / crankshaft synchronization (see Engine Service Manual, "Cylinder Head, Camshaft and Valve Train" section). Are the camshaft and crankshaft timed properly?	Yes: Clear code and retest for SPN 636 FMI 2.
		No: Check for damage and re-time the camshaft and crankshaft. (see Engine Service Manual). After repairs are complete, retest for SPN 636 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 636 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 636 FMI 8 - CMP signal noise

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Camshaft Position (CMP) sensor signal difference greater than expected.	CMP signal difference	Engine cranking OR Key-On Engine-Running (KOER)	4 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects Camshaft Position (CMP) sensor signal difference is greater than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

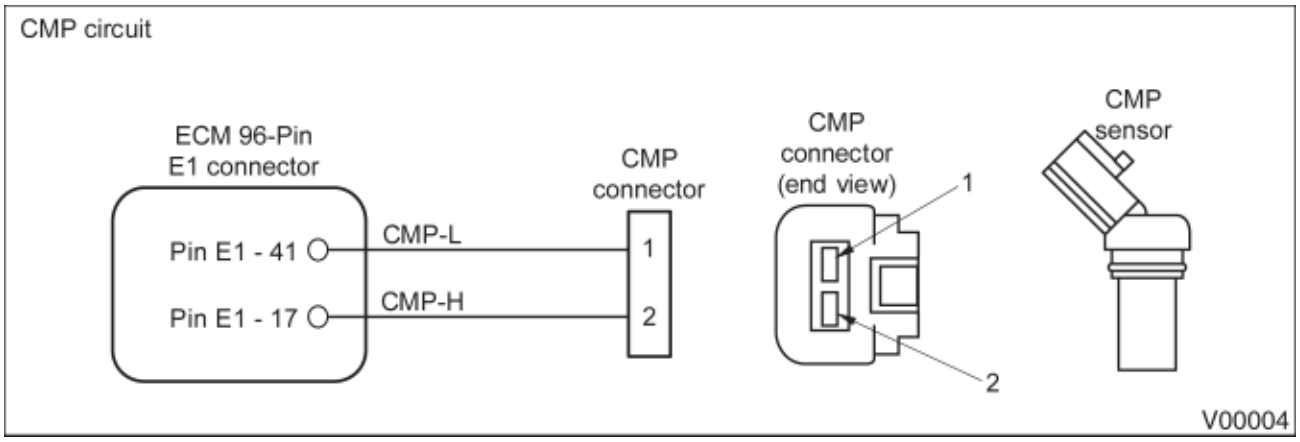


Figure 135 CMP sensor circuit diagram

Possible Causes

- Debris accumulation on the Camshaft Position (CMP) sensor
- CMP-L intermittent high resistance
- CMP-H intermittent high resistance
- CMP-L intermittent short to GND
- CMP-H intermittent short to GND
- CMP-L intermittent short to CMP-H
- Failed CMP

Step	Action	Decision
1	Inspect connections at Camshaft Position (CMP) sensor. Key OFF, disconnect CMP sensor. Check CMP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CMP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 636 FMI 8.

CAUTION: To prevent damage, do not use chemical cleaners to clean camshaft position sensor.

Step	Action	Decision
2	Remove CMP sensor. Inspect sensor for damage or debris build up on the sensor. Is the sensor free of damage or debris on the sensor surface?	Yes: Go to step 3. No: Clean CMP sensor with a rag or towel. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
3	Check for a failed CMP sensor. Connect Breakout Harness ZTSE6021 to CMP sensor and leave Breakout Harness disconnected from vehicle. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance 774 to 946 ohms?	Yes: Go to step 4. No: Replace the CMP sensor. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
4	Check for intermittent short to GND in CMP-H circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair intermittent short to GND between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
5	Check for short to GND in CMP-L circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair intermittent short to GND between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
6	Check CMP-L circuit for intermittent high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-1 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-41. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-1 and ECM pin E1-41. Is voltage less than 0.3 volts?	Yes: Go to step 7. No: Repair intermittent high resistance between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
7	Check CMP-H circuit for intermittent high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-2 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-17. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-2 and ECM pin E1-17. Is voltage less than 0.3 volts?	Yes: Go to step 8. No: Repair intermittent high resistance between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
8	Check for intermittent short CMP-L to CMP-H. With ECM disconnected, connect Breakout Harness ZTSE6021 to vehicle harness and leave CMP sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Repair short between CMP-L and CMP-H circuits. After repairs are complete, retest for SPN 636 FMI 8.

Step	Action	Decision
9	Check for incorrect output from the CMP sensor. Connect Breakout Harness ZTSE6021 between CMP sensor and vehicle harness. Using DMM set to AC Volts - RPM2. Measure RPM between pin-1 and pin-2 during cranking, low idle, and high idle. Is RPM measured 99 RPM to 250 RPM at cranking, 549 RPM to 700 RPM at low idle, and 1250 RPM to 1500 RPM at high idle?	Yes: Clear code and retest for SPN 636 FMI 8. No: Replace the CMP Sensor. After repairs are complete, retest for SPN 636 FMI 8.

NOTE: After performing all diagnostic steps, if SPN 636 FMI 8 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 636 FMI 10 - CMP signal inactive

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
No Camshaft Position (CMP) signal.	CMP circuit voltage < 0.405 volts	Engine cranking OR Key-On Engine-Running (KOER)	4 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) receives no signal from the Camshaft Position (CMP) sensor.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

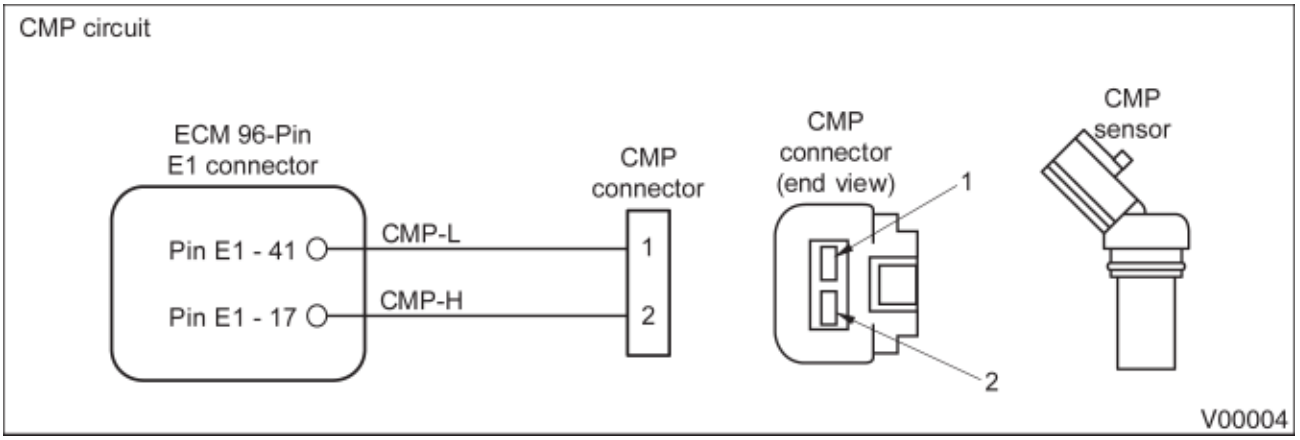


Figure 136 CMP sensor circuit diagram

Possible Causes

- Debris accumulation on the Camshaft Position (CMP) sensor
- CMP-L Open or high resistance
- CMP-H Open or high resistance
- CMP-L short to GND
- CMP-H short to GND
- CMP-L shorted to CMP-H
- Failed CMP

Step	Action	Decision
1	Inspect connections at Camshaft Position (CMP) sensor. Key OFF, disconnect CMP sensor. Check CMP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CMP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 636 FMI 10.

CAUTION: To prevent damage, do not use chemical cleaners to clean camshaft position sensor.

Step	Action	Decision
2	Remove CMP sensor. Inspect sensor for damage or debris build up on the sensor. Is the sensor free of damage or debris on the sensor surface?	Yes: Go to step 3. No: Clean CMP sensor with a rag or towel. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
3	Check for a failed CMP sensor. Connect Breakout Harness ZTSE6021 to CMP sensor and leave Breakout Harness disconnected from vehicle. Using DMM, measure resistance between pin-1 and pin-2. Is resistance 774 – 946 ohms?	Yes: Go to step 4. No: Replace the CMP sensor. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
4	Check for short to GND in CMP-H circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short to GND between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
5	Check for short to GND in CMP-L circuit. Connect Breakout Harness ZTSE6021 to vehicle harness and leave sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
6	Check CMP-L circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-1 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-41. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-1 and ECM pin E1-41. Is voltage less than 0.3 volts?	Yes: Go to step 7. No: Repair Open or high resistance between CMP connector pin-1 and ECM pin E1-41. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
7	Check CMP-H circuit for Open or high resistance (voltage drop). 1. Key OFF, disconnect CMP sensor and Engine Control Module (ECM). 2. Connect Breakout Harness ZTSE6021 to vehicle harness, and leave CMP sensor disconnected. 3. Using a jumper wire, connect Breakout Harness pin-2 to a known good ground. 4. Insert proper terminal into the ECM vehicle harness pin E1-17. 5. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal previously installed, and the other end to PWR (use a jumper wire if needed). 6. Using a DMM, measure voltage between Breakout Harness pin-2 and ECM pin E1-17. Is voltage less than 0.3 volts?	Yes: Go to step 8. No: Repair Open or high resistance between CMP connector pin-2 and ECM pin E1-17. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
8	Check for CMP-L shorted to CMP-H. With ECM Disconnected, connect Breakout Harness ZTSE6021 to vehicle harness and leave CMP sensor disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Repair short between CMP-L and CMP-H. After repairs are complete, retest for SPN 636 FMI 10.

Step	Action	Decision
9	Check for incorrect output from the CMP sensor. Connect Breakout Harness ZTSE6021 between CMP sensor and vehicle harness. Using DMM set to AC Volts - RPM2. Measure RPM between pin-1 and pin-2 during cranking, low idle, and high idle. Is RPM measured 99 RPM to 250 RPM at cranking, 549 RPM to 700 RPM at low idle, and 1250 RPM to 1500 RPM at high idle?	Yes: Clear code and retest for SPN 636 FMI 10. No: Replace the CMP sensor. After repairs are complete, retest for SPN 636 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 636 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Cylinder Balance

Overview of Cylinder Balance Sensor Group

SPN	FMI	Actions
651	13	Injector 1 programmable parameter error (page 319)
651	16	Injector 1 Fuel quantity/timing high error (page 321)
651	18	Injector 1 Fuel quantity/timing low error (page 324)
652	13	Injector 1 programmable parameter error (page 327)
652	16	Injector 2 Fuel quantity/timing high error (page 329)
652	18	Injector 2 Fuel quantity/timing low error (page 332)
653	13	Injector 1 programmable parameter error (page 335)
653	16	Injector 3 Fuel quantity/timing high error (page 337)
653	18	Injector 3 Fuel quantity/timing low error (page 340)
654	13	Injector 1 programmable parameter error (page 343)
654	16	Injector 4 Fuel quantity/timing high error (page 345)
654	18	Injector 4 Fuel quantity/timing low error (page 348)
655	13	Injector 1 programmable parameter error (page 351)
655	16	Injector 5 Fuel quantity/timing high error (page 353)
655	18	Injector 5 Fuel quantity/timing low error (page 356)
656	13	Injector 1 programmable parameter error (page 359)
656	16	Injector 6 Fuel quantity/timing high error (page 361)
656	18	Injector 6 Fuel quantity/timing low error (page 364)
1322	31	Misfire – Multiple cylinders (page 367)
1323	31	Misfire – Cylinder 1 (page 371)
1324	31	Misfire – Cylinder 2 (page 374)
1325	31	Misfire – Cylinder 3 (page 377)
1326	31	Misfire – Cylinder 4 (page 380)
1327	31	Misfire – Cylinder 5 (page 383)
1328	31	Misfire – Cylinder 6 (page 386)

Overview

Many factors influence the combustion process in a power cylinder. This can affect the production of torque or horsepower from that cylinder. Some of the factors include piston and cylinder geometry, injector performance, and fuel rail pressure. Variations in these factors can cause unevenness in torque and horsepower from one cylinder to the next. Power cylinder unevenness also causes increased engine noise and vibration, especially at low idle. This is also referred to as rough idle.

The Engine Control Module (ECM) uses a Cylinder Balance control strategy to even the power contribution of the cylinders, particularly at low idle. This strategy incorporates information from the Crankshaft Position (CKP)

sensor. The ECM uses the instantaneous engine speed near Top Dead Center (TDC) for each cylinder as an indication of that cylinder's power contribution. The ECM computes a nominal instantaneous engine speed value based on all cylinders. The nominal value would be the expected value from all cylinders if the engine is balanced.

By knowing the error quantities, the ECM can add or subtract fuel from a particular cylinder. The control strategy attempts to correct the cylinder unbalance by using fuel quantity compensation through adjustments of the pulse width values for each fuel injector. This method of compensation is repeated until all error quantities are close to zero causing all cylinders to contribute the same amount.

SPN 651 FMI 13 - Injector 1 Programmable Parameter Error

Condition / Description	Setting Criteria	Enable Conditions / Values
Incorrect Injector Quantity Adjustment (IQA) programed into Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into ECM.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Incorrectly Programmed IQA

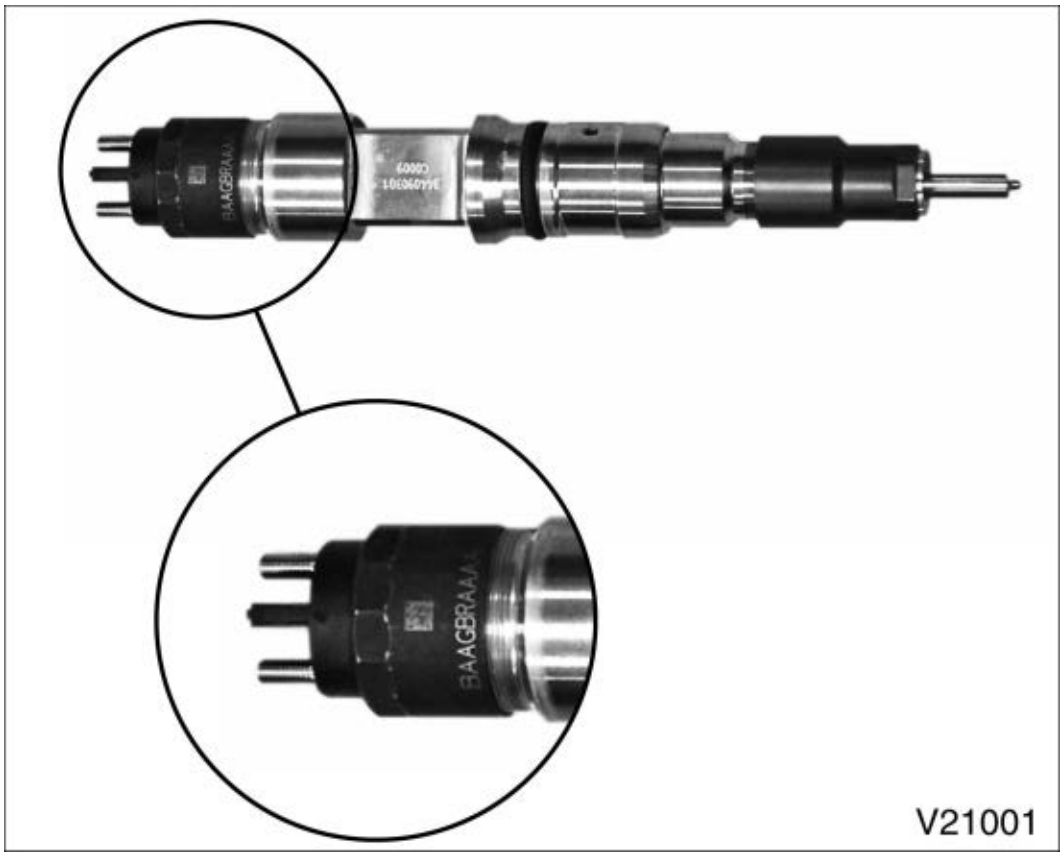


Figure 137 Location of IQA Code

Step 1	Check that proper Injector Quantity Adjustment (IQA) is programed into Electronic Control Module (ECM).	Decision
1. Remove upper valve cover and engine brake housing (see *Engine Service Manual*). Document IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, perform IQA Adjustment(page 1562).		Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 651 FMI 13.
Do IQA codes displayed in ServiceMaxx™ software match injectors in engine?		No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 651 FMI 13.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 651 FMI 13 fault code diagnostics.

SPN 651 FMI 16 - Injector 1 Fuel Quantity / Timing High Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 651 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 651 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 651 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 651 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test . Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 651 FMI 16?	Yes: Clear fault. No: Replace Injector 1. After repairs are complete, retest for SPN 651 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 651 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 651 FMI 18 - Injector 1 Fuel Quantity / Timing Low Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 651 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel

- Low Fuel Rail Pressure (FRP)
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 651 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 651 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 651 FMI 4, 5, and 13. After repairs are complete, retest for SPN 651 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check . Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 651 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 651 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 6. No: Retest for SPN 651 FMI 18.

Step	Action	Decision
6	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 651 FMI 18.
		No: Repair failed valve train components. After repairs are complete retest for SPN 651 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 651 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 652 FMI 13 - Injector 2 Programmable Parameter Error

Condition / Description	Setting Criteria	Enable Conditions / Values
Incorrect Injector Quantity Adjustment (IQA) programed into Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into ECM.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Incorrectly Programmed IQA

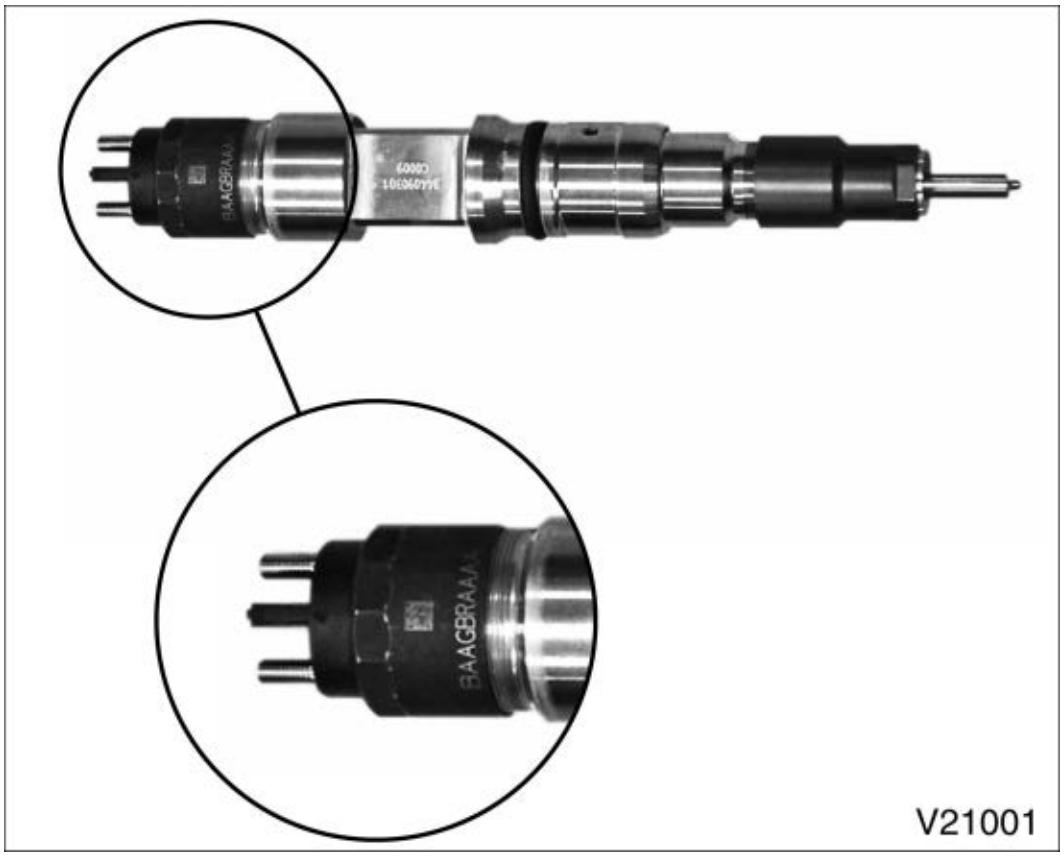


Figure 138 Location of IQA Code

Step 1	Check that proper Injector Quantity Adjustment (IQA) is programed into Electronic Control Module (ECM).	Decision
1. Remove upper valve cover and engine brake housing (see *Engine Service Manual*). Document IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, perform IQA Adjustment(page 1562).		Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 652 FMI 13.
Do IQA codes displayed in ServiceMaxx™ software match injectors in engine?		No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 652 FMI 13.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 652 FMI 13 fault code diagnostics.

SPN 652 FMI 16 - Injector 2 Fuel Quantity / Timing High Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 652 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 652 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 652 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 652 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 652 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 652 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test . Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 652 FMI 16.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 652 FMI 16?	Yes: Clear fault. No: Replace Injector 2. After repairs are complete, retest for SPN 652 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 652 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 652 FMI 18 - Injector 2 Fuel Quantity / Timing Low Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 652 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel

- Low Fuel Delivery Pressure (FDP)
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 652 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 652 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 652 FMI 4, 5, and 13. After repairs are complete, retest for SPN 652 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check . Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 652 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 652 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 6. No: Retest for SPN 652 FMI 18.

Step	Action	Decision
6	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 652 FMI 18.
		No: Repair failed valve train components. After repairs are complete retest for SPN 652 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 652 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 653 FMI 13 - Injector 3 Programmable Parameter Error

Condition / Description	Setting Criteria	Enable Conditions / Values
Incorrect Injector Quantity Adjustment (IQA) programed into Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into ECM.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Incorrectly Programmed IQA

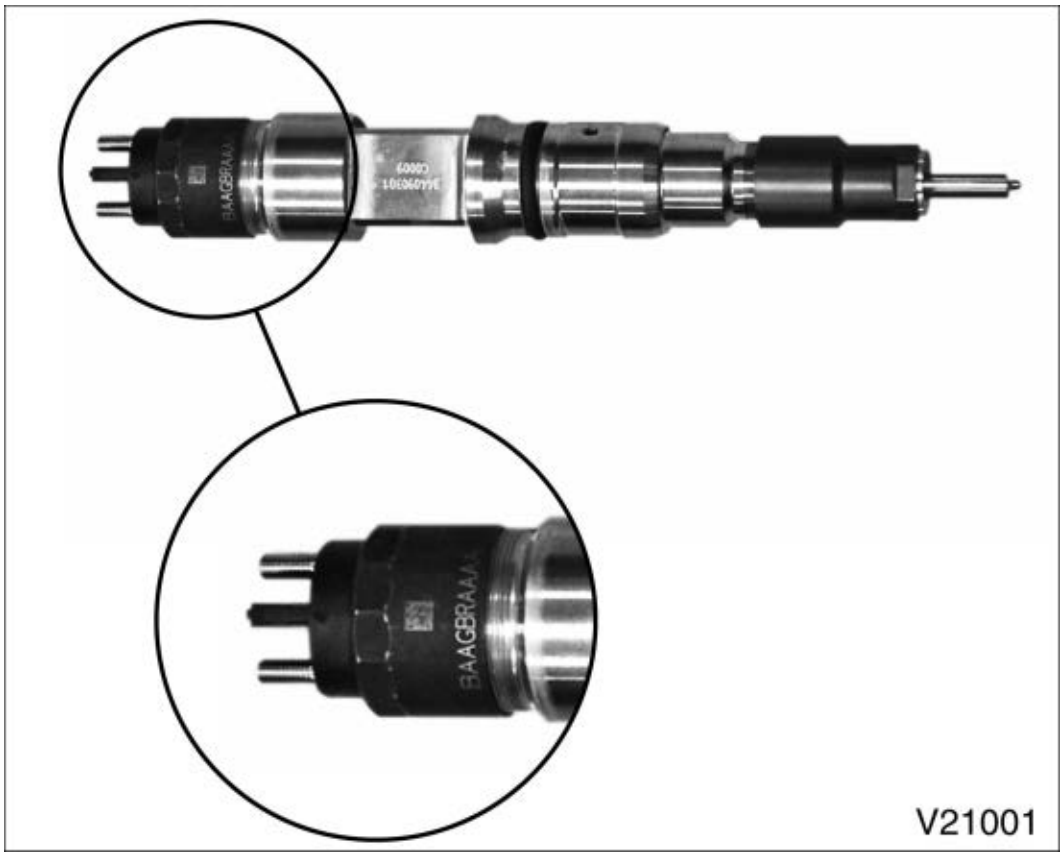


Figure 139 Location of IQA Code

Step 1	Check that proper Injector Quantity Adjustment (IQA) is programed into Electronic Control Module (ECM).	Decision
1. Remove upper valve cover and engine brake housing (see *Engine Service Manual*). Document IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, perform IQA Adjustment(page 1562).		Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 653 FMI 13.
Do IQA codes displayed in ServiceMaxx™ software match injectors in engine?		No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 653 FMI 13.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 653 FMI 13 fault code diagnostics.

SPN 653 FMI 16 - Injector 3 Fuel Quantity / Timing High Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 653 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 653 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 653 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 653 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 653 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 653 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test . Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 653 FMI 16.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 653 FMI 16?	Yes: Clear fault. No: Replace Injector 3. After repairs are complete, retest for SPN 653 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 653 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 653 FMI 18 - Injector 3 Fuel Quantity / Timing Low Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 653 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel

- Low Fuel Delivery Pressure (FDP)
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 653 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 653 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 653 FMI 4, 5, and 13. After repairs are complete, retest for SPN 653 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check . Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 653 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 653 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 6. No: Retest for SPN 653 FMI 18.

Step	Action	Decision
6	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 653 FMI 18.
		No: Repair failed valve train components. After repairs are complete retest for SPN 653 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 653 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 654 FMI 13 - Injector 4 Programmable Parameter Error

Condition / Description	Setting Criteria	Enable Conditions / Values
Incorrect Injector Quantity Adjustment (IQA) programed into Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into ECM.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Incorrectly Programmed IQA

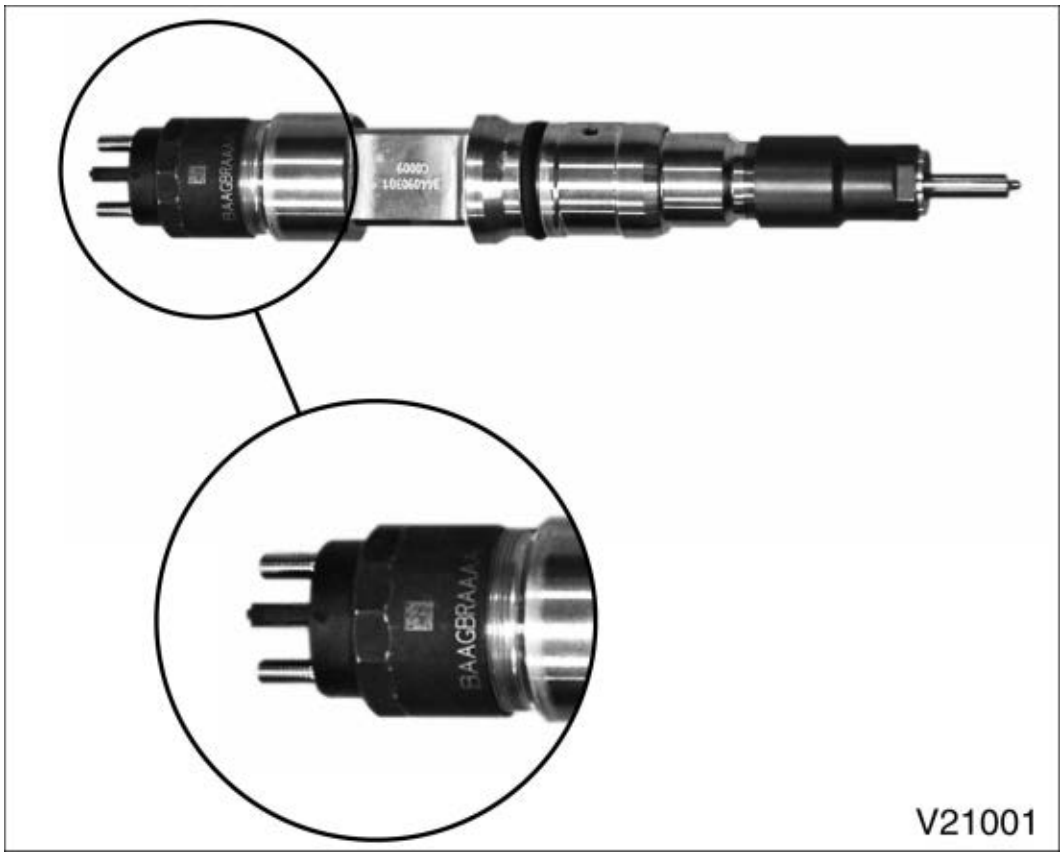


Figure 140 Location of IQA Code

Step 1	Check that proper Injector Quantity Adjustment (IQA) is programed into Electronic Control Module (ECM).	Decision
1. Remove upper valve cover and engine brake housing (see *Engine Service Manual*). Document IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, perform IQA Adjustment(page 1562).		Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 654 FMI 13.
Do IQA codes displayed in ServiceMaxx™ software match injectors in engine?		No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 654 FMI 13.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 654 FMI 13 fault code diagnostics.

SPN 654 FMI 16 - Injector 4 Fuel Quantity / Timing High Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 654 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 652 FMI 4, 5, 13, 20 and 21(CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 654 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 654 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 654 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 654 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test . Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 654 FMI 16.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 654 FMI 16?	Yes: Clear fault. No: Replace Injector 4. After repairs are complete, retest for SPN 654 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 654 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 654 FMI 18 - Injector 4 Fuel Quantity / Timing Low Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 654 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel

- Low Fuel Delivery Pressure (FDP)
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 654 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 654 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 654 FMI 4, 5, and 13. After repairs are complete, retest for SPN 654 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check . Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 654 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 654 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 6. No: Retest for SPN 654 FMI 18.

Step	Action	Decision
6	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 654 FMI 18.
		No: Repair failed valve train components. After repairs are complete retest for SPN 654 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 654 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 655 FMI 13 - Injector 5 Programmable Parameter Error

Condition / Description	Setting Criteria	Enable Conditions / Values
Incorrect Injector Quantity Adjustment (IQA) programed into Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into ECM.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Incorrectly Programmed IQA

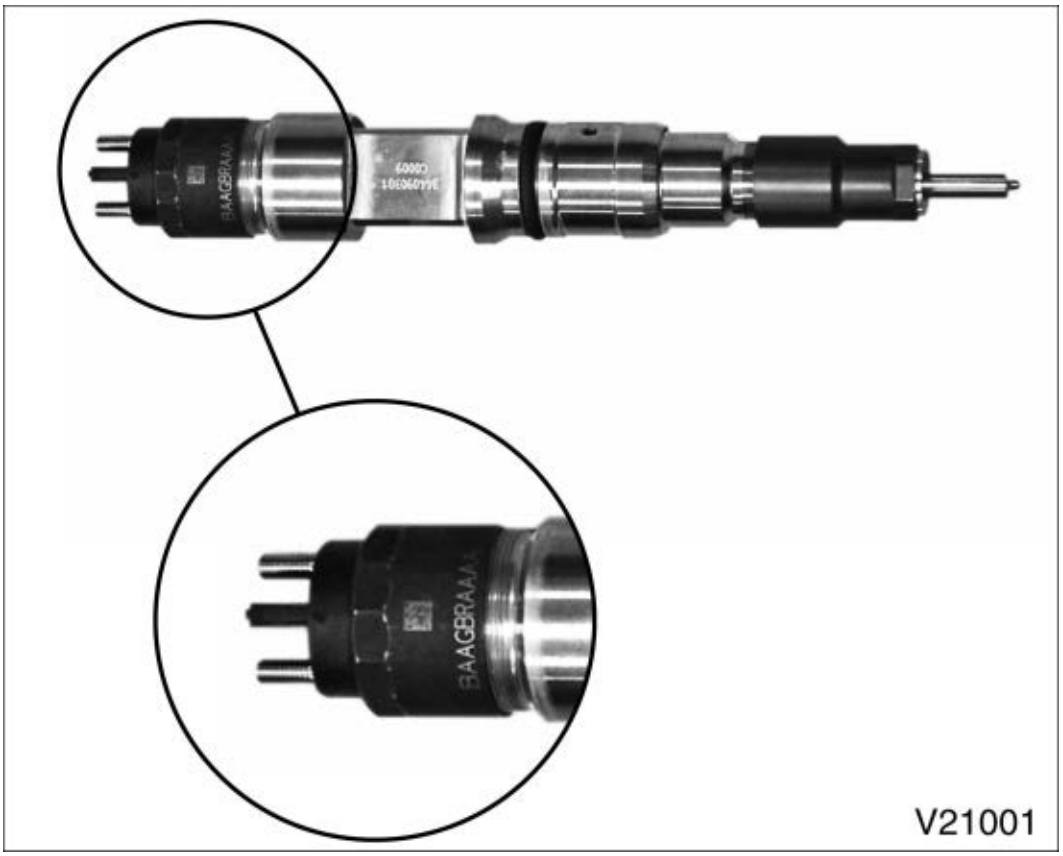


Figure 141 Location of IQA Code

Step 1	Check that proper Injector Quantity Adjustment (IQA) is programed into Electronic Control Module (ECM).	Decision
1. Remove upper valve cover and engine brake housing (see *Engine Service Manual*). Document IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, perform IQA Adjustment(page 1562).		Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 655 FMI 13.
Do IQA codes displayed in ServiceMaxx™ software match injectors in engine?		No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 655 FMI 13.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 655 FMI 13 fault code diagnostics.

SPN 655 FMI 16 - Injector 5 Fuel Quantity / Timing High Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 655 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 655 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 655 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 655 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 655 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 655 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test . Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 655 FMI 16.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 655 FMI 16?	Yes: Clear fault. No: Replace Injector 5. After repairs are complete, retest for SPN 655 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 655 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 655 FMI 18 - Injector 5 Fuel Quantity / Timing Low Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 655 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel

- Low Fuel Delivery Pressure (FDP)
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 655 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 655 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 655 FMI 4, 5, and 13. After repairs are complete, retest for SPN 655 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check . Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 655 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 655 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 6. No: Retest for SPN 655 FMI 18.

Step	Action	Decision
6	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 655 FMI 18.
		No: Repair failed valve train components. After repairs are complete retest for SPN 655 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 655 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 656 FMI 13 - Injector 6 Programmable Parameter Error

Condition / Description	Setting Criteria	Enable Conditions / Values
Incorrect Injector Quantity Adjustment (IQA) programed into Electronic Control Module (ECM).	IQA checksum or range error	Key ON (runs once per key cycle)

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an incorrect Injector Quantity Adjustment (IQA) has been programmed into ECM.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Incorrectly Programmed IQA

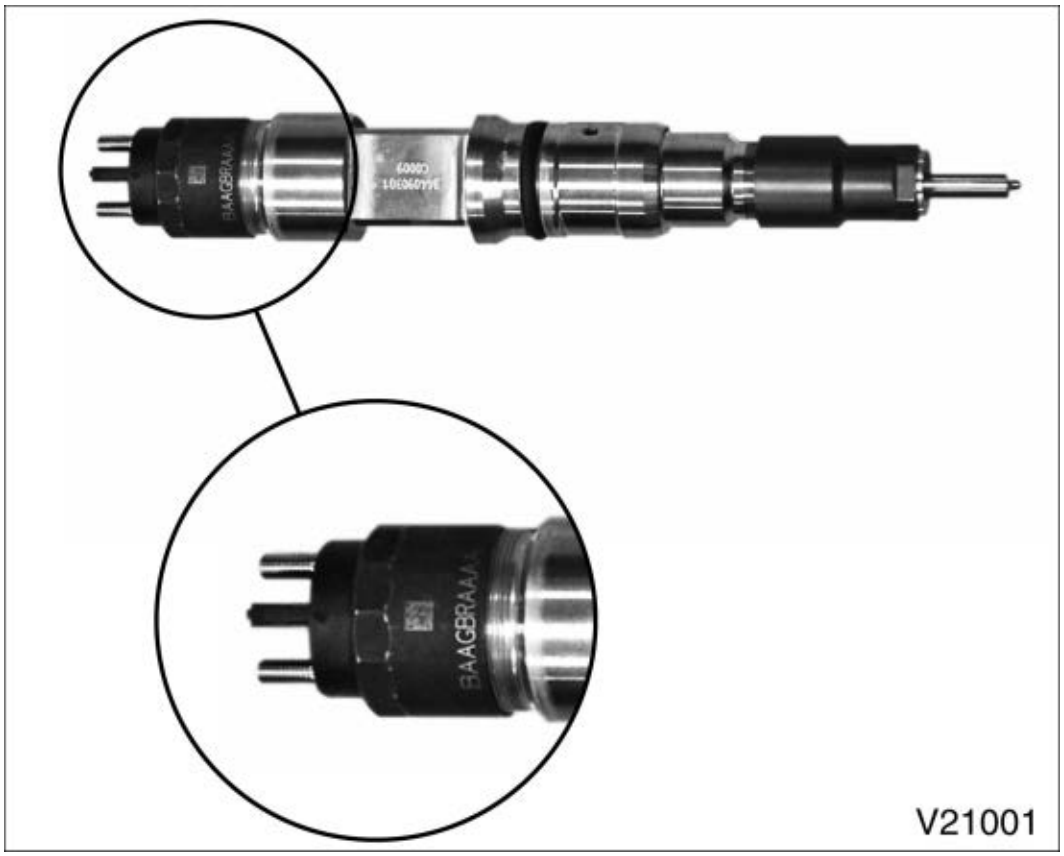


Figure 142 Location of IQA Code

Step 1	Check that proper Injector Quantity Adjustment (IQA) is programed into Electronic Control Module (ECM).	Decision
1. Remove upper valve cover and engine brake housing (see *Engine Service Manual*). Document IQA code for all six injectors. 2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, perform IQA Adjustment(page 1562).		Yes: Clear fault code. Recheck IQA codes. After repairs are complete, retest for SPN 656 FMI 13.
Do IQA codes displayed in ServiceMaxx™ software match injectors in engine?		No: Reprogram ECM with correct IQA codes (follow on screen instructions). After repairs are complete, retest for SPN 656 FMI 13.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 656 FMI 13 fault code diagnostics.

SPN 656 FMI 16 - Injector 6 Fuel Quantity / Timing High Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized for longer than expected.	The sum of actual and learned energizing time > 580 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine Speed Steady: Engine speed variation < 100 rpm, per time > 3 seconds Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel injector is energized longer than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 656 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Aerated fuel delivery

- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 656 FMI 4, 5, and 13 (CYL/INJ); and SPN 3055 FMI 0, 1, 15, and 17. Is EST DTC list free of SPN 94; SPN 157; SPN 656 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15, and 17?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 656 FMI 4, 5, and 13; and SPN 3055 FMI 0, 1, 15 and 17. After repairs are complete, retest for SPN 656 FMI 16.

Step	Action	Decision
2	Check for low Fuel Delivery Pressure (FDP). Using EST, monitor FDP at idle. Is FDP above 85 psi??	Yes: Go to step 3. No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 656 FMI 16.

Step	Action	Decision
3	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test . Is low-pressure fuel system free from aeration?	Yes: Go to step 4. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 656 FMI 16.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Run the fault monitors to determine source of fault. • Using EST, load the HD-OBD monitors session. Click the refresh button at the bottom to load the values. Save a screen shot documenting the Injector quantity/timing error values. • Clear all faults, Start the engine and run for 5 minutes at high idle. Verify that the SCR inlet temp is above 446°F (230°C) after 5 minutes, and that the engine coolant temperature is above 160°F (71°C). • Return the engine to normal idle for 5 minutes • Using the HD-OBD monitors session monitor the injector timing quantity error values. Refresh the page using the refresh button at the bottom and save a screenshot of the new values. • Compare last screenshot to the previous. Verify all values changed from the previous screenshot indicating the monitors have run properly. Is EST DTC list free from SPN 656 FMI 16?	Yes: Clear fault. No: Replace Injector 6. After repairs are complete, retest for SPN 656 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 656 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 656 FMI 18 - Injector 6 Fuel Quantity / Timing Low Error

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel injector is energized shorter than expected.	The sum of actual and learned fuel rail pressure energizing times < 320 microseconds	Charge Air Cooler Outlet Temperature (CACOT) > 14°F (-10°C) Selective Catalyst Reduction (SCR) warm-up mode inactive Engine Coolant Temperature 1 (ECT1) > 158°F (70°C) and < 239°F (115°C) Engine speed steady: Engine speed variation < 100 rpm, per time > 3 seconds] Ambient air pressure (BARO) > 11.6 psi (80 kpa) and < 16 psi (110 kpa) Idle speed error < 50 rpm Engine speed < 800 rpm Fuel command > 6 mg/stroke and < 66 mg / stroke Vehicle stationary Time in entry conditions > 2 seconds Fuel rail pressure deviation < 725 psi (5000 kpa)	1 second

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects fuel injector is energized shorter than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); and SPN 656 FMI 4, 5, and 13 (CYL/INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated fuel

- Low Fuel Delivery Pressure (FDP)
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); and SPN 656 FMI 4, 5, and 13 (CYL/INJ). Is EST DTC list free of SPN 94; SPN 157; and SPN 655 FMI 4, 5, and 13?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; and SPN 656 FMI 4, 5, and 13. After repairs are complete, retest for SPN 656 FMI 18.

Step	Action	Decision
2	Check fuel for contamination. Perform Fuel Quality Check . Is the fuel contaminated?	Yes: Drain fuel tank and fill fuel tank with appropriate diesel fuel. After repairs are complete, retest for SPN 656 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 656 FMI 18. No: Go to step 4.

Step	Action	Decision
4	Perform KOEO Relative Compression Test(page 1592). Did test complete successfully?	Yes: Go to step 5. No: Repair/Replace X. After repairs are complete, retest for SPN 651 FMI 16.

Step	Action	Decision
5	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 6. No: Retest for SPN 656 FMI 18.

Step	Action	Decision
6	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 656 FMI 18.
		No: Repair failed valve train components. After repairs are complete retest for SPN 656 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 656 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1322 FMI 31- Misfire - Cylinder 1

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on multiple cylinders.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects multiple cylinder misfires from the Crankshaft Position (CKP) sensor signal.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Crankshaft Position (CKP) sensor out of calibration
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1322 FMI 31.

Step	Action	Decision
2	Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1323; SPN 1324; SPN 1325; SPN 1326; SPN 1327; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1323; SPN 1324; SPN 1325; SPN 1326; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1322 FMI 31.

Step	Action	Decision
3	Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1322 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check . Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1322 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests . After repairs are complete, retest for SPN 1322 FMI 31.
		No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 1322 FMI 31.

Step	Action	Decision
7	Using EST with ServiceMaxx software, perform crank sensor relearn procedure. 1. Select Sessions > Programming > Service Interval (tab) > Crankshaft Position Learning Reset Request (ID 95232). 2. In Value field select Yes from the drop-down menu. 3. Select Program Engine button (when finished programming Value field will switch back to No). 4. Clear Fault Code and perform drive cycle 2. Did SPN 1322 FMI 31 become active?	Yes: Go to step 8.

Step	Action	Decision
8	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1322 FMI 31.
		No: Go to step 9.

Step	Action	Decision
9	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 10.
		No: Retest for SPN 1322 FMI 31.

Step	Action	Decision
10	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1322 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1322 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1322 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1323 FMI 31- Misfire - Cylinder 1

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 1.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 1 misfire from the Crankshaft Position (CKP) sensor.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1323 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1324; SPN 1325; SPN 1326; SPN 1327; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1324; SPN 1325; SPN 1326; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1323 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1323 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check . Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1323 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests . After repairs are complete, retest for SPN 1323 FMI 31.
		No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 1323 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1323 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1323 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1323 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1323 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1323 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1324 FMI 31- Misfire - Cylinder 1

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 2.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 2 misfire from the Crankshaft Position (CKP) sensor.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1324 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1324; SPN 1325; SPN 1326; SPN 1327; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1325; SPN 1326; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1324 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1324 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check . Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1324 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests . After repairs are complete, retest for SPN 1324 FMI 31.
		No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 1324 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1324 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1324 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1324 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1324 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1324 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1325 FMI 31- Misfire - Cylinder 1

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 3.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 3 misfire from the Crankshaft Position (CKP) sensor.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1325 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325 ; SPN 1326; SPN 1327; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1326; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1325 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1325 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check . Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1325 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests . After repairs are complete, retest for SPN 1325 FMI 31.
		No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 1325 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1325 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1325 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1325 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1325 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1325 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1326 FMI 31- Misfire - Cylinder 1

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 4.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 4 misfire from the Crankshaft Position (CKP) sensor.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1326 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325; SPN 1327; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1326 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1326 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check . Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1326 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests . After repairs are complete, retest for SPN 1326 FMI 31.
		No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 1326 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1326 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1326 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1326 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1326 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1326 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1327 FMI 31- Misfire - Cylinder 1

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 5.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 5 misfire from the Crankshaft Position (CKP) sensor.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1327 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); and SPN 1328 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325; SPN 1326; and SPN 1328?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325 ; SPN 1326; SPN 1327; and SPN 1328. After repairs are complete, retest for SPN 1327 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1327 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check . Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1327 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests . After repairs are complete, retest for SPN 1327 FMI 31.
		No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 1327 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1327 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1327 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1327 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1327 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1327 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1328 FMI 31- Misfire - Cylinder 1

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Crankshaft acceleration indicates misfire on cylinder 6.	Misfire Count > 180	Engine Running Engine speed > 500 rpm and < 950 rpm Idle speed error < 200 rpm Fuel command > 2 mg / stroke and < 60mg / stroke Engine Coolant Temperature 1 (ECT1) > 86°F (30°C) Vehicle speed < 2 mph (3 km/h) Diesel Particulate Filter (DPF) Not regenerating	440 engine revolutions

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects a cylinder 6 misfire from the Crankshaft Position (CKP) sensor.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP)

SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); SPN 1327 (CYL); and SPN 1328 (CYL)

SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low Fuel Delivery Pressure (FDP)
- Low Fuel Rail Pressure (FRP)
- Contaminated fuel
- Failed injector (Mechanical)
- Base engine compression imbalance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 (FDP); SPN 157 (FRP); SPN 633 (FPCV); and SPN 3055 (FRP). Is EST DTC list free of SPN 94; SPN 157; SPN 633; and SPN 3055?	Yes: Go to step 2. No: Repair SPN 94; SPN 157; SPN 633; and SPN 3055. After repairs are complete, retest for SPN 1328 FMI 31.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 111 (EWPS); SPN 636 FMI 2, 8, and 10 (CMP); SPN 637 FMI 8 and 10 (CKP); SPN 731 (CYL); SPN 1322 (CYL); SPN 1323 (CYL); SPN 1324 (CYL); SPN 1325 (CYL); SPN 1326 (CYL); and SPN 1327 (CYL). Is EST DTC list free of SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325 ; SPN 1326; and SPN 1327?	Yes: Go to step 3. No: Repair SPN 111; SPN 636 FMI 2, 8, and 10; SPN 637 FMI 8 and 10; SPN 731; SPN 1322; SPN 1323; SPN 1324; SPN 1325 ; SPN 1326; and SPN 1327. After repairs are complete, retest for SPN 1328 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 (CYL/INJ); SPN 652 (CYL/ INJ); SPN 653 (CYL / INJ); SPN 654 (CYL / INJ); SPN 655 (CYL / INJ); SPN 656 (CYL / INJ); SPN 2797 (INJ); and SPN 2798 (INJ). Is EST DTC list free of SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798?	Yes: Go to step 4. No: Repair SPN 651; SPN 652; SPN 653; SPN 654; SPN 655; SPN 656; SPN 2797; and SPN 2798. After repairs are complete, retest for SPN 1328 FMI 31.

Step	Action	Decision
4	Check for poor fuel quality or contaminants. Perform Fuel Quality Check . Is fuel sample clean and free of sediments, traces of gasoline or kerosene, and waxing or icing?	Yes: Go to step 5. No: Drain fuel and fill with new or known good diesel fuel. After repairs are complete, retest for SPN 1328 FMI 31.

Step	Action	Decision
5	Using EST with ServiceMaxx software, check Fuel Rail Pressure (FRP). Select Sessions > Performance. Start engine and monitor FRP. Is Fuel Rail Pressure 10,500 psi (72,395 kPa) or greater?	Yes: Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Using EST with ServiceMaxx software, check Fuel Delivery Pressure (FDP). Select Sessions > Performance. Start engine and monitor FDP. Is Fuel Delivery Pressure 60 psi (414 kpa) or greater?	Yes: Perform High-pressure Fuel System tests . After repairs are complete, retest for SPN 1328 FMI 31.
		No: Perform Low-pressure Fuel System tests . After repairs are complete, retest for SPN 1328 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 1328 FMI 31.
		No: Go to step 8.

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Retest for SPN 1328 FMI 31.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 1328 FMI 31.
		No: Repair failed valve train components. After repairs are complete retest for SPN 1328 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1328 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEF: DV (Diesel Exhaust Fluid Dosing Valve) Sensor

Overview of DEF: DV Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
5394	5	DEFDC open load / circuit (short)	• Failed DEF: DV • DEF: DV-1 circuit Open or high resistance • DEF: DV-1 short to GND • DEF: DV-2 circuit Open or high resistance • DEF: DV-2 short to GND • DEF: DV-1 shorted to DEF: DV-2 • DEF: DV-2 short to PWR	Step-Based Diagnostics (page 391)
5394	7	DEF Dosing Valve - Mechanical system not responding	• DEF tank, supply module, or doser valve line or connection loose, leaking, or damaged • DEF: DV mechanical failure (stuck open or closed)	Step-Based Diagnostics (page 394)

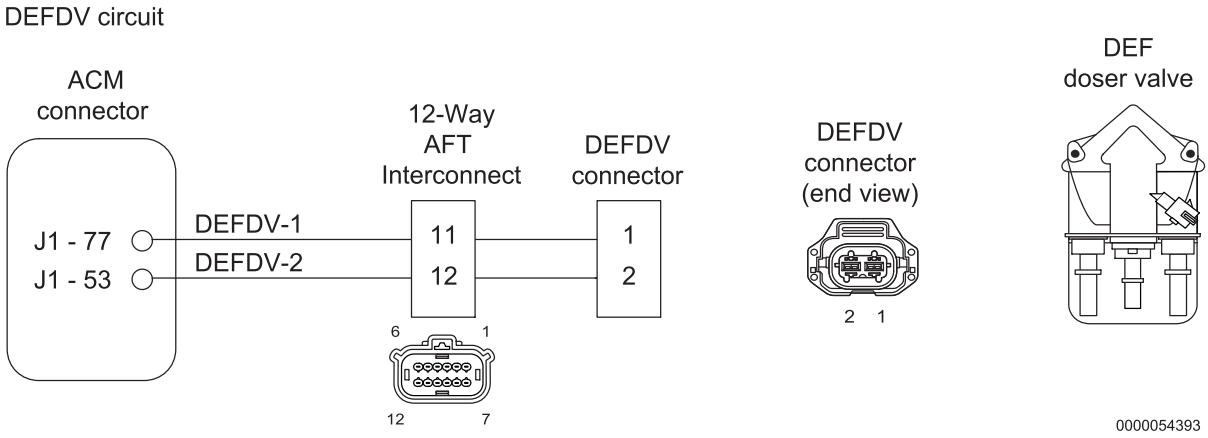


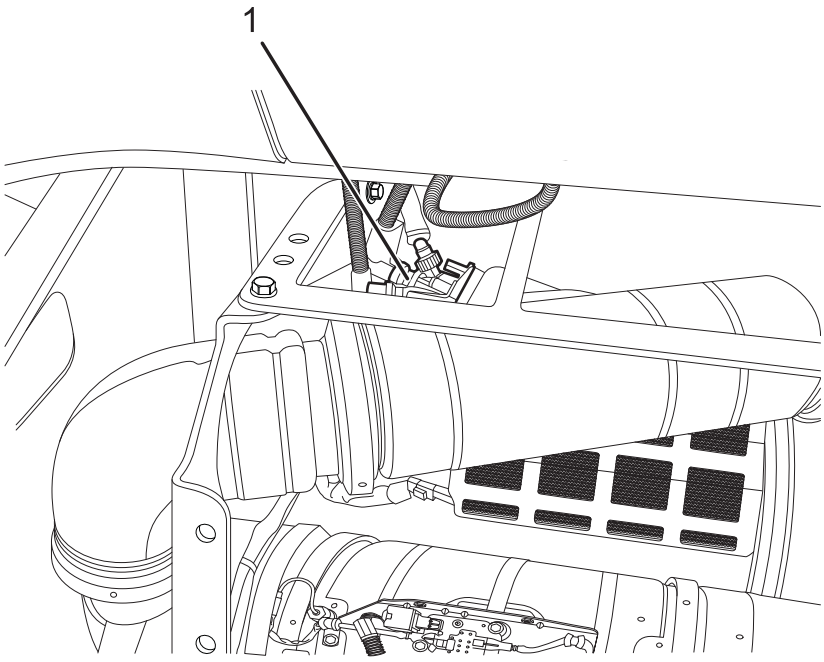
Figure 143 DEF: DV Circuit Diagram

Overview

The aftertreatment Diesel Exhaust Fluid Doser Valve (DEF: DV) is controlled by the Aftertreatment Control Module (ACM). When the ACM commands DEF dosing, it opens the doser valve and allows DEF to be sprayed into the exhaust stream.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- SCR (ACM) Breakout Harness 18-537-01
- Breakout Harness ZTSE4828
- DEF Refractometer 5025
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000054404

Figure 144 DEF: DV Location (Typical)

1. Diesel Exhaust Fluid Doser Valve (DEF: DV)

SPN 5394 FMI 5 - DEFDC Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Doser Valve (DEF: DV) current below normal or open circuit. Open signal voltage detected at the DEF: DV.	Resistance between DEF: DV-1 or DEF: DV-2 and ground < 0.2 ohms Resistance between pin J1-53 and pin J1-77 > 1,000,000 ohms Resistance between DEF: DV-2 and battery positive < 0.2 ohms	DEF: DV command is OFF	2 seconds

Fault Overview

Fault codes sets when the Aftertreatment Control Module (ACM) detects that the Diesel Exhaust Fluid Doser Valve (DEF: DV) circuit is open or shorted. DEF injection into the aftertreatment system is disabled, and engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced and vehicle speed limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

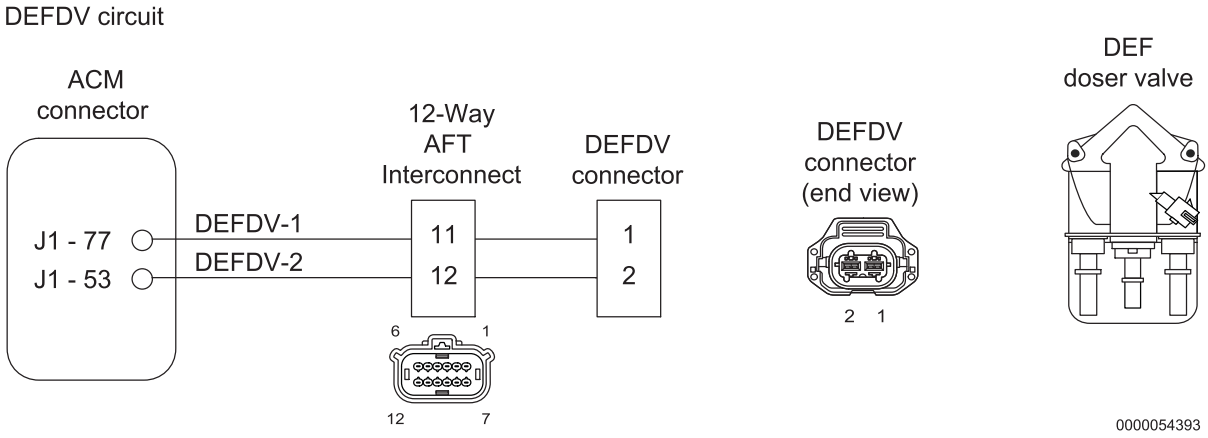


Figure 145 DEF: DV Circuit Diagram

Possible Causes

- Failed DEF: DV
- DEF: DV-1 circuit Open or high resistance
- DEF: DV-1 short to GND
- DEF: DV-2 circuit Open or high resistance
- DEF: DV-2 short to GND
- DEF: DV-1 shorted to DEF: DV-2
- DEF: DV-2 short to PWR

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Doser Valve (DEF: DV). KeyOFF, disconnect DEF: DV. Check DEF: DV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF: DV connector, Harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, Harness, or terminal damage. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
2	Check DEF: DV-1 circuit for short to ground. Connect Breakout Harness ZTSE4828 to DEF: DV and leave DEF: DV disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4828 pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to ground between DEF: DV connector pin-1 and Aftertreatment Control Module (ACM) connector pin J1-77. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
3	Check DEF: DV-2 circuit for short to ground. Connect Breakout Harness ZTSE4828 to DEF: DV and leave DEF: DV disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4828 pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short to ground between DEF: DV connector pin-2 and ACM connector pin J1-53. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
4	Inspect connections at the Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, Harness, and terminals clean and undamaged?	Yes: Go to step 5. Repair connector, Harness, or terminal damage. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
5	Check DEF: DV-1 circuit for Open or high resistance. Connect Breakout Harness ZTSE4828 to DEF: DV and leave DEF: DV disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-537-01 to ACM and leave module disconnected. Use a DMM to measure resistance from Breakout Harness ZTSE4828 pin-1 and 180-pin Breakout Box pin J1-77. Is resistance less than 5 ohms?	Yes: Go to step 6. No: Repair Open between DEF: DV connector pin-1 and ACM connector pin J1-77. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
6	Check DEF: DV-2 circuit for Open or high resistance. Connect Breakout Harness ZTSE4828 to DEF: DV and leave DEF: DV disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-537-01 to ACM and leave module disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4828 pin-2 and 180-pin Breakout Box pin J1-53. Is resistance less than 5 ohms?	Yes: Go to step 7. No: Repair Open between DEF: DV connector pin-2 and ACM connector pin J1-53. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
7	Check for DEF: DV-1 circuit shorted to DEF: DV-2 circuit. Connect Breakout Harness ZTSE4828 to DEF: DV connector and leave DEF: DV disconnected. Key OFF, with ACM disconnected, use a DMM to measure resistance between Breakout Harness ZTSE4828 pin-1 and pin-2. Is resistance greater than 1000 ohms?	Yes: Go to step 8. No: Repair short between DEF: DV connector pin-1 and pin-2. After repairs are complete, retest for SPN 5394 FMI 5.

Step	Action	Decision
8	Check DEF: DV-2 circuit for short to power. Key-On Engine-Off (KOEO), with Breakout Harness ZTSE4828 connected to DEF: DV, use a DMM to measure voltage between Breakout Harness ZTSE4828 pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Replace DEF: DV. After repairs are complete, retest for SPN 5394 FMI 5. No: Repair short to power between DEF: DV pin-2 and ACM connector J1-53. After repairs are complete, retest for SPN 5394 FMI 5.

NOTE: After doing all diagnostic steps, if SPN 5394 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5394 FMI 7 - DEF Dosing Valve - Mechanical System Not Responding

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Dosing Valve is mechanically stuck closed or open based on the minimum pressure variation during injection.	Difference between the maximum and minimum DEF supply pressure within one injection cycle < 4 psi (30 kPa) (gauge) for greater than or equal to 2 out of 3 times within each set of diagnostic tests.	Inactive: SPN 3361 FMI 3 and 4; SPN 4334 FMI 2, 3, 4, 16, and 18; and SPN 5394 FMI 5. Exhaust temperature ≥ 32°F (0°C) for 10 seconds Key-On Engine-Running (KOER) Exhaust Mass flow rate ≥ 50 g/hr DEF dosing command ≥ 9.8 % DEF dosing command ≤ 88.2 % Supply Module Pressure ≥ 58 psi (400 kPa) (gauge)	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects a mechanical failure of the Diesel Exhaust Fluid Doser Valve (DEF: DV). DEF injection into the aftertreatment system is disabled, and engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

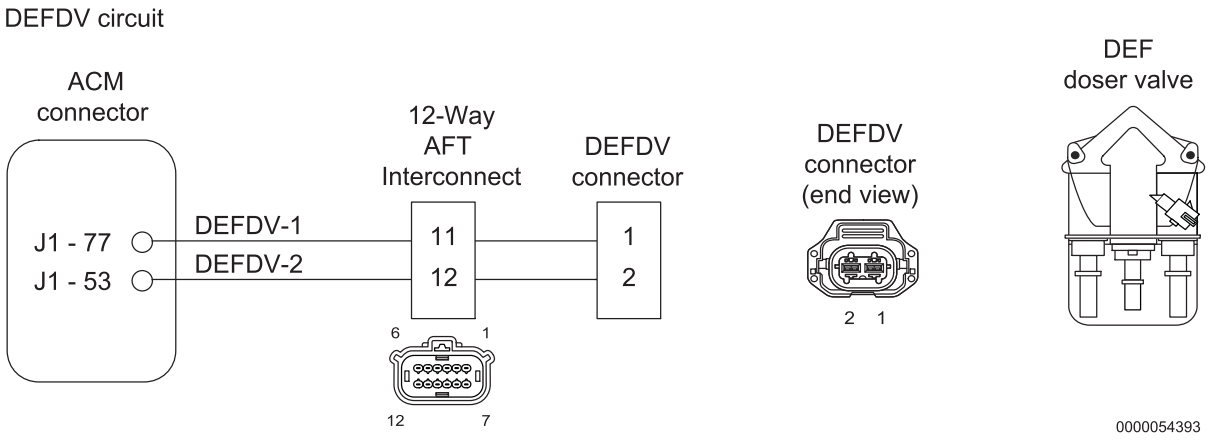


Figure 146 DEF: DV Circuit Diagram

Possible Causes

- DEF tank, supply module, or doser valve line or connection loose, leaking, or damaged
- Faulty DEF doser valve
- Faulty DEF supply module

Step	Action	Decision
1	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEF: DV) lines and connections for: cracks and pitting; and loose, leaking, or damaged connections. Are DEF tank, DEF supply module, and DEF: DV lines and connections in good condition?	Yes: Perform the DEF Doser Pump Override Test . No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 5394 FMI 7.

NOTE: After doing all diagnostic steps, if SPN 5394 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEF: LHR (Diesel Exhaust Fluid Line Heater Relay) Sensor

Overview of DEF: LHR Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
5491	3	DEF: LHR short to PWR (Open or High Resistance)	• DEF L-HTR Relay CTL short to PWR • DEF L-HTR Relay CTL Open or high resistance • DEF L-HTR Relay GND Open or high resistance • Failed DEF Line Heater Relay (DEF: LHR)	Step-Based Diagnostics (page 398)
5491	4	DEF: LHR short to GND	• DEF L-HTR Relay CTL circuit short to GND • DEF L-HTR Relay GND shorted to DEF L-HTR Relay CTL • Failed DEF Line Heater Relay (DEF: LHR)	Step-Based Diagnostics (page 402)

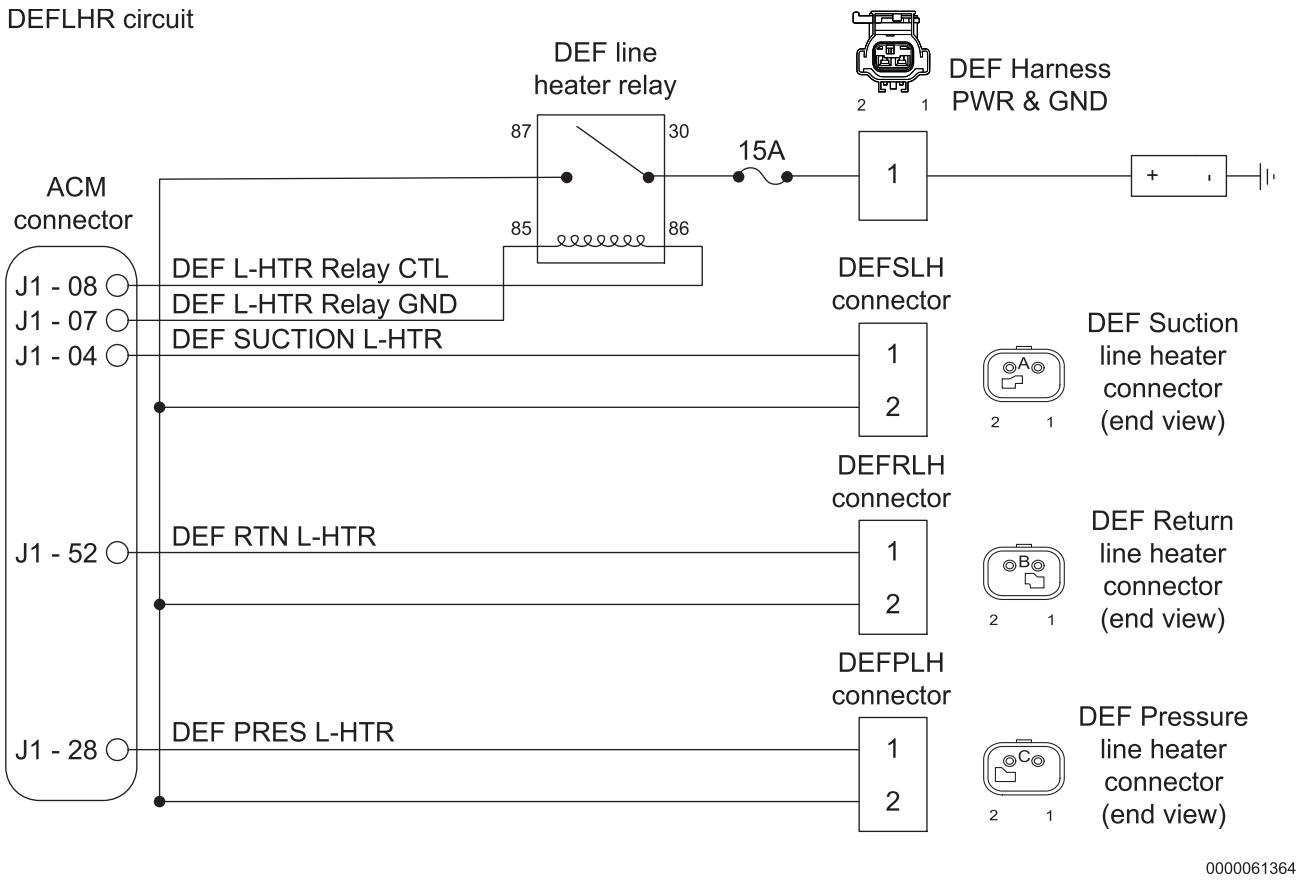


Figure 147 DEF: LHR Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Line Heater Relay (DEF: LHR) is used to control the DEF Suction Line Heater (DEFSLH), DEF Pressure Line Heater (DEFPLH) and DEF Return Line Heater (DEFRLH), which are wrapped around the DEF suction, pressure, and return lines. The Aftertreatment Control Module (ACM) turns the line heaters on by controlling the DEF: LHR. This is done by sending power through the DEF L-HTR Relay CTL circuit to the DEF: LHR. The DEF: LHR is constantly grounded by the ACM through DEF-L HTR Relay GND.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- Breakout Harness ZTSE4908
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

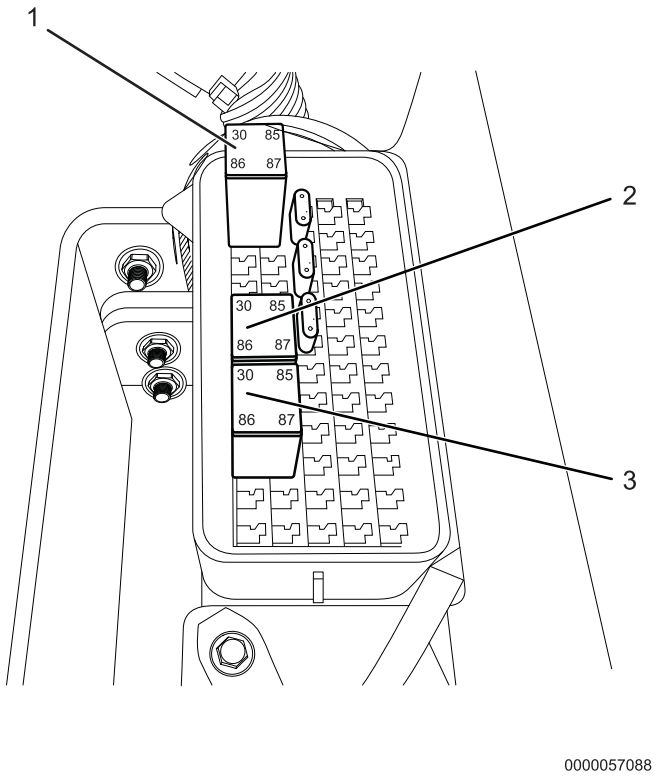


Figure 148 DEF: LHR Location

1. DEF Line Heater Relay (DEF: LHR)
2. DEF Unit HTR Relay (DEFUHR)
3. Switched Ignition Relay

SPN 5491 FMI 3 - DEF: LHR Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Line Heater Relay (DEF: LHR) circuit is shorted to PWR, Open, or high resistance.	Resistance between DEF L-HTR Relay CTL and DEF L-HTR Relay GND > 500,000 Ohms OR DEF L-HTR Relay CTL is shorted to PWR.	DEF: LHR commanded ON Key ON.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Line Heater Relay (DEF: LHR) is high or open circuit.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

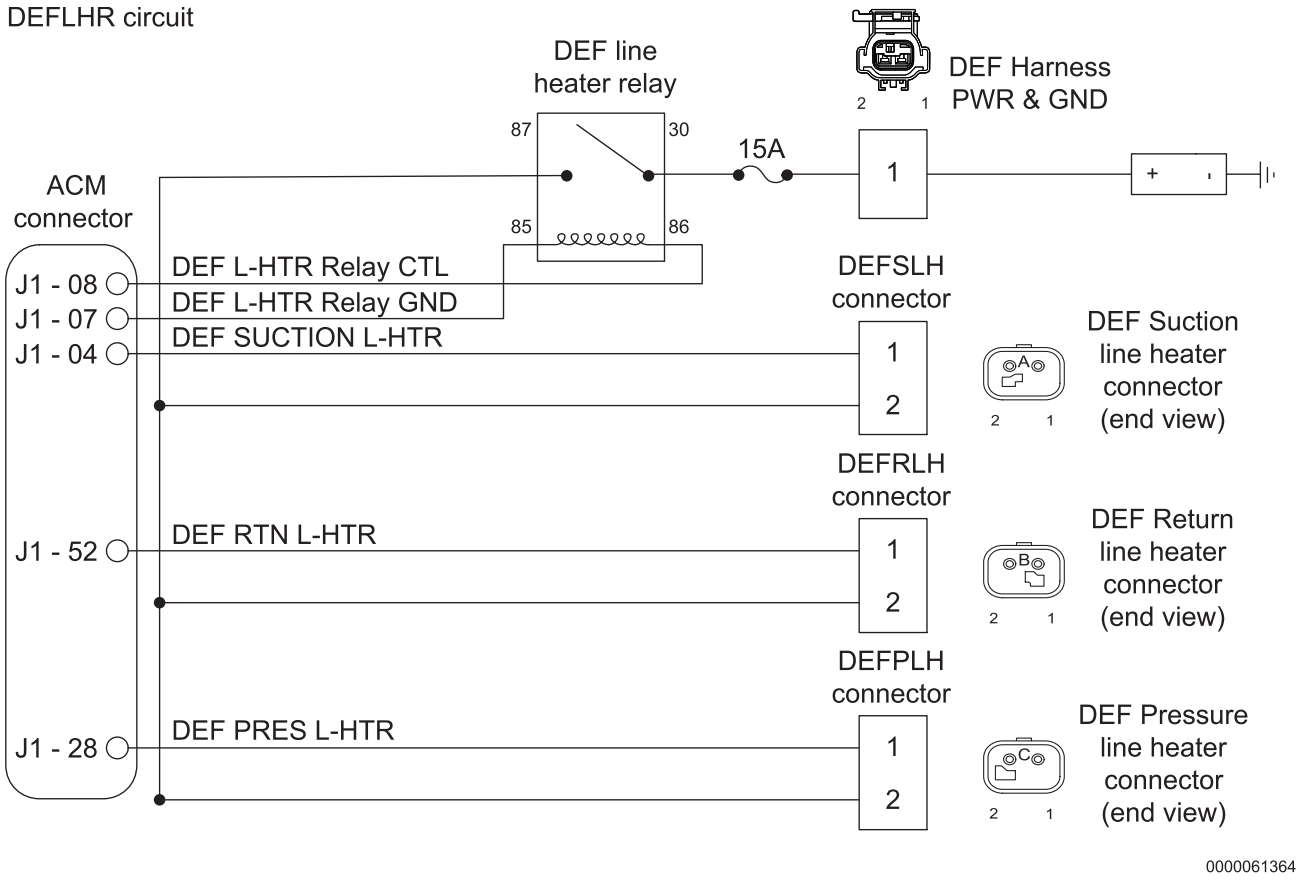


Figure 149 DEF: LHR Circuit Diagram

Possible Causes

- DEF L-HTR Relay CTL short to PWR
- DEF L-HTR Relay CTL Open or high resistance
- DEF L-HTR Relay GND Open or high resistance
- Failed DEF Line Heater Relay

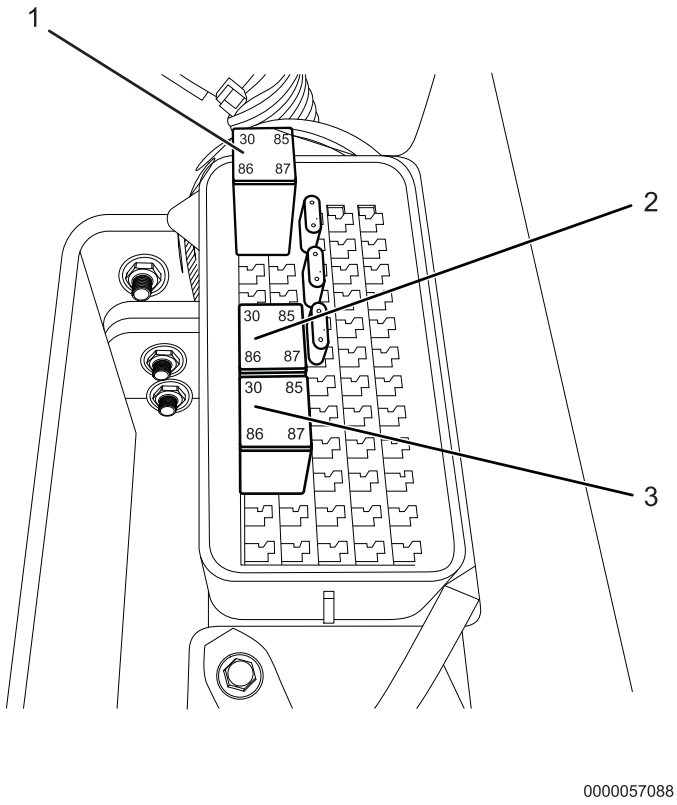


Figure 150 DEF: LHR Location

1. DEF Line Heater Relay (DEF: LHR)
2. DEF Unit HTR Relay (DEFUHR)
3. Switched Ignition Relay

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 5491 FMI 3.

Step	Action	Decision
2	Check for a failed DEF Line Heater Relay (DEF: LHR). Remove the DEF: LHR. Install DEF: LHR into breakout harness ZTSE4908 and leave harness disconnected from PDM. Using a DMM, check resistance between pin-85 and pin-86. Is resistance between 100 and 300 ohms?	Yes: Go to step 3. No: Replace DEF: LHR. After repairs are complete, retest for SPN 5491 FMI 3.

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Leave connector J1 unplugged. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5491 FMI 3.

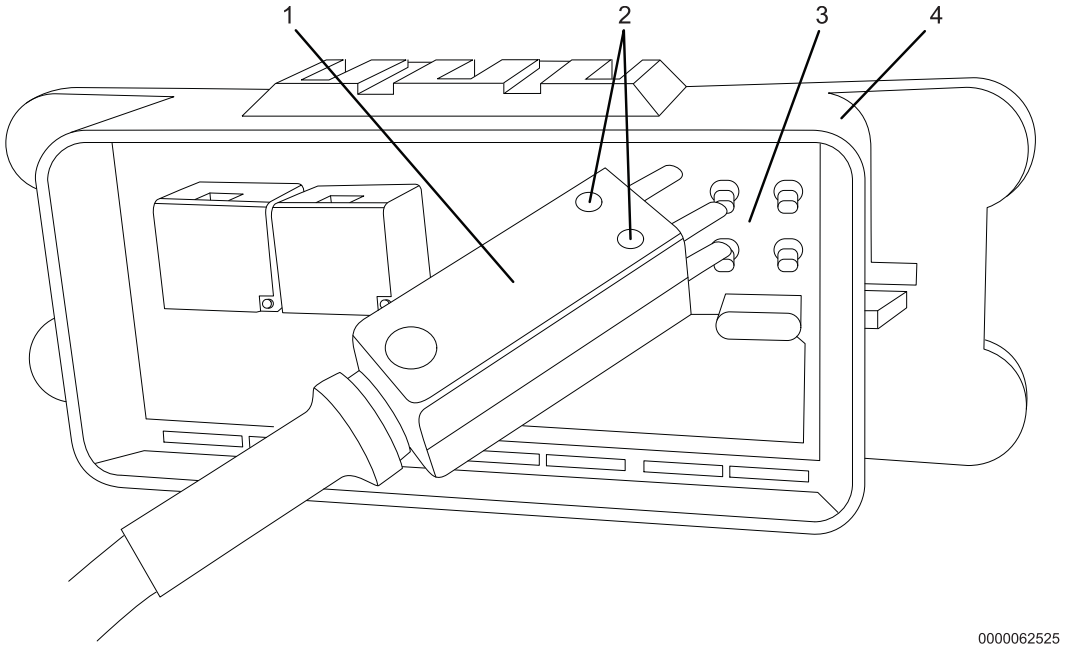


Figure 151 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 Must be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation Will result in incorrect measurements.

Step	Action	Decision
4	Check DEF L-HTR Relay CTL circuit for a short to PWR. Install breakout harness ZTSE4908 into PDM and leave relay disconnected. With J1 disconnected from ACM. Key-On Engine-Off (KOEO), use a DMM to measure voltage between pin-86 and a known good ground. Is voltage less than 0.5 volt?	Yes: Go to step 4. No: Repair short to PWR in DEF L-HTR Relay CTL circuit between DEF: LHR pin-86 and ACM pin J1-08. When repairs are complete, retest for SPN 5491 FMI 3.

Step	Action	Decision
5	Check DEF Line Heater Relay CTL circuit for an Open or high resistance. Install 180-pin breakout box with Breakout Harness 18-537-01 to vehicle harness, leave ACM disconnected. Key OFF, with ZTSE4908 installed and relay disconnected, use a DMM to measure resistance between pin-86 and ACM pin J1-08. Is resistance less than 5 ohms?	Yes: Repair Open or high resistance in DEF L-HTR Relay GND circuit between DEF: LHR pin-85 and ACM pin J1-07. When repairs are complete, retest for SPN 5491 FMI 3.
		No: Repair Open or high resistance in DEF L-HTR Relay CTL circuit between DEF: LHR pin-86 and ACM pin J1-08. When repairs are complete, retest for SPN 5491 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 5491 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5491 FMI 4 - DEF: LHR Short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Line Heater Relay (DEF: LHR) voltage below normal or shorted to GND.	Resistance between DEF L-HTR Relay CTL circuit and ground < 0.2 Ohms	DEF: LHR commanded ON Key ON	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal voltage from the Diesel Exhaust Fluid Line Heater Relay (DEF: LHR) is lower than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

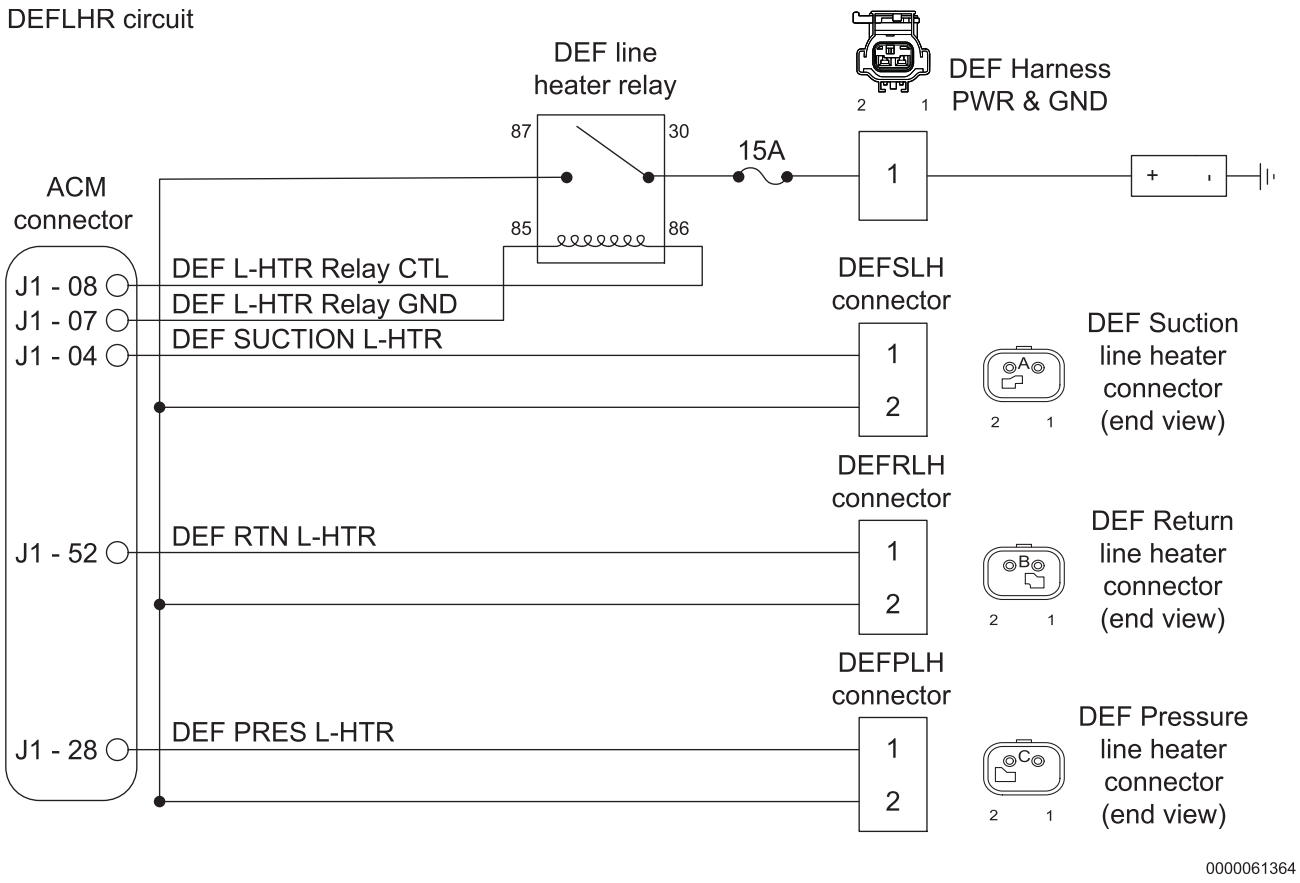


Figure 152 DEF: LHR Circuit Diagram

Possible Causes

- DEF L-HTR Relay CTL circuit short to GND
- DEF L-HTR Relay CTL shorted to DEF L-HTR Relay GND
- Failed DEF Line Heater Relay (DEF: LHR)

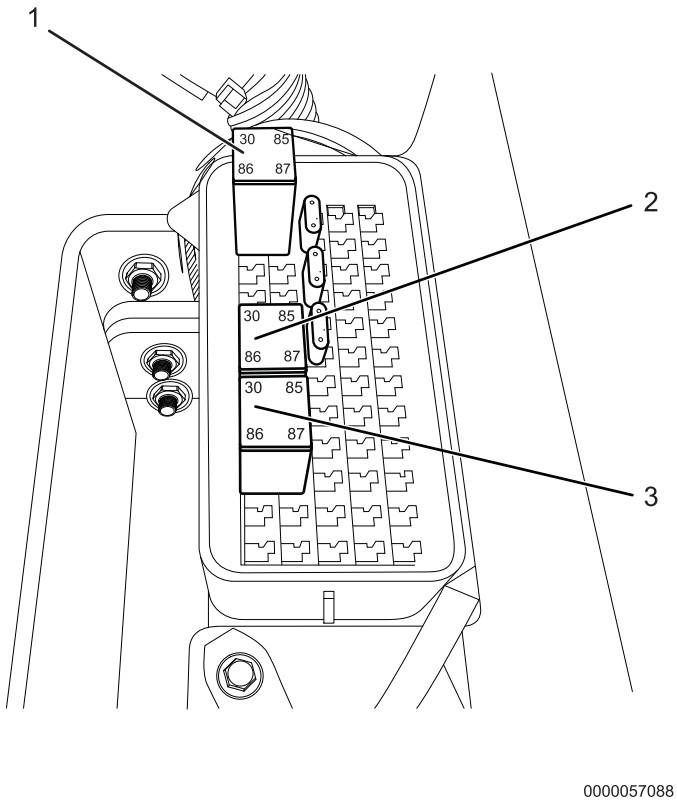


Figure 153 DEF: LHR Location

1. DEF Line Heater Relay (DEF: LHR)
2. DEF Unit HTR Relay (DEFUHR)
3. Switched Ignition Relay

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 5491 FMI 4.

Step	Action	Decision
2	Check for a failed DEF Line Heater Relay (DEF: LHR). Remove the DEF: LHR. Install relay into Breakout Harness ZTSE4908 and leave disconnected from PDM. Using a DMM, check resistance between pin-85 and pin-86. Is the resistance between 100 and 300 ohms?	Yes: Go to step 3. No: Replace DEF: LHR. After repairs are complete, retest for SPN 5491 FMI 4.

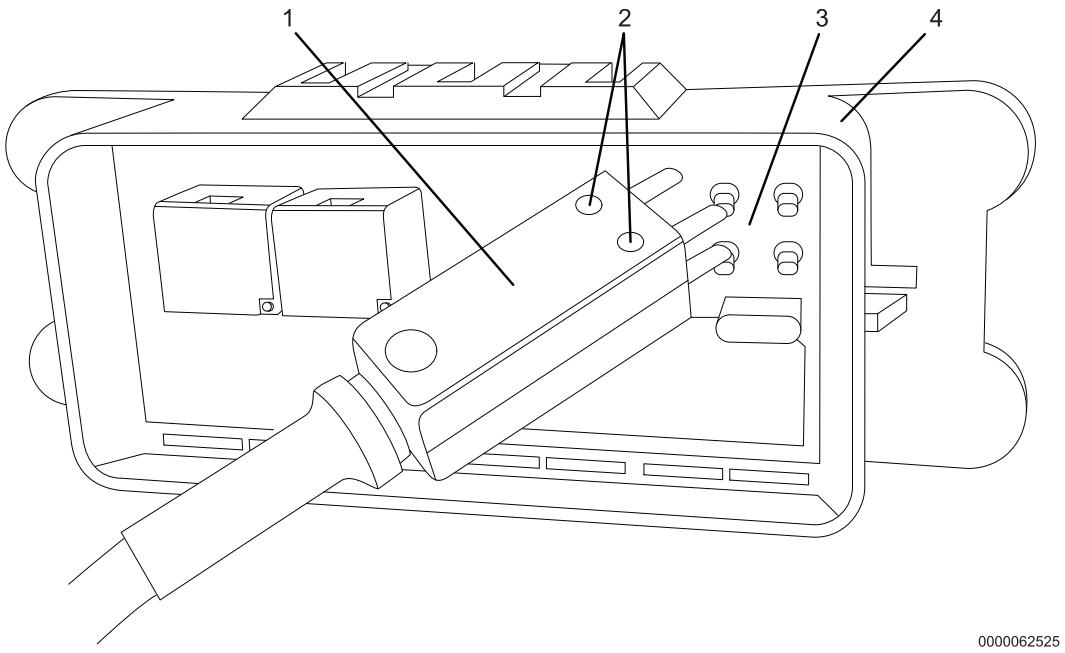


Figure 154 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 Must be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation Will result in incorrect measurements.

Step	Action	Decision
3	Check for DEF L-HTR Relay CTL shorted to DEF L-HTR Relay GND. Install Breakout Harness ZTSE4908 into PDM, leaving relay disconnected. Using a DMM, Key OFF check resistance between pin-85 and pin-86. Is resistance less than 100 ohms?	Yes: Repair short between DEF L-HTR CTL and DEF L-HTR Relay GND circuits. After repairs are complete, retest for SPN 5491 FMI 4.
		No: Repair short to GND in DEF L-HTR Relay CTL circuit between DEF: LHR pin-86 and ACM pin J1-08. After repairs are complete, retest for SPN 5491 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 5491 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEF: LP (Diesel Exhaust Fluid Line Pressure) Sensor

Overview of DEF: LP Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
4334	2	DEF: LP signal erratic, intermittent, or incorrect	• Debris in DEF tank / restricted DEF tank screen • DEF tank, supply module, or doser valve line, or connection loose, leaking, or damaged • Failed Diesel Exhaust Fluid (DEF) supply module • Restricted DEF suction, pressure, or return line • Restricted DEF supply module filter	Step-Based Diagnostics (page 409)
4334	3	DEF: LP signal Out of Range HIGH	• DEF: LP signal circuit short to PWR • Failed DEF supply module • SIG GND circuit Open or high resistance	Step-Based Diagnostics (page 412)
4334	4	DEF: LP signal Out of Range LOW	• DEF: LP signal circuit short to GND • DEF: LP signal circuit Open or high resistance • Failed DEF supply module • VREF-4 circuit Open or high resistance	Step-Based Diagnostics (page 414)

4334	16	DEF: LP above Maximum Pressure	• Failed DEF supply module • Restricted DEF return line	Step-Based Diagnostics (page 417)
4334	18	DEF: LP below normal operating range	• Debris in DEF tank / restricted DEF tank screen • DEF tank, supply module, or doser valve line, or connection loose, leaking, or damaged • Failed DEF supply module • Low DEF tank level • Restricted DEF suction line	Step-Based Diagnostics (page 419)

DEF: AP Circuit

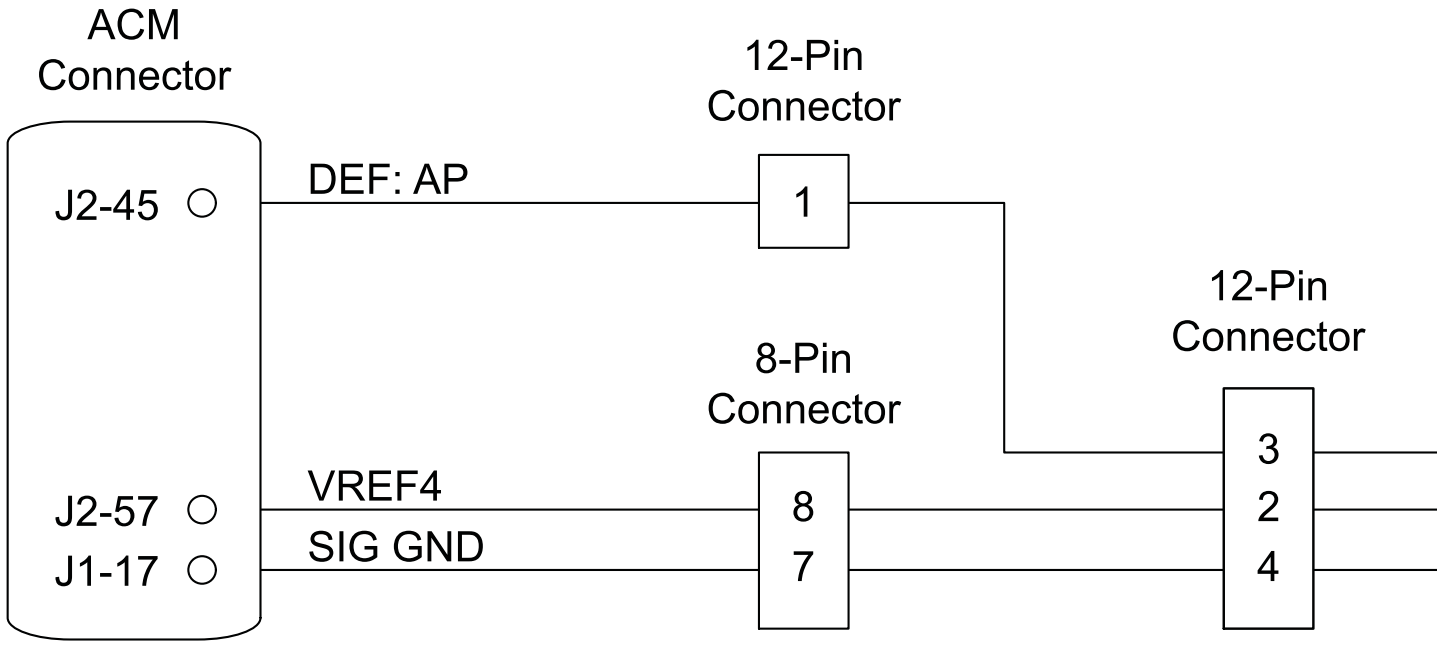


Figure 155 DEF: LP Sensor Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Line Pressure (DEF: LP) sensor measures DEF pressure from the DEF Supply Pump (DEFSP). When DEF pressure is high, the signal from the DEF: LP sensor is high. The DEF: LP sensor is located within the DEF Supply Module and is a non-serviceable component.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- SCR (ACM) Breakout Harness 18-537-01
- Breakout Harness 18-909-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

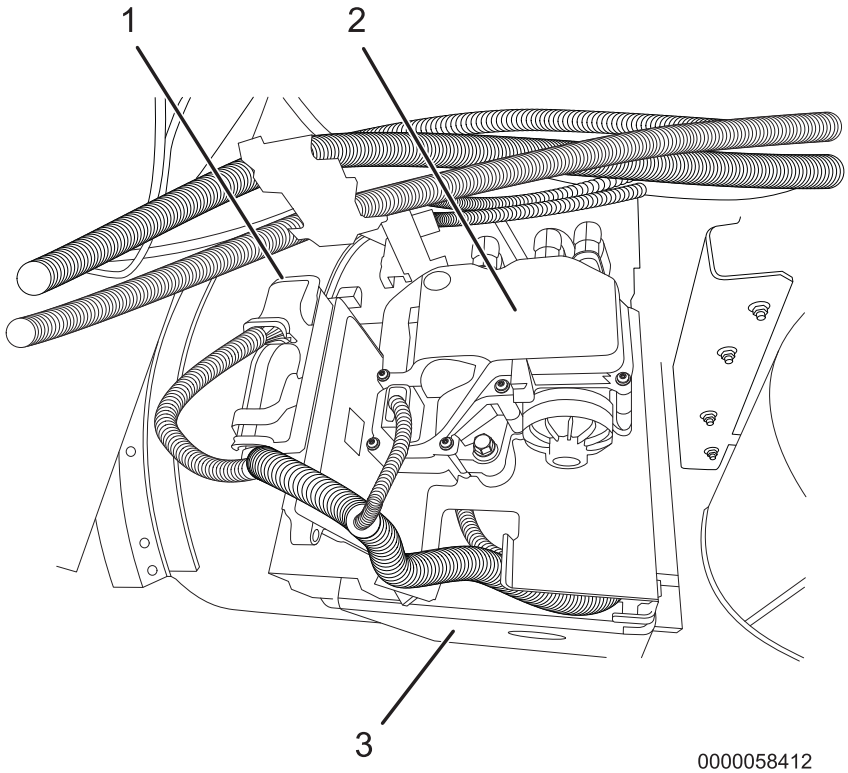


Figure 156 DEF Supply Module Location (Typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module
3. DEF tank

SPN 4334 FMI 2 - DEFAP Signal Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Line Pressure (DEF: LP) sensor signal is erratic, intermittent, or incorrect.	DEF supply module pump pressure measured after priming > 160 psi (1,100 kPa) (gauge) OR DEF supply module pump pressure < 102 psi (700 kPa) (gauge) OR DEF supply module pump pressure measured at start of priming > 7 psi (50 kPa) (gauge) OR DEF supply module pump pressure < -7 psi (-50 kPa) (gauge).	DEF supply module filled with DEF. Pressure > 29 psi (200 kPa) DEF tank has been defrosted. DEF supply line has been defrosted. DEF supply module has been defrosted, or DEF supply module defrost is not required. Engine Running Inactive: SPN 3361 FMI 3 and 4 (DEFSP); SPN 4334 FMI 3 and 4 (DEF: LP); SPN 4376 FMI 3 and 4 (DEFRV)	240 seconds

Fault Overview

Fault code sets when the Diesel Exhaust Fluid (DEF) supply module is unable to maintain the commanded diesel exhaust fluid pressure. Engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4334 FMI 3 and 4 (DEF: LP)

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

DEF: AP Circuit

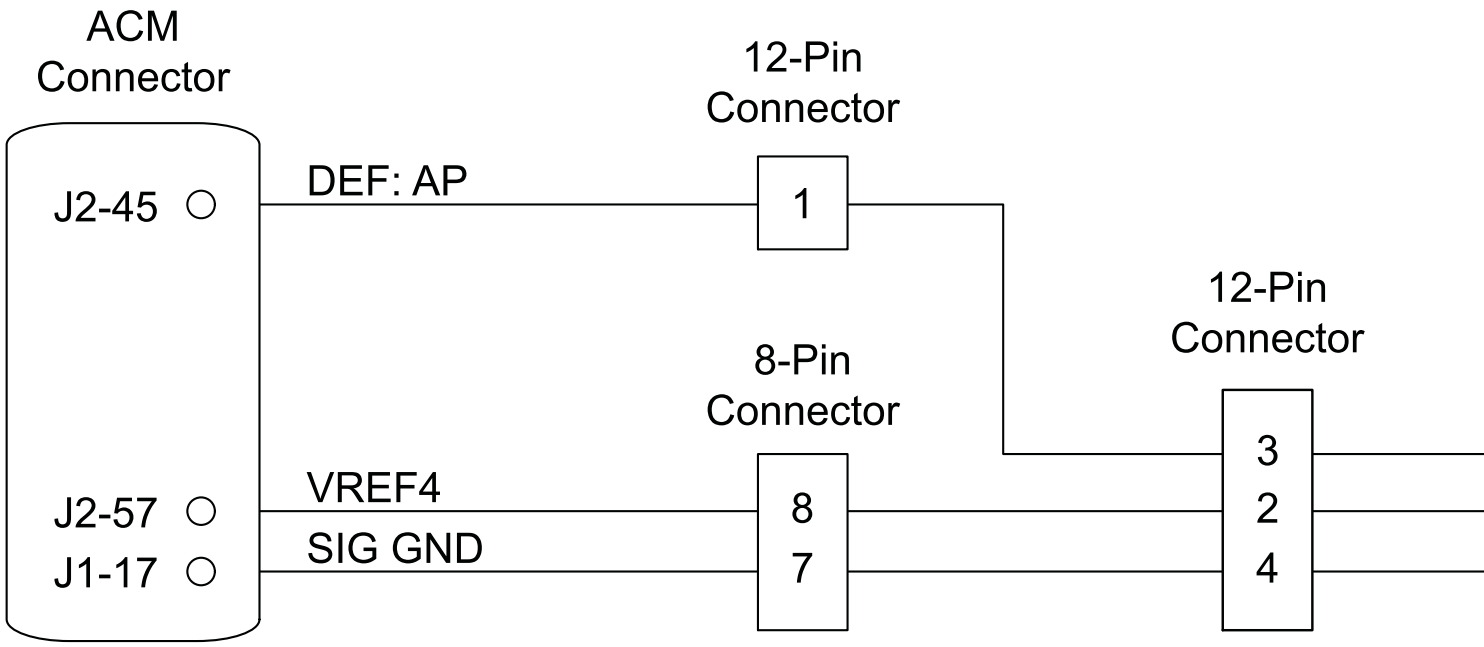


Figure 157 DEF: LP Sensor Circuit Diagram

Possible Causes

- Debris in DEF tank / restricted DEF tank screen
- DEF tank, supply module, or doser valve line or connection loose, leaking, or damaged
- Failed Diesel Exhaust Fluid (DEF) supply module
- Restricted DEF suction, pressure, or return line
- Restricted DEF supply module filter

Step	Action	Decision
1	Using Electronic Service Tool (EST) with Service Maxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4334 FMI 3 and 4 (DEF: LP). Is EST DTC list free of SPN 4334 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 4334 FMI 3 and 4. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
3	Check Diesel Exhaust Fluid (DEF) tank for debris or foreign particles. Also check DEF tank vent for restrictions or fluid crystallization. Are the DEF tank and DEF tank vent clean and free of debris, restrictions, and fluid crystallization?	Yes: Go to step 4. No: Drain DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
4	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections. Are the DEF tank, DEF supply module, and DEFDV lines and connections in good condition, not cracked, leaking, or damaged?	Yes: Go to step 5. No: Repair or replace failed line or connection. After repairs are complete retest for SPN 4334 FMI 2.

Step	Action	Decision
5	Check DEF supply module for restrictions. Unscrew DEF supply module filter cap, and remove filter from supply module. Inspect DEF supply module filter for restrictions and debris. Is the DEF supply module filter free of debris and restrictions?	Yes: Go to step 6. No: Replace DEF supply module filter and clean DEF supply module using 18-200-01. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
6	Check for failed Diesel Exhaust Fluid Line Pressure (DEF: LP) sensor. Key OFF, disconnect DEF supply module pressure line at DEFDV and place appropriate container under vehicle to catch DEF. Key ON, using EST with ServiceMaxx, load the Signals session and monitor DEF Line Pressure signal. Is DEF: LP signal 0 psi ± 10 psi?	Yes: Go to step 7. No: Replace the DEF supply module. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
7	Check DEF supply module suction line for restrictions. Disconnect both ends of suction line and blow compressed air through the line. Does compressed air flow freely through the suction line?	Yes: Go to step 8. No: Clean or replace DEF supply module suction line. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
8	Check DEF supply module return line for restrictions. Disconnect both ends of return line and blow compressed air through the line. Does compressed air flow freely through the return line?	Yes: Go to step 9. No: Clean or replace DEF supply module return line. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
9	Check DEF supply module pressure line for restrictions. Disconnect both ends of pressure line and blow compressed air through the line. Does compressed air flow freely through the pressure line?	Yes: Retest for SPN 4334 FMI 2. No: Clean or replace DEF supply module pressure line. After repairs are complete, retest for SPN 4334 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4334 FMI 2 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4334 FMI 3 - DEFAP Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Line Pressure (DEF: LP) sensor signal is high.	DEF: LP > 4.75 volts [189 psi (1,300 kPa gauge)]	Key ON	8 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal from the Diesel Exhaust Fluid Line Pressure (DEF: LP) sensor is greater than 4.75 volts for 8 seconds. DEF injection into the aftertreatment system is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3512 FMI 14 (VREF-4)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DEF: AP Circuit

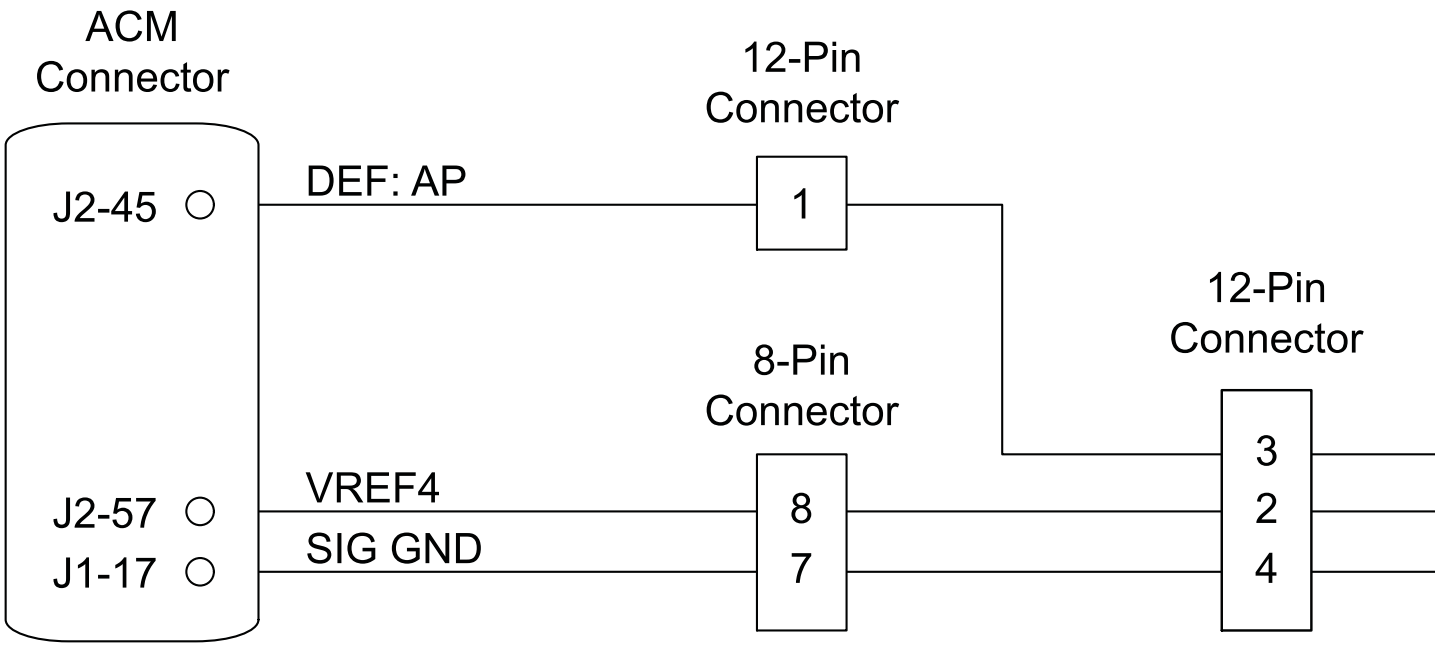


Figure 158 DEF: LP Sensor Circuit Diagram

Possible Causes

- DEF: LP signal circuit short to PWR
- Failed DEF supply module
- SIG GND circuit Open or high resistance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 4334 FMI 3.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4334 FMI 3.

Step	Action	Decision
3	Check DEF: LP signal circuit for short to power. Key-On Engine-Off (KOEO), with Breakout Harness 18-909-01 connected to DEF supply module, use a DMM to measure voltage between DEF supply module pin-3 and a known good ground. Is voltage less than 4.75 volts?	Yes: Go to step 4. No: Repair short to power between DEF supply module connector pin-3 and ACM connector pin J2-45. After repairs are complete, retest for SPN 4334 FMI 3.

Step	Action	Decision
4	Check SIG GND circuit for Open or high resistance. Connect Breakout Harness 18-909-01 to DEF supply module and leave DEF supply module disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-537-01 (96-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-4 and 180-pin Breakout Box pin J1-17. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 4334 FMI 3. No: Repair Open or high resistance between DEF supply module pin-4 and ACM connector pin J1-17. After repairs are complete, retest for SPN 4334 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4334 FMI 3 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4334 FMI 4 - DEFAP Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Line Pressure (DEF: LP) sensor signal is low.	DEF: LP < 0.25 volts [15 psi (100 kPa gauge)]	Key ON	8 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal from the Diesel Exhaust Fluid Line Pressure (DEF: LP) sensor is less than 0.25 volts for 8 seconds. DEF injection into the aftertreatment system is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3512 FMI 14 (VREF-4)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DEF: AP Circuit

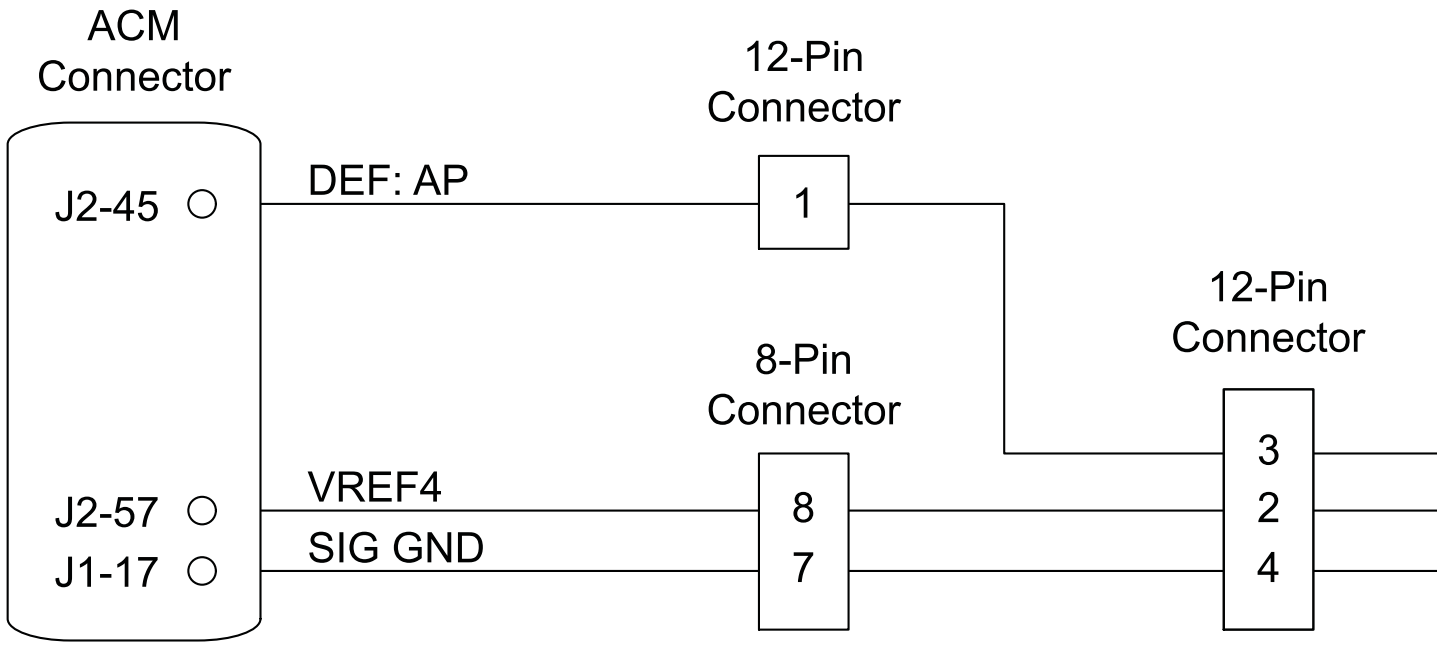


Figure 159 DEF: LP Sensor Circuit Diagram

Possible Causes

- DEF: LP signal circuit short to GND
- DEF: LP signal circuit Open or high resistance
- Failed DEF supply module
- VREF-4 circuit Open or high resistance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with Service Maxx™software, check Diagnostic Trouble Code (DTC) list for SPN 3512 FMI 14 (VREF-4). Is EST DTC list free of SPN 3512 FMI 14?	Yes: Go to step 2. No: Repair SPN 3512 FMI 14. After repairs are complete, retest for SPN 4334 FMI 2.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4334 FMI 4.

Step	Action	Decision
3	Check DEF: LP signal circuit for short to ground. Connect Breakout Harness 18-909-01 to DEF supply module and leave DEF supply module disconnected. Use a DMM to measure resistance between Breakout Harness 18-909-01 pin-3 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short to ground between DEF supply module connector pin-3 and ACM connector pin J2-45. After repairs are complete, retest for SPN 4334 FMI 4.

Step	Action	Decision
4	Check VREF-4 circuit for Open or high resistance. Connect Breakout Harness 18-909-01 to DEF supply module and leave DEF supply module disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-537-01 (58-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-2 and 180-pin Breakout Box pin J2-57. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair Open or high resistance between DEF supply module pin-2 and ACM connector pin J2-57. After repairs are complete, retest for SPN 4334 FMI 4.

Step	Action	Decision
5	Check DEF: LP signal circuit for Open or high resistance. Connect Breakout Harness 18-909-01 to DEF supply module and leave DEF supply module disconnected. Connect 180-pin Breakout Box with SCR (ACM) Breakout Harness 18-537-01 (58-pin) to ACM and leave ACM disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-3 and 180-pin Breakout Box pin J2-45. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 4334 FMI 4. No: Repair Open or high resistance between DEF supply module pin-3 and ACM connector pin J2-45. After repairs are complete, retest for SPN 4334 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4334 FMI 4 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4334 FMI 16 - DEFAP above Maximum Pressure

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Blockage in the DEF supply module return line has been detected.	DEF: LP > 160 psi (1,100 kPa) (gauge)	Inactive: SPN 3361 FMI 3 and 4 (DEFSP); SPN 4334 FMI 2, 3, and 4 (DEF: LP) Key ON DEF supply module defrost not required or DEF supply module defrost is completed.	20 seconds

Fault Overview

Fault code sets when the Diesel Exhaust Fluid Line Pressure (DEF: LP) sensor detects pressure in the DEF supply module is above 160 psi (1100 kPa) for more than 20 seconds. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced, and vehicle speed limited if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1761 (DEFTLT), SPN 3031 (DEFTLT), SPN 3361 (DEFSP), SPN 3362 (DEFSP), SPN 3363 FMI (DEFTHV), SPN 4376 (DEFRV), SPN 5394 (DEFDV), SPN 5491 (DEFLHR), SPN 5745 (DEFDUH), SPN 5746 (DEFUHR), SPN 5798 (DEFDUH)

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

DEF: AP Circuit

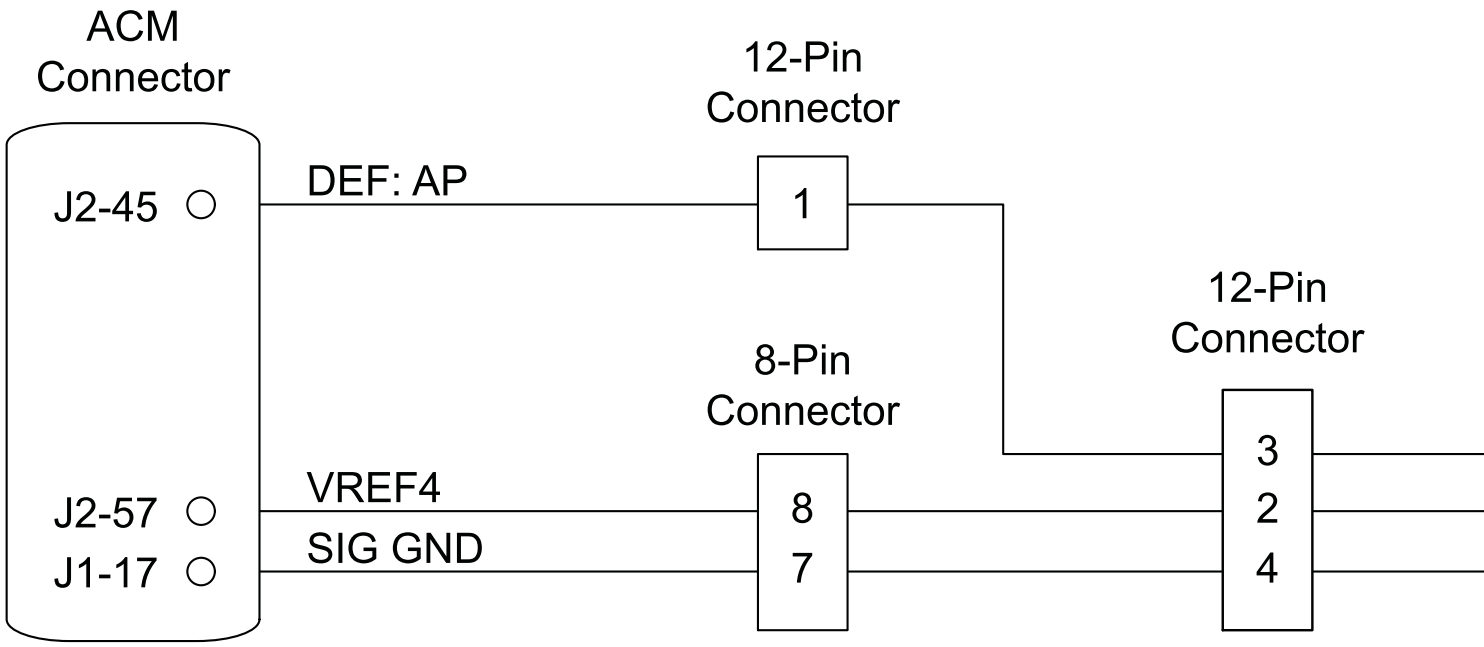


Figure 160 DEF: LP Sensor Circuit Diagram

Possible Causes

- Failed DEF supply module
- Restricted DEF return line

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 (DEFTLT), SPN 3031 (DEFTLT), SPN 3361 (DEFSP), SPN 3362 (DEFSP), SPN 3363 FMI (DEFTHV), SPN 4376 (DEFRV), SPN 5394 (DEFDV), SPN 5491 (DEFLHR), SPN 5745 (DEFDUH), SPN 5746 (DEFUHR), and SPN 5798 (DEFDUH). Is EST DTC list free of SPN 1761, SPN 3031, SPN 3361, SPN 3362, SPN 3363 FMI, SPN 4376, SPN 5394, SPN 5491, SPN 5745, SPN 5746, and SPN 5798?	Yes: Go to step 2. No: Repair SPN 1761, SPN 3031, SPN 3361, SPN 3362, SPN 3363 FMI, SPN 4376, SPN 5394, SPN 5491, SPN 5745, SPN 5746, and SPN 5798. After repairs are complete, retest for SPN 4334 FMI 16.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4334 FMI 16.

Step	Action	Decision
3	Check DEF supply module return line for restrictions. Disconnect both ends of return line and blow compressed air through the line. Does compressed air flow freely through the return line?	Yes: Clean DEF supply module using 18-200-01 and perform drive cycle 27. If SPN 4334 FMI 16 is still active, replace DEF supply module. After repairs are complete, retest for SPN 4334 FMI 16. No: Clean or replace DEF supply module return line. After repairs are complete, retest for SPN 4334 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 4334 FMI 16 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4334 FMI 18 - DEFAP Below Normal Operating Range

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Low Diesel Exhaust Fluid Line Pressure (DEF: LP) signal.	DEF: LP < 102 psi (700 kPa) (gauge)	Inactive: SPN 3361 FMI 3 and 4 (DEFSP); SPN 4334 FMI 2, 3, and 4 (DEF: LP) DEF tank has been defrosted. DEF supply module has been filled with DEF fluid. DEF supply module suction line has been defrosted. DEF supply module has been defrosted. Engine-Running	200 seconds

Fault Overview

Fault code sets when the Diesel Exhaust Fluid Line Pressure (DEF: LP) sensor detects the DEF supply module is unable to build or maintain adequate pressure. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced, and vehicle speed limited if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1761 (DEFTLT), SPN 3031 (DEFTLT), SPN 3361 (DEFSP), SPN 3362 (DEFSP), SPN 3363 FMI (DEFTHV), SPN 4376 (DEFRV), SPN 5394 (DEFDV), SPN 5491 (DEFLHR), SPN 5745 (DEFDUH), SPN 5746 (DEFUHR), SPN 5798 (DEFDUH)

Drive Cycle to Determine Fault Status

Drive Cycle 27 in 2013 HD-OBD Diagnostic Reference Manual.

DEF: AP Circuit

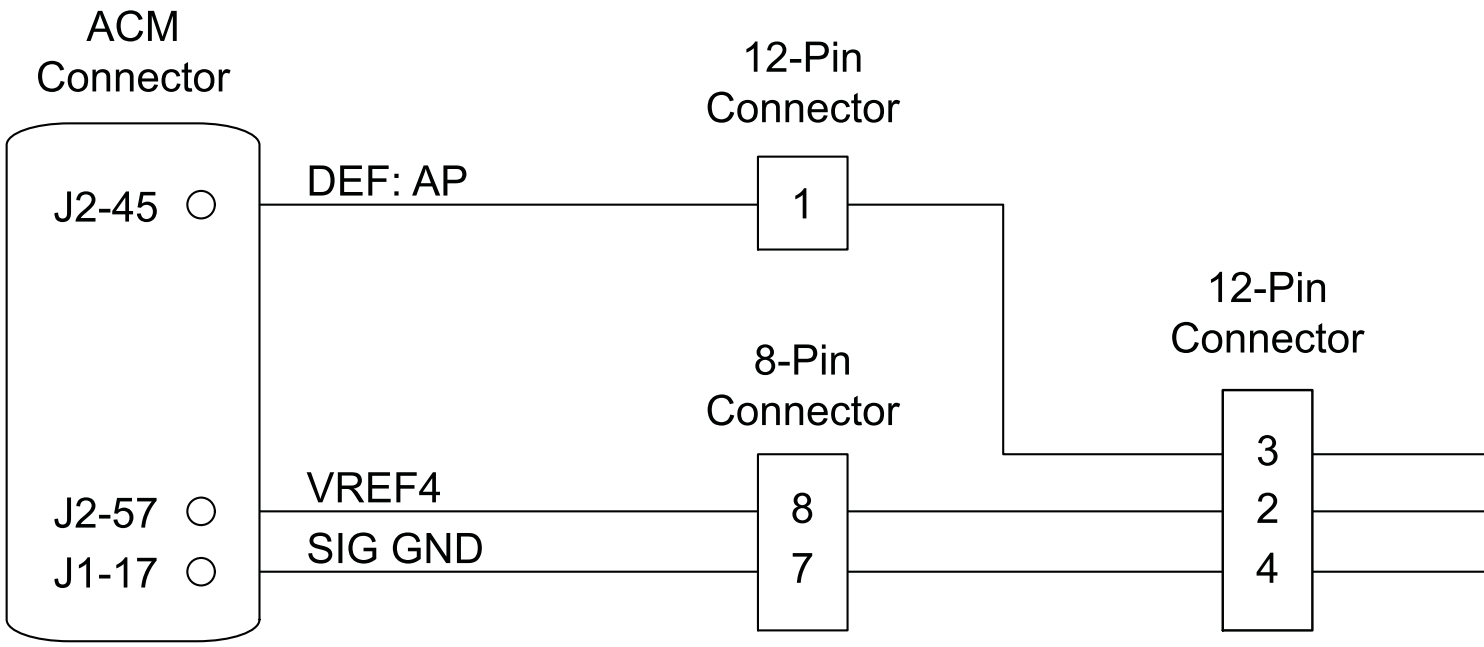


Figure 161 DEF: LP Sensor Circuit Diagram

Possible Causes

- Debris in DEF tank / restricted DEF tank screen
- DEF tank, supply module, or doser valve line or connection loose, leaking, or damaged
- Failed DEF supply module
- Low DEF tank level
- Restricted DEF suction line

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 (DEFTLT), SPN 3031 (DEFTLT), SPN 3361 (DEFSP), SPN 3362 (DEFSP), SPN 3363 FMI (DEFTHV), SPN 4376 (DEFRV), SPN 5394 (DEFDV), SPN 5491 (DEFLHR), SPN 5745 (DEFDUH), SPN 5746 (DEFUHR), and SPN 5798 (DEFDUH). Is EST DTC list free of SPN 1761, SPN 3031, SPN 3361, SPN 3362, SPN 3363 FMI, SPN 4376, SPN 5394, SPN 5491, SPN 5745, SPN 5746, and SPN 5798?	Yes: Go to step 2. No: Repair SPN 1761, SPN 3031, SPN 3361, SPN 3362, SPN 3363 FMI, SPN 4376, SPN 5394, SPN 5491, SPN 5745, SPN 5746, and SPN 5798. After repairs are complete, retest for SPN 4334 FMI 18.

Step	Action	Decision
2	Check DEF tank level. Read DEF level using the vehicle instrument panel gauge and perform a visual inspection of fluid level in the DEF tank. Is DEF tank fluid level below 1/2 tank?	Yes: Fill DEF tank with appropriate diesel exhaust fluid. After repairs are complete, retest for SPN 4334 FMI 18. No: Go to step 3.

Step	Action	Decision
3	Check Diesel Exhaust Fluid (DEF) tank for debris or foreign particles. Also check DEF tank vent for restrictions or fluid crystallization. Are the DEF tank and DEF tank vent clean and free of debris, restrictions, and fluid crystallization?	Yes: Go to step 4. No: Drain DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4334 FMI 18.

Step	Action	Decision
4	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEFDV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections. Are the DEF tank, DEF supply module and DEFDV lines and connections in good condition, not cracked, leaking, or damaged?	Yes: Go to step 5. No: Repair or replace failed line or connection. After repairs are complete retest for SPN 4334 FMI 18.

Step	Action	Decision
5	Check DEF supply module suction line for restrictions. Disconnect both ends of suction line and blow compressed air through the line. Does compressed air flow freely through the suction line?	Yes: Go to step 6. No: Clean or replace DEF supply module suction line. After repairs are complete, retest for SPN 4334 FMI 18.

Step	Action	Decision
6	Check DEF tank fluid pickup screen for restrictions. Remove DEF tank pickup assembly (see Exhaust Aftertreatment System with DPF and SCR Service Manual). Inspect the DEF tank fluid pickup screen for restrictions or buildup. Is the DEF tank fluid pickup screen free of restrictions?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 4334 FMI 18. No: Clean or replace DEF tank fluid pickup screen. Drain, clean, and fill the DEF tank. Clean DEF supply module using 18-200-01. After repairs are complete, retest for SPN 4334 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 4334 FMI 18 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

DEF: PLH (Diesel Exhaust Fluid Pressure Line Heater) Sensor

Overview of DEF: PLH Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
4340	3	DEFL1HC short to PWR	• DEF PRES L-HTR circuit short to power • Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR) • DEF Pressure Line Heater (DEFPLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFPLH pin-2	Step-Based Diagnostics (page 425)
4340	5	DEFL1HC open load / circuit	• Failed Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) • DEF Press L-HTR circuit Open or high resistance • DEF Press L-HTR circuit short to GND • DEFPLH power circuit Open or high resistance • DEFPLH power circuit short to GND • Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)	Step-Based Diagnostics (page 430)

- Failed DEFLHR

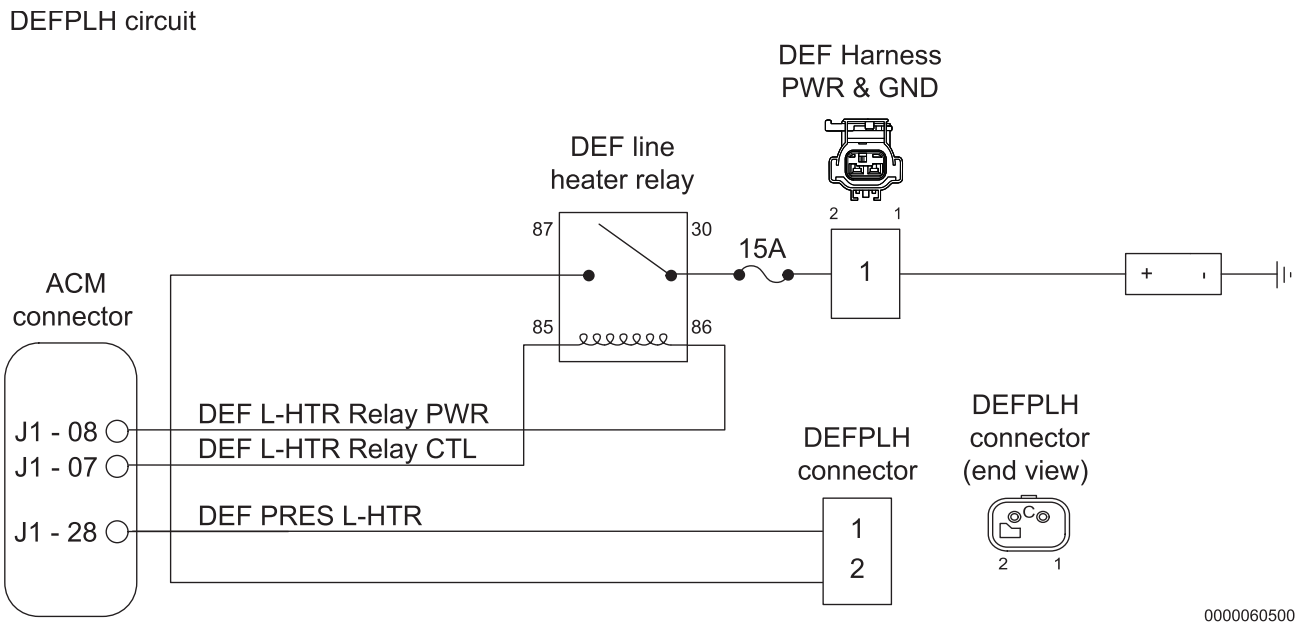


Figure 162 DEFPLH Circuit Diagram

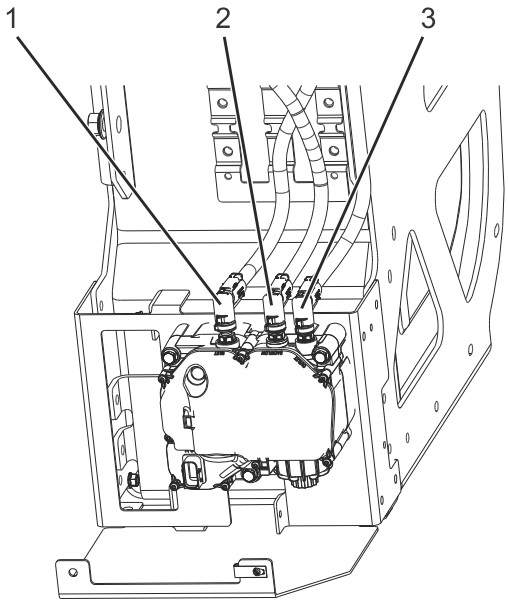
NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) is used to maintain proper DEF temperature during cold conditions. The DEFPLH is wrapped around the pressure line between DEF Doser Valve (DEFDV) and the DEF supply module. When DEF temperature is too low, the Aftertreatment Control Module (ACM) turns on the DEF Line Heater Relay (DEFLHR) allowing power to be sent to the DEFPLH.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- Breakout Harness 18-047-01
- Breakout Harness ZTSE4908
- Digital Multimeter (DMM)
- Standard test light
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000054407

Figure 163 DEF Supply Module Line Routing

1. DEF supply module suction line
2. DEF supply module return (backflow) line
3. DEF supply module pressure line

SPN 4330 FMI 3 - DEFL: 1HC Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) current is greater than expected.	DEFPLH current > 0.5 A	Key ON The DEF Line Heater Relay (DEFLHR) command OFF.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) is greater than 0.5 amps. Engine torque will be reduced, and vehicle speed will be limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

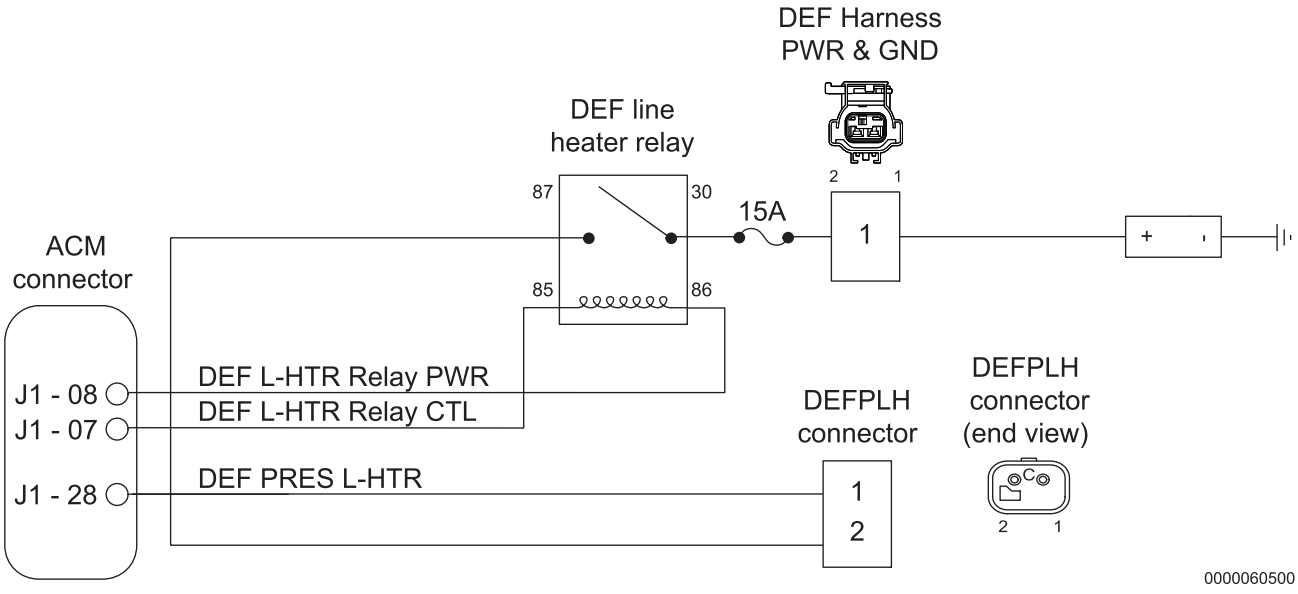
Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive Cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

DEFPLH circuit



Possible Causes

- DEF PRES L-HTR circuit short to power
- Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR)

- DEF Pressure Line Heater (DEFPLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFPLH pin-2

NOTE: DEF: RLH, DEF: PLH, and DEF: SLH share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4340 FMI 3.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Pressure Line Heater (DEFPLH). Key OFF, disconnect DEFPLH. Check DEFPLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFPLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4340 FMI 3.

Step	Action	Decision
3	Determine if DEF PRES L-HTR circuit is shorted to power. Connect Breakout Harness 18-047-01 to vehicle harness and leave DEFPLH disconnected. Key ON, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is Breakout Harness pin-1 voltage 0.5 volts or less?	Yes: Go to step 4. No: Repair short to PWR between Aftertreatment Control Module (ACM) pin J1-28 and DEFPLH connector pin-1. After repairs are complete, retest for SPN 4340 FMI 3.

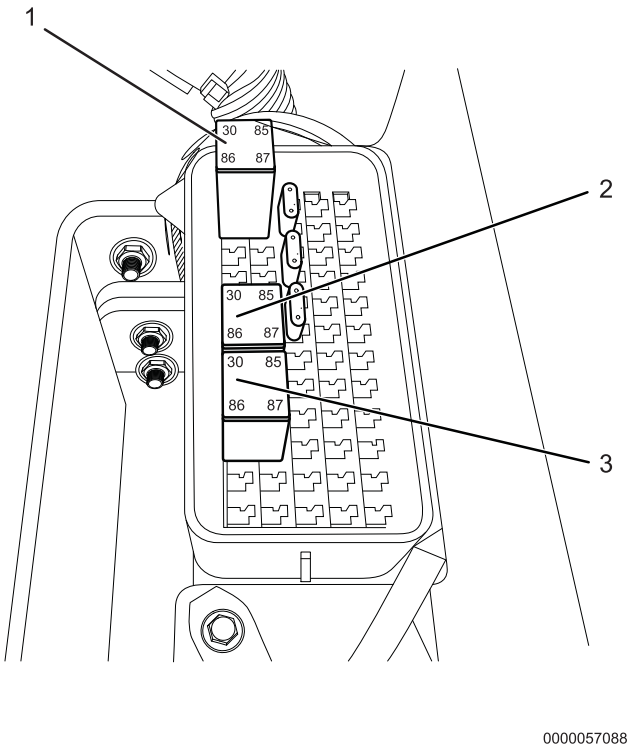


Figure 165 Power Distribution Module (PDM) Fuses and Relays

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

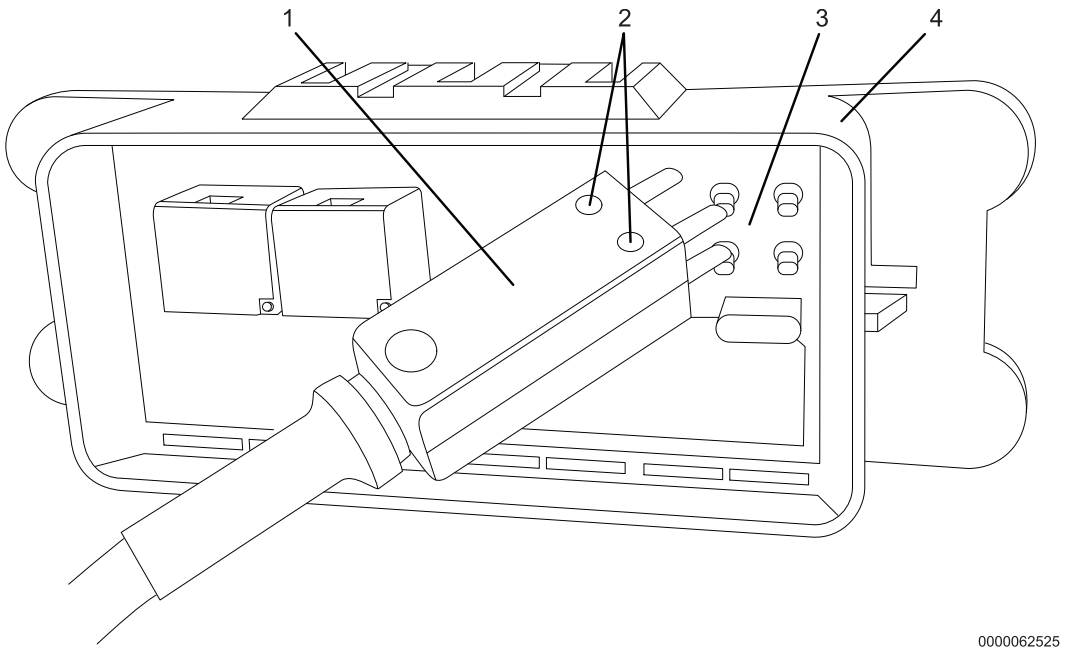


Figure 166 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Determine if DEF Line Heater Relay (DEFLHR) has failed. Key OFF, remove DEFLHR and install Breakout Harness ZTSE4908, leaving relay disconnected. Key ON, measure voltage at Power Distribution Module (PDM) terminal 87 for the DEFLHR. Is PDM terminal 87 for DEFLHR voltage 0.5 volts or more?	Yes: Repair short to power between PDM terminal 87 for the DEFLHR and the DEFPLH connector pin-2. After repairs are complete, retest for SPN 4340 FMI 3.
		No: Replace the DEFLHR. After repairs are complete, retest for SPN 4340 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4340 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4330 FMI 5 - DEF: L1HC Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) circuit Open. Current less than expected.	DEFPLH current < 0.3 A	Key ON The DEF Line Heater Relay (DEFLHR) command ON.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) is less than 0.3 amps. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

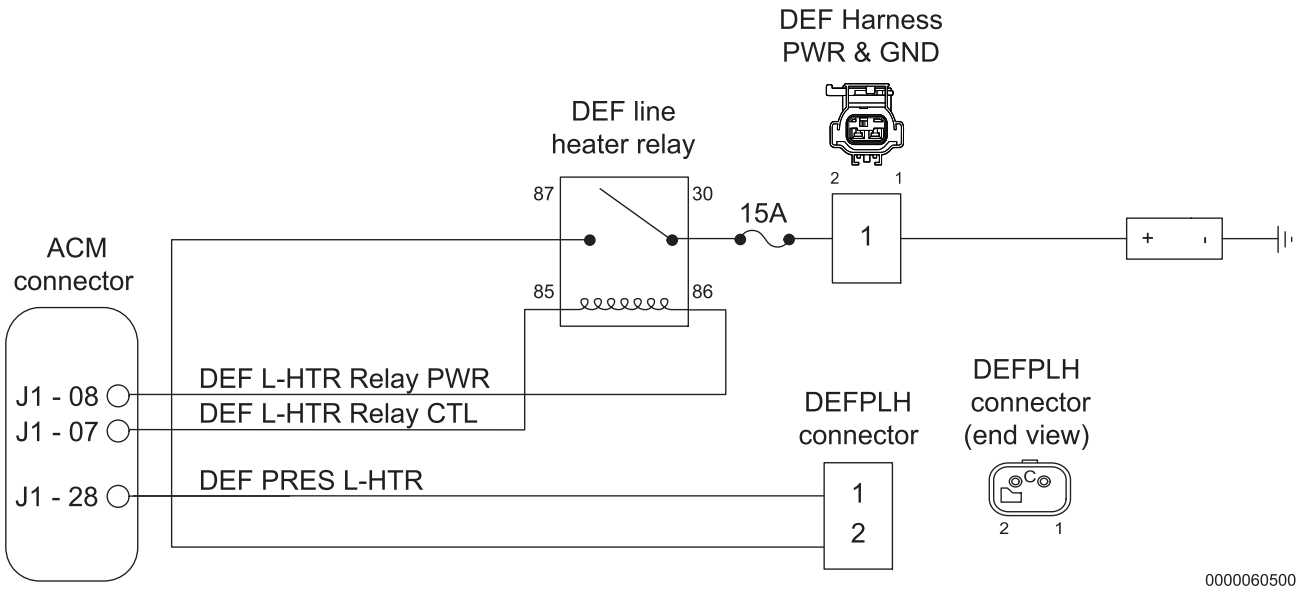
Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

DEFPLH circuit



Possible Causes

- Failed Diesel Exhaust Fluid Press Line Heater (DEFPLH)
- DEF Press L-HTR circuit Open or high resistance
- DEF Press L-HTR circuit short to GND
- DEFPLH power circuit Open or high resistance
- DEFPLH power circuit short to GND
- Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)
- Failed DEFLHR

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4340 FMI 5.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Pressure Line Heater (DEFPLH). Key OFF, disconnect DEFPLH. Check DEFPLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFPLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4340 FMI 5.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Determine if DEFPLH is receiving power. Connect Breakout Harness 18-047-01 to vehicle harness and leave DEFPLH disconnected. Using EST with ServiceMaxx software, select Tests > KOEO Aftertreatment Tests > DEF Line Heater Test. Run test and measure voltage between Breakout Harness pin-2 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 9. No: Go to step 4.

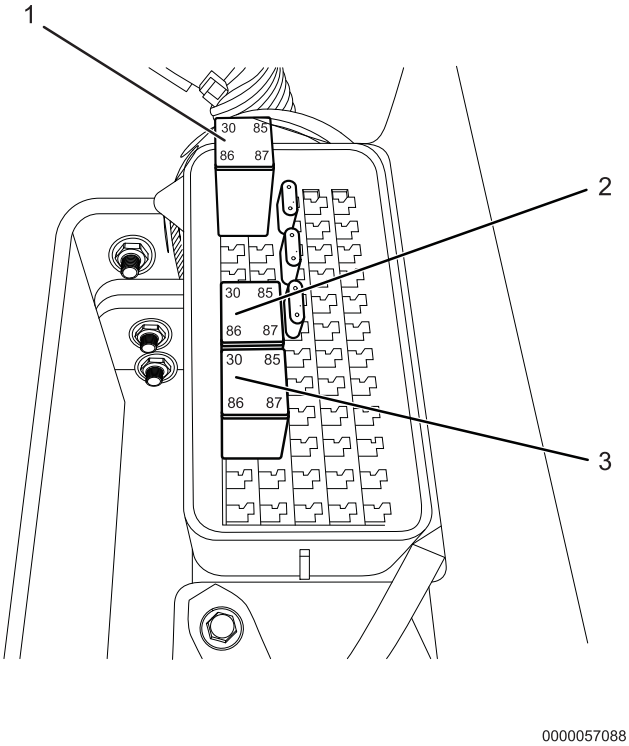


Figure 168 Power Distribution Module (PDM) Fuses and Relays

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

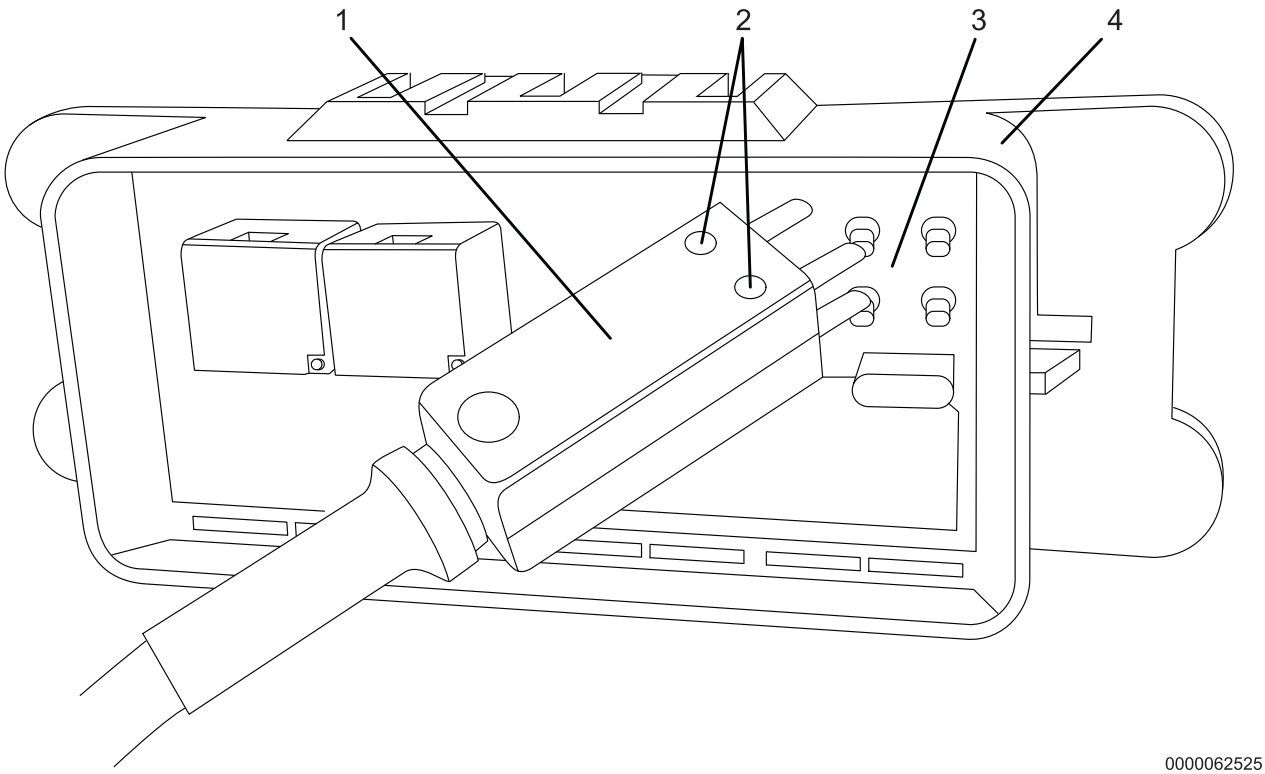


Figure 169 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Test DEFLHR PWR circuit and fuse. Remove DEFLHR. Install Breakout Harness ZTSE4908 and leave DEFLHR disconnected. Connect test light between breakout harness pin-30 and known good ground. Does test light illuminate and is the fuse in good condition and not blown?	Yes: Go to step 8. No: Go to step 5.

Step	Action	Decision
5	Check for PWR at DEFLHR 15 amp fuse. KOEO, using a DMM check for voltage between vehicle side of DEFLHR 15 amp fuse and a known good ground. Is voltage within 0.5 volts of battery voltage.	Yes: Got to step 6.
		No: Repair Open between DEFLHR 15 amp fuse and vehicle PWR. After repairs are complete retest for SPN 4340 FMI 5.

Step	Action	Decision
6	With DEFPLH disconnected. Replace DEFLHR 15 amp fuse. Does the DEFLHR 15 amp fuse blow immediately when replaced?	Yes: Repair short to GND between DEFLHR 15 amp fuse and DEFLHR pin-30. After repairs are complete, retest for SPN 4340 FMI 5.
		No: Go to step 7.

Step	Action	Decision
7	Check for short to GND between DEFLHR pin-87 and DEFPLH. Install DEFLHR. Using Electronic Service Tool (EST) with ServiceMaxx™ software, select KOEO Aftertreatment Tests > DEF Line Heater Test. Run DEF Line Heater Test. Inspect to see if DEFLHR 15 amp fuse blows when DEF line heaters are actuated ON. Does the DEFLHR 15 amp fuse blow when DEF line heaters are actuated ON?	Yes: Repair short to GND between DEFLHR pin-87 and DEFPLH, DEF Suction Line Heater (DEFSLH), or DEF Return Line Heater (DEFRLH). After repairs are complete, retest for SPN 4340 FMI 5.
		No: Repair Open or high resistance between DEFLHR pin-87 and DEFPLH, DEF Suction Line Heater (DEFSLH), or DEF Return Line Heater (DEFRLH). After repairs are complete, retest for SPN 4340 FMI 5.

Step	Action	Decision
8	Check for Open or high resistance circuit between DEFPLH connector pin-2 and DEFLHR pin-87. Connect Breakout Harness 18-047-01 to vehicle harness and leave DEFPLH disconnected. Key OFF, with Breakout Harness ZTSE4908 connected to Power Distribution Module (PDM) and DEFLHR disconnected, measure resistance between Breakout Harness ZTSE4908 pin-87 and Breakout Harness 18-047-01 pin-2. Is resistance less than 5 ohms?	Yes: Replace the DEFLHR. After repairs are complete, retest for SPN 4340 FMI 5.
		No: Repair Open or high resistance between DEFPLH pin-2 and DEFLHR pin-87. After repairs are complete, retest for SPN 4340 FMI 5.

Step	Action	Decision
9	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 10. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4340 FMI 5.

Step	Action	Decision
10	Measure for Open or high resistance in DEF PRES L-HTR circuit. Connect 180-pin Breakout Box with Breakout Harness 18-537-01 to vehicle harness and leave ACM disconnected. Key OFF, with Breakout Harness 18-047-01 connected to vehicle harness and DEFPLH disconnected, measure resistance between Breakout Harness 18-537-01 pin J1-28 and Breakout Harness 18-047-01 pin-1. Is resistance less than 5 ohms?	Yes: Go to step 11. No: Repair Open or high resistance between ACM connector pin J1-28 and DEFPLH connector pin-1. After repairs are complete, retest for SPN 4340 FMI 5.

Step	Action	Decision
11	Measure for short to GND in DEF PRES L-HTR circuit with ACM disconnected. Key OFF, with Breakout Harness 18-047-01 connected to vehicle harness and DEFPLH disconnected. Measure resistance between Breakout Harness 18-047-01 pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace DEFPLH. After repairs are complete, retest for SPN 4340 FMI 5. No: Repair short to GND between ACM connector pin J1-28 and DEFPLH connector pin-1. After repairs are complete, retest for SPN 4340 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 4340 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEF: RLH (Diesel Exhaust Fluid Return Line Heater) Sensor

Overview of DEF: RLH Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
4342	3	DEFL2HC short to PWR	• DEF RTN L-HTR circuit short to power • Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR) • DEF Return Line Heater (DEFRLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFRLH pin-2	Step-Based Diagnostics (page 438)
4342	5	DEFL2HC open load / circuit	• Failed Diesel Exhaust Fluid Return Line Heater (DEFRLH) • DEF RTN L-HTR circuit Open or high resistance • DEF RTN L-HTR circuit short to GND • DEFRLH power circuit Open or high resistance • DEFRLH power circuit short to GND • Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)	Step-Based Diagnostics (page 443)

- Failed DEFLHR

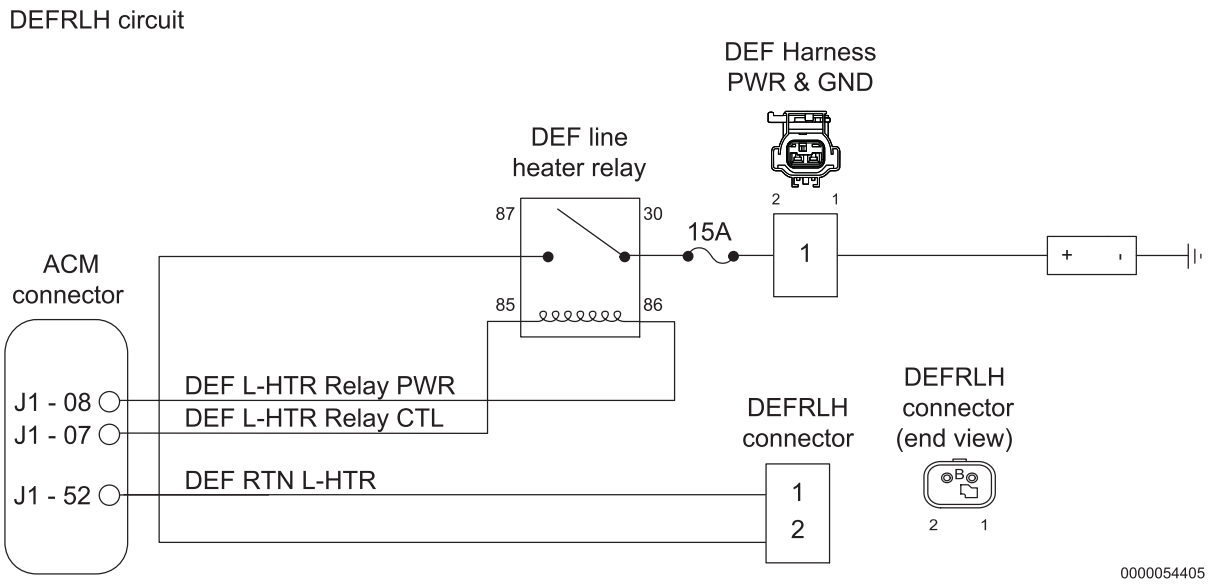


Figure 170 Diesel Exhaust Fluid Return Line Heater (DEFRLH) Circuit Diagram

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Return Line Heater (DEFRLH) is used to prevent DEF freezing during cold conditions. The DEFRLH is wrapped around the return line between the DEF tank and the DEF supply module. When DEF temperature is too low, the Aftertreatment Control Module (ACM) turns on the DEF Line Heater Relay (DEFLHR) allowing power to be sent to the DEFRLH.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- Breakout Harness 18-046-01
- Breakout Harness ZTSE4908
- Digital Multimeter (DMM)
- Standard test light
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

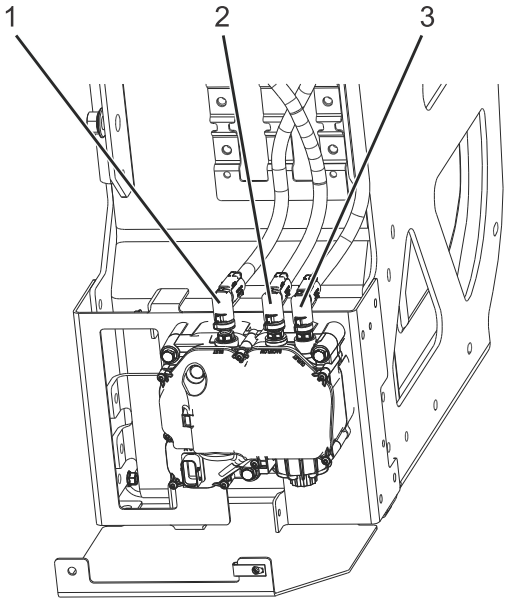


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Figure 171 DEF Supply Module Line Routing

1. DEF supply module suction line
2. DEF supply module return (backflow) line
3. DEF supply module pressure line

SPN 4332 FMI 3 - DEF: L2HC Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Return Line Heater (DEFRLH) current greater than expected.	DEFRLH current > 0.5 A	Key ON DEF Line Heater Relay (DEFLHR) command OFF.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Return Line Heater (DEFRLH) is greater than 0.5 amps. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive Cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

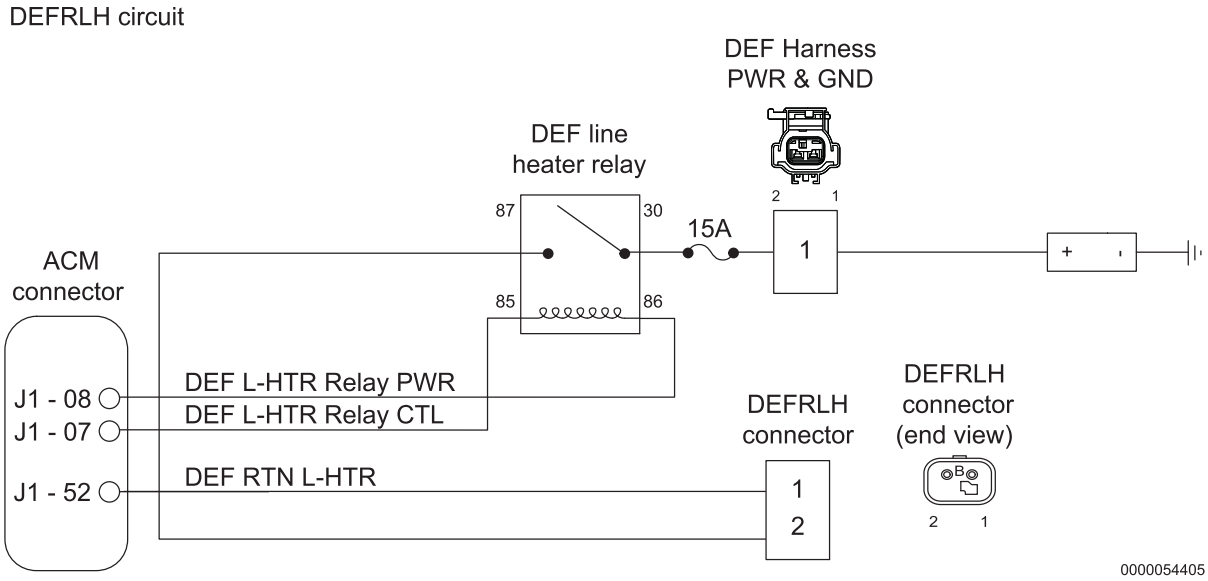

Figure 172 Diesel Exhaust Fluid Return Line Heater (DEFRLH) Circuit Diagram

Possible Causes

- DEF RTN L-HTR circuit short to power
- Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR)

- DEF Return Line Heater (DEFRLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFRLH pin-2

NOTE: DEFRLH, DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more then one DEF line heater fault is set, suspect a common power circuit problem.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4342 FMI 3.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Return Line Heater (DEFRLH). Key OFF, disconnect DEFRLH. Check DEFRLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFRLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4342 FMI 3.

Step	Action	Decision
3	Determine if DEF RTN L-HTR circuit is shorted to power. Connect Breakout Harness 18-046-01 to vehicle harness and leave DEFRLH disconnected. Key ON, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is Breakout Harness pin-1 voltage 0.5 volts or less?	Yes: Go to step 4. No: Repair short to PWR between Aftertreatment Control Module (ACM) pin J1-52 and DEFRLH connector pin-1. After repairs are complete, retest for SPN 4342 FMI 3.

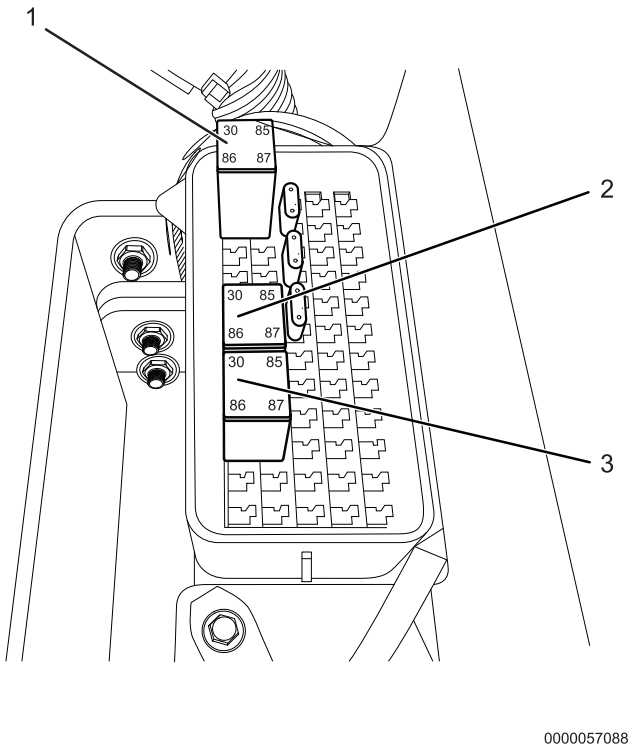

Figure 173 Power Distribution Module (PDM) Fuses and Relays (Typical)

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

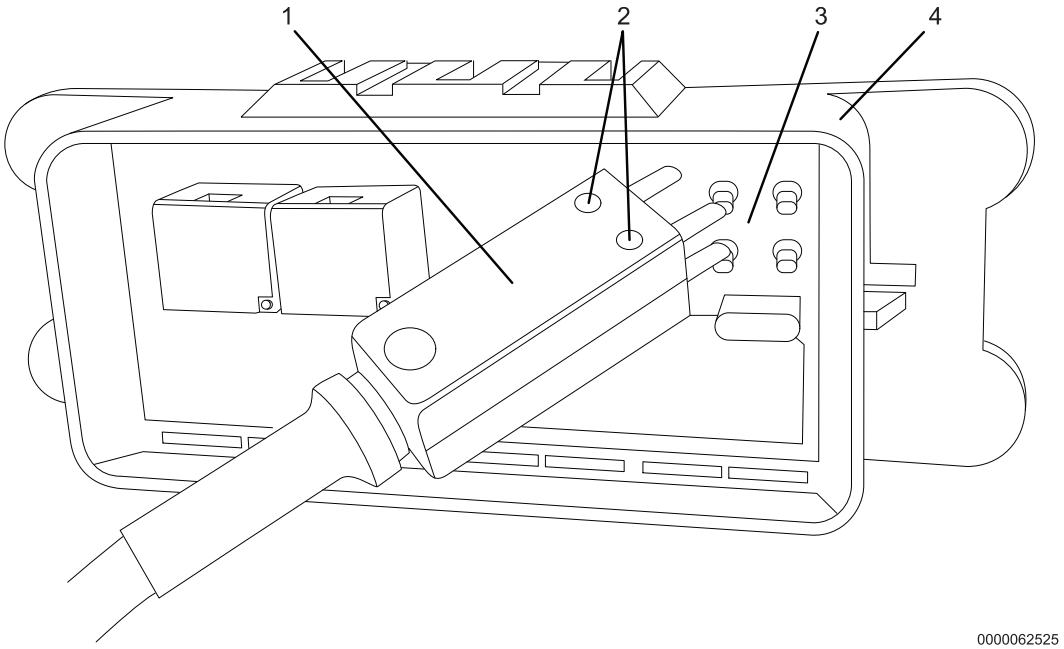

Figure 174 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Determine if DEFLHR has failed. Key OFF, remove DEFLHR. Install Breakout Harness ZTSE4908, leaving DEFLHR disconnected. Key ON, measure voltage at Power Distribution Module (PDM) terminal 87 for the DEFLHR. Is PDM terminal 87 for DEFLHR voltage 0.5 volts or more?	Yes: Repair short to power between PDM terminal 87 for DEFLHR and the DEFRLH connector pin-2. After repairs are complete, retest for SPN 4342 FMI 3.
		No: Replace the DEFLHR. After repairs are complete, retest for SPN 4342 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4342 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4332 FMI 5 - DEF: L2HC Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Return Line Heater (DEFRLH) circuit Open. Current less than expected.	DEFRLH current < 0.3 A	Key ON The DEF Line Heater Relay (DEFLHR) commanded ON.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Return Line Heater (DEFRLH) is less than 0.3 amps. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

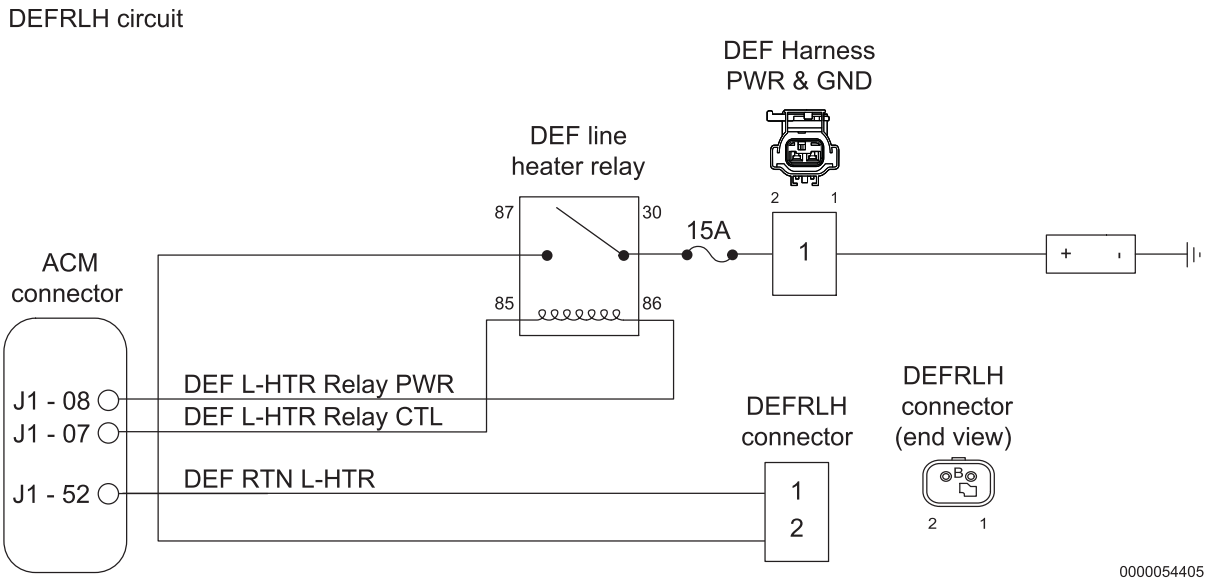

Figure 175 Diesel Exhaust Fluid Return Line Heater (DEFRLH) Circuit Diagram

Possible Causes

- Failed Diesel Exhaust Fluid Return Line Heater (DEFRLH)
- DEF RTN L-HTR circuit Open or high resistance
- DEF RTN L-HTR circuit short to GND
- DEFRLH power circuit Open or high resistance
- DEFRLH power circuit short to GND
- Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)
- Failed DEFLHR

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Return Line Heater (DEFRLH). Key OFF, disconnect DEFRLH. Check DEFRLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFRLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4342 FMI 5.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Determine if DEFRLH is receiving power. Connect Breakout Harness 18-046-01 to vehicle harness and leave DEFRLH disconnected. Using EST with ServiceMaxx software, select Tests > KOEO Aftertreatment Tests > DEF Line Heater Test. Run test and measure voltage between Breakout Harness 18-046-01 pin-2 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 9. No: Go to step 4.

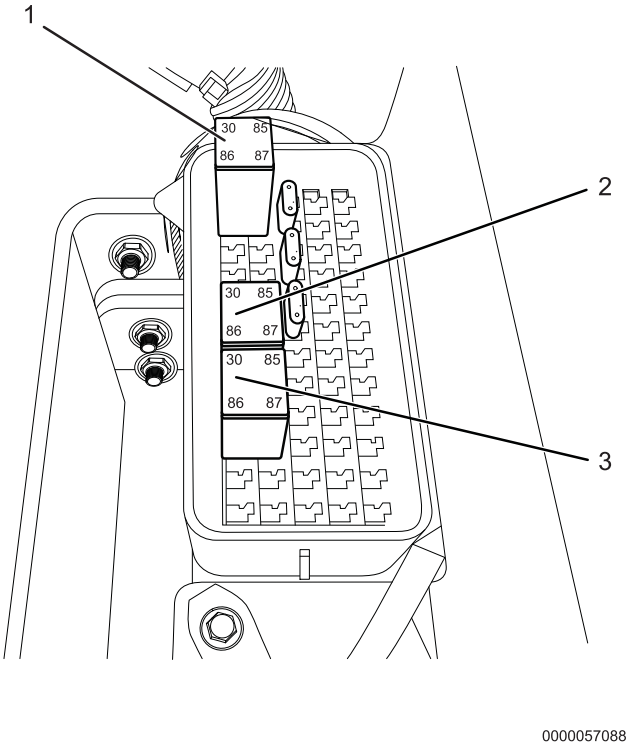

Figure 176 Power Distribution Module (PDM) Fuses and Relays (Typical)

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

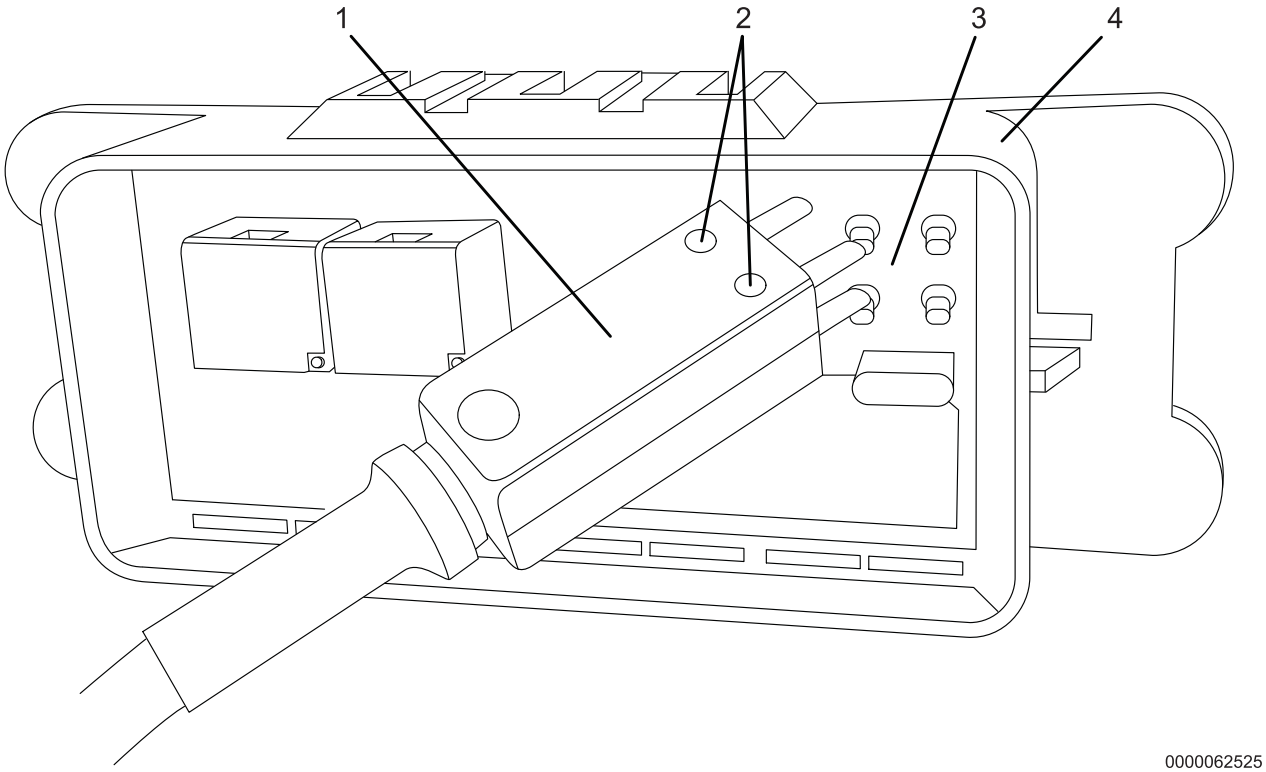

Figure 177 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Test DEFLHR PWR circuit and fuse. Remove DEFLHR. Install Breakout Harness ZTSE4908 and leave DEFLHR disconnected. Connect test light between a known good ground and pin-30 of the DEFLHR. Does test light illuminate and is DEF line heater relay 15 amp fuse in good condition and not blown?	Yes: Go to step 8. No: Go to step 5.

Step	Action	Decision
5	Check for PWR at DEFLHR 15 amp fuse. KOEO, using a DMM check for voltage between vehicle side of DEFLHR 15 amp fuse and a known good ground. Is voltage within 0.5 volts of battery voltage.	Yes: Got to step 6.
		No: Repair Open or high resistance between DEFLHR 15 amp fuse and vehicle PWR. After repairs are complete retest for SPN 4342 FMI 5.

Step	Action	Decision
6	Check for short to GND between DEF line heater relay 15 amp fuse and DEF line heater relay. With DEF line heater relay disconnected. Remove and Replace DEF line heater relay 15 amp fuse. Does the DEF line heater relay 15 amp fuse blow when replaced?	Yes: Repair short to GND between DEF line heater relay 15 amp fuse and DEF line heater relay pin-30. After repairs are complete, retest for SPN 4342 FMI 5.
		No: Repair short GND between DEF line heater relay and DEFRLH, DEF Pressure Line Heater (DEFPLH), or DEF Suction Line Heater (DEFSLH). After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
7	Check for short to GND between DEFLHR pin-87 and DEFRLH. Install DEFLHR. Using Electronic Service Tool (EST) with ServiceMaxx™ software, select KOEO Aftertreatment Tests > DEF Line Heater Test. Run DEF Line Heater Test. Inspect to see if DEFLHR 15 amp fuse blows when DEF line heaters are actuated ON. Does the DEFLHR 15 amp fuse blow when DEF line heaters are actuated ON?	Yes: Repair short GND between DEFLHR pin-87 and DEFRLH, DEF Pressure Line Heater (DEFPLH), or DEF Suction Line Heater (DEFSLH). After repairs are complete, retest for SPN 4342 FMI 5.
		No: Repair Open or high resistance between DEFLHR pin-87 and DEFRLH, DEF Suction Line Heater (DEFSLH), or DEF Pressure Line Heater (DEFRLH). After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
8	Check for an Open or high resistance circuit between DEFRLH connector pin-2 and DEFLHR pin-87. Connect Breakout Harness 18-046-01 to vehicle harness and leave DEFRLH disconnected. Key OFF, with Breakout Harness ZTSE4908 connected to Power Distribution Module (PDM), measure resistance between Breakout Harness ZTSE4908 pin-87 and Breakout Harness 18-046-01 pin-2. Is resistance less than 5 ohms?	Yes: Replace the DEFLHR. After repairs are complete, retest for SPN 4342 FMI 5. No: Repair Open or high resistance between DEFRLH pin-2 and DEFLHR pin-87. After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
9	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 10. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
10	Measure for Open or high resistance in DEF RTN L-HTR circuit. Connect 180-pin Breakout Box with Breakout Harness 18-537-01 to vehicle harness and leave ACM disconnected. Key OFF, with Breakout Harness 18-046-01 connected to vehicle harness and DEFRLH disconnected, measure resistance between Breakout Harness 18-537-01 pin J1-52 and Breakout Harness 18-046-01 pin-1. Is resistance less than 5 ohms?	Yes: Go to step 11. No: Repair Open or high resistance between ACM connector pin J1-52 and DEFRLH connector pin-1. After repairs are complete, retest for SPN 4342 FMI 5.

Step	Action	Decision
11	Measure for short to GND in DEF RTN L-HTR circuit with ACM disconnected. Key OFF, with Breakout Harness 18-046-01 connected to vehicle harness and DEFRLH disconnected, measure resistance between Breakout Harness 18-046-01 pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace DEFRLH. After repairs are complete, retest for SPN 4342 FMI 5. No: Repair short to GND between ACM connector pin J1-52 and DEFRLH connector pin-1. After repairs are complete, retest for SPN 4342 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 4342 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEF: SLH (Diesel Exhaust Fluid Suction Line Heater) Sensor

Overview of DEF: SLH Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
4344	3	DEFL3HC short to PWR	• DEF Suction L-HTR circuit short to power • Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR) • DEF Suction Line Heater (DEFSLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFSLH pin-2	Step-Based Diagnostics (page 451)
4344	5	DEFL3HC open load / circuit	• Failed Diesel Exhaust Fluid Suction Line Heater (DEFSLH) • DEF Suction L-HTR circuit Open or high resistance • DEF Suction L-HTR circuit short to GND • DEFSLH power circuit Open or high resistance • DEFSLH power circuit short to GND • Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)	Step-Based Diagnostics (page 456)

- Failed DEFLHR

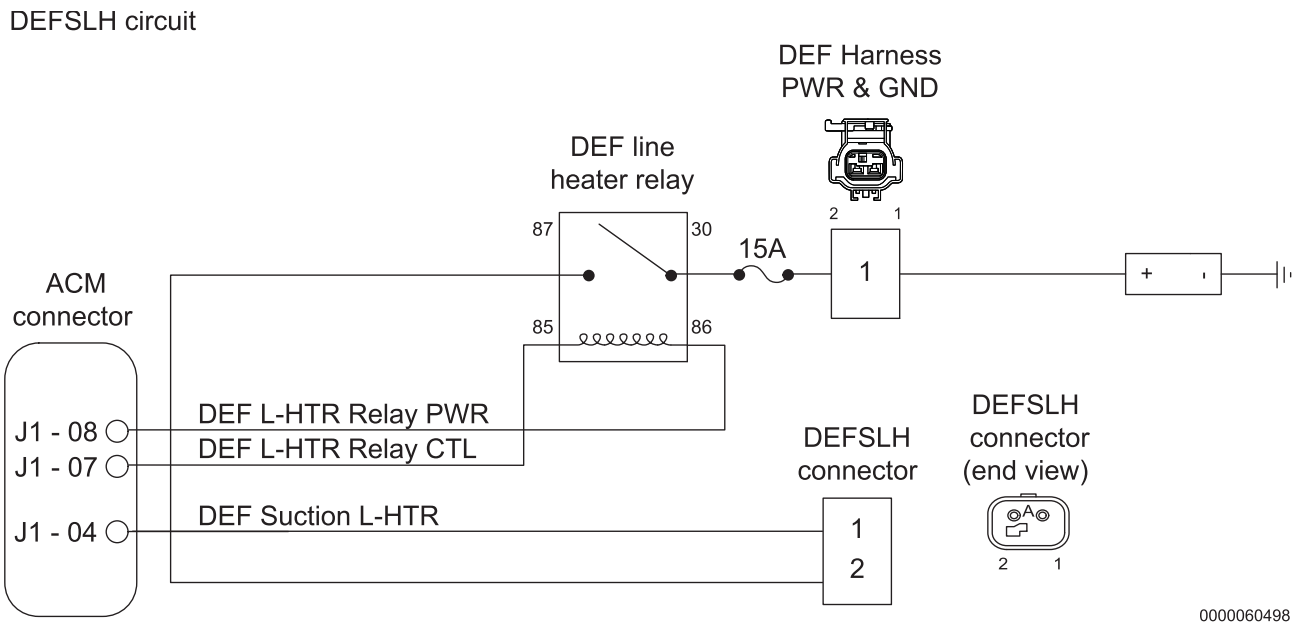

Figure 178 DEFSLH Circuit Diagram

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Suction Line Heater (DEFSLH) is used to maintain proper DEF temperature during cold conditions. The DEFSLH is wrapped around the suction line between DEF tank and the DEF supply module. When DEF temperature is too low, the Aftertreatment Control Module (ACM) turns on the DEF Line Heater Relay (DEFLHR) allowing power to be sent to the DEFSLH.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- Breakout Harness 18-045-01
- Breakout Harness ZTSE4908
- Digital Multimeter (DMM)
- Standard test light
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

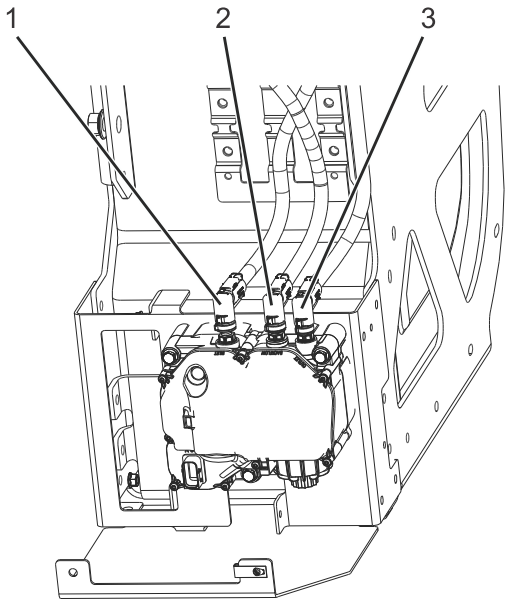

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Figure 179 DEF Supply Module Line Routing

1. DEF supply module suction line
2. DEF supply module return (backflow) line
3. DEF supply module pressure line

SPN 4344 FMI 3 - DEF: L3HC Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Suction Line Heater (DEFSLH) current is greater than expected.	DEFSLH current > 0.5 A	Key ON The DEF Line Heater Relay (DEFLHR) command OFF.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Suction Line Heater (DEFSLH) is greater than 0.5 amps. Engine torque will be reduced, and vehicle speed will be limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

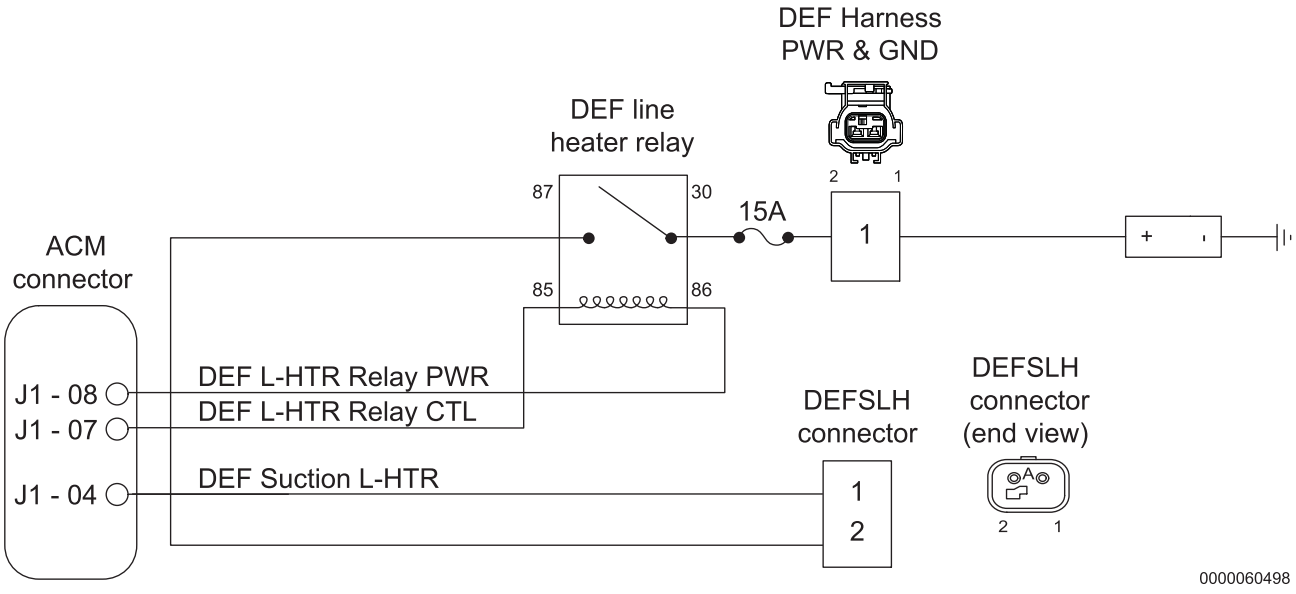
Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive Cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSLH circuit



Possible Causes

- DEF Suction L-HTR circuit short to power
- Failed Diesel Exhaust Fluid Line Heater Relay (DEFLHR)

- DEF Suction Line Heater (DEFSLH) PWR circuit shorted to PWR between DEFLHR pin-87 and DEFSLH pin-2

NOTE: DEFRLH, DEFPLH, and DEFSLH share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4344 FMI 3.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Suction Line Heater (DEFSLH). Key OFF, disconnect DEFSLH. Check DEFSLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFSLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4344 FMI 3.

Step	Action	Decision
3	Determine if DEF Suction L-HTR circuit is shorted to PWR. Connect Breakout Harness 18-045-01 to vehicle harness and leave DEFSLH disconnected. Key ON, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is Breakout Harness pin-1 voltage 0.5 volts or less?	Yes: Go to step 4. No: Repair short to PWR between Aftertreatment Control Module (ACM) pin J1-04 and DEFSLH connector pin-1. After repairs are complete, retest for SPN 4344 FMI 3.

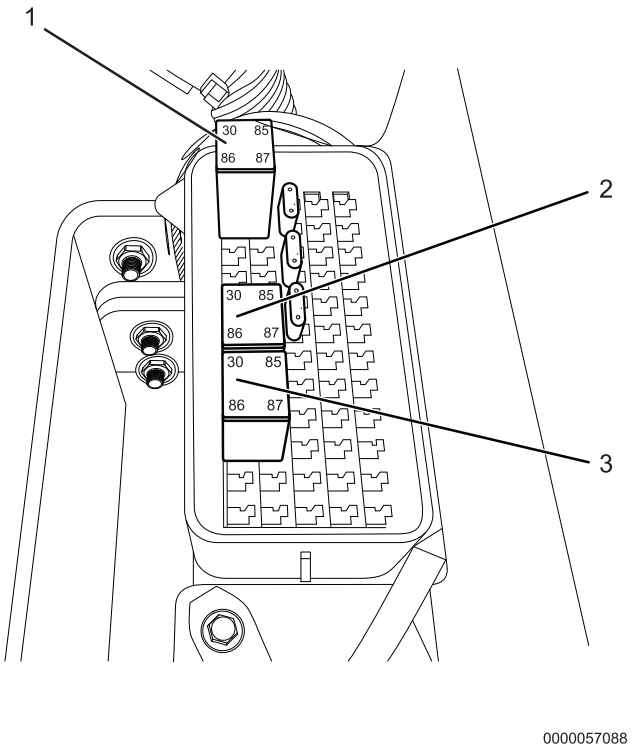


Figure 181 Power Distribution Module (PDM) Fuses and Relays

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

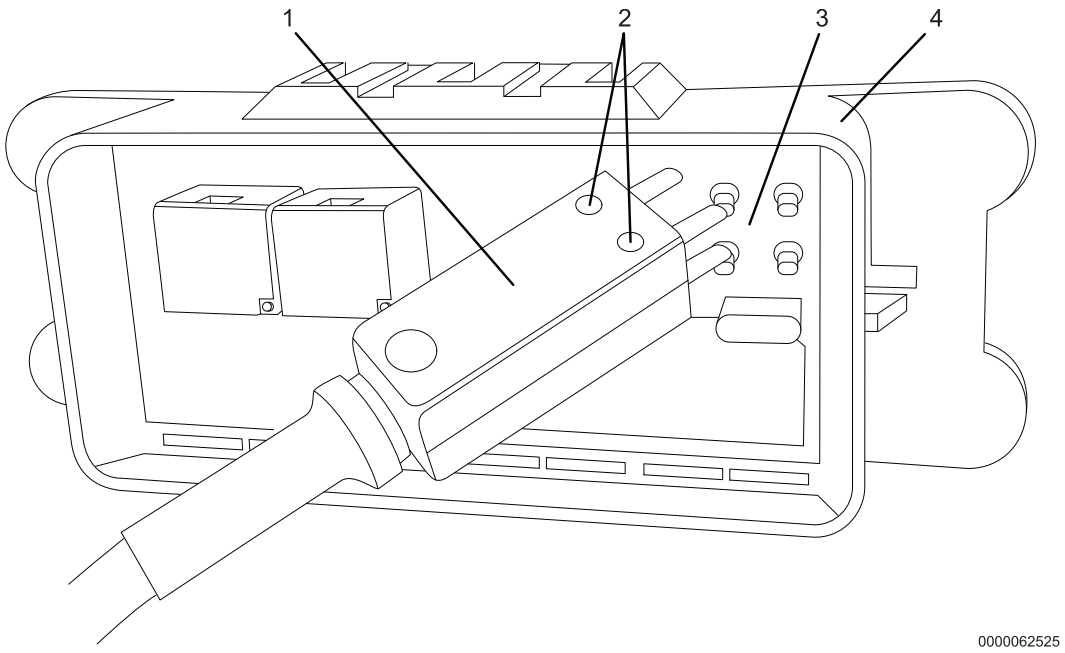


Figure 182 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Determine if DEF Line Heater Relay (DEFLHR) has failed. Key OFF, remove DEFLHR. Install Breakout Harness ZTSE4908, leaving DEFLHR disconnected. Key ON, measure voltage at Power Distribution Module (PDM) terminal 87 for the DEFLHR. Is PDM terminal 87 for DEFLHR voltage 0.5 volts or more?	Yes: Repair short to power between PDM terminal 87 for the DEFLHR and the DEFSLH connector pin-2. After repairs are complete, retest for SPN 4344 FMI 3.
		No: Replace the DEFLHR. After repairs are complete, retest for SPN 4344 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4344 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4344 FMI 5 - DEF: L3HC Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Suction Line Heater (DEFSLH) circuit Open. Current less than expected.	DEFSLH current < 0.3 A	Key ON The DEF Line Heater Relay (DEFLHR) command ON.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects current from the Diesel Exhaust Fluid Suction Line Heater (DEFSLH) is less than 0.3 amps. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5491 (DEFLHR)

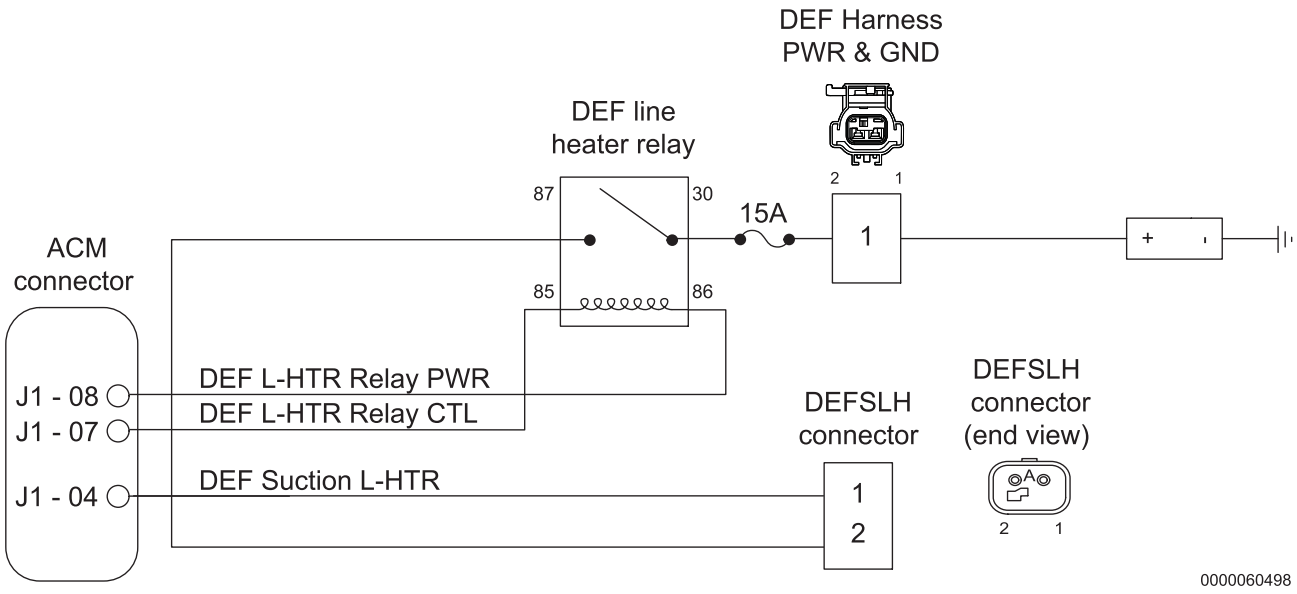
Fault Facts

Diesel Exhaust Fluid Return Line Heater (DEFRLH), DEF Pressure Line Heater (DEFPLH), and DEF Suction Line Heater (DEFSLH) share a common power circuit. If more than one DEF line heater fault is set, suspect a common power circuit problem.

Drive Cycle to Determine Fault Status

Drive cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSLH circuit



Possible Causes

- Failed Diesel Exhaust Fluid Suction Line Heater (DEFSLH)
- DEF Suction L-HTR circuit Open or high resistance
- DEF Suction L-HTR circuit short to GND
- DEFSLH power circuit Open or high resistance
- DEFSLH power circuit short to GND
- Blown fuse or Open power circuit to DEF Line Heater Relay (DEFLHR)
- Failed DEFLHR

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5491 (DEFLHR). Is EST DTC list free of SPN 5491?	Yes: Go to step 2. No: Repair SPN 5491. After repairs are complete, retest for SPN 4344 FMI 5.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Suction Line Heater (DEFSLH). Key OFF, disconnect DEFSLH. Check DEFSLH and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFSLH connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4344 FMI 5.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Determine if DEFSLH is receiving power. Connect Breakout Harness 18-045-01 to DEFSLH and leave DEFSLH disconnected. Using EST with ServiceMaxx software, select Tests > KOEO Aftertreatment Tests > DEF Line Heater Test. Run test and measure voltage between Breakout Harness pin-2 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 9. No: Go to step 4.

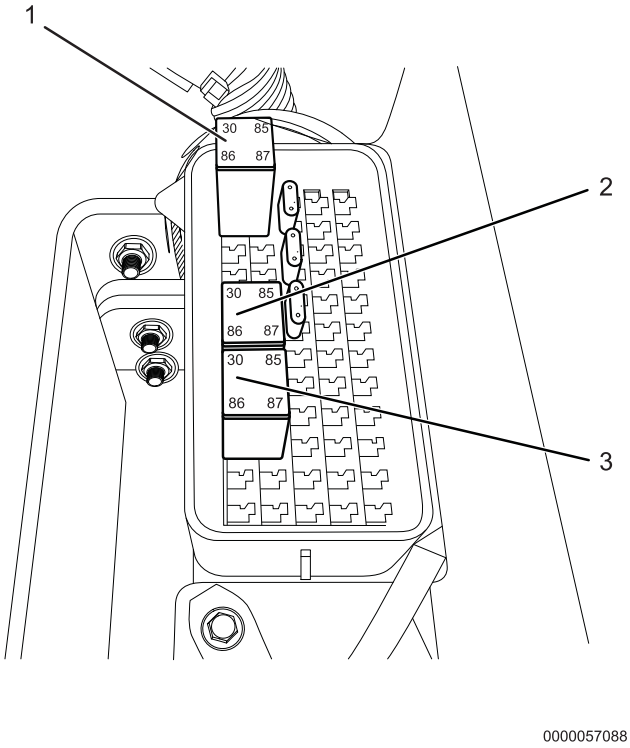


Figure 184 Power Distribution Module (PDM) Fuses and Relays

1. DEF Line Heater Relay
2. DEF Unit HTR Relay
3. Switched Ignition Relay

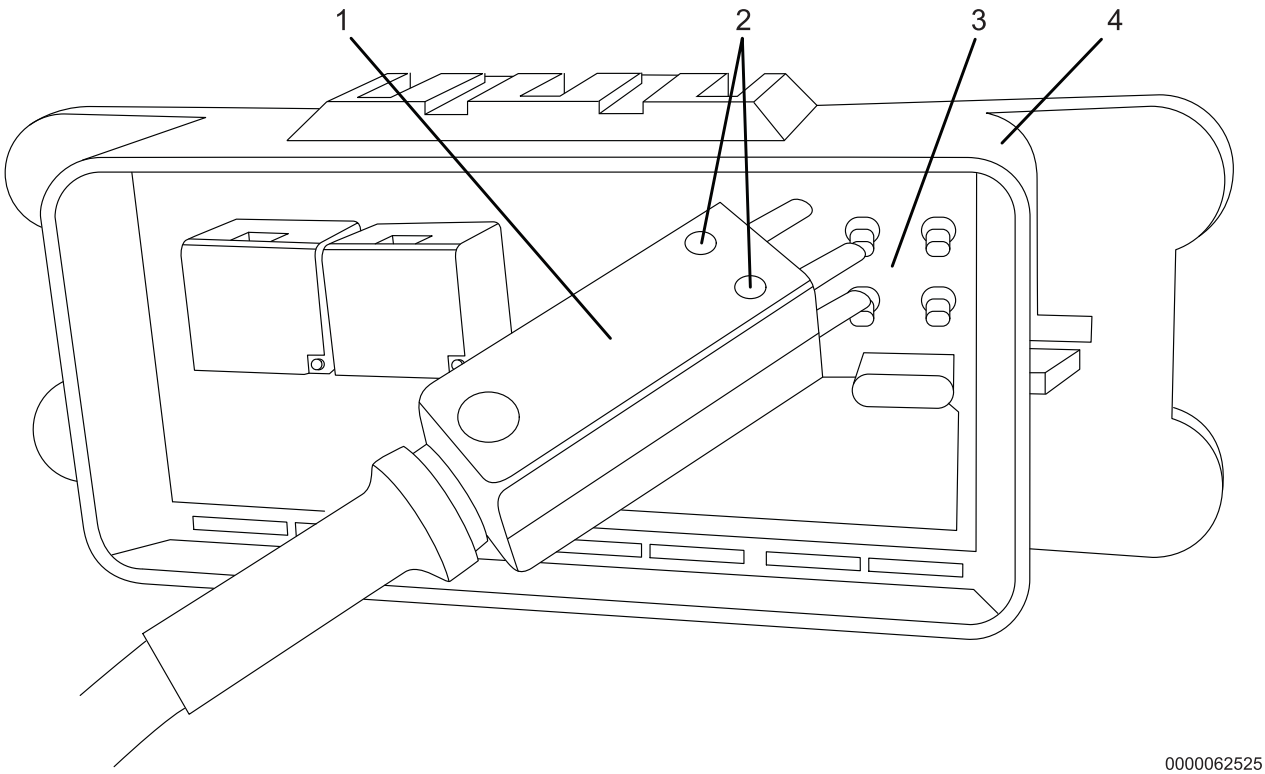


Figure 185 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Test DEFLHR PWR circuit and fuse. Remove DEFLHR. Install Breakout Harness ZTSE4908 to vehicle harness and leave DEFLHR disconnected. Connect test light between Breakout Harness pin-30 and a known good ground. Does test light illuminate and is the fuse in good condition and not blown?	Yes: Go to step 8. No: Go to step 5.

Step	Action	Decision
5	Check for PWR at DEFLHR 15 amp fuse. KOEO, using a DMM check for voltage between vehicle side of DEFLHR 15 amp fuse and a known good ground. Is voltage within 0.5 volts of battery voltage.	Yes: Got to step 6.
		No: Repair Open or high resistance between DEFLHR 15 amp fuse and vehicle PWR. After repairs are complete retest for SPN 4344 FMI 5.

Step	Action	Decision
6	With DEFSLH disconnected. Replace DEFLHR 15 amp fuse. Does the DEFLHR fuse blow immediately when replaced?	Yes: Repair short to GND between DEFLHR 15 amp fuse and DEFLHR pin-30. After repairs are complete, retest for SPN 4344 FMI 5.
		No: Go to step 7.

Step	Action	Decision
7	Check for short to GND between DEFLHR pin-87 and DEFSLH. Install DEFLHR. Using EST with ServiceMaxx™ software, select KOEO Aftertreatment Tests > DEF Line Heater Test. Run DEF Line Heater Test. Inspect to see if DEFLHR 15 amp fuse blows when DEF line heaters are actuated ON. Does the DEFLHR 15 amp fuse blow when DEF line heaters are actuated ON?	Yes: Repair short to GND between DEFLHR pin-87 and DEFSLH, DEF Pressure Line Heater (DEFPLH), or DEF Return Line Heater (DEFRLH). After repairs are complete, retest for SPN 4344 FMI 5.
		No: Repair Open or high resistance between DEFLHR pin-87 and DEFSLH, DEF Pressure Line Heater (DEFPLH), or DEF Return Line Heater (DEFRLH). After repairs are complete, retest for SPN 4344 FMI 5.

Step	Action	Decision
8	Check for Open or high resistance circuit between DEFSLH connector pin-2 and DEFLHR pin-87. Connect Breakout Harness 18-045-01 to vehicle harness and leave DEFSLH disconnected. Key OFF, with Breakout Harness ZTSE4908 connected to Power Distribution Module (PDM), measure resistance between Breakout Harness ZTSE4908 pin-87 and Breakout Harness 18-045-01 pin-2. Is resistance less than 5 ohms?	Yes: Replace the DEFLHR. After repairs are complete, retest for SPN 4344 FMI 5.
		No: Repair Open or high resistance between DEFSLH pin-2 and DEFLHR pin-87. After repairs are complete, retest for SPN 4344 FMI 5.

Step	Action	Decision
9	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 10. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4344 FMI 5.

Step	Action	Decision
10	Measure for Open or high resistance in DEF Suction L-HTR circuit. Connect 180-pin Breakout Box with Breakout Harness 18-537-01 to vehicle harness and leave ACM disconnected. Key OFF, with Breakout Harness 18-045-01 connected to vehicle harness and DEFSLH disconnected, measure resistance between Breakout Harness 18-537-01 pin J1-04 and Breakout Harness 18-045-01 pin-1. Is resistance less than 5 ohms?	Yes: Go to step 11. No: Repair Open or high resistance between ACM connector J1-04 and DEFSLH connector pin-1. After repairs are complete, retest for SPN 4344 FMI 5.

Step	Action	Decision
11	Measure for short to GND in DEF Suction L-HTR circuit with ACM disconnected. Key OFF, with Breakout Harness 18-045-01 to vehicle harness and DEFSLH disconnected. Measure resistance between Breakout Harness 18-045-01 pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace DEFSLH. After repairs are complete, retest for SPN 4344 FMI 5. No: Repair short to GND between ACM connector J1-04 and DEFSLH connector pin-1. After repairs are complete, retest for SPN 4344 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 4344 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEF: SM (Diesel Exhaust Fluid Supply Module) Sensor

Overview of DEF: SM Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
4337	2	DEF Supply Module Temperature erratic, intermittent, or incorrect	• DEFSP Temp / CTL circuit intermittent short to GND • DEFSP Temp / CTL circuit intermittent short to PWR • DEFSP Temp / CTL circuit intermittent Open or high resistance • Failed DEF Supply Module	Step-Based Diagnostics (page 465)
4337	10	DEF Supply Module Temperature abnormal rate of change	• DEFSP Temp / CTL circuit intermittent short to GND • DEFSP Temp / CTL circuit intermittent short to PWR • DEFSP Temp / CTL circuit intermittent Open or high resistance • Failed DEF Supply Module	Step-Based Diagnostics (page 469)
4376	3	DEF Return Valve short to PWR (Open or high resistance)	• High resistance or open in DEFRV GND circuit • High resistance or open in DEFRV CTL circuit • Short to PWR in DEFRV CTL circuit • Failed DEFRV	Step-Based Diagnostics(page 472)

4376	4	DEF Return Valve short to GND	• Short to GND in DEFRV CTL circuit • DEFRV GND shorted to DEFRV CTL • Failed DEFRV	Step-Based Diagnostics(page 475)
4376	7	DEF Return Valve - Mechanical system not responding or out of adjustment	• Blocked DEF lines or fittings, or incorrect connections • Failed DEFRV • Restriction in DEF tank	Step-Based Diagnostics(page 477)

DEFRV circuit

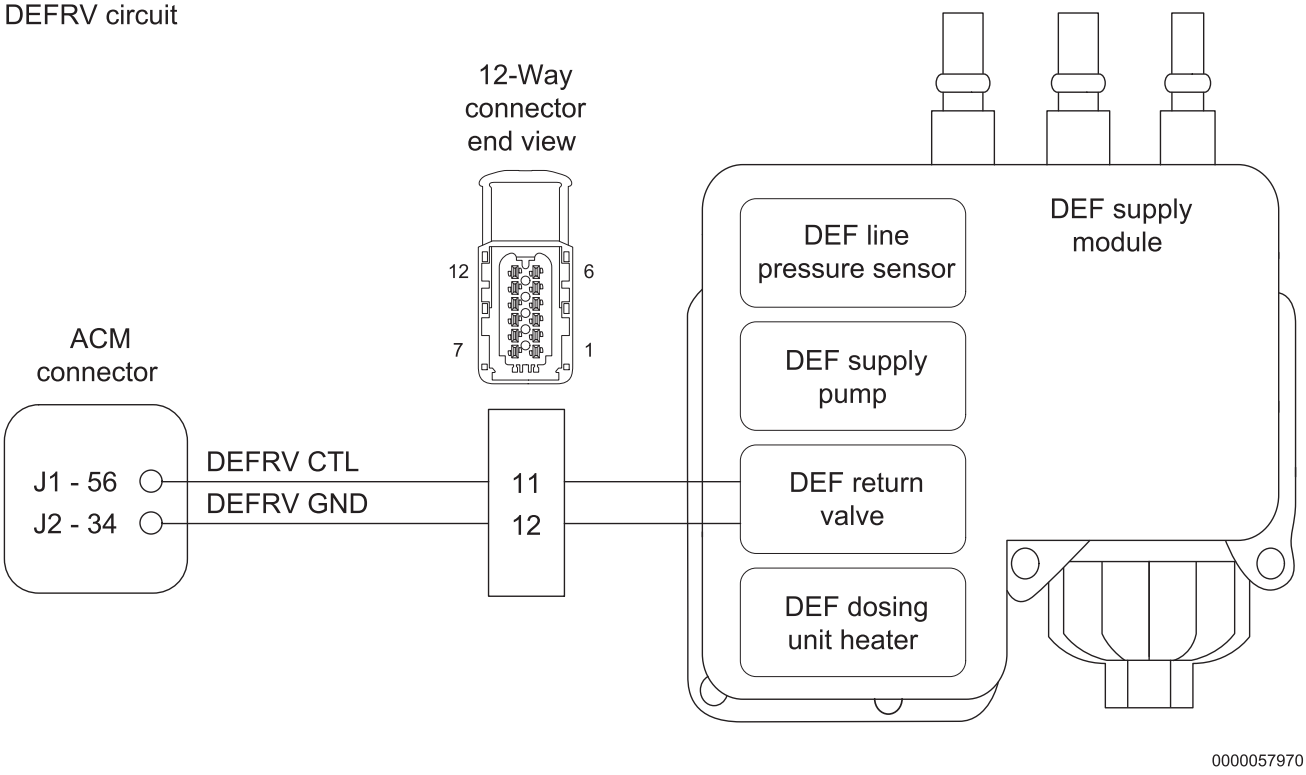


Figure 186 DEFRV Circuit Diagram

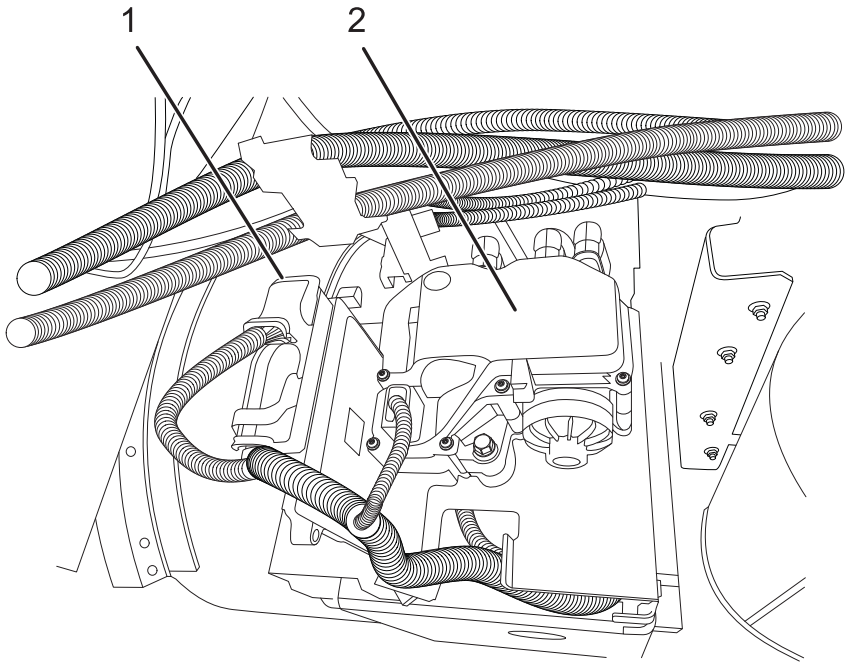
NOTE: See latest version of N13 with SCR (EPA 10) with HD-OBD Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid return Valve (DEFRV) controls DEF flow through the DEF supply module. When the DEFRV is energized DEF is returned to the DEF tank through the DEF return line. The DEFRV is not serviceable individually and is part of the DEF supply module.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- Breakout Harness 18-909-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000054368

Figure 187 DEF supply module location

1. Aftertreatment Control Module (ACM)
2. DEF supply module

SPN 4337 FMI 2 - Diesel Exhaust Fluid Dosing Unit Temperature – Data Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) supply module temperature is in range but not rational	Difference between DEF supply module temperature at Key ON and Inlet Air Temperature (IAT) at Key ON > 72°F (40°C) Difference between DEF supply module temperature at Key ON and coolant temperature at Key ON > 72°F (40°C)	Engine is cold soaked 10 hours Inactive: SPN 3361 FMI 2 (DEF supply pump) Block heater not detected Valid DEF supply module temperature value is available Valid DEF Dosing Unit Heater (DEFDUH) temperature value is available Diagnostic has not previously completed during this key cycle	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid (DEF) supply module temperature differs from the engine coolant temperature and the inlet air temperature (IAT) by more than 72°F (40°C) at Key ON.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 2, 3, 4 (ECT1); SPN 172 FMI 2, 3, 4 (IAT); SPN 3361 FMI 2, 3, 4, 31 (DEF Supply Pump); SPN 4076 FMI 2, 3, 4 (ECT2).

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

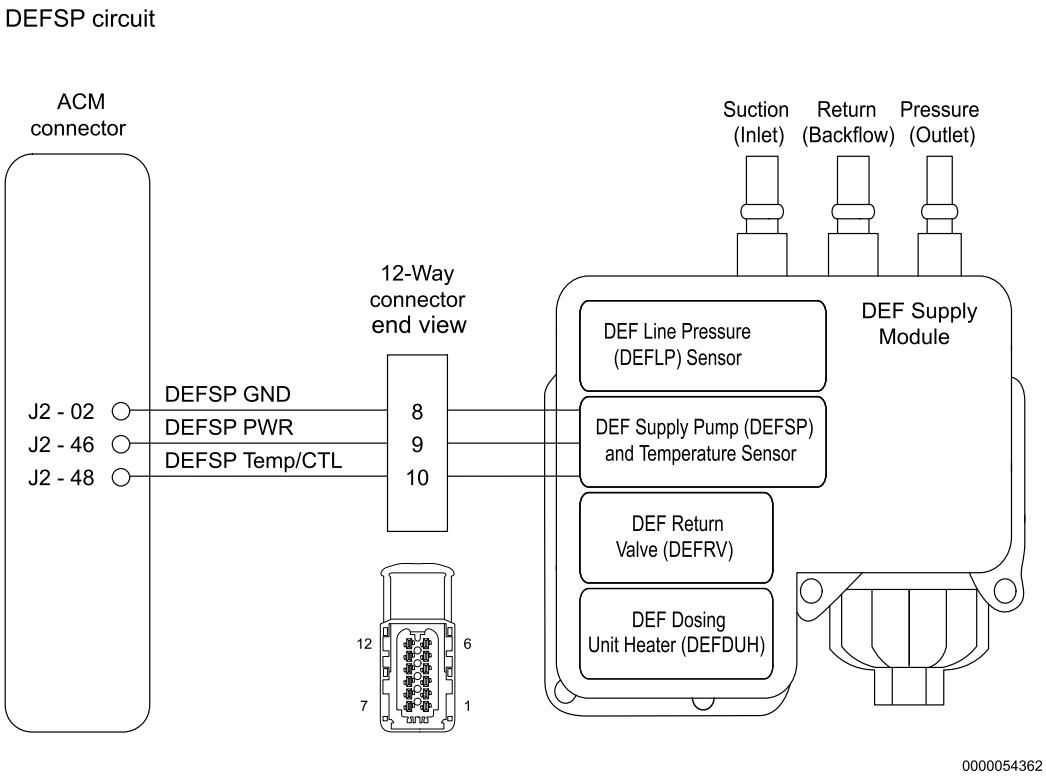


Figure 188 DEF (Diesel Exhaust Fluid) Supply Pump Circuit Diagram

Possible Causes

- DEFSP Temp / CTL circuit intermittent short to GND
- DEFSP Temp / CTL circuit intermittent short to PWR
- DEFSP Temp / CTL circuit intermittent Open or high resistance
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 2, 3, 4 (ECT1); SPN 172 FMI 2, 3, 4 (IAT); SPN 3361 FMI 2, 3, 4, 31 (DEF Supply Pump); SPN 4076 FMI 2, 3, 4 (ECT2). Is EST DTC list free of SPN 110 FMI 2, 3, 4; SPN 172 FMI 2, 3, 4; SPN 3361 FMI 2, 3, 4, 31; SPN 4076 FMI 2, 3, 4?	Yes: Go to step 2. No: Repair SPN 110 FMI 2, 3, 4; SPN 172 FMI 2, 3, 4; SPN 3361 FMI 2, 3, 4, 31; SPN 4076 FMI 2, 3, 4. After repairs are complete, retest for SPN 4337 FMI 2.

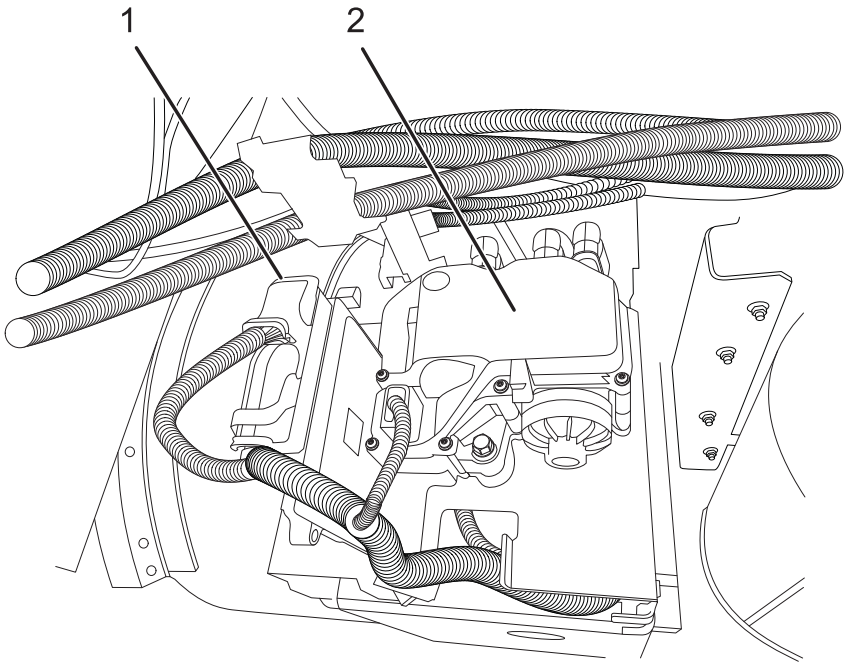


Figure 189 DEF Supply Module Location (typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module

Step	Action	Decision
2	Inspect connections at DEF supply module. Key OFF, disconnect DEF supply module connectors. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4337 FMI 2.

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4337 FMI 2.

Step	Action	Decision
4	Check for intermittent short to GND in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key OFF, with ACM disconnected, use a DMM to measure resistance between Breakout Harness pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair intermittent short to GND between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 2.

Step	Action	Decision
5	Check for intermittent short to PWR in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key-On Engine-Off (KOEO), with ACM disconnected, use a DMM to measure voltage between Breakout Harness pin-10 and a known good ground. Is voltage less than 1 volt?	Yes: Go to step 6. No: Repair intermittent short to PWR between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 2.

Step	Action	Decision
6	Check for intermittent Open or high resistance in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-537-01 to ACM harness, and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-10 and Breakout Box pin J2-48. Is resistance less than 5 ohms?	Yes: Replace the DEF supply module. After repairs are complete, retest for SPN 4337 FMI 2. No: Repair intermittent Open or high resistance between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4337 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4337 FMI 10 - Diesel Exhaust Fluid Dosing Unit Temperature – Abnormal Rate of Change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) supply module temperature is in range but not rational (not heating)	Difference between maximum and minimum DEF supply module temperature is < 9°F (5°C) within 10 minutes.	Inactive: SPN 3361 FMI 2 (DEFSP Signal); SPN 4337 FMI 2 (DEFSP Temp); SPN 5746 FMI 3, 4 (DEFUHR) Valid DEF supply module temperature value is available Valid DEF Dosing Unit Heater (DEFDUH) temperature value is available Initial DEF supply module heater temperature at Key ON < 25°F (-4°C) DEF supply module heater is active Diagnostic has not previously completed during this key cycle Key-On Engine-Running (KOER)	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid (DEF) supply module is not heating properly.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 171 FMI 2, 3, 4 (AAT); SPN 3361 FMI 2 (DEFSP Signal); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 (DEFDUH); SPN 5746 (DEFUHR); SPN 5798 (DEFDUH Temperature)

Drive Cycle to Determine Fault Status

Drive Cycle 28 in 2013 HD-OBD Diagnostic Reference Manual.

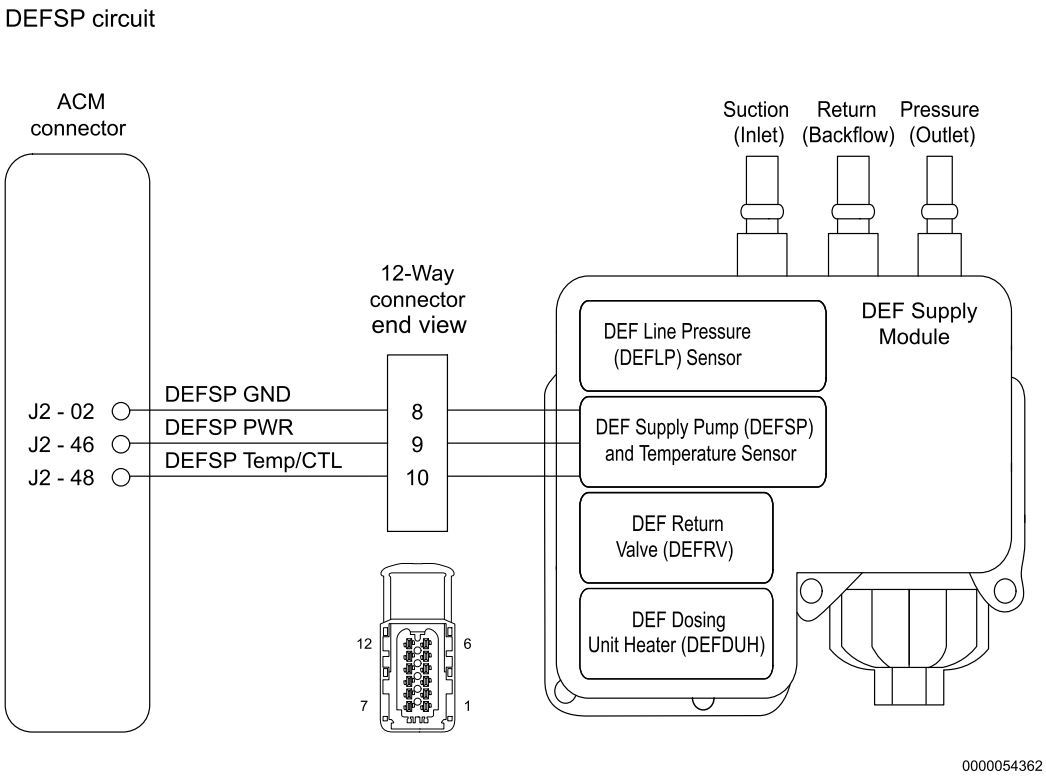


Figure 190 DEF (Diesel Exhaust Fluid) Supply Pump Circuit Diagram

Possible Causes

- DEFSP Temp / CTL circuit intermittent short to GND
- DEFSP Temp / CTL circuit intermittent short to PWR
- DEFSP Temp / CTL circuit intermittent Open or high resistance
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 171 FMI 2, 3, 4 (AAT); SPN 3361 FMI 2 (DEFSP Signal); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 (DEFDUH); SPN 5746 (DEFUHR); SPN 5798 (DEFDUH Temp). Is EST DTC list free of SPN 171 FMI 2, 3, 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745; SPN 5746; SPN 5798?	Yes: Go to step 2. No: Repair SPN 171 FMI 2, 3, 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745; SPN 5746; SPN 5798. After repairs are complete, retest for SPN 4337 FMI 10.

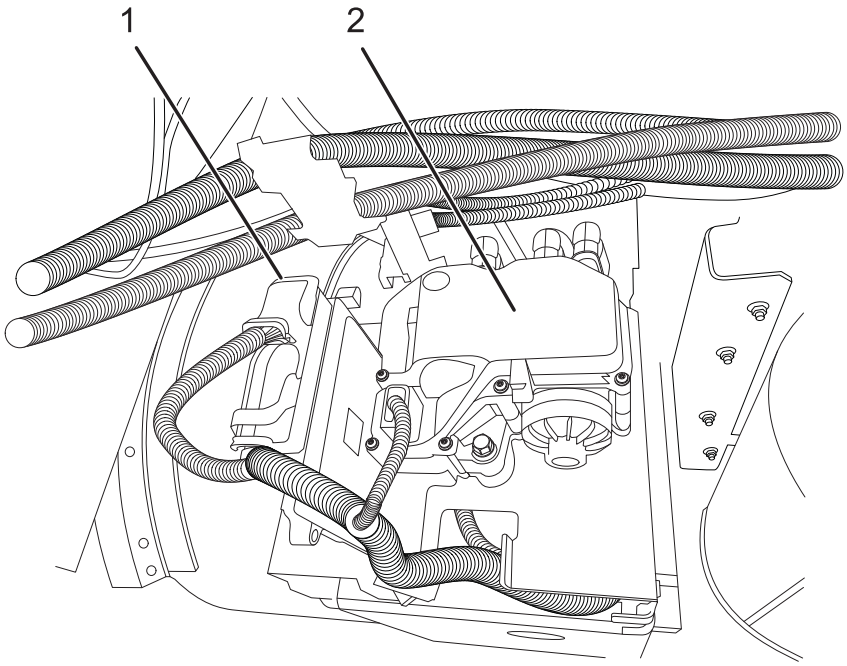


Figure 191 DEF Supply Module Location (typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module

Step	Action	Decision
2	Inspect connections at DEF supply module. Key OFF, disconnect DEF supply module connectors. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4337 FMI 10.

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4337 FMI 10.

Step	Action	Decision
4	Check for intermittent short to GND in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key OFF, with ACM disconnected, use a DMM to measure resistance between Breakout Harness pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair intermittent short to GND between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 10.

Step	Action	Decision
5	Check for intermittent short to PWR in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key-On Engine-Off (KOEO), with ACM disconnected, use a DMM to measure voltage between Breakout Harness pin-10 and a known good ground. Is voltage less than 1 volt?	Yes: Go to step 6. No: Repair intermittent short to PWR between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 10.

Step	Action	Decision
6	Check for Open or high resistance in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-537-01 to ACM harness and leave ACM disconnected. Key OFF, use a DMM measure resistance between Breakout Harness pin-10 and Breakout Box pin J2-48. Is resistance less than 5 ohms?	Yes: Replace the DEF Supply module. After repairs are complete, retest for SPN 4337 FMI 10. No: Repair Open or high resistance between DEFSP pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 4337 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 4337 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4376 FMI 3 - DEF Return Valve Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Return Valve (DEFRV) voltage above normal, shorted to high source, or Open. High signal voltage detected.	The resistance between the DEFRV CTL circuit and ground > 500,000 Ohms	Key ON DEFRV commanded ON	2 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Diesel Exhaust Fluid Return Valve (DEFRV) voltage is more than expected for 1 second. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Fact

The Diesel Exhaust Fluid Return Valve (DEFRV) is internal to the DEF supply module and is not serviceable individually. If fault is active, the dosing system may not be able to purge, and DEF may be left in the lines. DEF remaining in the lines can freeze and cause the Selective Catalytic Reduction (SCR) system to become damaged in cold weather.

DEFRV circuit

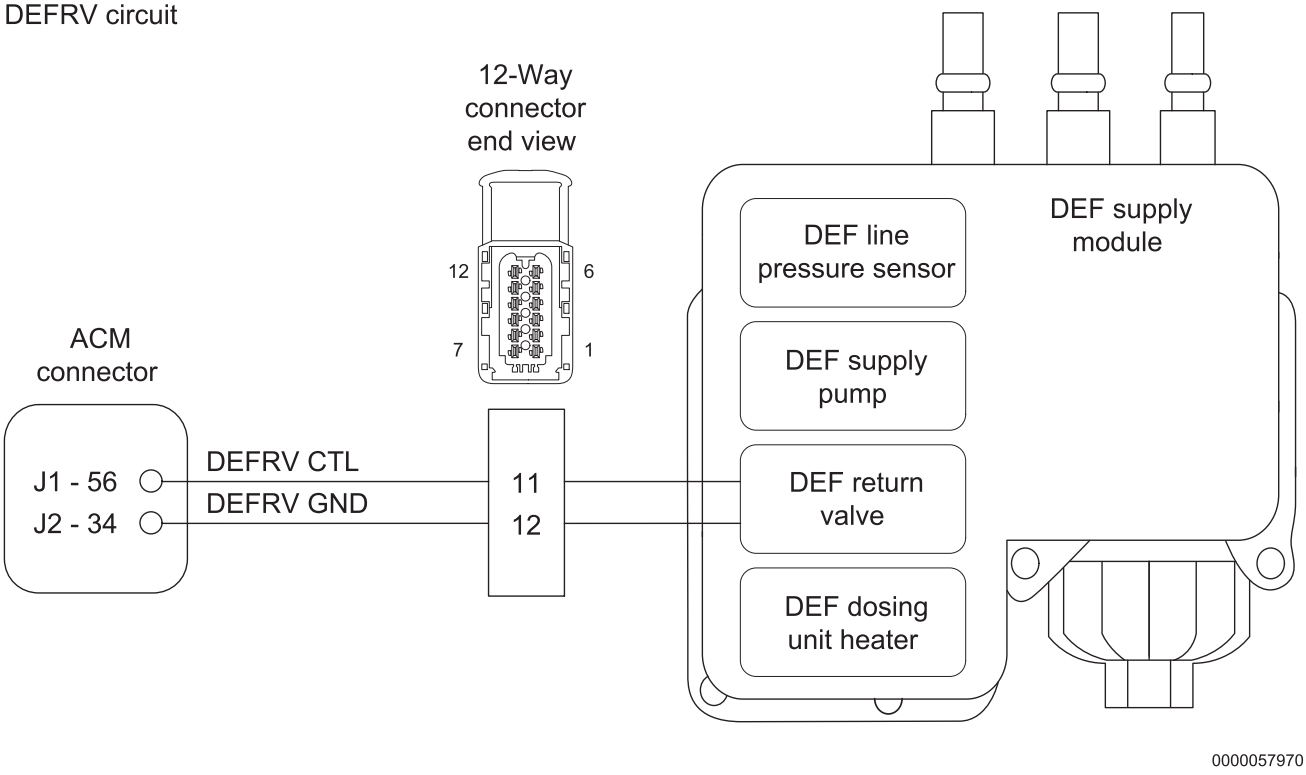


Figure 192 DEFRV Circuit Diagram

Possible Causes

- High resistance or Open in DEFRV CTL circuit
- High resistance or Open in DEFRV GND circuit
- Short to PWR in DEFRV CTL circuit
- Failed DEFRV

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4376 FMI 3.

Step	Action	Decision
2	Check for failed Diesel Exhaust Fluid Return Valve (DEFRV). Key OFF, connect Breakout Harness 18-909-01 to DEF supply module, and leave vehicle harness disconnected. Measure resistance between DEFRV CTL pin-11 and DEFRV GND pin-12. Is resistance between 5 and 10 ohms?	Yes: Go to step 3. No: Replace DEF supply module. After repairs are complete, retest for SPN 4376 FMI 3.

Step	Action	Decision
3	Check DEFRV CTL for short to PWR. Connect Breakout Harness 18-909-01 between DEF supply module and vehicle harness. Key-On Engine-Off (KOEO) measure voltage between DEFRV CTL pin-11 and a known good ground. Is voltage less than 0.5 volts?	Yes: Go to step 4. No: Repair short to power in DEFRV CTL circuit. After repairs are complete, retest for SPN 4376 FMI 3.

Step	Action	Decision
4	Inspect connections at Aftertreatment control module (ACM). Key OFF, disconnect ACM connector. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4376 FMI 3.

Step	Action	Decision
5	Check DEFRV CTL circuit for high resistance or Open. Connect 180-pin Breakout Box with Breakout Harness 18-537-01 to ACM vehicle harness, and leave ACM disconnected. Disconnect Breakout Harness 18-909-01 from DEF supply module, and leave connected to vehicle harness. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-12 and 180-pin Breakout Box pin J2-34. Is resistance less than 5 ohms?	Yes: Repair Open or high resistance in DEFRV CTL circuit between ACM J1-56 and supply module pin-11. After repairs are complete, retest for SPN 4376 FMI 3. No: Repair Open or high resistance in DEFRV GND circuit between ACM J2-34 and supply module pin-12. After repairs are complete, retest for SPN 4376 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4376 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4376 FMI 4 - DEF Return Valve Short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Return Valve (DEFRV) - Voltage below normal, or shorted to low source. Low signal voltage detected.	Resistance between DEFRV CTL and GND < 0.2 ohms	Key ON DEFRV commanded ON	2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects Diesel Exhaust Fluid Return Valve (DEFRV) voltage is less than expected value for 1 second. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Fact

The DEFRV is internal to the DEF supply module and is not serviceable individually. If fault is active, the dosing system may not be able to purge and DEF may be left in the lines. DEF lines can freeze and cause the Selective Catalytic Reduction (SCR) system to become damaged in cold weather.

DEFRV circuit

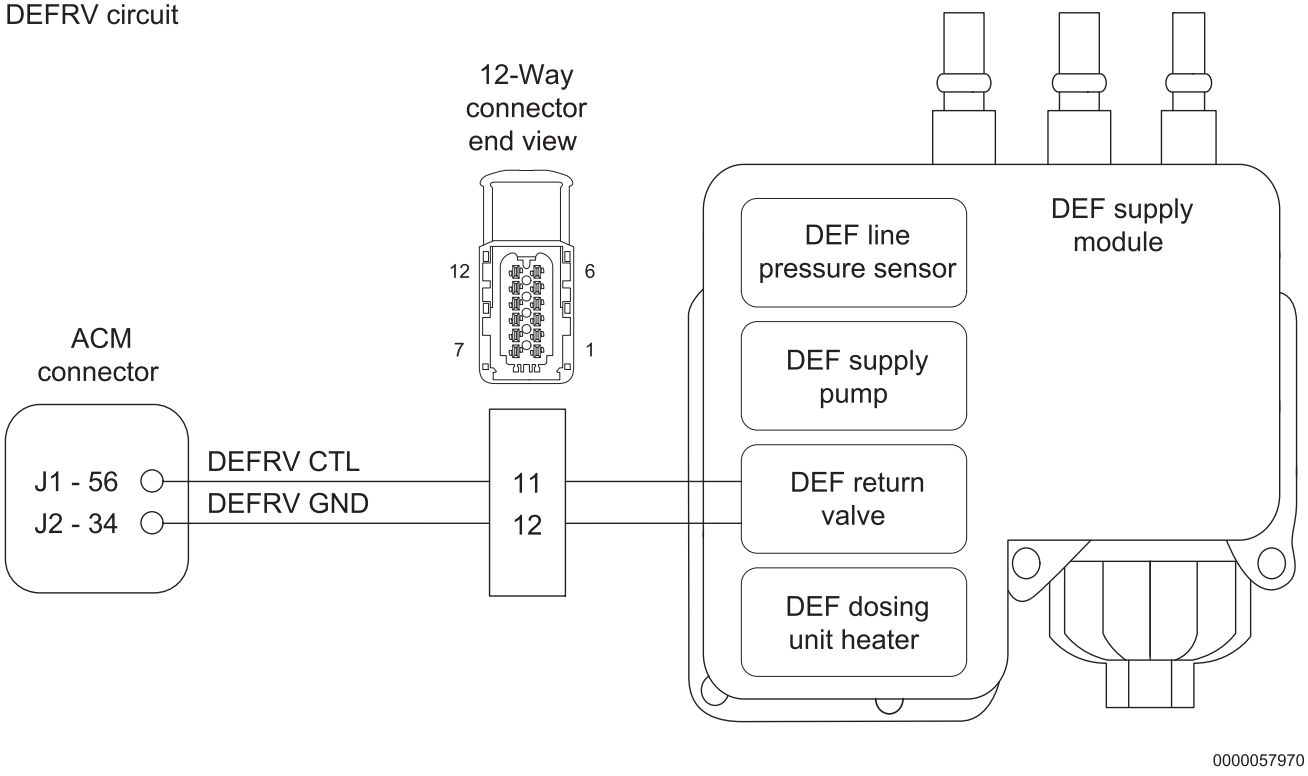


Figure 193 DEFRV Circuit Diagram

Possible Causes

- Short to GND in DEFRV CTL circuit
- DEFRV CTL shorted to DEFRV GND
- Failed DEFRV

Step	Action	Decision
1	Check for failed Diesel Exhaust Fluid Return Valve (DEFRV). Connect Breakout Harness 18-909-01 to DEF supply module, and leave vehicle harness disconnected. Measure resistance between DEFRV CTL pin-11 and DEFRV GND pin-12. Is resistance greater than 5 ohms?	Yes: Go to step 2. No: Replace DEF supply module. After repairs are complete, retest for SPN 4376 FMI 4.

Step	Action	Decision
2	Check for short between DEFRV CTL and DEFRV GND circuits. Connect Breakout Harness 18-909-01 and leave DEF supply module disconnected. Key OFF, measure resistance between Breakout Harness pin-11 and pin-12. Is resistance greater than 1000 ohms?	Yes: Repair short to GND between DEFRV pin-11 and ACM pin J1-56. After repairs are complete, retest for SPN 4376 FMI 4.
		No: Repair short between DEFRV CTL and DEFRV GND circuits. After repairs are complete, retest for SPN 4376 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4376 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4376 FMI 7 - DEF Return Valve - Mechanical System Not Responding or Out of Adjustment

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The DEFRV is commanded open, but the DEF doser pressure does not drop as expected.	The DEF supply module pressure after the return valve is opened for 5 seconds > 72.5 psi (500 kPa)	Key ON Inactive: SPN 3361 FMI 3, 4 (DEFSP); SPN 4334 FMI 2, 3, 4 (DEFLP); SPN 4376 FMI 3, 4 (DEFRV) DEF supply pump command ≥ 5 % (pump ON) DEF supply module pressure sampled when the return valve was opened > 101.5 psi (700 kPa) DEFRV commanded ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Diesel Exhaust Fluid Return Valve (DEFRV) is commanded open, but the DEF doser pressure does not drop as expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4334 FMI 2, 3, 4, 16, and 18 (DEFLP); and SPN 4376 FMI 3 and 4 (DEFRV)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Fact

The DEFRV is internal to the DEF supply module and is not serviceable individually. If fault is active, the dosing system may not be able to purge, and DEF may be left in the lines. DEF lines can freeze and cause the Selective Catalytic Reduction (SCR) system to become damaged in cold weather.

DEFRV circuit

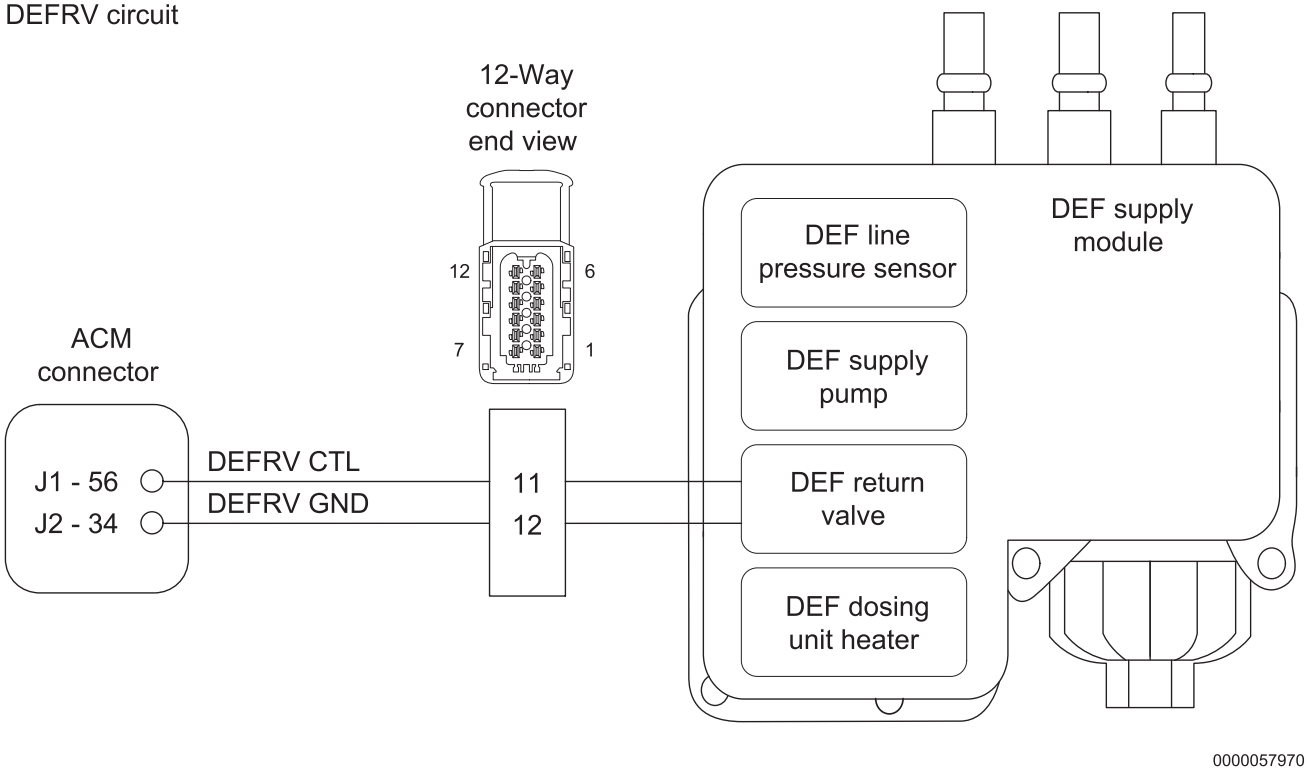


Figure 194 DEFRV Circuit Diagram

Possible Causes

- Restricted DEF return line or fittings, or incorrect connections
- Restriction in DEF tank
- Failed DEFRV

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check for SPN 4334 FMI 2, 3, 4, 16, and 18 (DEFLP); and SPN 4376 FMI 3 and 4 (DEFRV). Is EST DTC list free of SPN 4334 FMI 2, 3, 4, 16, and 18; and SPN 4376 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 4334 FMI 2, 3, 4, 16, and 18; and SPN 4376 FMI 3 and 4. After repairs are complete, retest for SPN 4376 FMI 7.

Step	Action	Decision
2	Check DEF supply module return line for restrictions. Disconnect both ends of return line and blow compressed air through the line. Does compressed air flow freely through the return line?	Yes: Go to step 3. No: Clean or replace DEF supply module return line. After repairs are complete, retest for SPN 4376 FMI 7.

Step	Action	Decision
3	Check Diesel Exhaust Fluid (DEF) tank for debris, foreign particles, or ice. Also check DEF tank vent for restrictions or fluid crystallization. Are the DEF tank and DEF tank vent clean and free of debris, restrictions, and fluid crystallization?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 4376 FMI 7. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. Clean DEF supply module using 18-200-01. After repairs are complete, retest for SPN 4376 FMI 7.

NOTE: After performing all diagnostic steps, if SPN 4376 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEF: SMH (Diesel Exhaust Fluid Supply Module Heater) Sensor

Overview of DEF: SMH Sensor Group

SPN	FMI	Description
5745	3	DEF Supply Module Heater Out of Range HIGH (page 482)
5745	4	DEF Supply Module Heater Out of Range LOW (page 489)
5745	18	DEF Supply Module Heater below Warning Temperature (page 506)
5746	3	DEF Supply Module Heater Relay short to PWR (Open or High Resistance) (page 510)
5746	4	DEF Supply Module Heater Relay short to GND (page 514)
5798	2	DEF Supply Module Heater Temperature erratic, intermittent or incorrect (page 517)
5798	10	DEF Supply Module Heater Temperature abnormal rate of change (page 521)

Overview

The Diesel Exhaust Fluid Dosing Unit Heater (DEF: SMH) is controlled by the Aftertreatment Control Module (ACM). When the ACM commands DEF: SMH On, it heats the DEF supply module to prevent freezing. Diagnostics are run when the DEF Unit HTR Relay (DEF: SMH) is Off. DEF: SMH is not serviceable individually, and is part of the DEF supply module.

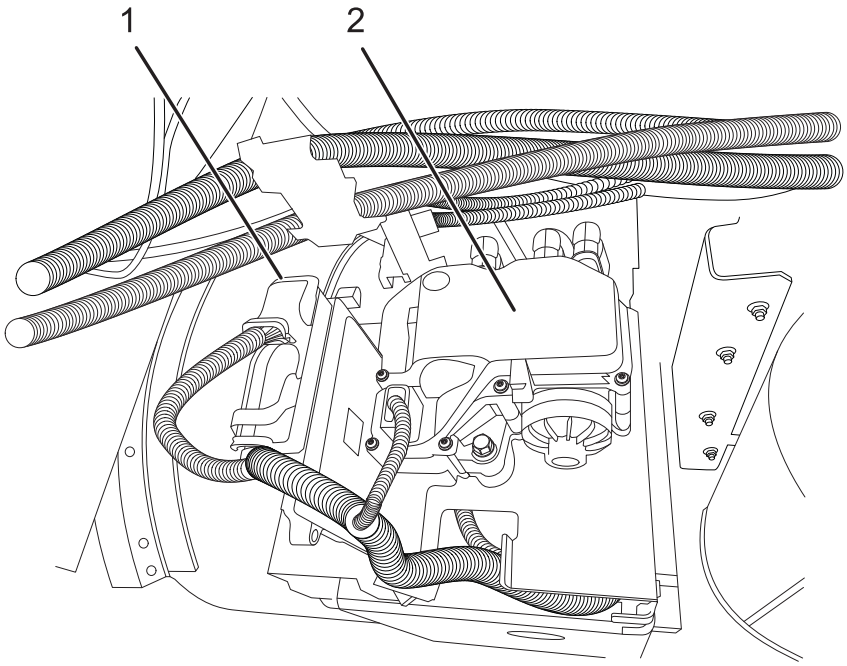


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Figure 195 DEF Supply Module Location

1. Aftertreatment Control Module (ACM)
2. DEF supply module

SPN 5745 FMI 3 - DEF Dosing Unit Heater Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Exhaust Fluid (DEF) supply module temperature too high when heater is off.	DEF supply module temperature rises > 54°F (12°C) within a predetermined time	DEFSMH Relay command is OFF Initial DEFSMH temperature at Key ON ≤ 104°F (40°C) Inactive: SPN 3361 FMI 2 (DEFSP); SPN 5746 FMI 3, 4 (DEFSMH Relay); SPN 5798 FMI 2 (DEFSMH Temp)

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects Diesel Exhaust Fluid Supply Module Heater (DEFSMH) is active when not commanded ON. DEF injection into aftertreatment system will be disabled, and engine torque will be reduced if engine is operated for an extended period of time with this fault code active.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected.

Associated Faults

SPN 3361 (DEFSP); SPN 5746 FMI 3, 4 (DEFSMH); and SPN 5798 FMI 2 (DEFSP Temp)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- DEFSMH power circuit short to PWR
- Failed DEFSMH Relay
- Failed DEF supply module

Step 1	Check for active faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5745 FMI 4. Is SPN 5745 FMI 4 an active fault?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure .

Step 2	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3361 (DEFSP); SPN 5746 FMI 3, 4 (DEFSMH Relay); and SPN 5798 FMI 2 (DEFSP Temp). Is EST DTC list free of SPN 3361; 5746 FMI 3 and 4; and SPN 5798 FMI 2?		Yes: Go to Step 3. No: Repair SPN 3361; SPN 5746 FMI 3 and 4; and SPN 5798 FMI 2. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 3.

Step 3	Inspect connections at DEF supply module connector.	Decision
A. Key OFF. B. Disconnect DEF supply module connector. C. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DEF supply module connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests . No: Repair connector, harness, or terminal damage. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 3.

Pin-Point Tests (SPN 5745 FMI 3)

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4908
- Digital Multimeter (DMM)

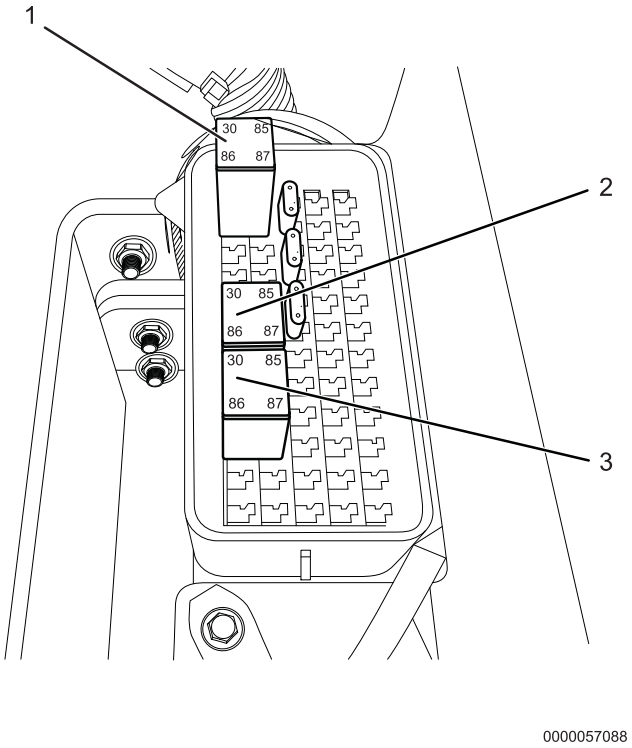

Figure 196 Power Distribution Module (PDM) Fuses and Relays (typical)

1. DEF line heater relay
2. DEFSMH Relay
3. Switched ignition relay

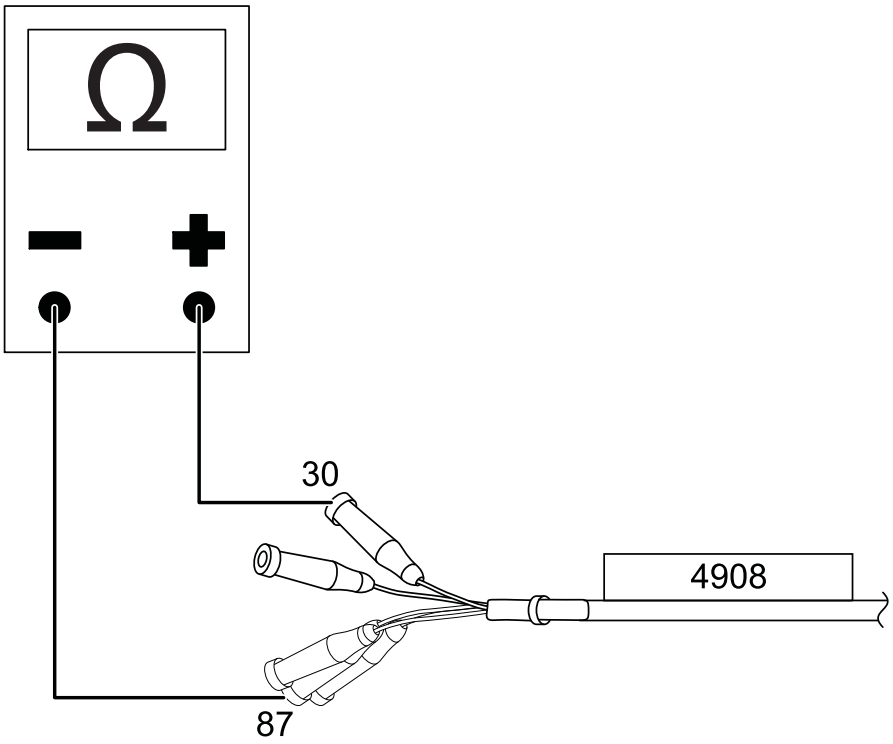

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Figure 197 Test 1 DEFSMH Relay Resistance Check

Test 1 Setup
A. Key OFF. B. Remove DEFSMH Relay. C. Install DEFSMH Relay into Breakout Harness ZTSE4098.

Test 1	Specification
Use DMM to measure resistance between Breakout Harness ZTSE4908 pin-30 and pin-87.	Greater than 10,000 ohms
Decision	
Is resistance greater than 10,000 ohms?	Yes: Go to Test 2.
	No: Replace DEFSMH Relay. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 3.

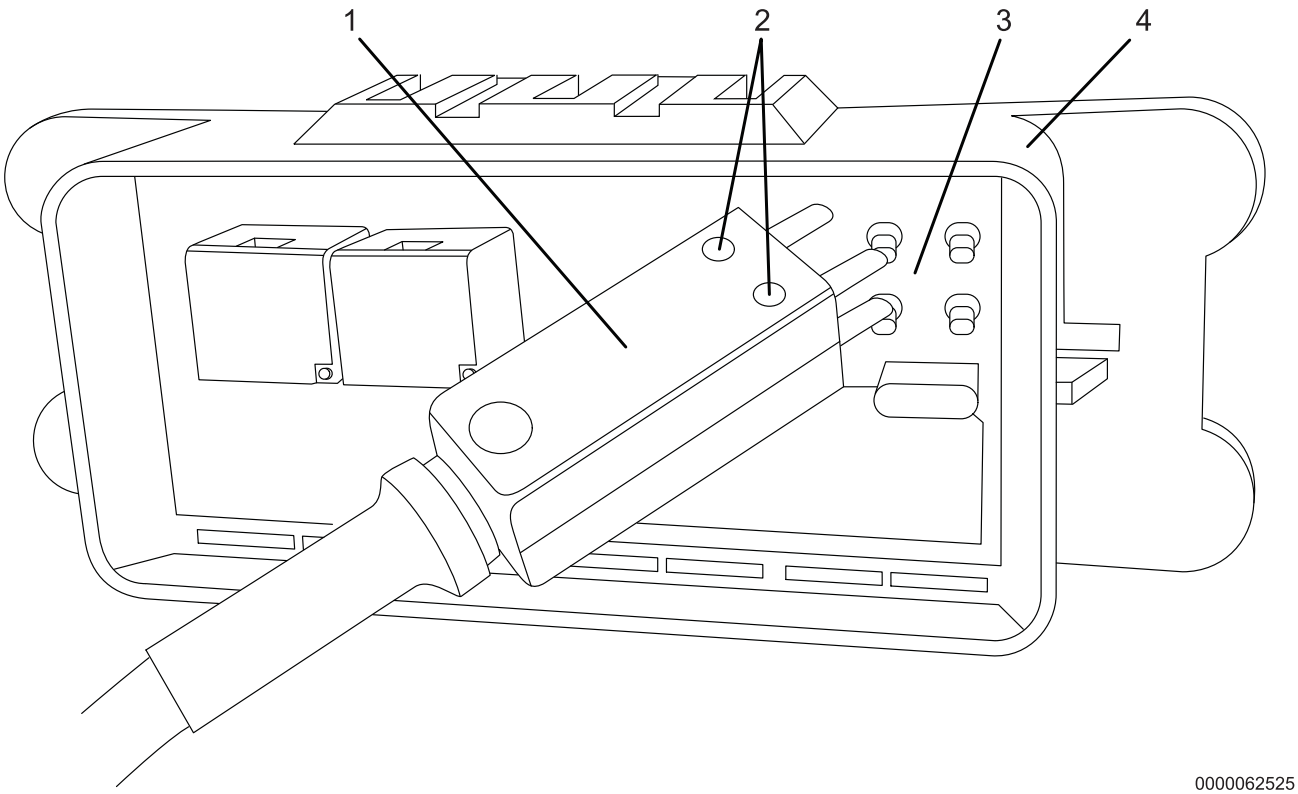

Figure 198 Installation of Breakout Harness ZTSE4908

1. Breakout Harness ZTSE4908
2. Installation dimples
3. Relay socket
4. PDM

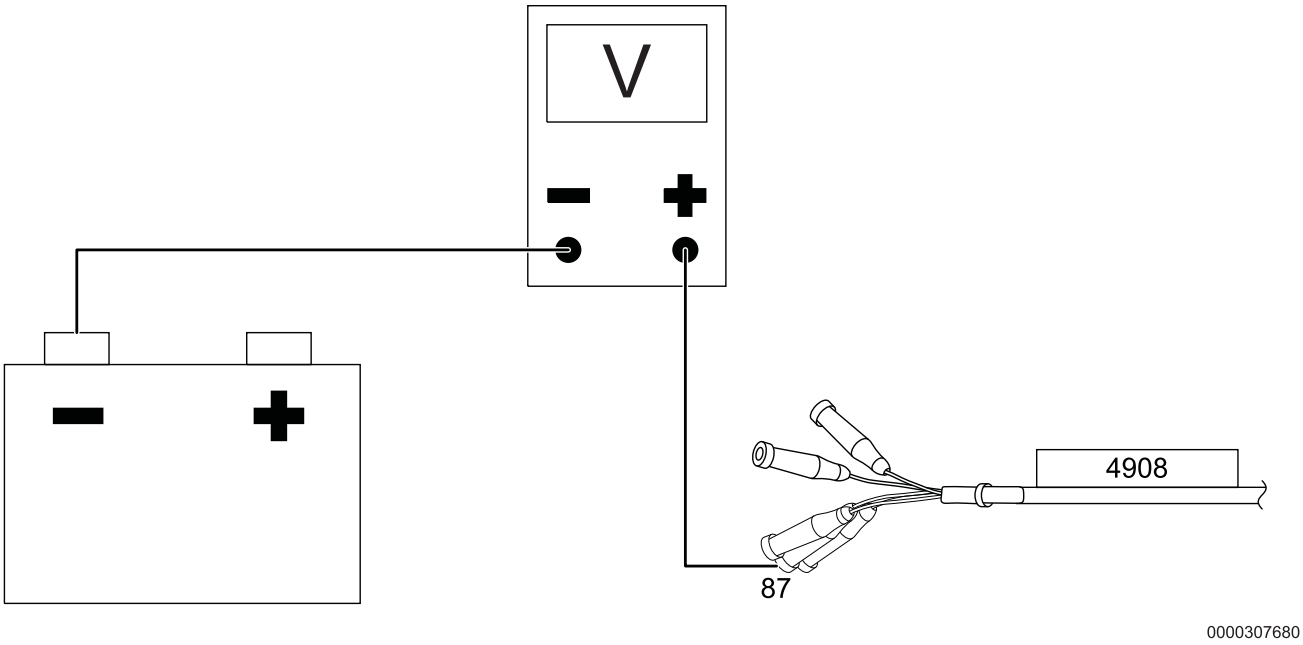

Figure 199 Test 2 DEFSMH Relay Circuit Voltage Check

For correct diagnosis, Breakout Harness ZTSE4908 must be installed with installation dimples toward top of PDM. Reversed installation will result in incorrect measurements.

Test 2 Setup
A. Key OFF. B. Remove DEFSMH Relay. C. Install Breakout Harness ZTSE4908 into PDM, and leave relay disconnected. D. Key ON.

Test 2	Specification
Use DMM to measure voltage between Breakout Harness ZTSE4908 pin-87 and known good ground.	Less than 0.5 volts.
Decision	
Is voltage less than 0.5 volts?	Yes: Replace DEF supply module. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 3.
	No: Repair short to PWR between DEFSMH Relay pin-87 and DEF supply module connector pin-5. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and proper decision was made. Return to SPN 5745 FMI 3 fault code diagnostics.

SPN 5745 FMI 4 - DEF Dosing Unit Heater Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Exhaust Fluid (DEF) supply module temperature is too low when heater is on.	DEF supply module temperature does not rise by at least 41°F (5°C) within predetermined time when heater is ON	Initial temperature at Key ON < 25°F (-4°C) DEF supply module heater is ON The diagnostic has not previously completed during this key cycle Inactive: SPN 3361 FMI 2 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5746 FMI 3, 4 (DEFSMH Relay); SPN 5798 FMI 2 (DEFSMH Temp)

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the DEF supply module temperature is too low when the heater is in the ON position. DEF injection into the aftertreatment system will be disabled, and engine torque will be reduced if the engine is operated for an extended period of time with this fault code active.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected.

Fault Facts

None

Associated Faults

SPN 3361 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5746 FMI 3, 4 (DEFSMH); and SPN 5798 FMI 2 (DEFSMH Temp).

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- DEFSMH power circuit Open or high resistance
- DEFSMH power circuit short to GND
- DEFSMH GND circuit Open or high resistance
- Failed DEFSMH Relay
- Failed DEF supply module
- Blown fuse or Open power circuit to DEFSMH

Step 1	Check for active faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5745 FMI 4. Is SPN 5745 FMI 4 an active fault?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure .

Step 2	Check for associated faults.	Decision
Using EST with ServiceMaxx™ software, check DTC list for SPN 3361 FMI 2 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5746 FMI 3, 4 (DEF:SMH Relay); SPN 5798 FMI 2 (DEFSMH Temp). Is EST DTD free of SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5746 FMI 3, 4; and / or SPN 5798 FMI 2?		Yes: Go to Step 3. No: Repair SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5746 FMI 3, 4; and SPN 5798 FMI 2. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 4.

Step 3	Inspect connections at DEF supply module.	Decision
A. Key OFF. B. Disconnect DEF supply module connector. C. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DEF supply module, connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests. No: Repair connector, harness, or terminal damage. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 4.

Pin-Point Tests (SPN 5745 FMI 4)

DEF: SMH Circuit

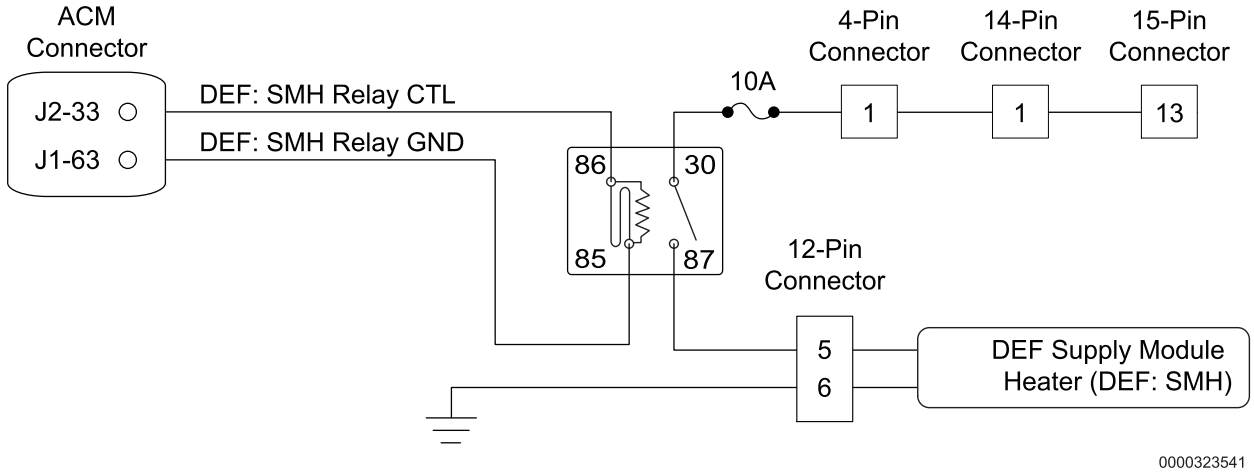

Figure 200 Diesel Exhaust Fluid Supply Module Heater (DEFSMH) Circuit Diagram

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness 18-909-01
- Breakout Harness ZTSE4908
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)

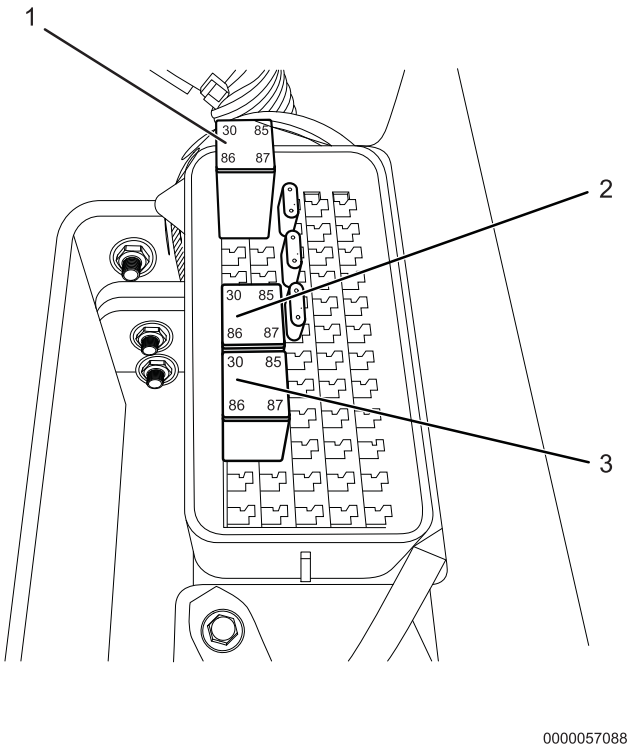

Figure 201 PDM Fuses and Relays (Typical)

1. DEF line heater relay
2. DEFSMH Relay
3. Switched ignition relay

Test 1 Setup
A. Key OFF. B. Remove DEFSMH Relay 10-amp fuse.

Test 1	Specification
Use DMM to measure resistance of DEFSMH Relay 10-amp fuse.	Less than 1 ohm
Decision	
Is resistance of DEFSMH Relay fuse less than 1 ohm?	Yes: Reinstall DEFSMH Relay 10-amp fuse. Go to Test 5.
	No: Go to Test 2.

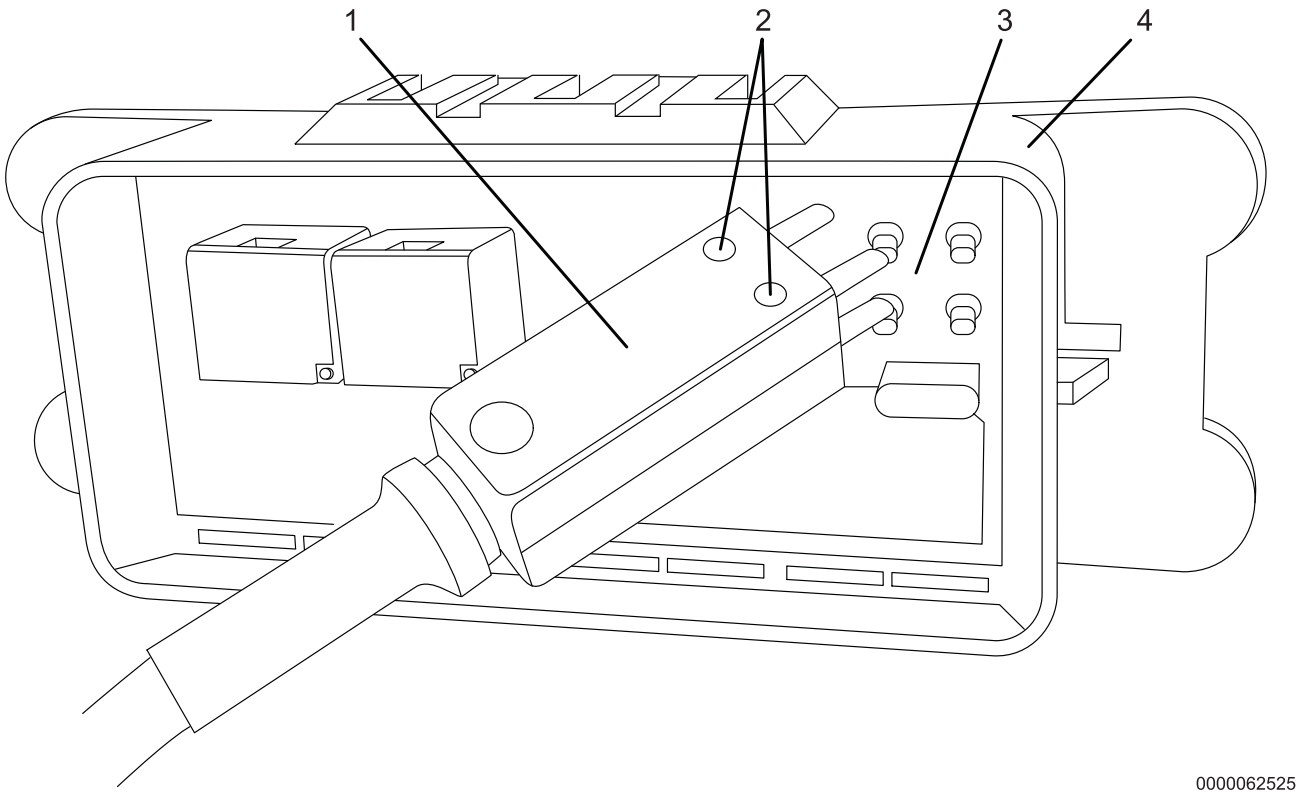

Figure 202 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. PDM

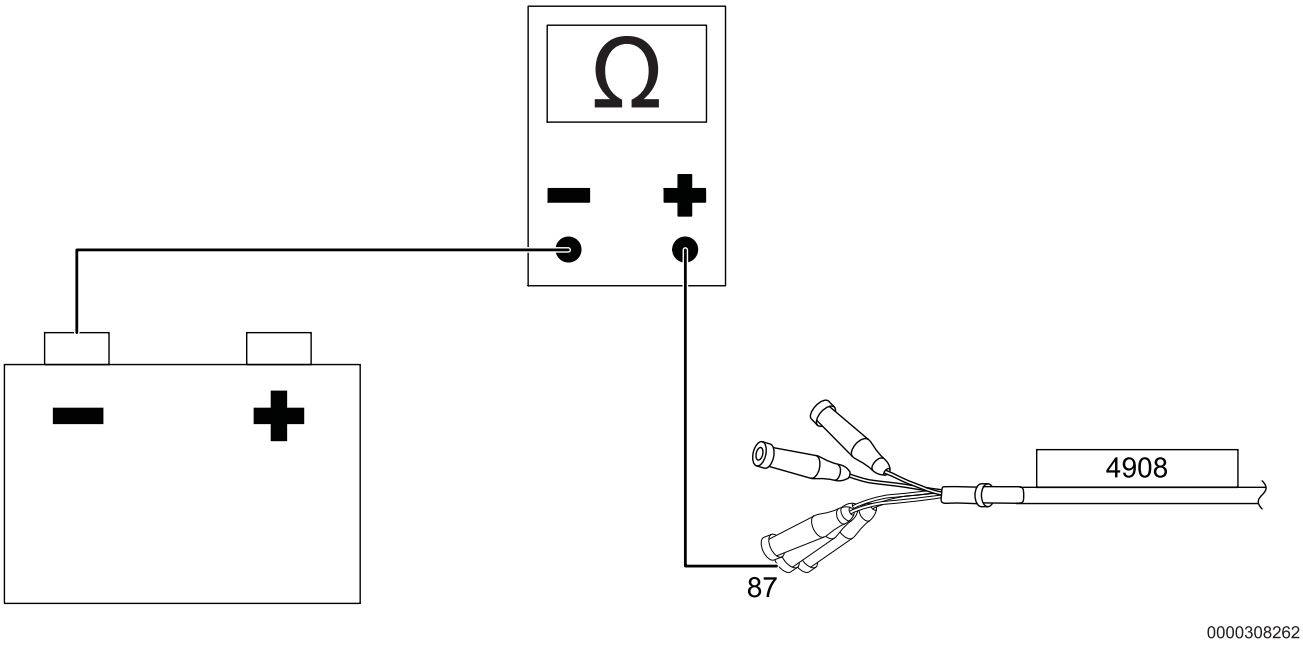

Figure 203 Test 2 DEFSMH Relay Circuit Resistance Check

For correct diagnosis, Breakout Harness ZTSE4908 must be installed with installation dimples toward top of PDM. Reversed installation will result in incorrect measurements.

Test 2 Setup
A. Key OFF. B. Remove DEFSMH Relay. C. Install Breakout Harness ZTSE4908 into PDM and leave DEFSMH Relay disconnected.

Test 2	Specification
Use DMM to measure resistance between Breakout Harness ZTSE4908 pin-87 and known good ground.	Greater than 1000 ohms
Decision	
Is resistance greater than 1000 ohms?	Yes: Go to Test 3.
	No: Repair short to GND between DEF supply module pin-5 and DEFSMH Relay pin-87. Replace fuse. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 4.

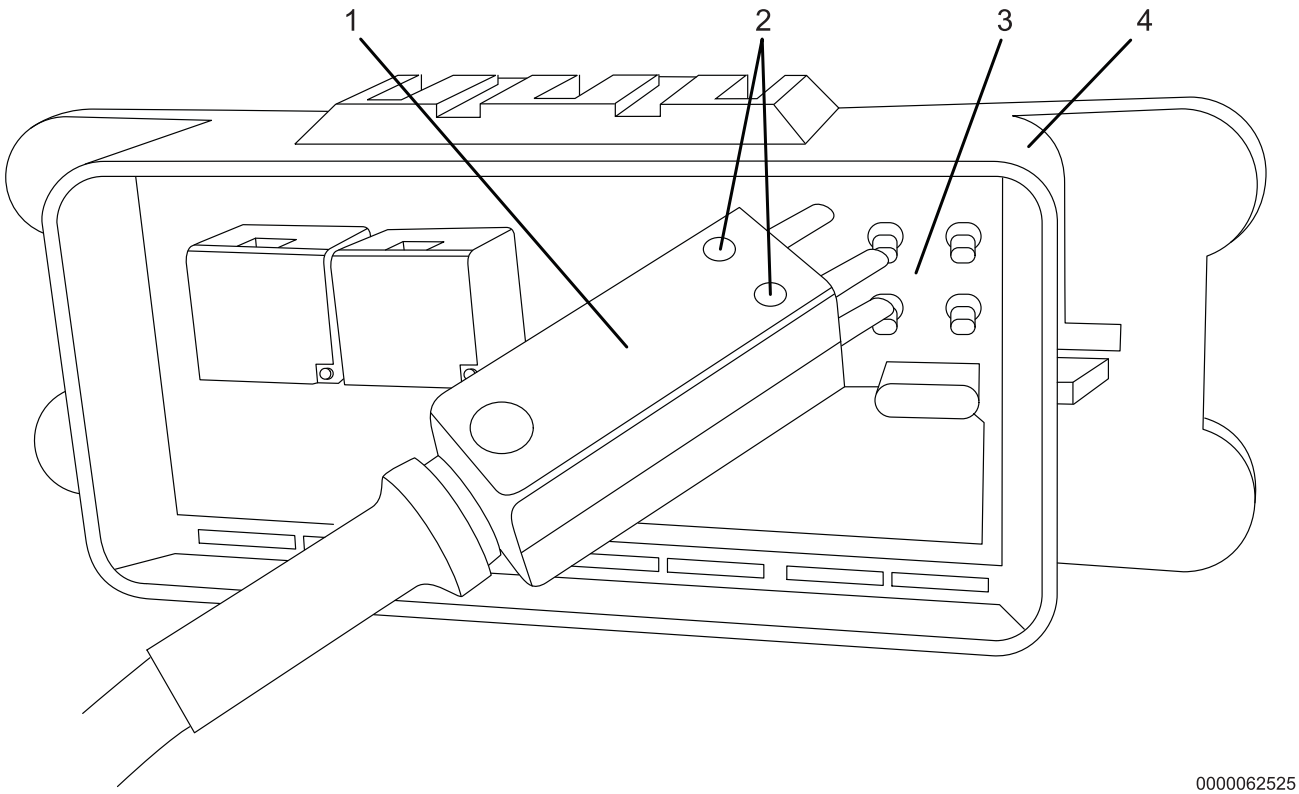

Figure 204 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. PDM

For correct diagnosis, Breakout Harness ZTSE4908 must be installed with installation dimples toward top of PDM. Reversed installation will result in incorrect measurements.

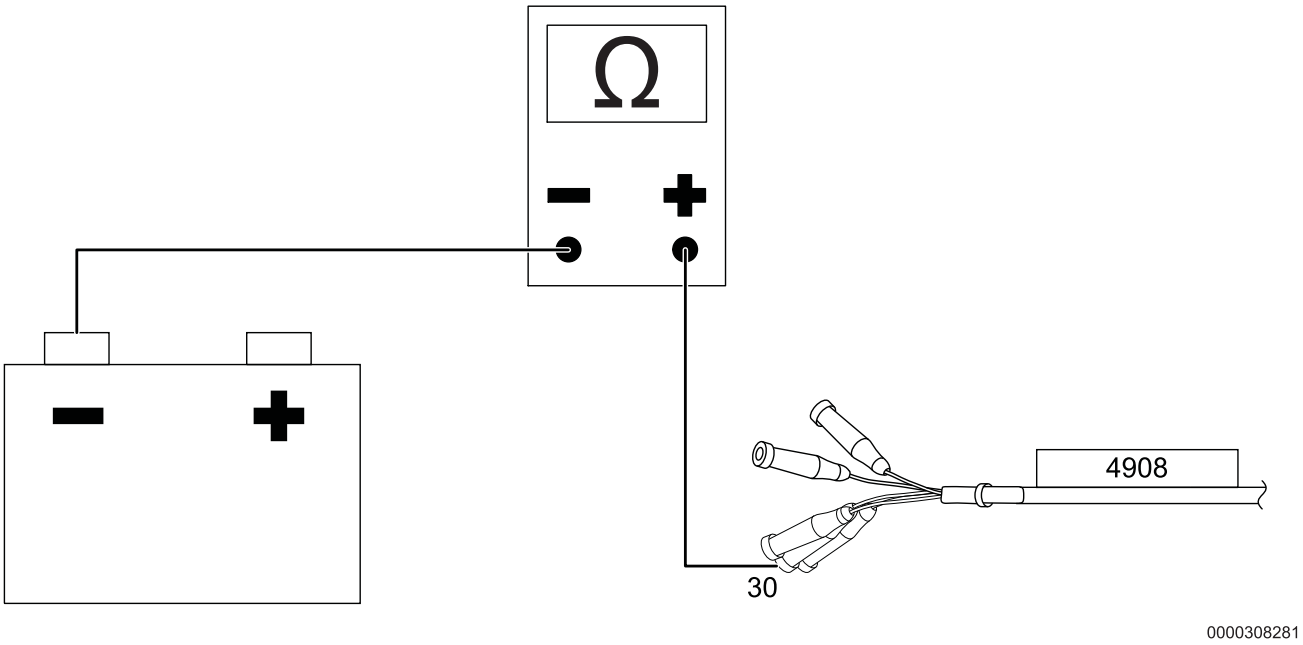

Figure 205 Test 3 DEFSMH Relay Circuit Resistance Check

Test 3 Setup
A. Key OFF. B. Remove DEFSMH Relay. C. Install Breakout Harness ZTSE4908 into PDM and leave DEFSMH Relay disconnected.

Test 3	Specification
Use DMM to measure resistance between Breakout Harness ZTSE4908 pin-30 and known good GND.	Greater than 1000 ohms
Decision	
Is resistance greater than 1000 ohms?	Yes: Go to Test 4.
	No: Repair short to GND between DEFSMH Relay pin-30 and 4-pin connector pin-1. Replace fuse. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 4.

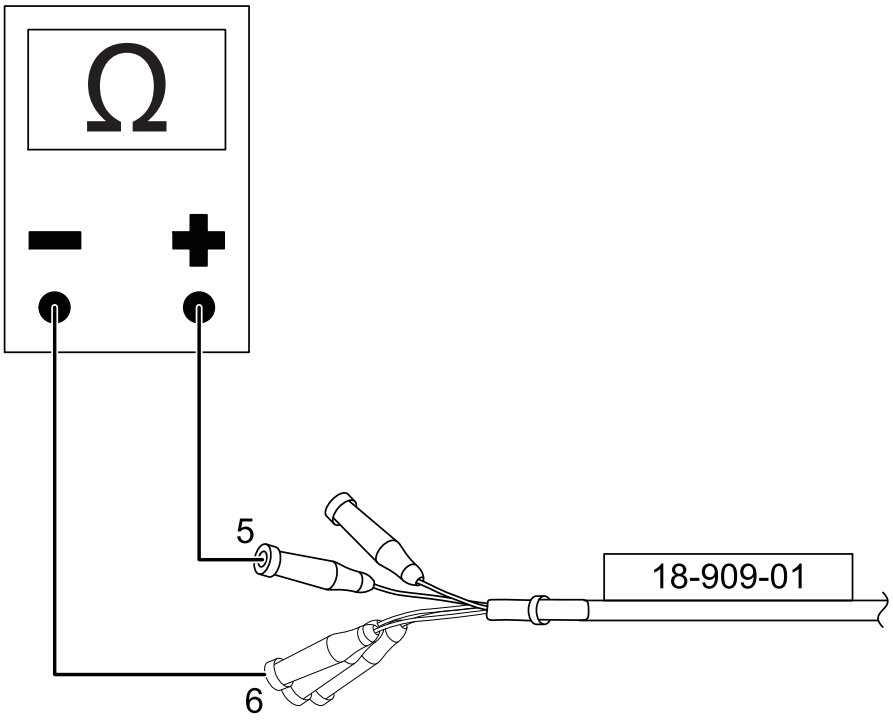

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Figure 206 Test 4 DEFSMH Circuit Resistance Check

Test 4 Setup
A. Key OFF. B. Connect Breakout Harness 18-909-01 to DEF supply module and leave vehicle harness disconnected.

Test 4	Specification
Use DMM to measure resistance between Breakout Harness 18-909-01 pin-5 and pin-6.	Between 1 and 5 ohms
Decision	
Is resistance between 1 and 5 ohms?	Yes: Go to Test 5.
	No: Replace DEF supply module and replace DEF: SMH Relay fuse. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 4.

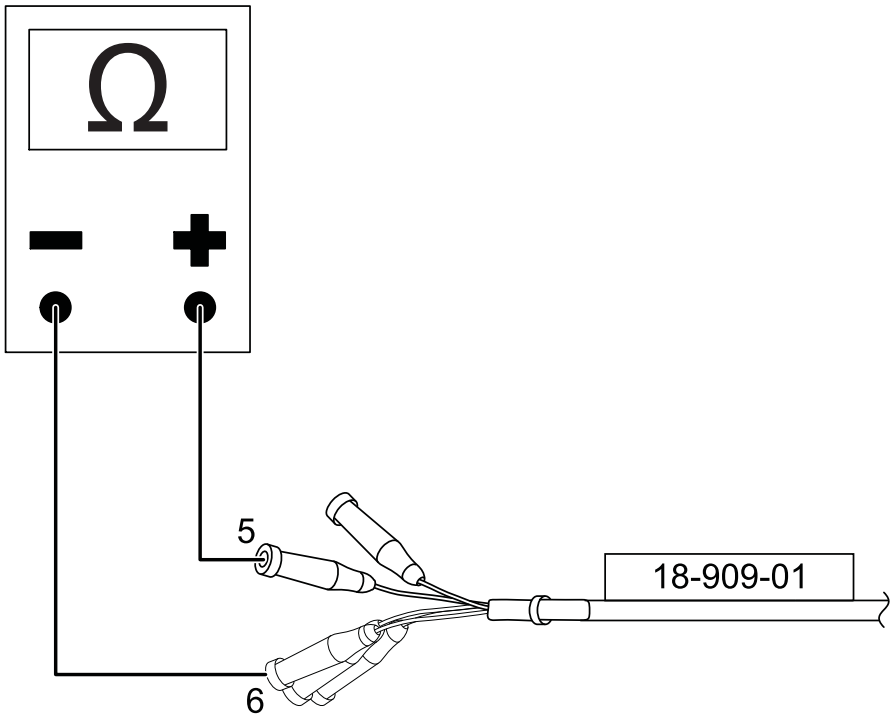

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Figure 207 Test 5 DEFSMH Circuit Resistance Check

Test 5 Setup
A. Key OFF. B. Connect Breakout Harness 18-909-01 to DEF supply module and leave vehicle harness disconnected.

Test 5	Specification
Use DMM to measure resistance between Breakout Harness 18-909-01 pin-5 and pin-6.	Between 1 and 5 ohms
Decision	
Is resistance between 1 and 5 ohms?	Yes: Go to Test 6.
	No: Replace DEF supply module. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 4.

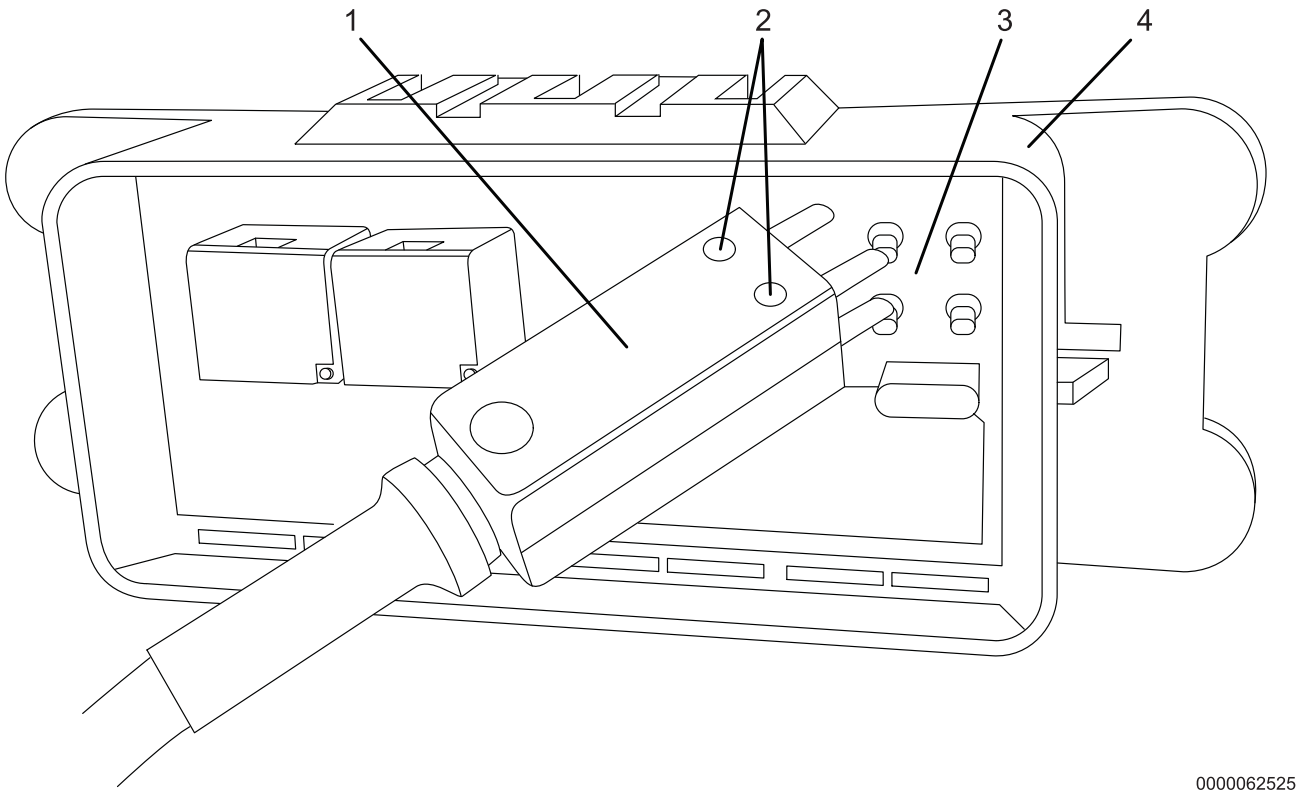

Figure 208 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. PDM

For correct diagnosis, Breakout Harness ZTSE4908 must be installed with installation dimples toward top of PDM. Reversed installation will result in incorrect measurements.

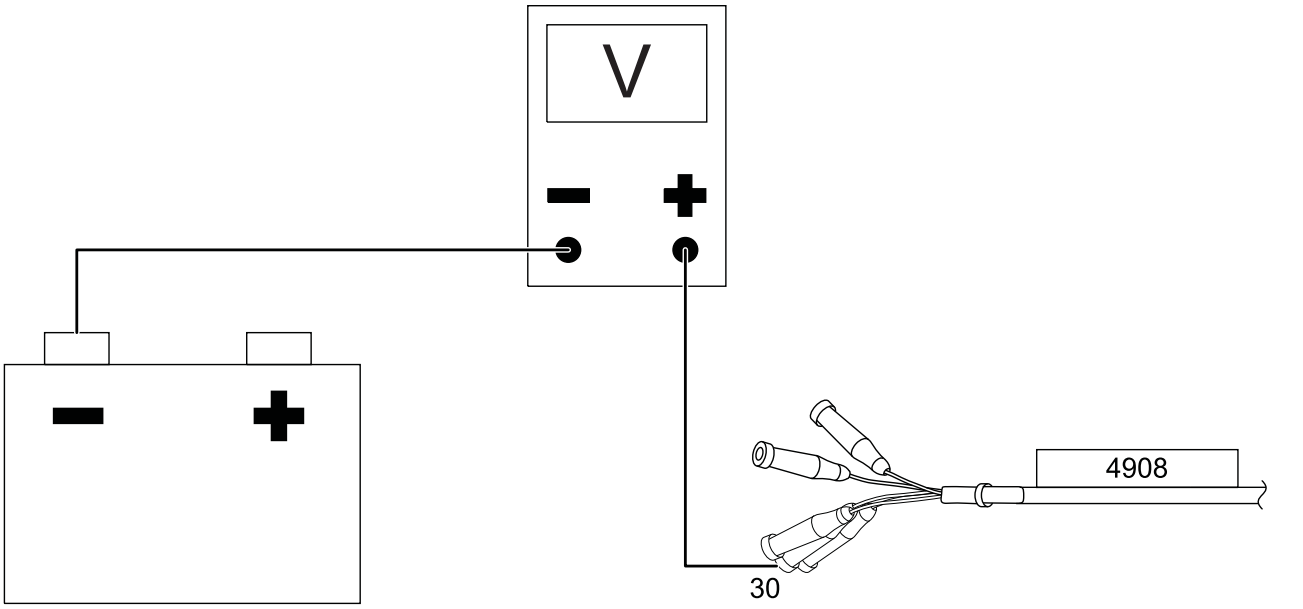

Figure 209 Test 6 DEFSMH Relay Circuit Voltage Check

Test 6 Setup
A. Key OFF. B. Remove DEFSMH Relay. C. Install DEFSMH Relay into Breakout Harness ZTSE4908. D. Install Breakout Harness ZTSE4908 into PDM. E. Key ON.

Test 6	Specification
Use DMM to measure voltage between Breakout Harness ZTSE4908 pin-30 and known good ground.	Voltage within 0.5 volts of B+
Decision	
Is voltage within 0.5 volts of B+?	Yes: Go to Test 7.
	No: Repair Open or high resistance in PWR circuit to DEFSMH Relay terminal 30. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 4.

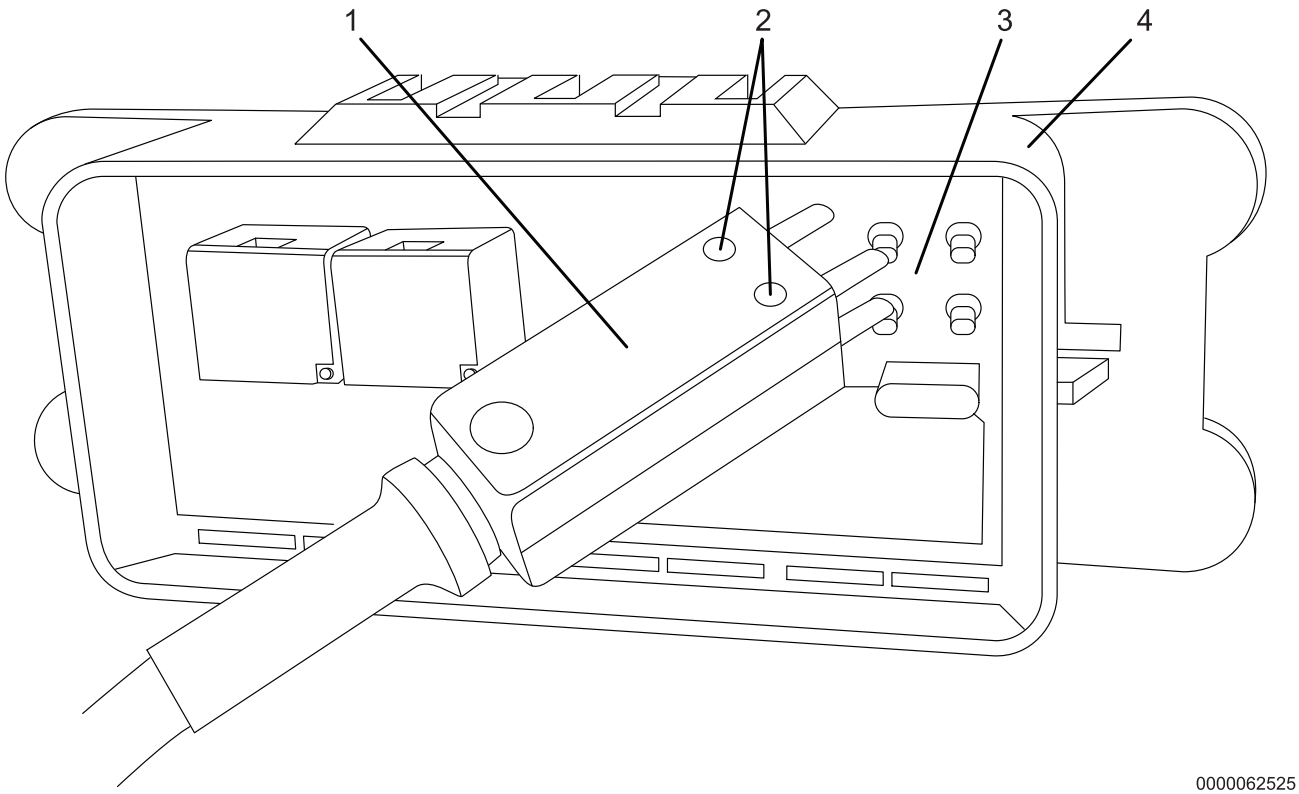

Figure 210 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. PDM

For correct diagnosis, Breakout Harness ZTSE4908 must be installed with installation dimples toward top of PDM. Reversed installation will result in incorrect measurements.

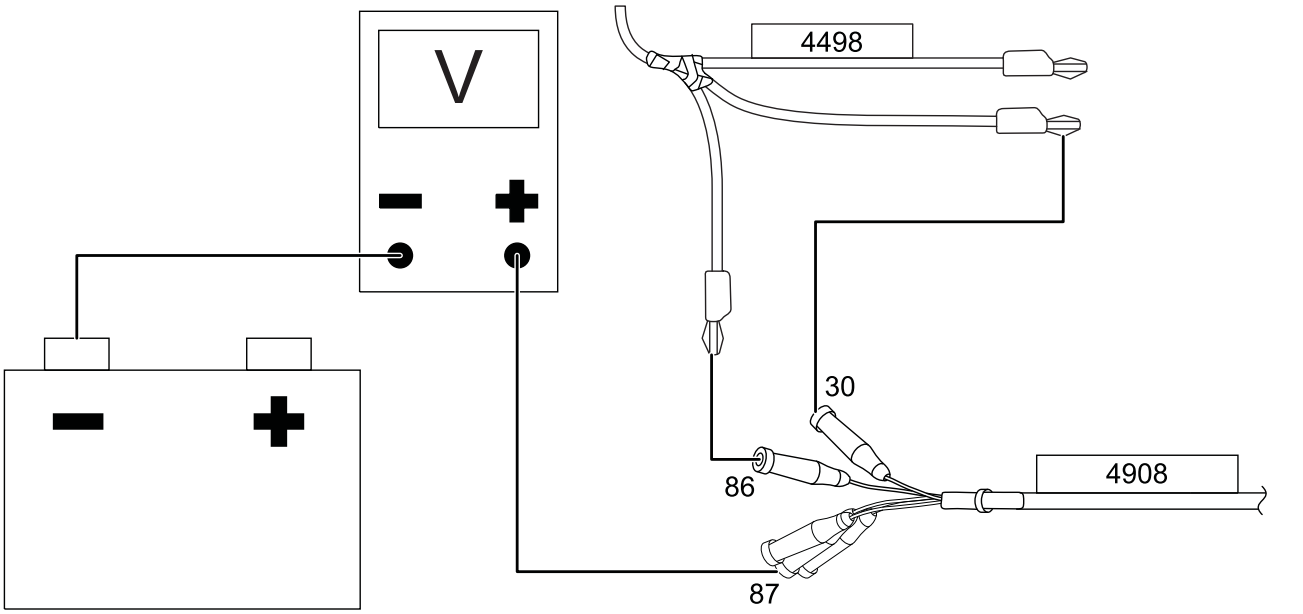

Figure 211 Test 7 DEFSMH Relay Circuit Voltage Check

Test 7 Setup
A. Key OFF. B. Remove DEFSMH Relay. C. Install DEFSMH Relay into Breakout Harness ZTSE4908. D. Install Breakout Harness ZTSE4908 into PDM. E. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4908 pin-30 to pin-86. F. Key ON.

Test 7	Specification
Use DMM to measure voltage between Breakout Harness ZTSE4908 pin-87 and known good ground.	Voltage within 0.5 volts of B+
Decision	
Is voltage within 0.5 volts of B+?	Yes: Go to Test 8.
	No: Replace DEFSMH Relay. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 4.

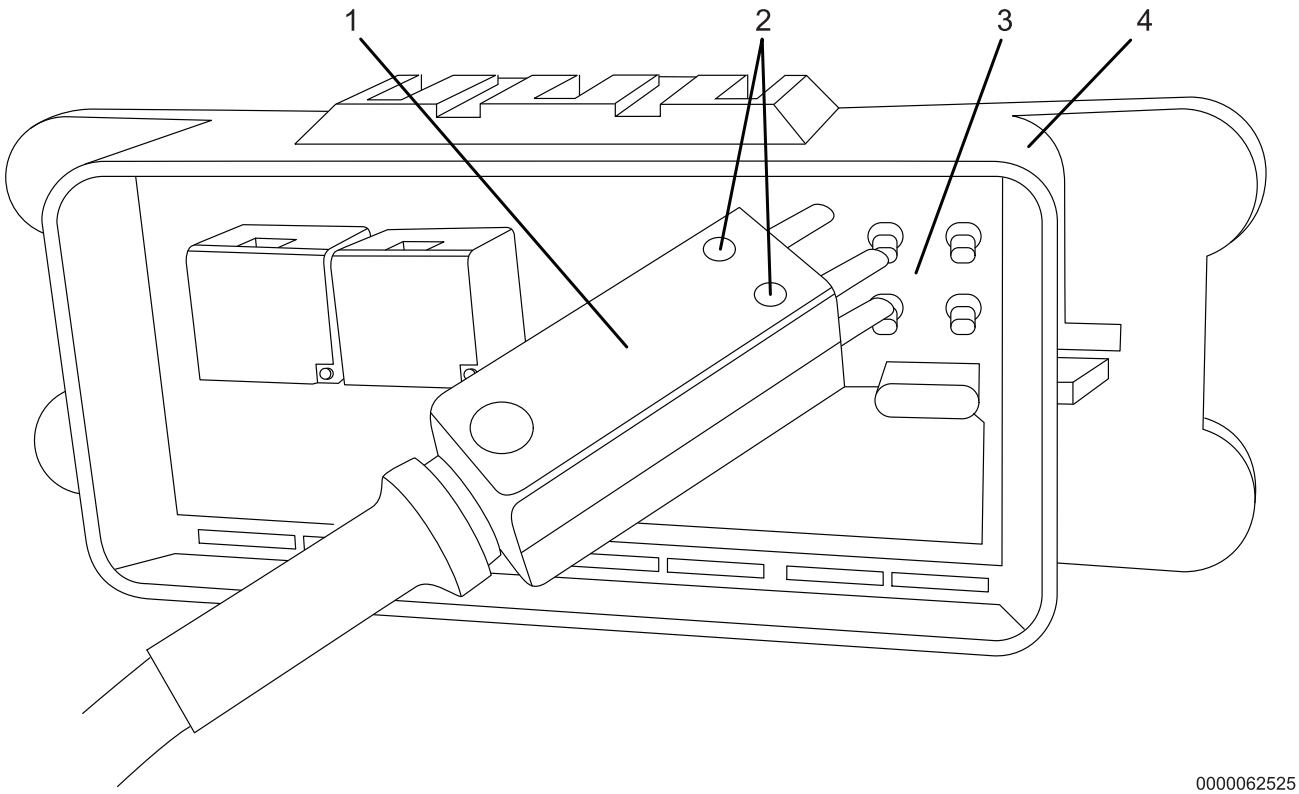

Figure 212 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. PDM

For correct diagnosis, Breakout Harness ZTSE4908 must be installed with installation dimples toward top of PDM. Reversed installation will result in incorrect measurements.

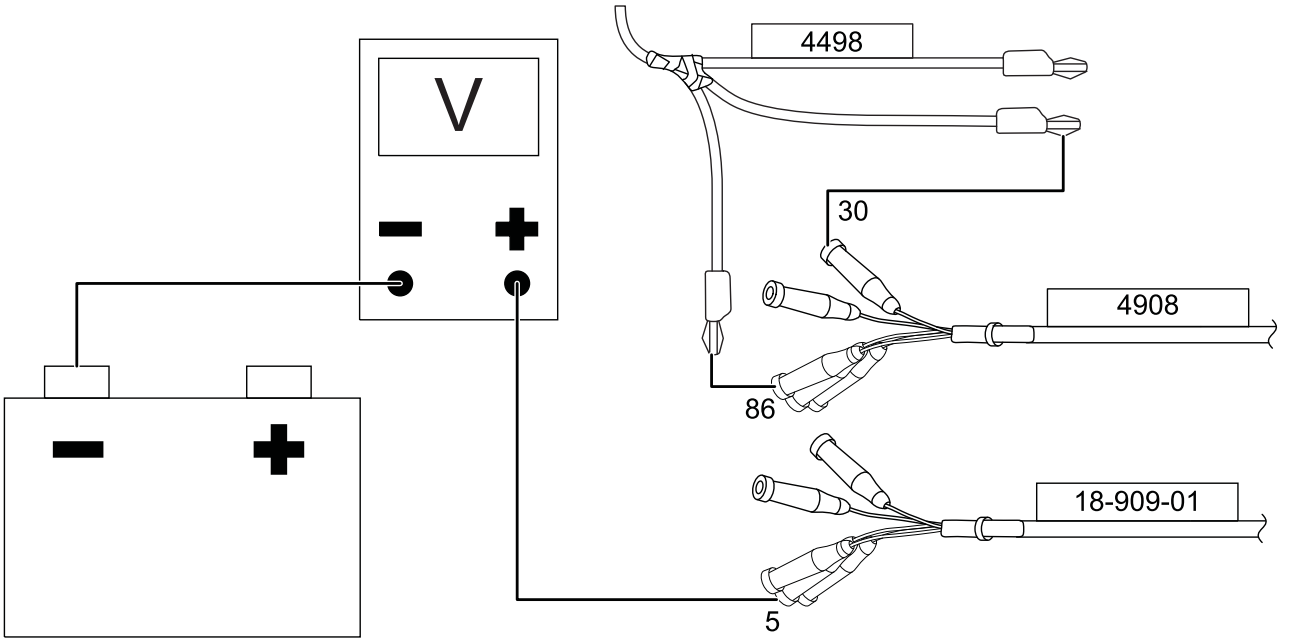

Figure 213 Test 8 DEFSMH Circuit Voltage Check

Test 8 Setup
A. Key OFF. B. Connect Breakout Harness 18-909-01 between DEF supply module vehicle harness connector and DEF supply module. C. Install DEFSMH Relay into Breakout Harness ZTSE4908. D. Install Breakout Harness ZTSE4908 into PDM. E. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4908 pin-30 to pin-86. F. Key ON.

Test 8	Specification
Use DMM to measure voltage between Breakout Harness 18-909-01 pin-5 and known good ground.	Voltage within 0.5 volts of B+
Decision	
Is voltage within 0.5 volts of B+?	Yes: Repair Open between DEF supply module pin-6 and ground. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest SPN 5745 FMI 4.
	No: Repair Open between DEFSMH Relay pin-87 and DEF supply module pin-5. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 5745 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 5745 FMI 4 fault code diagnostics.

SPN 5745 FMI 18 - DEF Dosing Unit Heater below Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEF supply module failed to reach target temperature within a predetermined time from the start of DEF supply module heating.	DEF supply module heating is active for between 10 an 120 minutes (specific time depends on initial temperature), and supply module temperature remains less than 25°F (-4°C).	Inactive: SPN 3361 FMI 2 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5746 FMI 3 and 4 (DEF: SMH). Heating of the DEF supply module is required. A valid DEF supply module temperature value is available, and a valid DEF supply module heater temperature value is available from the DEF supply module. Ambient air temperature < 41°F (5°C).	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the DEF supply module has failed to rise to greater than 25°F (-4 °C) after a predetermined time. Diesel exhaust fluid injection into the aftertreatment system will be disabled. Engine torque will be reduced if the engine is operated for a limited period of time with the fault code active. Engine torque will be severely reduced, and vehicle speed will be limited after extended engine operation with fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 171 FMI 2, 3, and 4; SPN 3361 FMI 2 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 FMI 3, 4 (DEF: SMH); SPN 5746 FMI 3,4 (DEF: SMH).

Drive Cycle to Determine Fault Status

Drive Cycle 29 in 2013 HD-OBD Diagnostic Reference Manual.

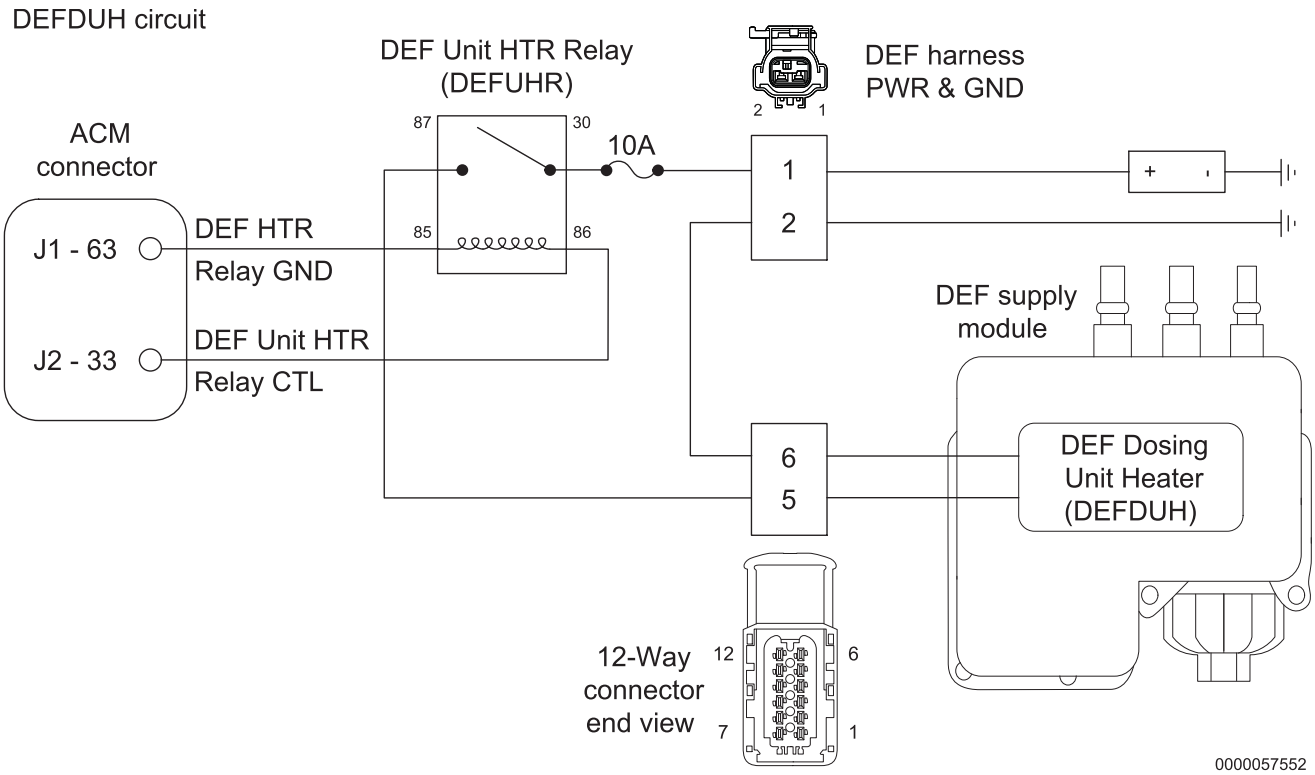

Figure 214 DEF: SMH Circuit Diagram

Possible Causes

- DEF: SMH GND circuit high resistance
- DEF: SMH power circuit high resistance
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™, check Diagnostic Trouble Code (DTC) list for SPN 171 FMI 2, 3, 4 (AAT); SPN 3361 FMI 2 (DEFSP); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 FMI 3, 4 (DEF: SMH); SPN 5746 FMI 3, 4 (DEF: SMH). Is EST DTC list free of SPN 171 FMI 2, 3, and 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745 FMI 3, 4; and SPN 5746 FMI 3, 4?	Yes: Go to step 2. No: Repair SPN 171 FMI 2, 3, 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745 FMI 3, 4; SPN 5746 FMI 3, 4. After repairs are complete, retest for SPN 5745 FMI 18.

Step	Action	Decision
2	Check DEF: SMH GND circuit for high resistance. Key OFF, connect Breakout Harness 18-909-01 to DEF supply module harness, and leave module disconnected. Using a DMM, measure resistance between pin-6 of Breakout Harness 18-909-01 and a known good ground. Is resistance less than 5 ohms?	Yes: Go to step 3. No: Repair high resistance in DEF: SMH GND circuit between DEF supply module pin-6 and GND. When repairs are complete, retest for SPN 5745 FMI 18.

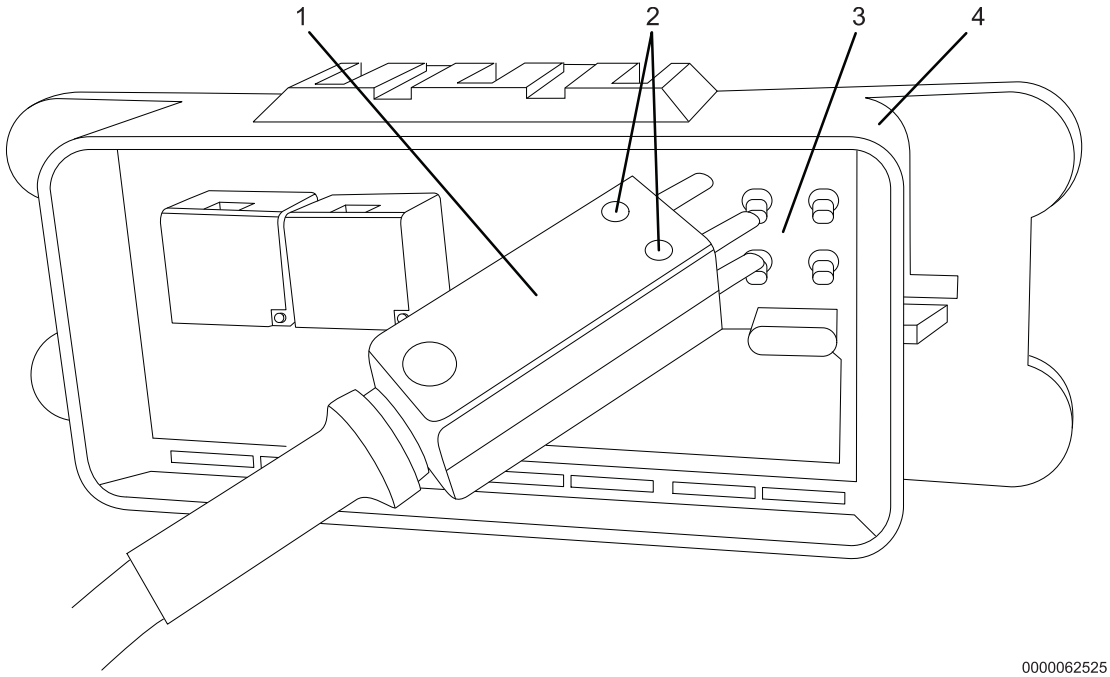

Figure 215 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 Must be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation Will result in incorrect measurements.

Step	Action	Decision
3	Check DEF: SMH power circuit for high resistance. Key OFF, remove DEF: SMH. Install Breakout Harness ZTSE4908 into PDM, and leave relay disconnected. Using a DMM, measure resistance between pin-5 of Breakout Harness 18-909-01 and pin-87 of Breakout Harness ZTSE4908. Is resistance less than 5 ohms?	Yes: Go to step 4. No: Repair high resistance in DEF: SMH power circuit between pin-5 of DEF supply module connector and pin-87 of DEF: SMH. When repairs are complete, retest for SPN 5745 FMI 18.

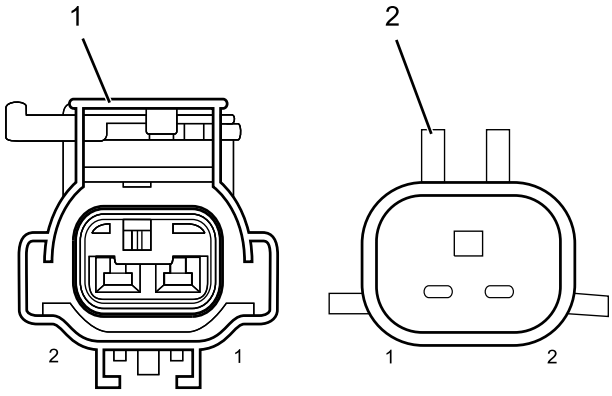

Figure 216 DEF Harness PWR and GND connector view

1. Female connector
2. Male connector

Step	Action	Decision
4	Check DEF: SMH relay power circuit for high resistance. Key OFF, disconnect DEF harness PWR and GND connector and install Breakout Harness ZTSE4760A to female side. Using a DMM, measure resistance between pin-30 of Breakout Harness ZTSE4908 and pin-1 of Breakout Harness ZTSE4760A. Is resistance less than 5 ohms?	Yes: Replace the DEF supply module. When repairs are complete, retest for SPN 5745 FMI 18. No: Repair high resistance in DEF: SMH power circuit between DEF harness PWR and GND pin-1 and DEF: SMH pin-30. When repairs are complete, retest for SPN 5745 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 5745 FMI 18 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5746 FMI 3 - DEF Dosing Unit Heater Relay Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Unit HTR Relay (DEF: SMH) circuit is shorted to PWR, Open, or high resistance.	Resistance between DEF Unit HTR Relay CTL and DEF Unit HTR Relay GND > 500,000 Ohms, or DEF Unit HTR Relay CTL is shorted to power.	DEF: SMH command ON Key ON.	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Unit HTR Relay (DEF: SMH) voltage signal is high.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

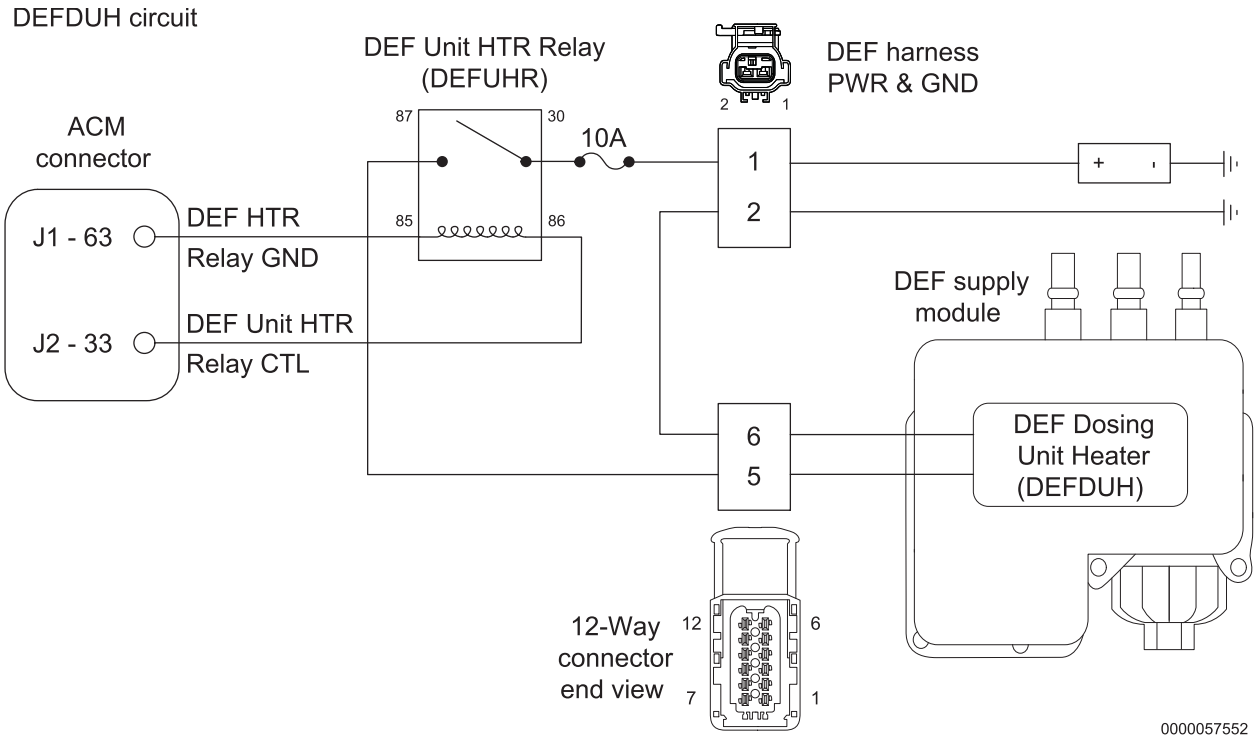

Figure 217 DEF: SMH Circuit Diagram

Possible Causes

- DEF Unit HTR Relay CTL short to PWR

- DEF Unit HTR Relay CTL Open or high resistance
- DEF Unit HTR Relay GND Open or high resistance
- Failed DEF Unit HTR Relay (DEF: SMH)

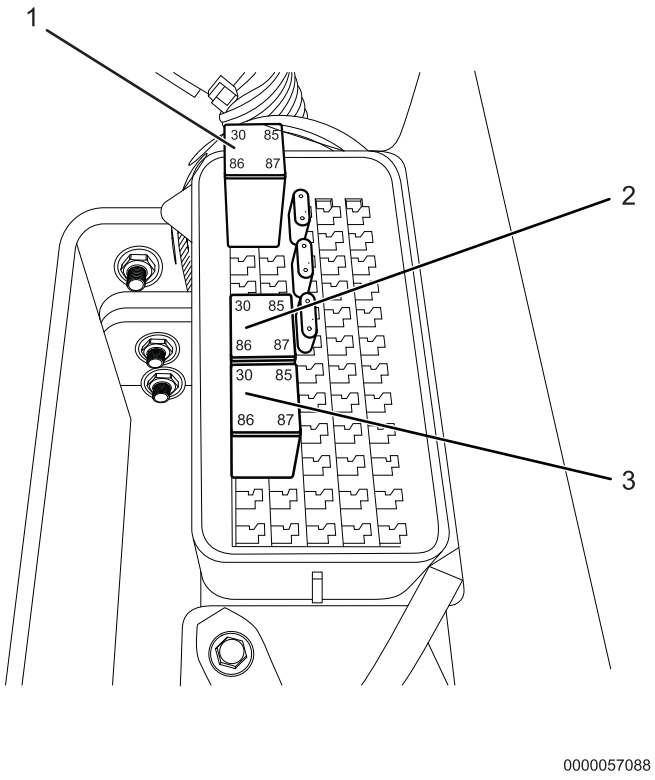

Figure 218 DEF: SMH Location

1. DEF Line Heater Relay (DEF: LHR)
2. DEF Unit HTR Relay (DEF: SMH)
3. Switched Ignition Relay

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 5746 FMI 3.

Step	Action	Decision
2	Check for a failed DEF Unit HTR Relay (DEF: SMH). Remove the DEF: SMH. Install DEF: SMH into Breakout Harness ZTSE4908 and leave harness disconnected from PDM. Using a DMM, check resistance between pin-85 and pin-86. Is resistance less than 300 ohms?	Yes: Go to step 3. No: Replace DEF: SMH. After repairs are complete, retest for SPN 5746 FMI 3.

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Leave connector J2 unplugged. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5746 FMI 3.

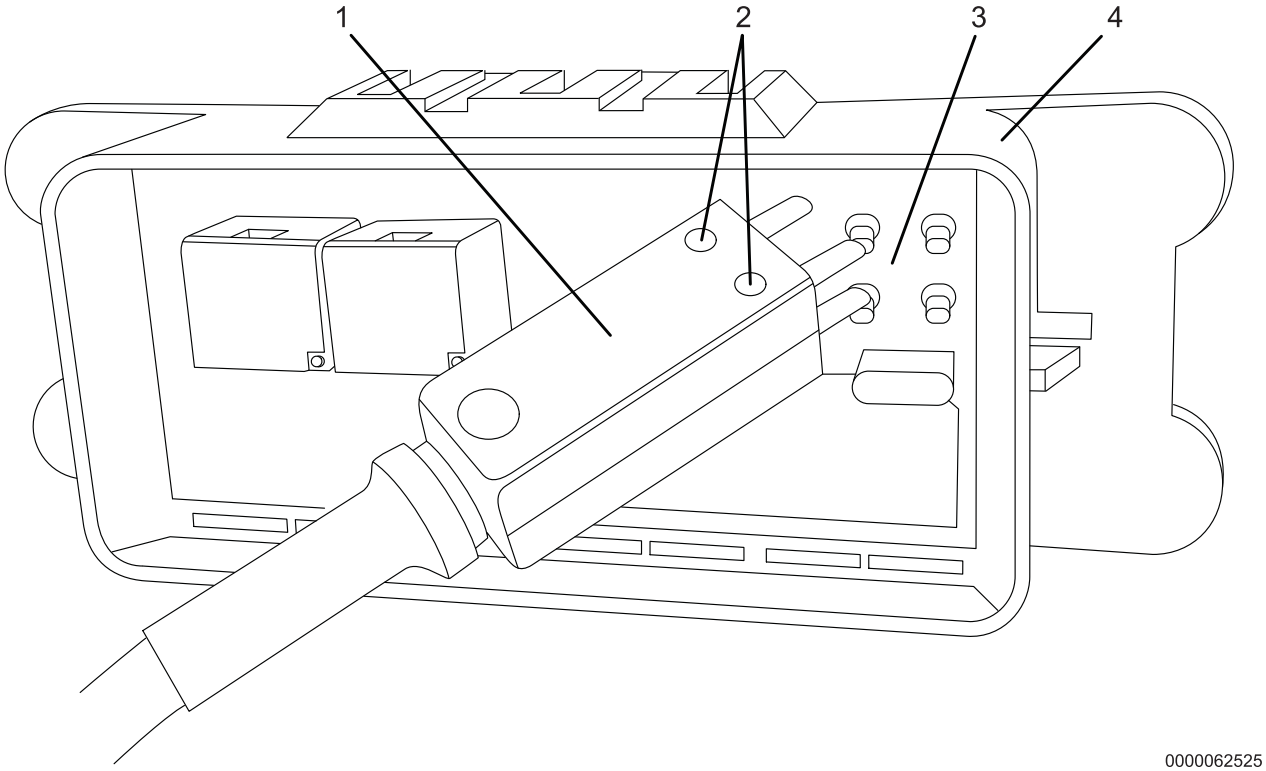

Figure 219 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Check DEF Unit HTR relay CTL circuit for a short to PWR. Install Breakout Harness ZTSE4908 into Power Distribution Module (PDM). Disconnect connector J2 from ACM. Using a DMM, Key-On Engine-Off (KOEO), measure voltage between pin-86 and a known good ground. Is voltage less than 0.5 volt?	Yes: Go to step 5. No: Repair short to PWR between DEF: SMH pin-86 and ACM pin J2-33. When repairs are complete, retest for SPN 5746 FMI 3.

Step	Action	Decision
5	Check DEF Unit HTR relay CTL circuit for an Open or high resistance. Install 180-pin Breakout Box with Breakout Harness 18-537-01 to vehicle harness J2, leave ACM disconnected. With Breakout Harness ZTSE4908 installed, use a DMM to measure resistance between Breakout Harness pin-86 and Breakout Box pin J2-33. Is resistance less than 5 ohms?	Yes: Repair Open or high resistance between DEF: SMH pin-85 and ACM pin J1-63. When repairs are complete, retest for SPN 5746 FMI 3. No: Repair Open or high resistance between DEF: SMH pin-86 and ACM pin J2-33. When repairs are complete, retest for SPN 5746 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 5746 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5746 FMI 4 - DEF Dosing Unit Heater Relay Short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Unit HTR Relay (DEF: SMH) voltage below normal or shorted to GND.	Resistance between the DEF Unit HTR Relay CTL circuit and ground < 0.2 Ohms	DEF: SMH commanded ON Key ON	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the signal voltage from the Diesel Exhaust Fluid Unit HTR Relay (DEF: SMH) is lower than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

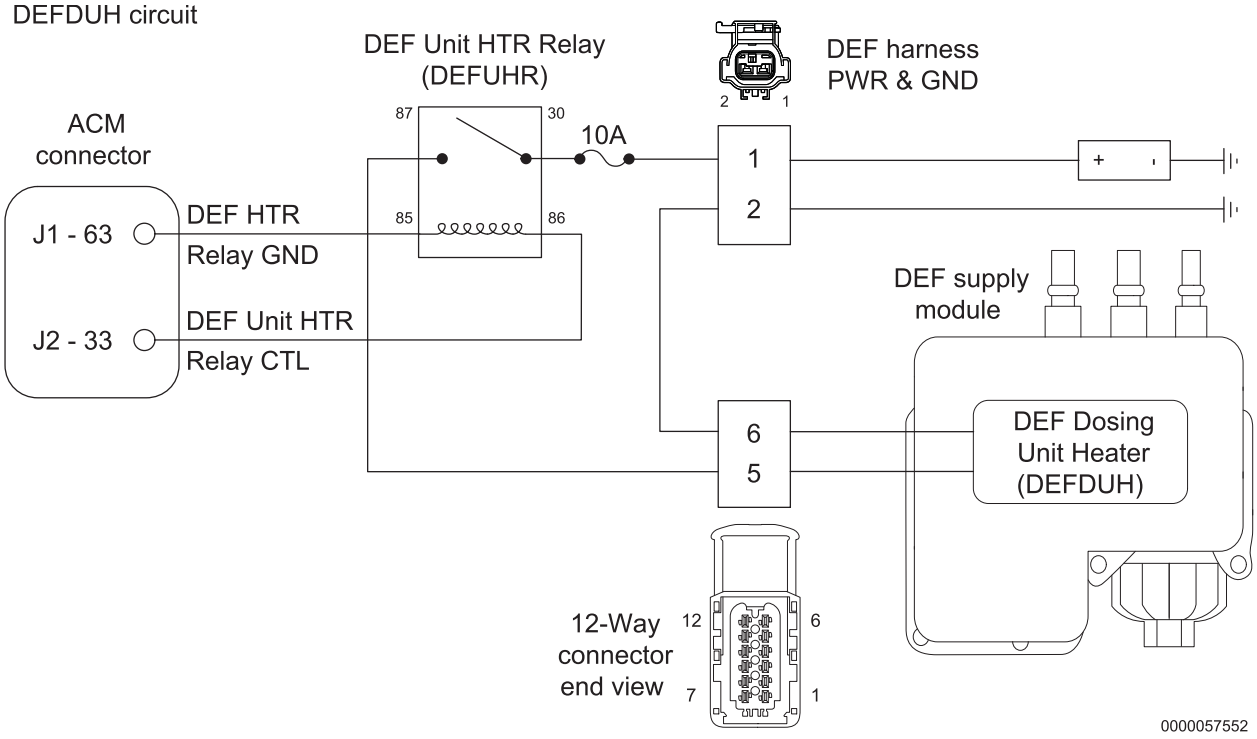

Figure 220 DEF: SMH Circuit Diagram

Possible Causes

- DEF Unit HTR Relay CTL circuit short to GND

- DEF Unit HTR Relay GND shorted to DEF Unit HTR Relay CTL
- Failed DEF Unit HTR Relay (DEF: SMH)

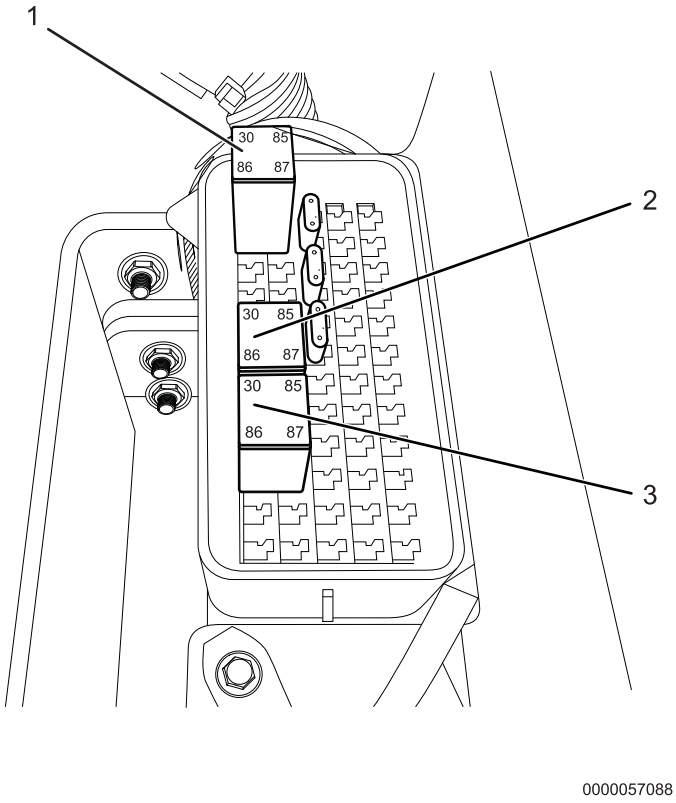

Figure 221 DEF: SMH Location

1. DEF Line Heater Relay (DEF: LHR)
2. DEF Unit HTR Relay (DEF: SMH)
3. Switched Ignition Relay

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 5746 FMI 4.

Step	Action	Decision
2	Check for a failed DEF Unit HTR Relay (DEF: SMH). Remove the DEF: SMH. Install relay into Breakout Harness ZTSE4908 and leave disconnected from PDM. Using a DMM, check resistance between pin-85 and pin-86. Is the resistance between 100 and 300 ohms?	Yes: Go to step 3. No: Replace DEF: SMH. After repairs are complete, retest for SPN 5746 FMI 4.

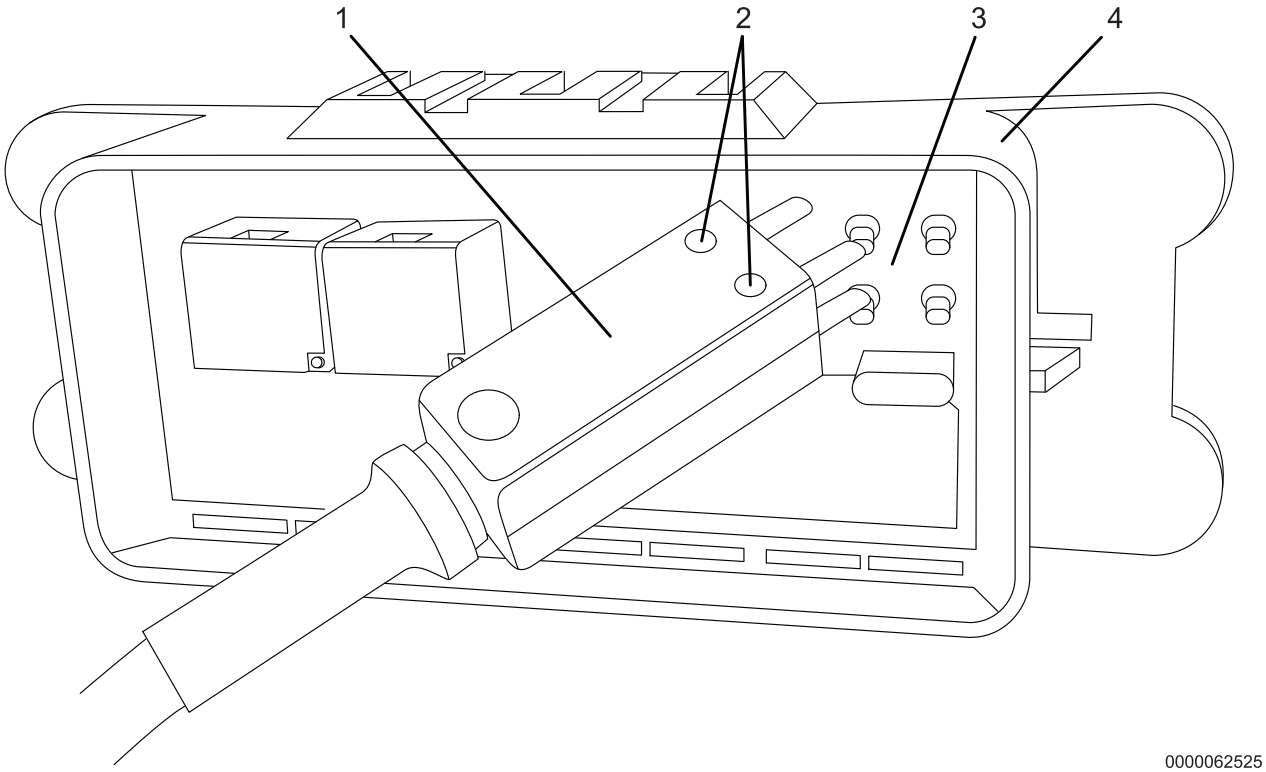

Figure 222 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Dimples
3. Relay socket
4. Power Distribution Module (PDM)

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 Must be installed with the dimples toward the top of the Power Distribution Module (PDM). Reversed installation Will result in incorrect measurements.

Step	Action	Decision
3	Check for DEF Unit HTR Relay CTL shorted to DEF Unit HTR Relay GND. Install Breakout Harness ZTSE4908 into PDM. Using a DMM, Key OFF check resistance between pin-85 and pin-86. Is resistance less than 100 ohms?	Yes: Repair short between DEF: SMH pin-86 and ACM pin J2-33, and DEF: SMH pin-85 and ACM pin J1-63. When repairs are complete, retest for SPN 5746 FMI 4.
		No: Repair short to GND in DEF Unit HTR Relay CTL circuit between DEF: SMH pin-86 and ACM pin J2-33. After repairs are complete, retest for SPN 5746 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 5746 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5798 FMI 2 - DEF Dosing Unit Heater Temperature Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Dosing Unit Heater (DEF: SMH) temperature sensor is in-range but not rational.	Difference between DEF: SMH temperature at Key ON and Inlet Air Temperature (IAT) at Key ON > 72°F (40°C) Difference between DEF: SMH temperature at Key ON and coolant temperature at Key ON > 72°F (40°C)	Engine is cold soaked 10 hours Inactive: SPN 3361 FMI 2 (DEF supply pump) Block heater not detected Valid DEF supply module temperature value is available Valid DEF: SMH temperature value is available Diagnostic has not previously completed during this key cycle	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Dosing Unit Heater (DEF: SMH) temperature differs from the engine coolant temperature and the inlet air temperature (IAT) by more than 72°F (40°C) at Key ON.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 2, 3, 4 (ECT1); SPN 172 FMI 2, 3, 4 (IAT); SPN 3361 FMI 2, 3, 4, 31 (DEF Supply Pump); SPN 4076 FMI 2, 3, 4 (ECT2).

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSP circuit

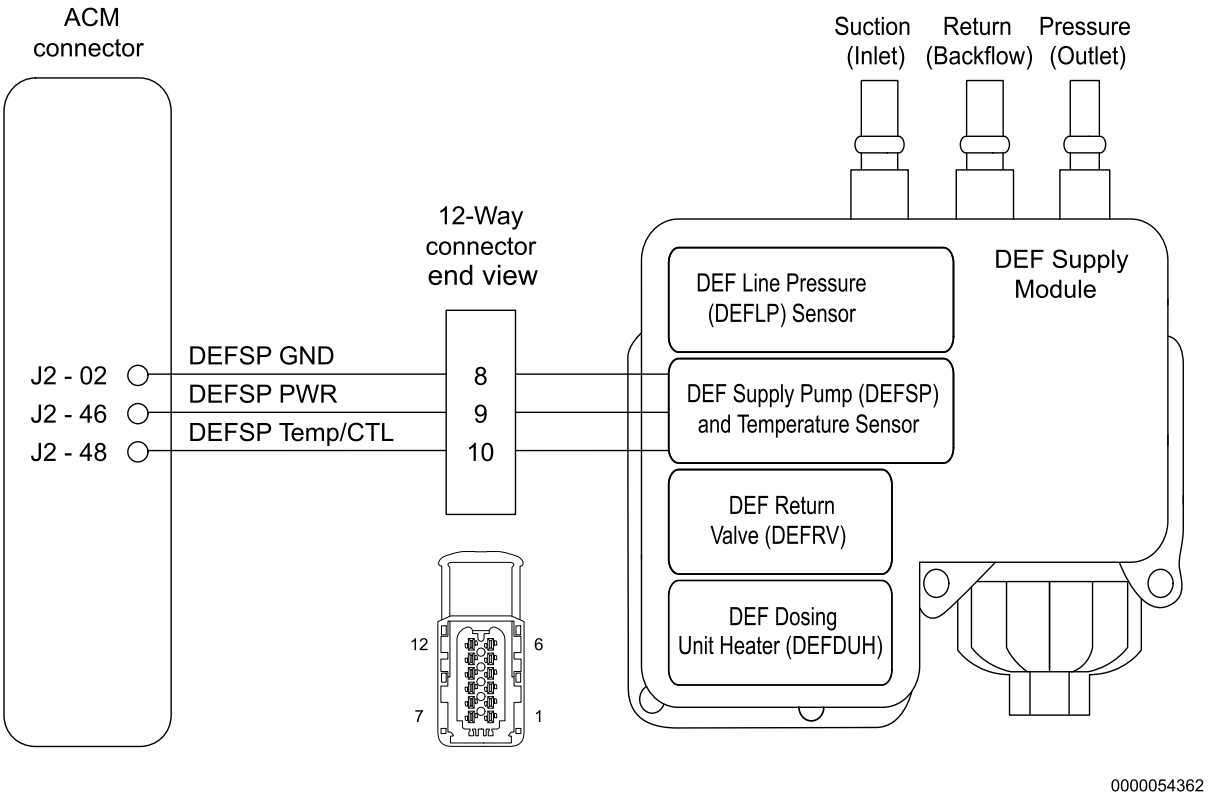

Figure 223 Diesel Exhaust Fluid (DEF) Supply Pump Circuit Diagram

Possible Causes

- DEFSP Temp / CTL circuit intermittent short to GND
- DEFSP Temp / CTL circuit intermittent short to PWR
- DEFSP Temp / CTL circuit intermittent Open or high resistance
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 2, 3, 4 (ECT1); SPN 172 FMI 2, 3, 4 (IAT); SPN 3361 FMI 2, 3, 4, 31 (DEF Supply Pump); SPN 4076 FMI 2, 3, 4 (ECT2). Is EST DTC list free of SPN 110 FMI 2, 3, 4; SPN 172 FMI 2, 3, 4; SPN 3361 FMI 2, 3, 4, 31; SPN 4076 FMI 2, 3, 4?	Yes: Go to step 2. No: Repair SPN 110 FMI 2, 3, 4; SPN 172 FMI 2, 3, 4; SPN 3361 FMI 2, 3, 4, 31; SPN 4076 FMI 2, 3, 4. After repairs are complete, retest for SPN 5798 FMI 2.

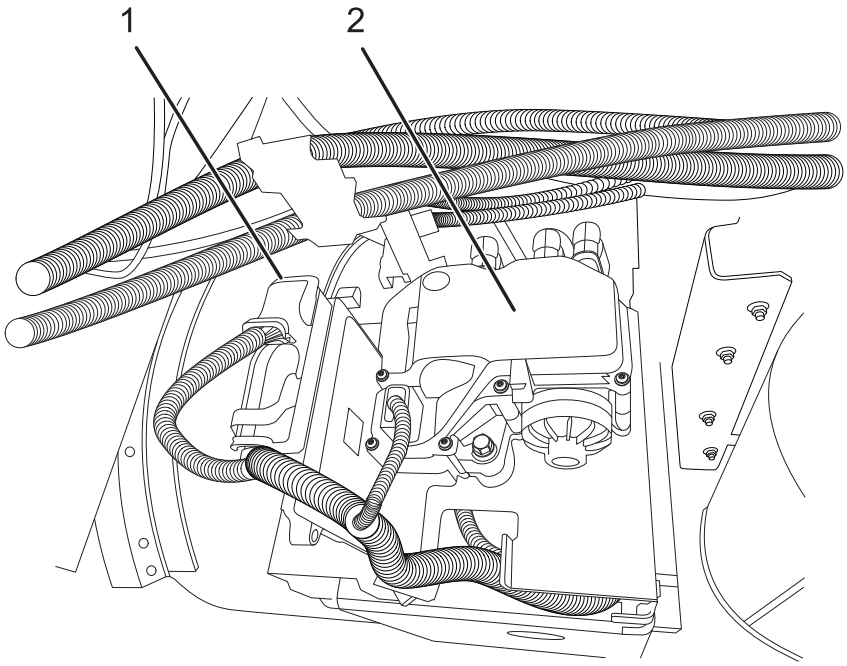

Figure 224 DEF Supply Module Location (typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module

Step	Action	Decision
2	Inspect connections at DEF supply module. Key OFF, disconnect DEF supply module connectors. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 3 No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5798 FMI 2

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4 No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5798 FMI 2.

Step	Action	Decision
4	Check for intermittent short to GND in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key OFF, with ACM disconnected, use a DMM to measure resistance between Breakout Harness pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5 No: Repair intermittent short to GND between DEF supply module pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 5798 FMI 2.

Step	Action	Decision
5	Check for intermittent short to PWR in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave supply module disconnected. Key-On Engine-Off (KOEO), with ACM disconnected, use a DMM to measure voltage between Breakout Harness pin-10 and a known good ground. Is voltage less than 1 volt?	Yes: Go to step 6. No: Repair intermittent short to PWR between DEF supply module pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 5798 FMI 2.

Step	Action	Decision
6	Check for intermittent Open or high resistance in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave supply module disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-537-01 to ACM harness, and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-10 and Breakout Box pin J2-48. Is resistance less than 5 ohms?	Yes: Replace the DEF supply module. After repairs are complete, retest for SPN 5798 FMI 2. No: Repair intermittent Open or high resistance between DEF supply module pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 5798 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 5798 FMI 2 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 5798 FMI 10 - DEF Dosing Unit Heater Temperature Abnormal Rate of Change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Dosing Unit Heater (DEF: SMH) temperature is in range but not rational (not heating).	Difference between maximum and minimum DEF: SMH temperature < 9°F (5°C) within 10 minutes.	Inactive: SPN 3361 FMI 2 (DEFSP); SPN 5746 FMI 3,4 (DEF: SMH); SPN 5798 FMI 2, 4 (DEF: SMH Temp). Valid DEF supply module temperature value is available Valid DEF: SMH temperature value is available Initial DEF supply module heater temperature at Key ON < 25°F (-4°C) DEF supply module heater is active Diagnostic has not previously completed during this key cycle Key-On Engine-Running (KOER)	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Dosing Unit Heater (DEF: SMH) is not heating properly.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 171 FMI 2, 3, 4 (AAT); SPN 3361 FMI 2 (DEFSP Signal); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 (DEF: SMH); SPN 5746 (DEF: SMH); SPN 5798 (DEF: SMH Temp)

Drive Cycle to Determine Fault Status

Drive Cycle 28 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSP circuit

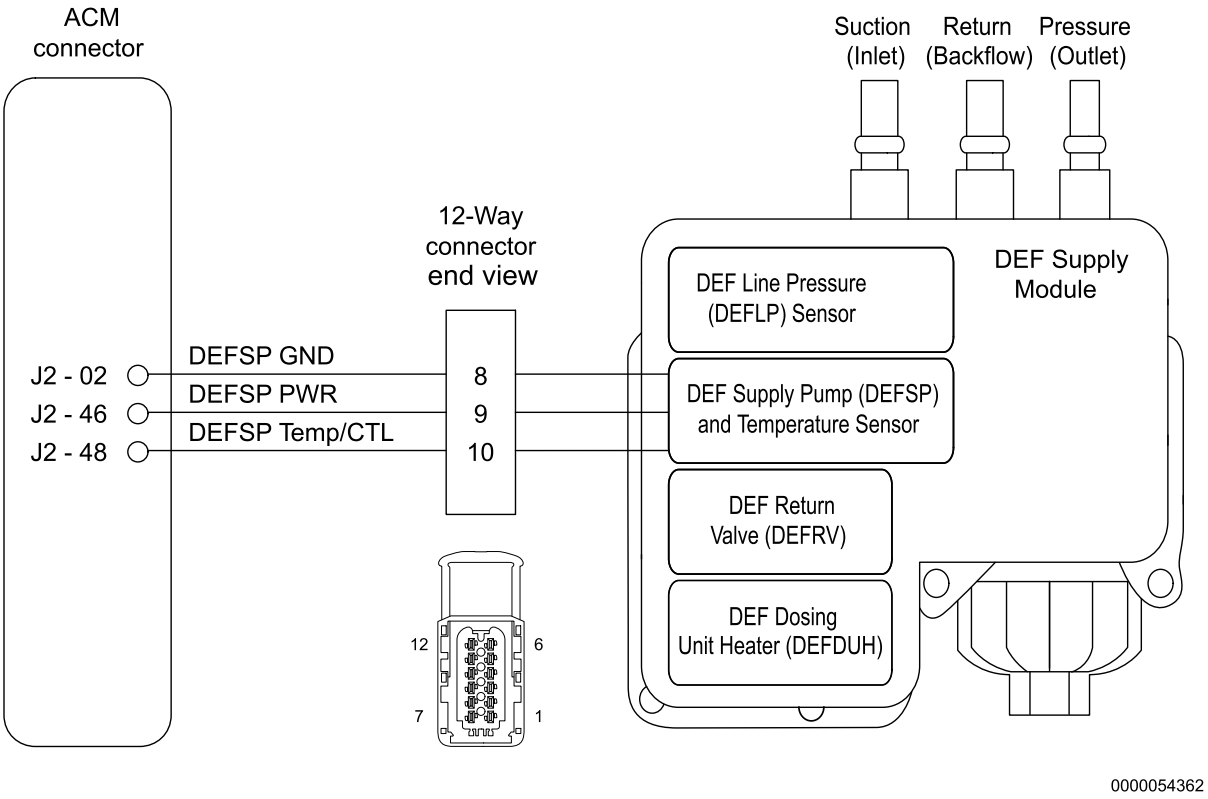

Figure 225 Diesel Exhaust Fluid (DEF) Supply Pump Circuit Diagram

Possible Causes

- DEFSP Temp / CTL circuit intermittent short to GND
- DEFSP Temp / CTL circuit intermittent short to PWR
- DEFSP Temp circuit / CTL intermittent Open or high resistance
- Failed DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 171 FMI 2, 3, 4 (AAT); SPN 3361 FMI 2 (DEFSP Signal); SPN 4337 FMI 2 (DEFSP Temp); SPN 5745 (DEF: SMH); SPN 5746 (DEF: SMH); SPN 5798 (DEF: SMH Temp). Is EST DTC list free of SPN 171 FMI 2, 3, 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745; SPN 5746; SPN 5798?	Yes: Go to step 2. No: Repair SPN 171 FMI 2, 3, 4; SPN 3361 FMI 2; SPN 4337 FMI 2; SPN 5745; SPN 5746; SPN 5798. After repairs are complete, retest for SPN 5798 FMI 10.

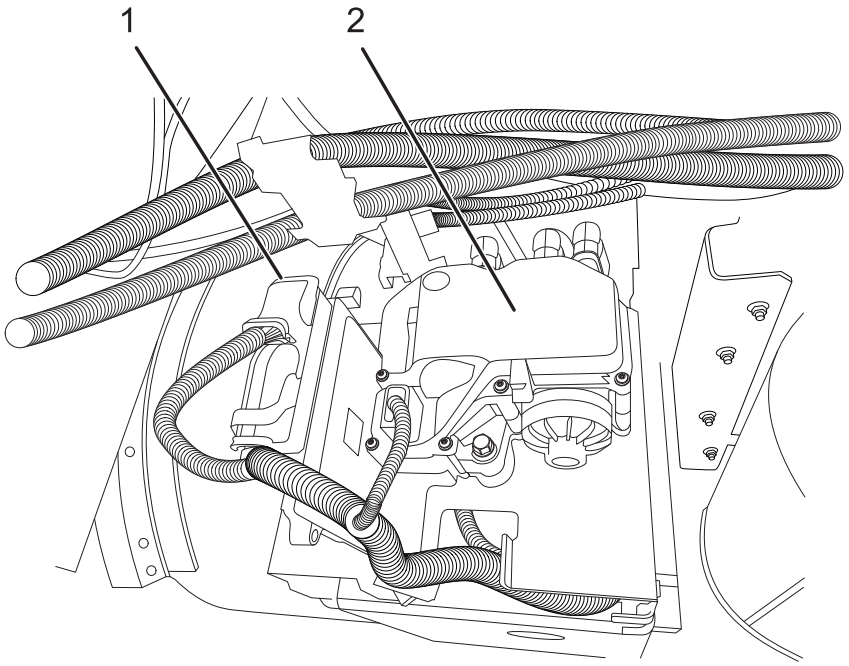

Figure 226 DEF Supply Module Location (typical)

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module

Step	Action	Decision
2	Inspect connections at DEF supply module. Key OFF, disconnect DEF supply module connectors. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5798 FMI 10.

Step	Action	Decision
3	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM connectors. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Leave connector J2 unplugged. Are the ACM connectors, harnesses, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5798 FMI 10.

Step	Action	Decision
4	Check for intermittent short to GND in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Key OFF, with ACM disconnected, use a DMM to measure resistance between Breakout Harness pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair intermittent short to GND in DEFSP Temp / CTL circuit between DEF supply module pin-10 and ACM pin J2-48.. After repairs are complete, retest for SPN 5798 FMI 10.

Step	Action	Decision
5	Check for intermittent short to PWR in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave supply module disconnected. Key-On Engine-Off (KOEO), with ACM disconnected, use a DMM to measure voltage between Breakout Harness pin-10 and a known good ground. Is voltage less than 1 volt?	Yes: Go to step 6. No: Repair intermittent short to PWR between DEF supply module pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 5798 FMI 10.

Step	Action	Decision
6	Check for intermittent Open or high resistance in DEFSP Temp / CTL circuit. Connect Breakout Harness 18-909-01 to DEF supply module harness, and leave DEF supply module disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-537-01 to ACM harness, and leave ACM disconnected. Using a DMM, measure resistance between Breakout Harness pin-10 and Breakout Box pin J2-48. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 5798 FMI 10. No: Repair intermittent Open or high resistance between DEF supply module pin-10 and ACM pin J2-48. After repairs are complete, retest for SPN 5798 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 5798 FMI 10 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

DEF: SP (Diesel Exhaust Fluid Supply Pump) Sensor

Overview of DEF: SP Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
3361	2	DEFSP signal erratic, intermittent or incorrect	• Failed Diesel Exhaust Fluid (DEF) supply module • DEFSP Temp / CTL circuit high resistance • DEFSP Temp / CTL circuit intermittent short to GND • DEFSP GND circuit high resistance • Power Distribution Module (PDM) loose fuse or relay	Step-Based Diagnostics (page 527)
3361	3	DEFSP signal Out of Range HIGH	• Failed DEF supply module • DEFSP Temp / CTL circuit short to PWR • DEFSP GND circuit high resistance or Open	Step-Based Diagnostics (page 531)
3361	4	DEFSP signal Out of Range LOW	• Failed DEF supply module • DEFSP Temp / CTL circuit Open or high resistance • DEFSP Temp / CTL circuit short to GND • DEFSP PWR circuit Open or high resistance	Step-Based Diagnostics (page 533)
3362	31	DEF dosing unable to prime	• Low DEF tank level • Failed DEF line heater • DEF tank, supply module, or doser valve line or connection loose, leaking, or damaged • Failed DEF supply module	Step-Based Diagnostics (page 535)

- Reversed DEF suction and return lines between DEF supply module and DEF tank.
- Debris in DEF tank
- DEF supply module suction line restricted

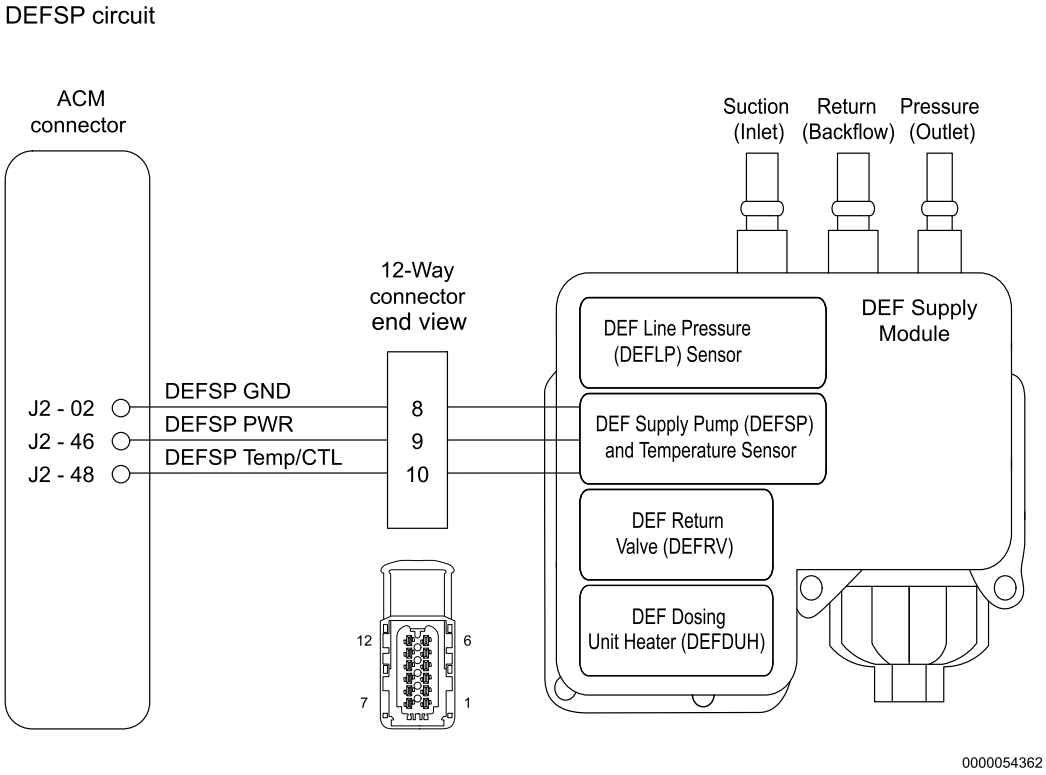

Figure 227 DEFSP Circuit Diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Supply Pump (DEFSP) is controlled using a PWM signal from the Aftertreatment Control Module (ACM). The DEFSP is installed in the DEF Supply Module and is a non-serviceable component. The DEF Supply Module has an internal temperature sensor used to monitor DEFSP temperature. When DEFSP temperature is too high, the ACM will deactivate the DEFSP.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- Supply Module Breakout Harness 18-909-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

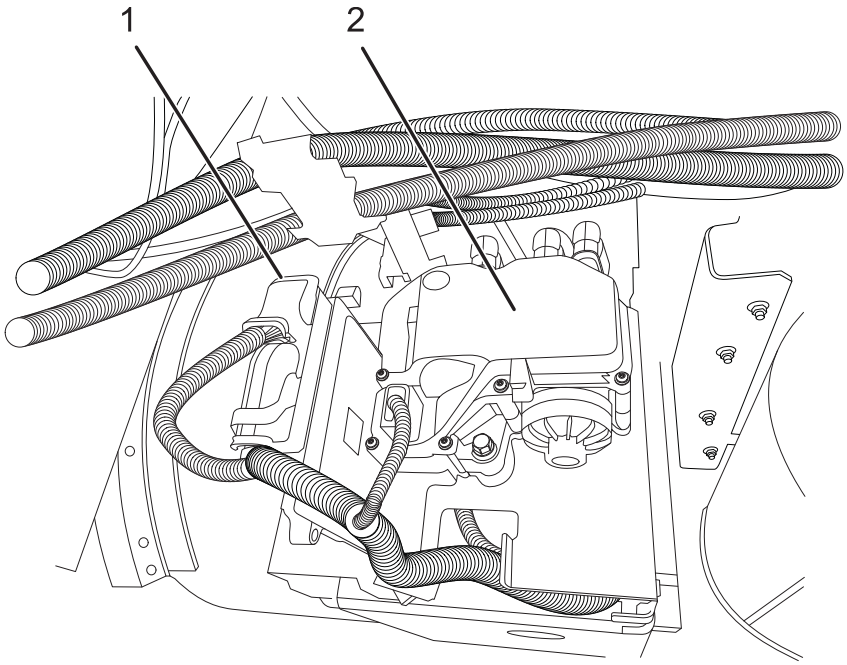

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Figure 228 DEF Supply Module Location

1. Aftertreatment Control Module (ACM)
2. Diesel Exhaust Fluid (DEF) supply module

SPN 3361 FMI 2 - DEF: SP Signal Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Loss of communication or invalid data from Diesel Exhaust Fluid Supply Pump (DEFSP).	Aftertreatment Control module (ACM) loses J1939 CAN data link communications with DEFSP or DEFSP temperature erratic.	Key ON Supply module in temperature feedback mode	0 seconds

Fault Overview

Fault code sets when the Diesel Exhaust Fluid Supply Pump (DEFSP) temperature is not communicated to the Aftertreatment Control Module (ACM) or is erratic. DEF injection into the exhaust system is disabled, and engine torque is reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 FMI 3 (DEFSP).

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 5 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSP circuit

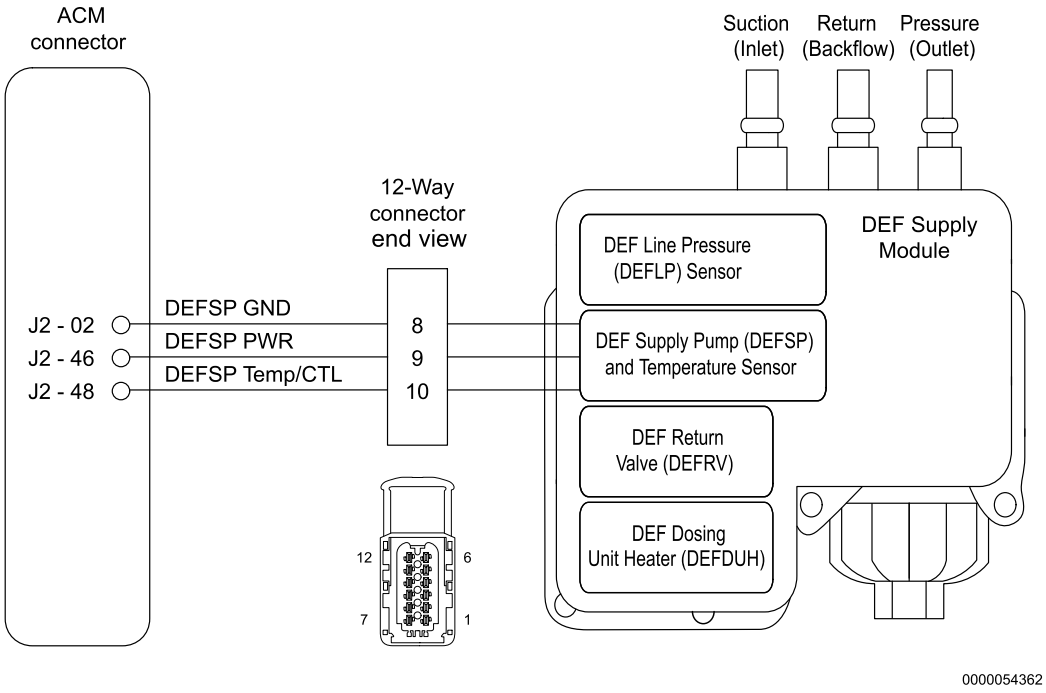

Figure 229 DEFSP Circuit Diagram

Possible Causes

- Failed Diesel Exhaust Fluid (DEF) supply module
- DEFSP Temp / CTL circuit high resistance
- DEFSP Temp / CTL circuit intermittent short to GND
- DEFSP GND circuit high resistance
- Power Distribution Module (PDM) loose fuse or relay

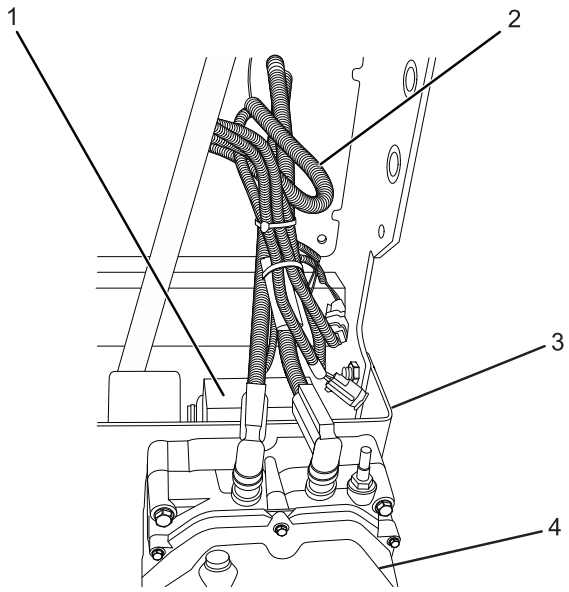

Figure 230 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 3361 FMI 2.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3361 FMI 2.

Step	Action	Decision
3	Check DEFSP Temp / CTL circuit for intermittent short to GND. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Use a DMM to measure resistance between Breakout Harness 18-909-01 pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair intermittent short to ground between DEF supply module connector pin–10 and ACM connector J2 pin-48. After repairs are complete, retest for SPN 3361 FMI 2.

Step	Action	Decision
4	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3361 FMI 2.

Step	Action	Decision
5	Check DEFSP Temp / CTL circuit for high resistance. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Connect 180-pin Breakout Box with ACM Breakout Harness 18-537-01 to Aftertreatment Control Module (ACM) and leave module disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-10 and 180-pin Breakout Box pin J2-48. Is resistance less than 5 ohms?	Yes: Go to step 6. No: Repair high resistance between DEF supply module pin–10 and ACM connector J2 pin–48. After repairs are complete, retest for SPN 3361 FMI 2

Step	Action	Decision
6	Check DEFSP GND circuit for high resistance. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Connect 180-pin Breakout Box with ACM Breakout Harness 18-537-01 to Aftertreatment Control Module (ACM) and leave module disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-8 and 180-pin Breakout Box pin J2-02. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 3361 FMI 2. No: Repair high resistance between DEF supply module pin-8 and ACM connector J2 pin–2. After repairs are complete, retest for SPN 3361 FMI 2.

NOTE: After doing all diagnostic steps, if SPN 3361 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3361 FMI 3 - DEF: SP Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEFSP Temp / CTL circuit voltage signal above normal, shorted to high source, or Open.	DEFSP Temp / CTL circuit voltage signal > 8.5 V	The DEF pump motor command is ON. The system has passed the DEF supply module temperature reading phase, and start controlling the DEF pump motor. DEF supply module power channel is ON. The DEF supply module power command is OFF.	4 seconds 2 seconds (Only when the DEF Supply Module power command is OFF)

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Supply Pump (DEFSP) is too high. DEF injection into the exhaust system is disabled, and engine torque is reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSP circuit

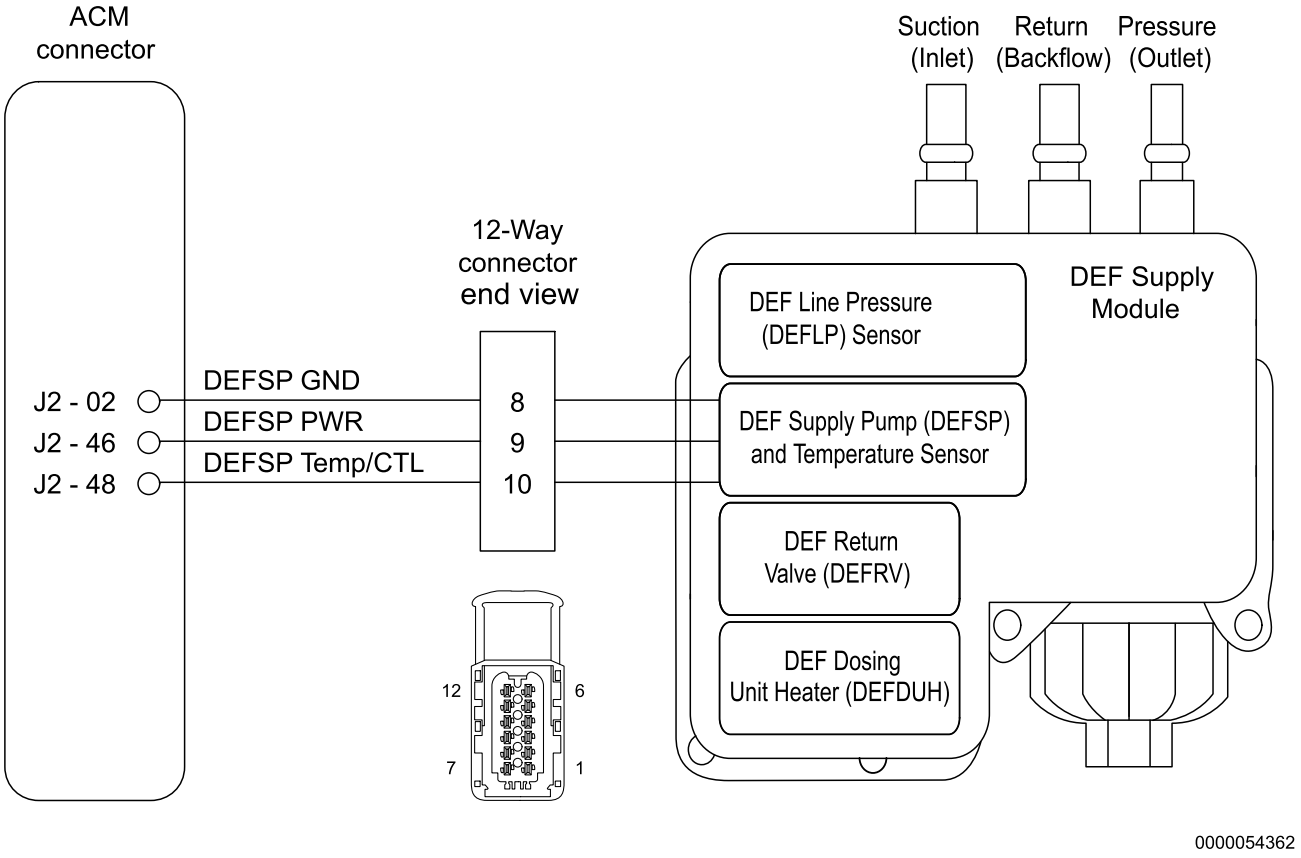

Figure 231 DEFSP Circuit Diagram

Possible Causes

- Failed DEF supply module
- DEFSP Temp / CTL circuit short to PWR
- DEFSP GND circuit high resistance or Open

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module 12-way connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3361 FMI 3.

Step	Action	Decision
2	Check DEFSP Temp / CTL circuit for short to PWR. Key-On Engine-Off (KOEO), with Breakout Harness 18-909-01 connected to Diesel Exhaust Fluid (DEF) supply module, use a DMM to measure voltage between DEF supply module pin-10 and a known good ground. Is voltage less than 8.5 volts?	Yes: Go to step 3. No: Repair short to PWR between DEF supply module connector pin-10 and ACM connector J2-48. After repairs are complete, retest for SPN 3361 FMI 3.

Step	Action	Decision
3	Check DEFSP GND circuit for high resistance or Open. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Connect 180-pin Breakout Box with ACM Breakout Harness 18-537-01 to Aftertreatment Control Module (ACM) and leave module disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 pin-8 and 180-pin Breakout Box pin J2-02. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 3361 FMI 3. No: Repair high resistance or Open between DEF supply module pin-8 and ACM connector J2-02. After repairs are complete, retest for SPN 3361 FMI 3.

NOTE: After doing all diagnostic steps, if SPN 3361 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3361 FMI 4 - DEF: SP Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEFSP Temp / CTL circuit voltage signal below normal or shorted to low source.	DEFSP Temp / CTL circuit voltage signal < 4.8 V	The system has passed the DEF Supply Module temperature reading phase, and start controlling the DEF pump motor. DEF Supply Module power channel is ON. The DEF Supply Module power command is ON.	4 seconds 2 seconds (Only when the DEF Supply Module power command is ON)

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Supply Pump (DEFSP) is too low. DEF injection into the exhaust system is disabled, and engine torque is reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSP circuit

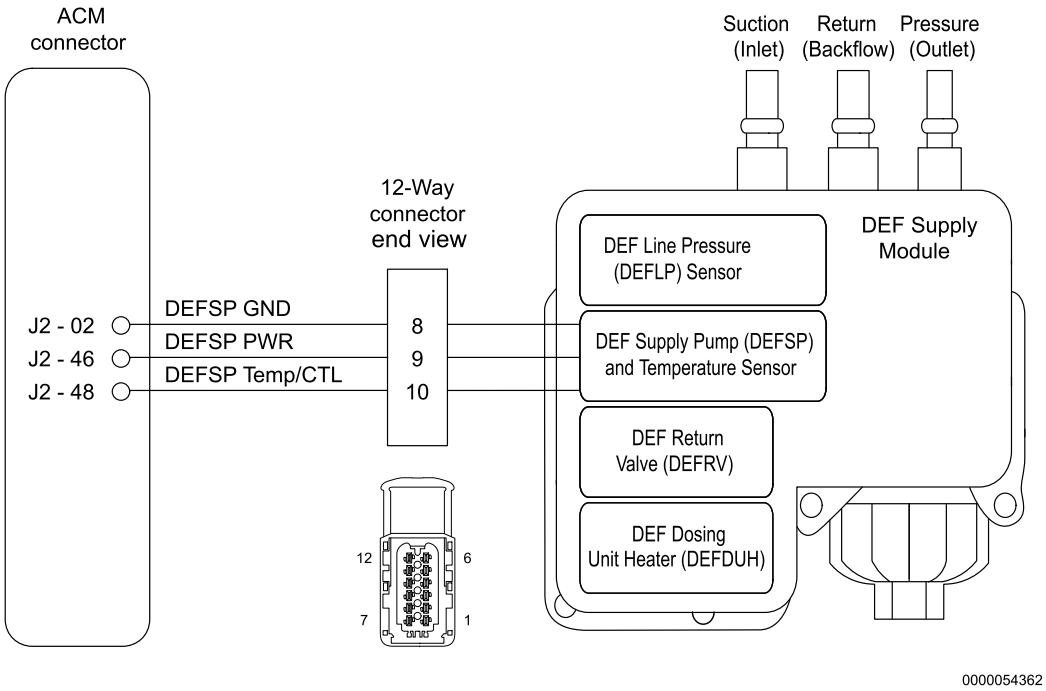

Figure 232 DEFSP Circuit Diagram

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid (DEF) supply module. Key OFF, disconnect DEF supply module 12-way connector. Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3361 FMI 4.

Step	Action	Decision
2	Check DEFSP Temp / CTL circuit for short to GND. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-909-01 pin-10 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to ground between DEF supply module connector pin-10 and ACM connector J2-48. After repairs are complete, retest for SPN 3361 FMI 4.

Step	Action	Decision
3	Check DEFSP PWR circuit for high resistance or Open. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Connect 180-pin Breakout Box with ACM Breakout Harness 18-537-01 to Aftertreatment Control Module (ACM) harness, and leave module disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness 18-909-01 pin-9 and 180-pin Breakout Box pin J2-46. Is resistance less than 5 ohms?	Yes: Go to step 4. No: Repair high resistance or Open between DEF supply module connector pin-9 and ACM connector J2-46. After repairs are complete, retest for SPN 3361 FMI 4.

Step	Action	Decision
4	Check DEFSP Temp / CTL circuit for high resistance or Open. Connect Breakout Harness 18-909-01 to DEF supply module and leave supply module disconnected. Connect 180-pin Breakout Box with ACM Breakout Harness 18-537-01 to Aftertreatment Control Module (ACM) harness, and leave module disconnected. Use a DMM to measure resistance from Breakout Harness 18-909-01 test pin-10 and 180-pin Breakout Box test J2-48. Is resistance less than 5 ohms?	Yes: Replace DEF supply module. After repairs are complete, retest for SPN 3361 FMI 4. No: Repair high resistance or Open between DEF supply module connector pin 10 and ACM connector J2-48. After repairs are complete, retest for SPN 3361 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 3361 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3362 FMI 31 - DEF Dosing Unable to Prime

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Checks whether the DEF dosing system fails to prime after a calibrated number of attempts.	DEF supply pressure does not exceed 29 PSI (200 kPa) within 200 seconds from the time DEF Supply Module has begun filling with DEF, or 200 seconds has elapsed since the DEF Supply Module has begun filling with DEF. DEF supply pressure does not remain between 116 PSI (800 kPa) and 145 PSI (1,000 kPa) for 3 seconds or longer for more than 5 times.	DEF Supply Module has begun filling with DEF Inactive: SPN 3361 FMI 3 and 4 (DEFSP), and SPN 4334 FMI 2, 3, and 4 (DEFLP).	0 seconds

Fault Overview

Fault code sets when the Diesel Exhaust Fluid Supply Pump (DEFSP) is unable to successfully build pressure or prime after multiple attempts.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1761 FMI 1 an 18 (DEFTLT), SPN 3363 FMI 7, 16, and 18 (DEFTHV), and SPN 4334 FMI 2, 16, and 18 (DEFLP).

Drive Cycle to Determine Fault Status

Drive Cycle 30 in 2013 HD-OBD Diagnostic Reference Manual.

DEFSP circuit

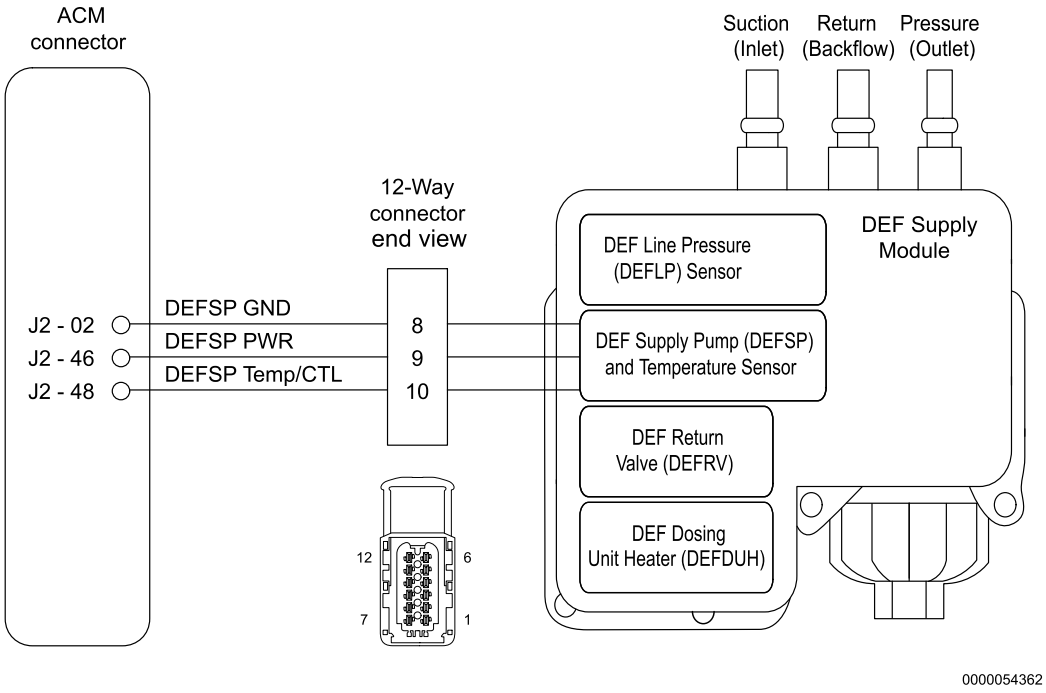

Figure 233 DEFSP Circuit Diagram

NOTE: Fault may set if the Diesel Exhaust Fluid (DEF) supply module was not allowed to shut down and purge fully following a recalibration of the Engine Control Module (ECM). A full key cycle that allows the dosing unit to purge, followed by a priming cycle, should correct this issue.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 FMI 1 and SPN 1761 FMI 18 (DEFTLT). Is EST DTC list free of 1761 FMI 1 and 18 (DEFTLT)?	Yes: Go to step 2. No: Repair SPN 1761 FMI 1 and 18. After repairs are complete, retest for SPN 3362 FMI 31.

Step	Action	Decision
2	Check DEF tank for debris or foreign particles. Also check DEF tank vent for restrictions or fluid crystallization. Are the DEF tank and DEF tank vent clean and free of debris, restrictions, and fluid crystallization?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and/or known good DEF. After repairs are complete, retest for SPN 3362 FMI 31.

Step	Action	Decision
3	Check for DEF line heater related faults. Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3363 FMI 7, 16, and 18 (DEFTHV). Is EST DTC list free of SPN 3363 FMI 7, 16, and 18 (DEFTHV)?	Yes: Go to step 4. No: Repair SPN 3363 FMI 7, 16, and 18. After repairs are complete, retest for SPN 3362 FMI 31.

Step	Action	Decision
4	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4334 FMI 2, 16, and 18 (DEFLP).	Yes: Go to step 5. No: Repair SPN 4334 FMI 2, 16, and 18. After repairs are

	Is EST DTC list free of SPN 4334 FMI 2, 16, and 18 (DEFLP) ?	complete, retest for SPN 3362 FMI 31.

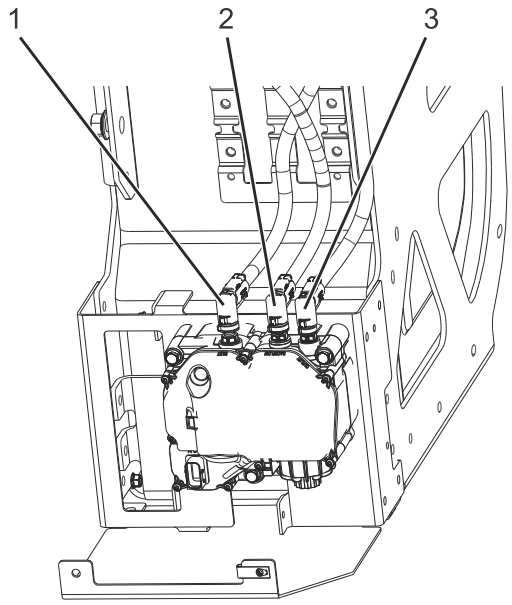

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Figure 234 DEF Supply Module Line Routing

1. DEF supply module suction line
2. DEF supply module return line
3. DEF supply module pressure line

Step	Action	Decision
5	Check DEF suction and return line are not reversed between DEF supply module and DEF tank. Verify suction and return lines are not swapped at DEF supply module or DEF tank. Are DEF suction and return lines correctly routed?	Yes: Go to step 6. No: Connect DEF suction and return lines to correct locations. After repairs are complete, retest for SPN 3362 FMI 31.

Step	Action	Decision
6	Check DEF tank, DEF supply module, and DEF doser valve lines and connections for: cracks and pitting; and loose, leaking, or damaged connections. Are DEF tank, DEF supply module, and DEF doser valve lines and connections in good condition?	Yes: Go to step 7. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 3362 FMI 31.

Step	Action	Decision
7	Check DEF supply module suction line for restrictions. Disconnect both ends of the suction line and blow compressed air through the supply line. Does compressed air flow freely through suction line?	Yes: Clean DEF supply module using 18-200-01 and perform drive cycle 30. See DEF Supply Module Flush . If SPN 3362 FMI 31 is still active, replace DEF supply module. After repairs are complete, retest for SPN 3362 FMI 31.
		No: Clean or replace DEF supply module suction line. After repairs are complete, retest for SPN 3362 FMI 31.

NOTE: After doing all diagnostic steps, if SPN 3362 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEF: THC Sensor

Overview of DEF: THC Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
3363	3	DEFTHV short to PWR (Open or high resistance)	• DEFTHV CTL short to PWR • DEFTHV CTL Open or high resistance • DEFTHV GND Open or high resistance • Failed Diesel Exhaust Fluid Tank Heater Valve (DEFTHV)	Step-Based Diagnostics (page 543)
3363	4	DEFTHV short to GND	• DEFTHV CTL short to GND • DEFTHV GND shorted to DEFTHV CTL • Failed DEFTHV	Step-Based Diagnostics (page 545)
3363	7	DEFTHV Mechanical system not responding or out of adjustment	• Failed DEFTHV (stuck closed) • Coolant line from DEFTHV to DEF tank leaking, damaged, kinked, or restricted • Coolant supply line to DEFTHV leaking, damaged, kinked, or restricted • Low engine coolant level	Step-Based Diagnostics (page 547)
3363	16	DEFTHV stuck on fault	• Failed DEFTHV (stuck open) • DEFTHV installed incorrectly (missing, bypassed, or reversed) • Failed Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module	Step-Based Diagnostics (page 549)

			• Auxiliary DEF tank heater installed	
3363	18	DEFTHV unable to thaw frozen DEF	• Failed DEFTHV (stuck closed) • Coolant line from DEFTHV to DEF tank leaking, damaged, kinked, or restricted • Coolant supply line to DEFTHV leaking, damaged, kinked, or restricted • Low engine coolant level	Step-Based Diagnostics (page 551)

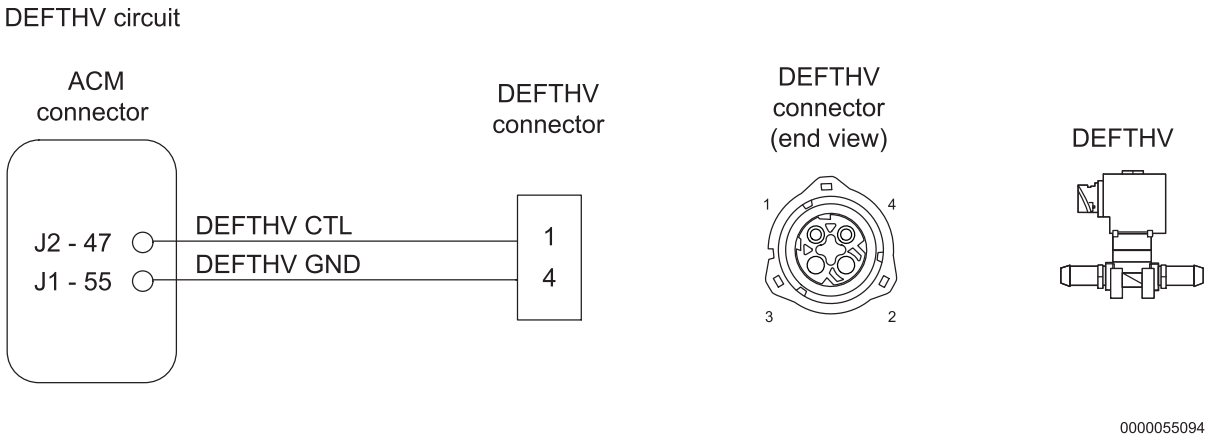

Figure 235 DEFTHV Circuit Diagram

Overview

The Diesel Exhaust Fluid Tank Heater Valve (DEFTHV) controls the flow of coolant to the DEF tank to thaw or prevent freezing of the DEF. When DEF temperature is low, the Aftertreatment Control Module (ACM) commands the DEFTHV open to allow coolant flow to the DEF tank. The ACM opens the DEFTHV by sending power through the DEFTHV CTL circuit. The DEFTHV GND circuit is constantly grounded through the ACM.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- Breakout Harness ZTSE4827
- Infrared Thermometer ZTSE4799
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software

- Interface cable (RP1210B compliant supporting J1939 and J1708)

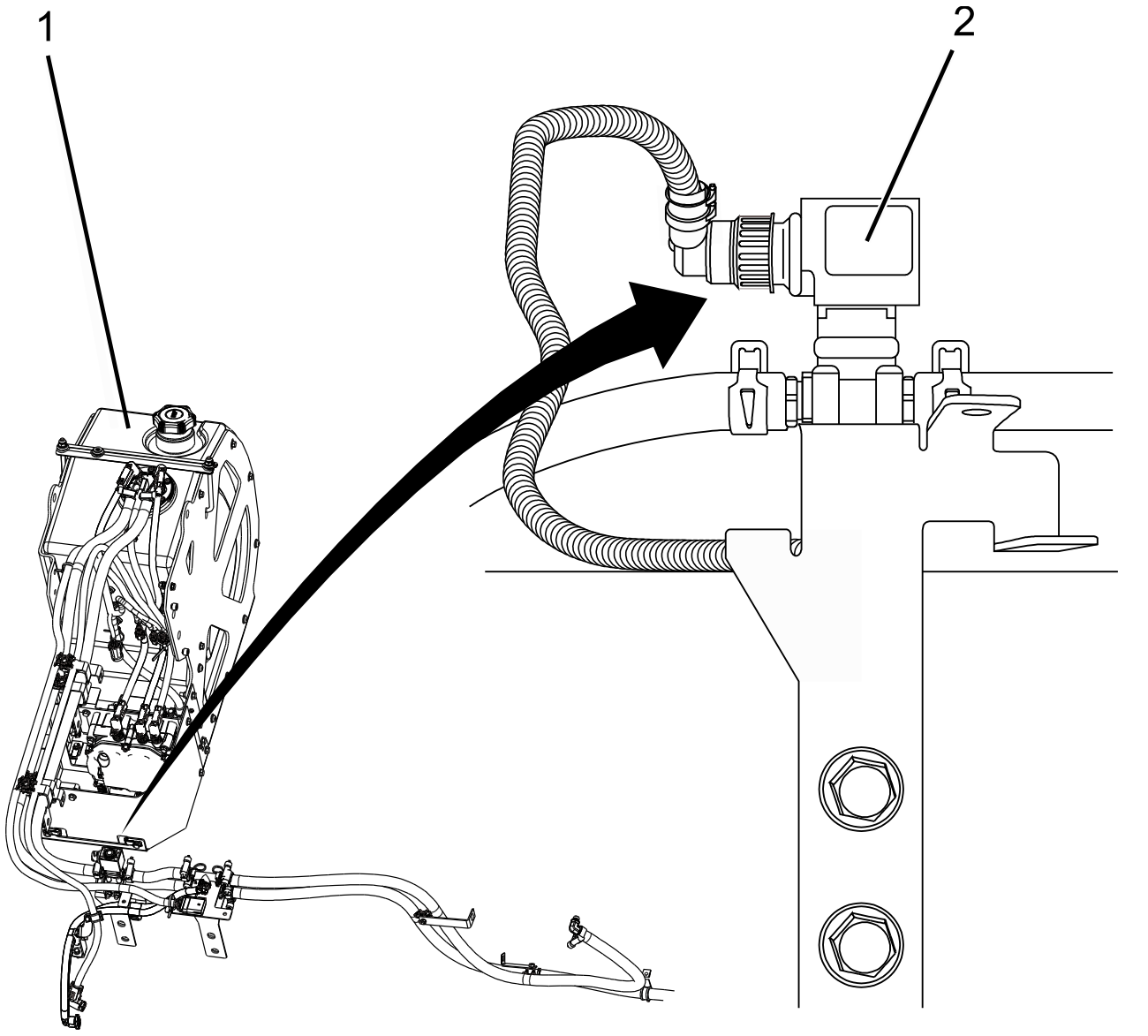

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Figure 236 DEFTHV Location (Typical)

1. Diesel Exhaust Fluid (DEF) tank
2. Diesel Exhaust Fluid Tank Heater Valve (DEFTHV)

SPN 3363 FMI 3 - DEF: THC Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid Tank Heater Valve (DEFTHV) control line is shorted to high source or open.	The resistance between DEFTHV GND and DEFTHV CTL > 500,000 ohms	Key ON	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Tank Heater Valve (DEFTHV) is high or open circuit. DEF tank heating is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

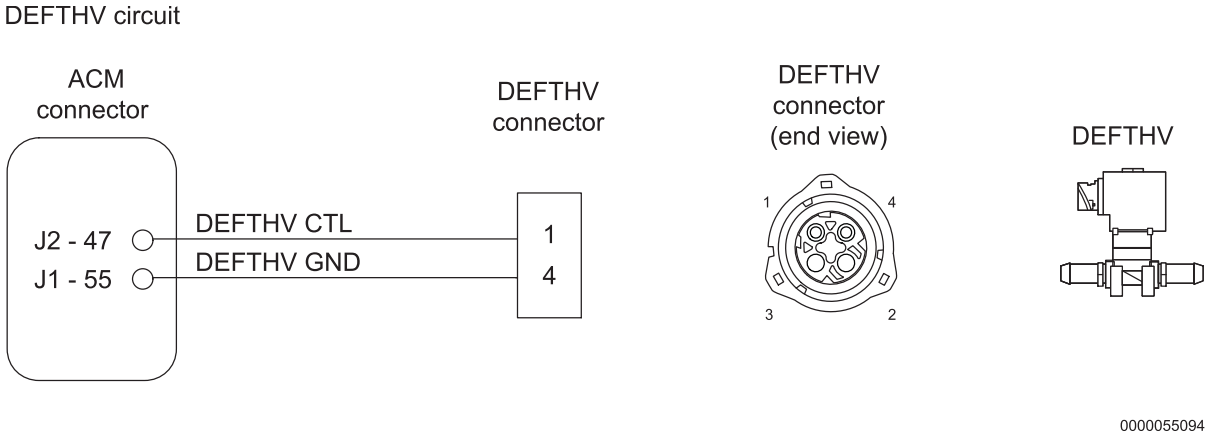

Figure 237 DEFTHV Circuit Diagram

Possible Causes

- DEFTHV CTL short to PWR
- DEFTHV CTL Open or high resistance
- DEFTHV GND Open or high resistance
- Failed DEFTHV

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Heater Valve (DEFTHV). Key OFF, disconnect DEFTHV. Check DEFTHV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTHV connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3363 FMI 3.

Step	Action	Decision
2	Check DEFTHV CTL circuit for short to power. Connect Breakout Harness ZTSE4827 to DEFTHV connector and leave DEFTHV disconnected. Key-On Engine-Off (KOEO), measure voltage between Breakout Harness ZTSE4827 pin-1 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 3. No: Repair short to power between DEFTHV pin-1 and Aftertreatment Control Module (ACM) connector J2-47. After repairs are complete, retest for SPN 3363 FMI 3.

Step	Action	Decision
3	Check DEFTHV CTL circuit for Open or high resistance. Connect Breakout Harness ZTSE4827 to DEFTHV connector and leave DEFTHV disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-537-01 to ACM harness and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4827 pin-1 and Breakout Box pin J2-47. Is resistance less than 5 ohms?	Yes: Go to step 4. No: Repair Open or high resistance between DEFTHV pin-1 and ACM connector J2-47. After repairs are complete, retest for SPN 3363 FMI 3.

Step	Action	Decision
4	Check DEFTHV GND circuit for Open or high resistance. Connect Breakout Harness ZTSE4827 to DEFTHV connector and leave DEFTHV disconnected. Connect 180-Pin Breakout Box and ACM Breakout Harness 18-537-01 to ACM harness and leave ACM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4827 pin-4 and Breakout Box pin J1-55. Is resistance less than 5 ohms?	Yes: Replace DEFTHV. After repairs are complete, retest for SPN 3363 FMI 3. No: Repair Open or high resistance between DEFTHV pin-4 and ACM connector J1-55. After repairs are complete, retest for SPN 3363 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3363 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3363 FMI 4 - DEF: THC Short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEFT T HTR CTL is shorted to ground.	The resistance between DEFTHV CTL and ground < 5 ohms	Key ON The Diesel Exhaust Fluid Tank Heater Valve (DEFTHV) is commanded ON.	3 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the voltage signal from the Diesel Exhaust Fluid Tank Heater Valve (DEFTHV) is low. DEF tank heating is disabled. Engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

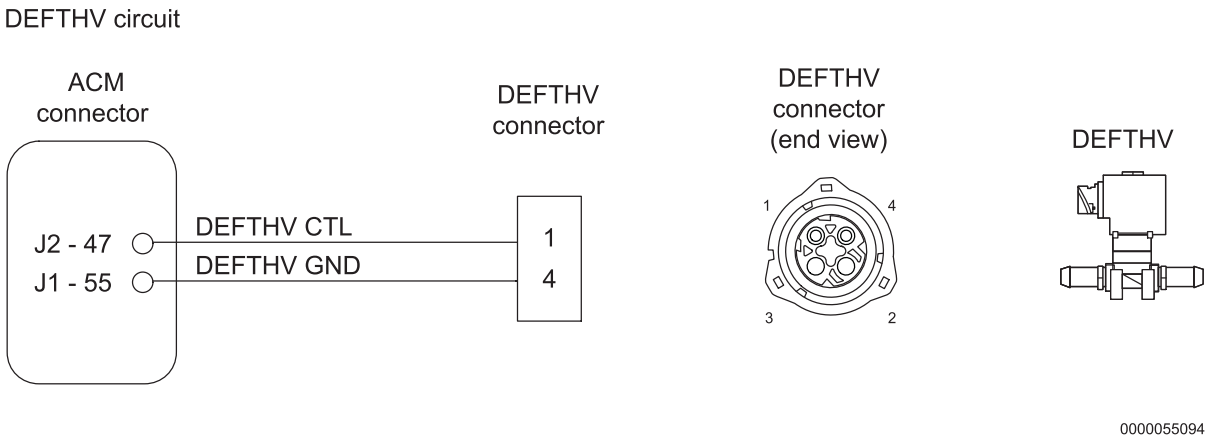

Figure 238 DEFTHV Circuit Diagram

Possible Causes

- DEFTHV CTL short to GND
- DEFTHV GND shorted to DEFTHV CTL
- Failed DEFTHV

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Heater Valve (DEFTHV). Key OFF, disconnect DEFTHV. Check DEFTHV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTHV connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3363 FMI 4.

Step	Action	Decision
2	Check DEFTHV CTL circuit for short to ground. Connect Breakout Harness ZTSE4827 to DEFTHV connector and leave DEFTHV disconnected. Key OFF, use a DMM to measure resistance between Breakout harness ZTSE4827 pin-1, and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to ground between DEFTHV connector pin-1 and ACM J2 connector pin-47. After repairs are complete, retest for SPN 3363 FMI 4.

Step	Action	Decision
3	Determine if DEFTHV GND circuit is shorted to DEFTHV CTL circuit. Connect Breakout Harness ZTSE4827 to DEFTHV connector and leave DEFTHV disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4827 pin-1 and pin-4. Is resistance greater than 1000 ohms?	Yes: Replace DEFTHV. After repairs are complete, retest for SPN 3363 FMI 4. No: Repair short between DEFTHV connector pin-1 and pin-4. After repairs are complete, retest for SPN 3363 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3363 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3363 FMI 7 - DEF: THC Mechanical System Not Responding or Out of Adjustment

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The monitor checks whether the DEF tank temperature does not rise when DEF tank heating is active.	The DEF tank temperature change < 4°F (2°C)	Key-On Engine-Running (KOER) Inactive: SPN 3031 FMI 2, 3, and 4, SPN 3363 FMI 3, and 4. DEF tank temperature between 50˚F (10˚C) and -31˚F (-35˚C) Coolant temperature > 158°F (70°C) Ambient air temperature > -22°F (-30°C) DEF tank heater commanded ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) commands the Diesel Exhaust Fluid Tank Heater Valve (DEFTHV) ON and the signal from the DEF Tank Level and Temperature (DEFTLT) sensor module does not show an increase in DEF temperature.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3031 FMI 2, 3, and 4 (DEFTLT), SPN 3363 FMI 3, and 4 (DEFTHV), SPN 4340 FMI 3, and 5 (DEFPLH), SPN 4342 FMI 5 (DEFRLH), SPN 4344 FMI 3, and 5 (DEFSLH), SPN 5745 FMI 3 and 4 (DEFDUH).

Drive Cycle to Determine Fault Status

Drive Cycle 23 in 2013 HD-OBD Diagnostic Reference Manual.

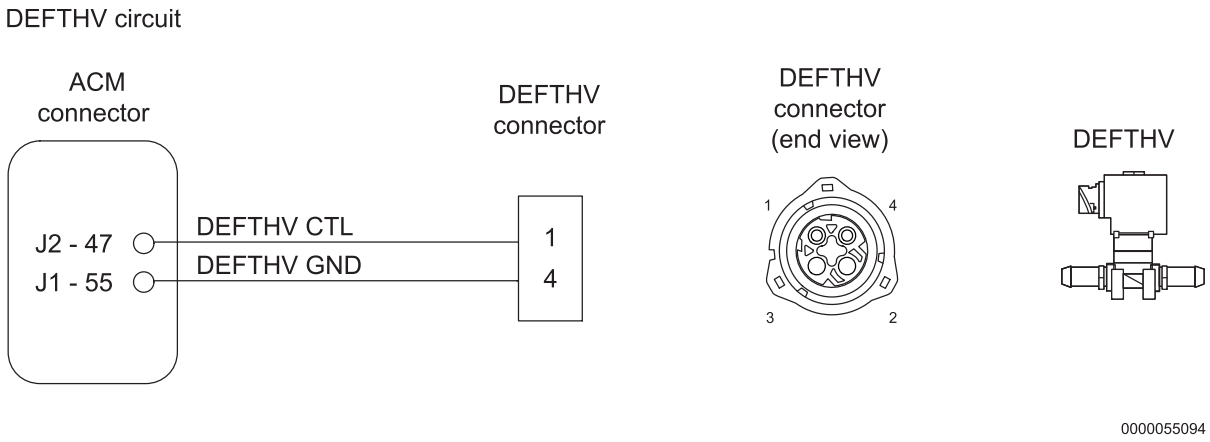

Figure 239 DEFTHV Circuit Diagram

Possible Causes

- Failed DEFTHV (stuck closed)
- Coolant line from DEFTHV to DEF tank leaking, damaged, kinked, or restricted
- Coolant supply line to DEFTHV leaking, damaged, kinked, or restricted
- Low engine coolant level

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3031 FMI 2, 3, and 4 (DEFTLT); SPN 3363 FMI 3 and 4 (DEFTHV); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); and SPN 5745 FMI 3 and 4 (DEFDUH). Is EST DTC list free of SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3 and 4; SPN 4340 FMI 3 and 5; SPN 4342 FMI 5; SPN 4344 FMI 3 and 5; and SPN 5745 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3 and 4; SPN 4340 FMI 3 and 5; SPN 4342 FMI 5; SPN 4344 FMI 3 and 5; and SPN 5745 FMI 3 and 4. After repairs are complete, retest for SPN 3363 FMI 7.

Step	Action	Decision
2	Check engine coolant level. Is engine coolant at the correct level?	Yes: Go to step 2. No: Add engine coolant as necessary. After repairs are complete, retest for SPN 3363 FMI 7.

Step	Action	Decision
3	Check coolant line from DEFTHV to DEF tank for leaks or damage; kinks or restrictions; loose connections; and leaking seals or gaskets. Is coolant line from DEFTHV to DEF tank unrestricted and in good condition?	Yes: Go to step 4.
		No: Repair or replace leaking or damaged coolant line from DEFTHV to DEF tank, fittings, or seals. Check engine coolant level and add as necessary. After repairs are complete, retest for SPN 3363 FMI 7.

Step	Action	Decision
4	Check coolant supply line to DEFTHV for leaks or damage; kinks or restrictions; loose connections; and leaking seals or gaskets. Is coolant line from DEFTHV to DEF tank unrestricted and in good condition?	Yes: Replace DEFTHV. After repairs are complete, retest for SPN 3363 FMI 7.
		No: Repair or replace leaking or damaged coolant line from DEFTHV to DEF tank, fittings, or seals. Check engine coolant level and add as necessary. After repairs are complete, retest for SPN 3363 FMI 7.

NOTE: After performing all diagnostic steps, if SPN 3363 FMI 7 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3363 FMI 16 - DEF: THC Stuck on Fault

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank heater circuit OK but DEF temperature above normal operating range.	Aftertreatment Control Module (ACM) determines Diesel Exhaust Fluid Tank Heater Valve (DEFTHV) is ON when commanded OFF.	Key ON DEF tank temperature > 170°F (77°C)	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) determines the Diesel Exhaust Fluid Tank Heater Valve (DEFTHV) is ON when commanded OFF due to DEF tank temperature above 170°F (77°C). Engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3031 FMI 2, 3, and 4 (DEFTLT), SPN 3363 FMI 3, and 4 (DEFTHV).

Fault Facts

If there is a problem with the DEFTHV, such as the valve stuck open, coolant leaking past the valve seat, or the valve is incorrectly installed, it can take long periods of operation at high load before tank temperature gradually increases to the fault code threshold of 170°F (77°C). When the temperature drops below 167°F (75°C) due to a stopped engine, overnight parking, or reduced coolant temperature, the fault code will go inactive while the root cause of the issue is still present.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

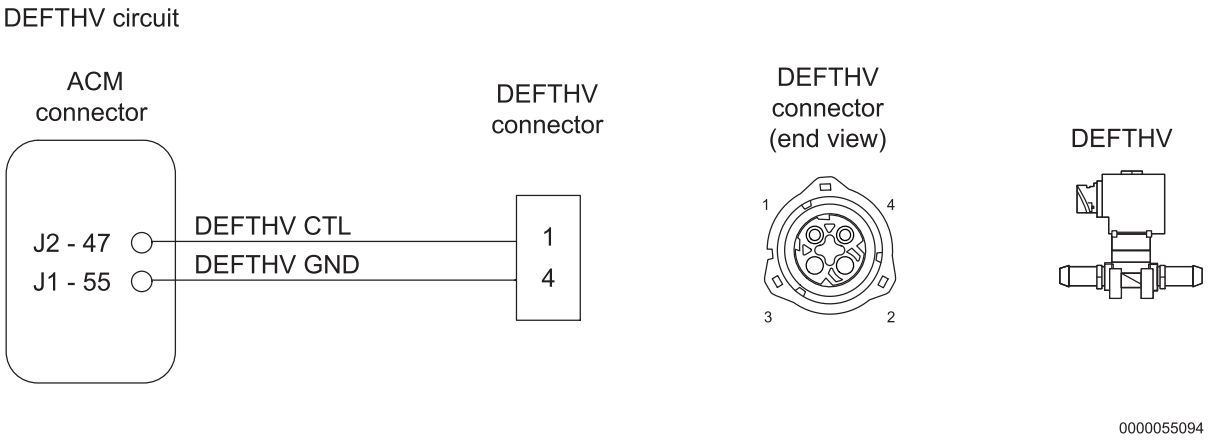

Figure 240 DEFTHV Circuit Diagram

Possible Causes

- Failed DEFTHV (stuck open)
- DEFTHV installed incorrectly (missing, bypassed, or reversed)
- Failed Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module
- Auxiliary DEF tank heater installed

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3031 FMI 2, 3, and 4 (DEFTLT); SPN 3363 FMI 3, and 4 (DEFTHV). Is EST DTC list free of SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3, and 4?	Yes: Go to step 2. No: Repair SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3, and 4. After repairs are complete, retest for SPN 3363 FMI 16.

Step		Decision
2	Inspect vehicle for an auxiliary Diesel Exhaust Fluid (DEF) tank heater. Is vehicle free of an auxiliary DEF tank heater?	Yes: Go to step 3. No: Remove auxiliary DEF tank heater. After repairs are complete, retest for SPN 3363 FMI 16.

Step	Action	Decision
3	Check for failed Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module. Using EST with ServiceMaxx software, load the signals session and monitor the DEF Tank Temp signal. Measure DEF tank temperature using Infrared Thermometer ZTSE4799 from the bottom of the DEF tank. Is EST reading within 18°F (10°C) of Infrared Thermometer reading?	Yes: Go to step 4. No: Replace DEFTLT sensor. After repairs are complete, retest for SPN 3363 FMI 16.

Step	Action	Decision
4	Verify Diesel Exhaust Fluid Tank Heater Valve (DEFTHV) is installed correctly (not missing, bypassed, or reversed). Is the DEFTHV installed correctly?	Yes: Replace DEFTHV. After repairs are complete, retest for SPN 3363 FMI 16. No: Install DEFTHV correctly (see Exhaust System Service Manual). After repairs are complete, retest for SPN 3363 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 3363 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3363 FMI 18 - DEF: THC Unable to Thaw Frozen DEF

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank temperature has failed to reach a target threshold within a predetermined time after heating is commanded.	The DEF tank temperature remains less than 19°F (-7°C) after the DEF tank heating is commanded active.	Key-On Engine-Running (KOER) Inactive: SPN 3031 FMI 2, 3, and 4, SPN 3363 FMI 3, and 4. DEF tank temperature between 50°F (10°C) and -31°F (-35°C) Coolant temperature > 158°F (70°C) Ambient air temperature > -22°F (-30°C) DEF tank heater commanded ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) determines the Diesel Exhaust Fluid Tank Heater Valve (DEFTHV) has been on long enough to thaw the DEF, but the DEF dosing system is unable to prime.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3031 FMI 2, 3, and 4 (DEFTLT), SPN 3363 FMI 3, and 4 (DEFTHV).

Drive Cycle to Determine Fault Status

Drive Cycle 24 in 2013 HD-OBD Diagnostic Reference Manual.

DEFTHV circuit

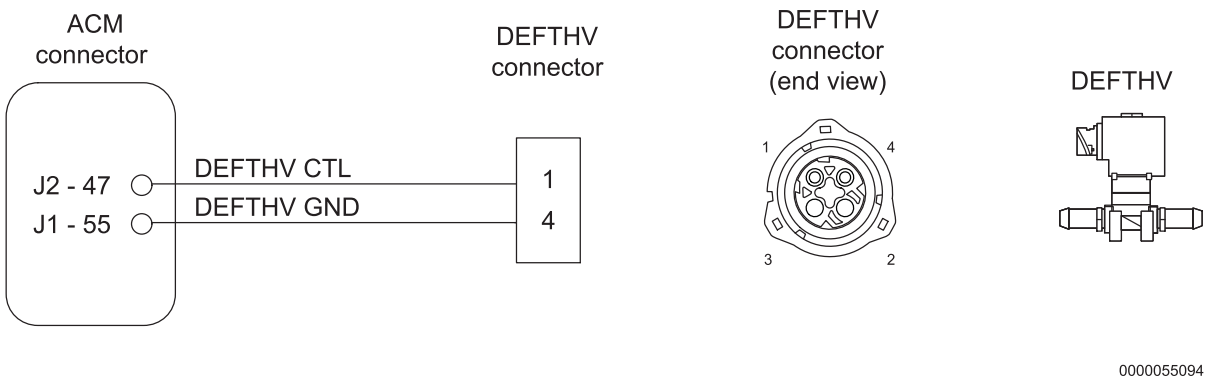

Figure 241 DEFTHV Circuit Diagram

Possible Causes

- Failed DEFTHV (stuck closed)
- Coolant line from DEFTHV to DEF tank leaking, damaged, kinked, or restricted
- Coolant supply line to DEFTHV leaking, damaged, kinked, or restricted
- Low engine coolant level

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3031 FMI 2, 3, and 4 (DEFTLT), SPN 3363 FMI 3, and 4 (DEFTHV). Is EST DTC list free of SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3, and 4?	Yes: Go to step 2. No: Repair SPN 3031 FMI 2, 3, and 4; SPN 3363 FMI 3, and 4. After repairs are complete, retest for SPN 3363 FMI 18.

Step	Action	Decision
2	Check engine coolant level. Is engine coolant at the correct level?	Yes: Go to step 3. No: Add engine coolant as necessary. After repairs are complete, retest for SPN 3363 FMI 18.

Step	Action	Decision
3	Check coolant line from DEFTHV to DEF tank for leaks or damage; kinks or restrictions; loose connections; and leaking seals or gaskets. Is coolant line from DEFTHV to DEF tank unrestricted and in good condition?	Yes: Go to step 4.
		No: Repair or replace leaking or damaged coolant line from DEFTHV to DEF tank, fittings, or seals. Check engine coolant level and add as necessary. After repairs are complete, retest for SPN 3363 FMI 18.

Step	Action	Decision
4	Check coolant supply line to DEFTHV for leaks or damage; kinks or restrictions; loose connections; and leaking seals or gaskets. Is coolant line from DEFTHV to DEF tank unrestricted and in good condition?	Yes: Replace DEFTHV. After repairs are complete, retest for SPN 3363 FMI 18.
		No: Repair or replace leaking or damaged coolant line from DEFTHV to DEF tank, fittings, or seals. Check engine coolant level and add as necessary. After repairs are complete, retest for SPN 3363 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 3363 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEF: TL Sensor

Overview of DEF: TL Sensor Group

SPN	FMI	Description
1761	1	Def level system warn and protection inducement (page 556)
1761	3	DEF: TL signal Out of Range HIGH (page 558)
1761	4	DEF: TL signal Out of Range LOW (page 560)
1761	10	DEF Level abnormal rate of change (page 562)
1761	11	DEF: TL signal erratic, intermittent, or incorrect (page 565)
1761	17	DEF: TL Inducement Level 1 (page 569)
1761	18	DEF: TL Inducement Level 2 (page 571)
1761	19	DEF: TL not detected on J1939 (page 573)

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module is a combination sensor used to monitor DEF tank level and temperature. The DEFTLT sensor module is installed inside the DEF tank and is a smart sensor that communicates to the Aftertreatment Control Module (ACM) through the J1939 Private CAN.

DEF Tank Level Inducement (Level 1–5).

- **Level 1**: SPN 1761 FMI 17 active, no lamp
- **Level 2**: SPN 1761 FMI 18 active, no lamp
- **Level 3–4** SPN 1761 FMI 1 active, Red Stop Lamp (RSL) active

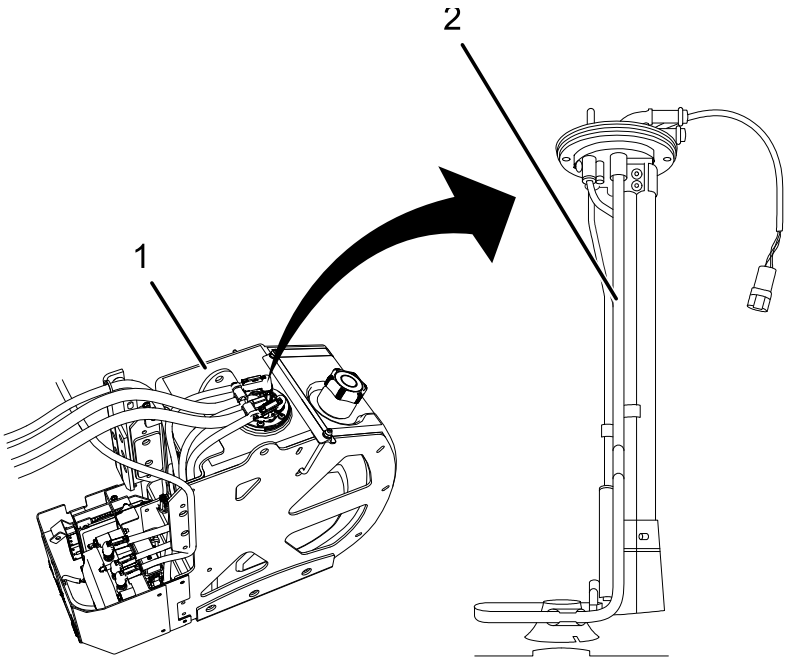

Figure 242 DEFTLT location

1. Diesel Exhaust Fluid (DEF) tank
2. Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module

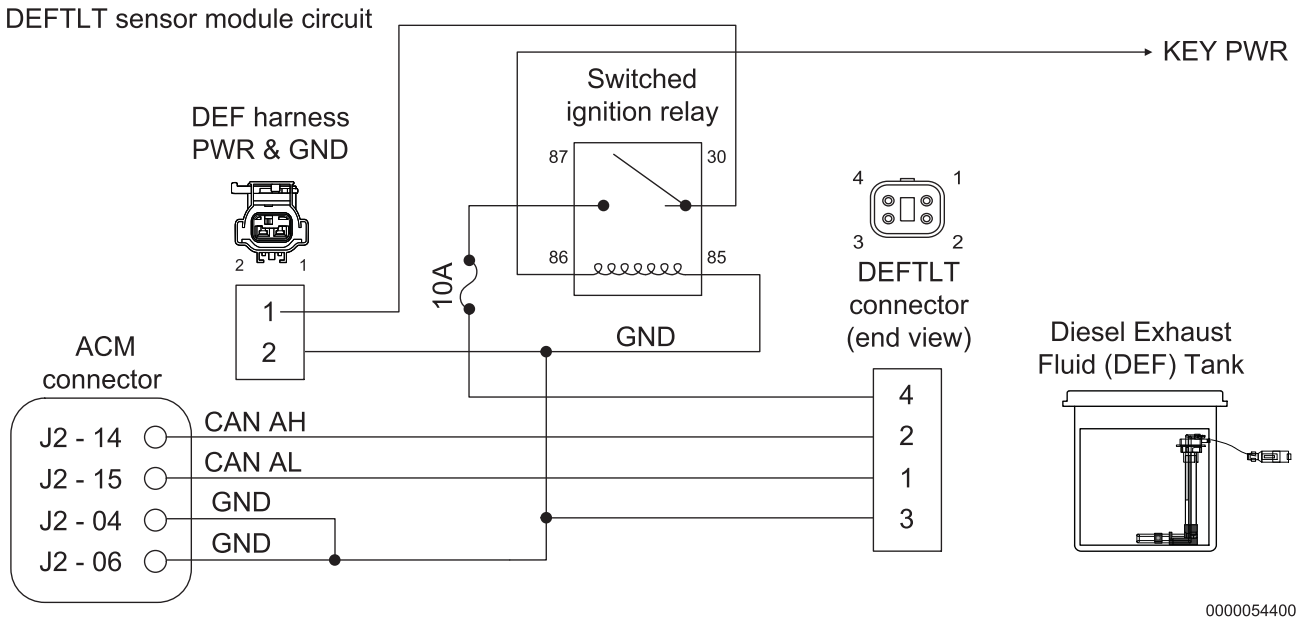

Figure 243 DEFTLT Sensor Module Circuit Diagram

SPN 1761 FMI 1 - DEF: TL Inducement (Level 3 - 4)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) level below critical threshold. Level 3 through 4 inducement.	DEF tank level = 0%	Engine Running	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Level (DEFTL) is equal to 0%. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced after extended engine operation with the fault code active. Five MPH Vehicle Speed Limit will be activated on Key OFF/ON event OR Fuel Refill OR when idling for 60 minutes while DEF level equals 0%.

Lamp Reaction

Red Stop Lamp (RSL) will illuminate after fault has been active for a set period of time.

Associated Faults

SPN 1761 FMI 3, 4, and 19 (DEFTLT)			

Fault Facts

This fault usually indicates there is no DEF in the DEF tank. Refilling the DEF tank with approved DEF will cause the fault to go inactive. This fault may become active during control module programming. To fix this occurrence, finish programming, then cycle ignition switch.

Drive Cycle to Determine Fault Status

Road Test

Possible Causes

- Low DEF tank level
- Failed Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module

Step 1	Check for associated faults..	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 556).		Yes: Go to Step 2.
Is EST DTC list free of Associated Faults?		No: Repair Associated Faults. After repairs are complete, retest for SPN 1761 FMI 1.

Step 2	Check for damaged Diesel Exhaust Fluid (DEF) tank and DEF lines	Decision
Inspect DEF tank and lines for damage and leaks.		Yes: Go to Step 3.
Are the DEF tank and lines free of damage and not leaking?		No: Repair damaged or leaking DEF tank and lines. After repairs are complete, retest for SPN 1761 FMI 1.

Step 3	Check DEF tank level.	Decision
Read DEF level using the vehicle instrument panel gauge and perform a visual inspection of fluid level in the DEF tank.		Yes: Go to Step 4.
Is DEF tank fluid level above 1/2 tank?		No: Fill DEF tank with appropriate diesel exhaust fluid. After repairs are complete, retest for SPN 1761 FMI 1.

Step 4	Inspect connections at DEF Tank Level (DEFTL).	Decision
A. Key OFF. B. Disconnect DEFTL connector. C. Check DEFTL and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Replace DEFTL sensor. After repairs are complete, retest for SPN 1761 FMI 1.
Are DEFTL connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 1.

End Diagnostic Steps
After performing diagnostic steps, if SPN 1761 FMI 1 remains, verify if step was completed correctly and proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 3 - DEFTL Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Exhaust Fluid Tank Level (DEFTL) sensor circuit voltage above normal or shorted to high source.	Aftertreatment Control Module (ACM) detects DEFTL signal voltage is greater than expected for more than 10 second.	Key ON

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects Diesel Exhaust Fluid Tank Level (DEFTL) signal voltage is greater than expected for 10 second. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced after extended engine operation with fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during first drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed DEFTLT sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 1761 FMI 3. Is EST DTC list SPN 1761 FMI 3 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Diesel Exhaust Fluid Tank Level (DEFTL) sensor.	Decision
A. Key OFF. B. Disconnect DEF Tank Level and Temperature (DEFTLT) sensor connector. C. Check DEFTLT sensor and connector terminals for damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Replace DEFTLT sensor. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 1761 FMI 3.
Are DEFTLT sensor connector, harness, and terminal clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 1761 FMI 3.

End Diagnostic Steps
After performing diagnostic steps, if SPN 1761 FMI 3 remains, verify if step was completed correctly and proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 4 - DEFTL Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Exhaust Fluid Tank Level (DEFTL) sensor circuit voltage below normal or shorted to low source.	Aftertreatment Control Module (ACM) detects DEFTL signal voltage is less than 0.25 volts for more than 1 second.	Key ON

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects Diesel Exhaust Fluid Tank Level (DEFTL) sensor signal voltage is less than 0.25 volts for more than 1 second. Engine torque will be reduced if fault is active for a limited period of time.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during first drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed DEFTLT sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 1761 FMI 3. Is EST DTC list SPN 1761 FMI 3 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module.	Decision
A. Key OFF. B. Disconnect DEFTLT sensor module connector. C. Check DEFTLT sensor module and connector terminals for damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DEFTLT sensor module connector, harness, and terminal clean and undamaged?		Yes: Replace DEFTLT sensor module. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 1761 FMI 4. No: Repair connector, harness, or terminal damage. After repairs are complete, perform the SCR Maintenance Reset Procedure (page 1615) and retest for SPN 1761 FMI 4.

End Diagnostic Steps
After performing diagnostic steps, if SPN 1761 FMI 4 remains, verify if step was completed correctly and proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 10 - DEF Level Abnormal Rate of Change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank level sensor circuit abnormal rate of change. A valid DEF tank level reading has not been received.	DEF tank level reading was invalid for an extended period of time.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Level (DEFTL) signal is invalid for an extended period of time. Engine torque will be reduced if fault is active for a limited period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1761 FMI 3, 4, and 19 (DEFTLT).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

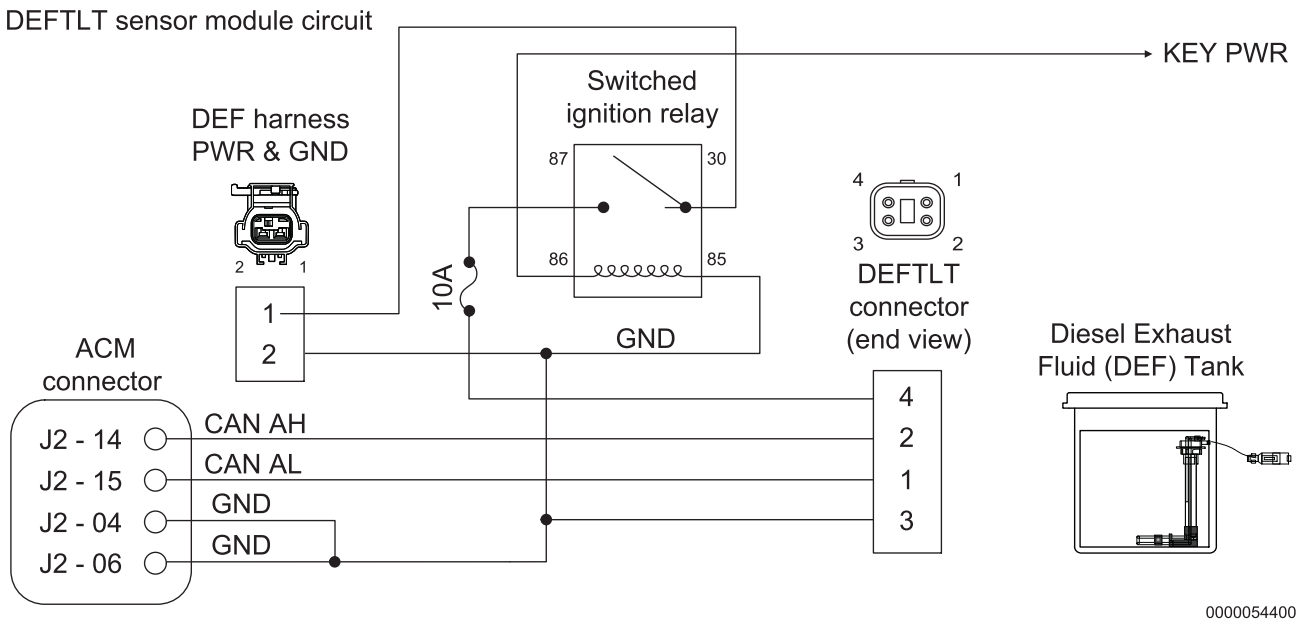

Figure 244 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 FMI 3, 4, and 19 (DEFTLT). Is EST DTC list free of SPN 1761 FMI 3, 4, and 19?	Yes: Go to step 2. No: Repair SPN 1761 FMI 3, 4, and 19. After repairs are complete, retest for SPN 1761 FMI 10.

Step	Action	Decision
2	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 10. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 10.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 11 - DEF: TL Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank level sensor circuit abnormal rate of change. A valid DEF tank level reading has not been received.	DEF tank level reading was invalid for an extended period of time.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Level (DEFTL) signal is invalid for an extended period of time. Engine torque will be reduced if fault is active for a limited period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1761 FMI 3, 4, and 19 (DEFTLT).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

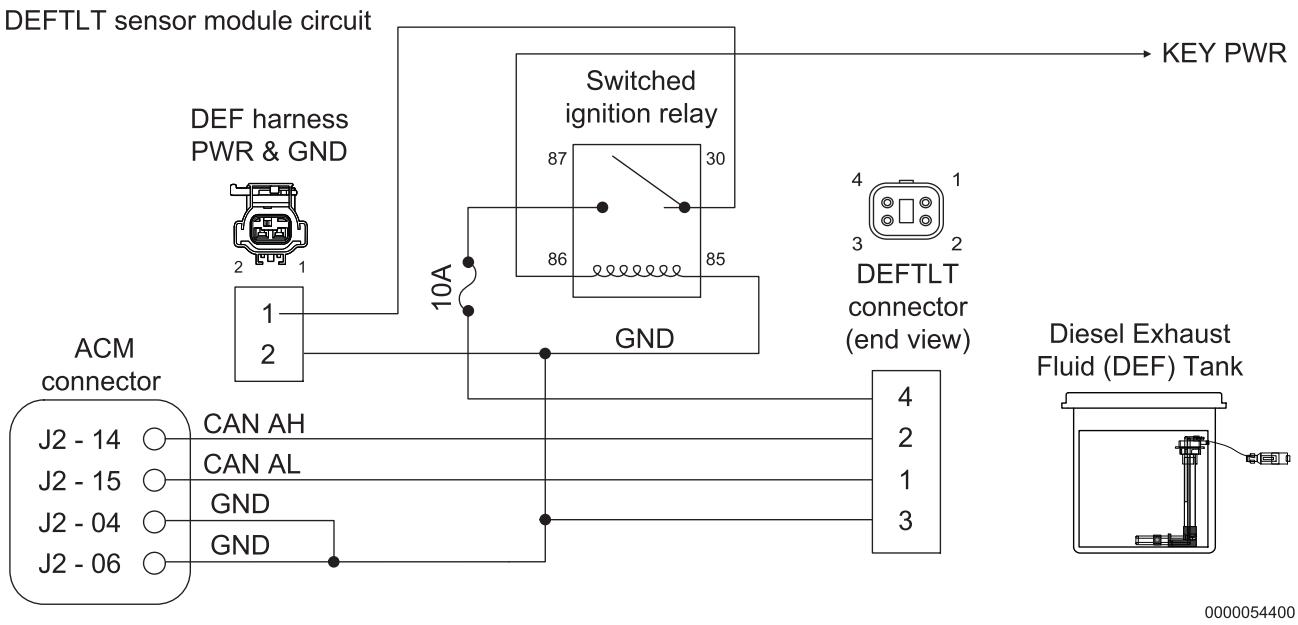

Figure 245 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module
- SWBAT circuit intermittent short to GND or high resistance
- Power Distribution Module (PDM) loose fuse or relay
- GND circuit intermittent high resistance or Open

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 FMI 3, 4, and 19 (DEFTLT). Is EST DTC list free of SPN 1761 FMI 3, 4, and 19?	Yes: Go to step 2. Repair SPN 1761 FMI 3, 4, and 19. After repairs are complete, retest for SPN 1761 FMI 11

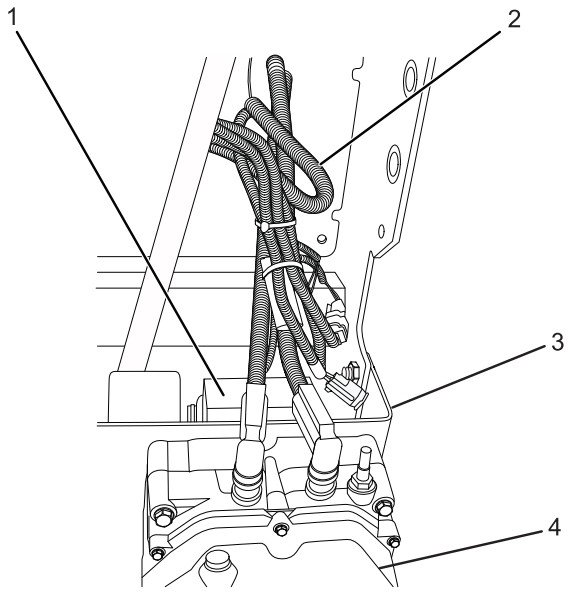

Figure 246 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
2	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 3.
		No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN retest for SPN 1761 FMI 11.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 11.

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits with the DEFTLT sensor module:

- NOx OUT sensor module
- NOx IN sensor module
- Ammonia (NH_3) Sensor Module
- SCR Temperature Sensor Module
- DOC / DPF temperature sensor module

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
4	Check voltage to the DEFTLT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-124-01 connected to DEFTLT sensor module, use a DMM to measure voltage between DEFTLT sensor module pin-3 and pin-4.	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 11.
	Is voltage within 0.5 volts of battery voltage?	No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for intermittent high resistance or short to ground. Connect Breakout Harness 18–124–01 and leave DEFTLT sensor module disconnected. (KOEO), measure voltage between Breakout Harness 18-124-01 pin-4 and a known good ground (wiggle test may be necessary if code is inactive or pending).	Yes: Repair high resistance between DEFTLT sensor module pin-3 and ground. After repairs are complete, retest for SPN 1761 FMI 11.
	Is voltage within 0.5 volts of battery voltage?	No: Repair high resistance or short to ground between DEFTLT sensor module pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 1761 FMI 11.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 11 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 17 - DEF: TL Inducement Level 1

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Exhaust Fluid (DEF) level below critical threshold. Level 1 inducement.	DEFTL > 2.2% and 5.6% full	Engine Running

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Diesel Exhaust Fluid Tank Level (DEFTL) is between > 2.2% and ≤ 5.6%.

Lamp Reaction

No Malfunction Indicator Lamp (MIL) will illuminate after fault is active.

Associated Faults

SPN 1761 FMI 3, 4, and 19 (DEFTLT)			

Fault Facts

This fault usually indicates there is no DEF in the DEF tank. Refilling the DEF tank with approved DEF will cause the fault to go inactive. This fault may become active during control module programming. To fix this occurrence, finish programming, then cycle ignition switch.

Drive Cycle to Determine Fault Status

Road Test

Possible Causes

- Low DEF tank level
- Failed Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module

Step 1	Check for associated faults..	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 569).		Yes: Go to Step 2.
Is EST DTC list free of Associated Faults?		No: Repair Associated Faults. After repairs are complete, retest for SPN 1761 FMI 17.

Step 2	Check for damaged Diesel Exhaust Fluid (DEF) tank and DEF lines	Decision
Inspect DEF tank and lines for damage and leaks.		Yes: Go to Step 3.
Are the DEF tank and lines free of damage and not leaking?		No: Repair damaged or leaking DEF tank and lines. After repairs are complete, retest for SPN 1761 FMI 17.

Step 3	Check DEF tank level.	Decision
Read DEF level using the vehicle instrument panel gauge and perform a visual inspection of fluid level in the DEF tank.		Yes: Go to step 4.
Is DEF tank fluid level above 1/2 tank?		No: Fill DEF tank with appropriate diesel exhaust fluid. After repairs are complete, retest for SPN 1761 FMI 17.

Step 4	Inspect connections at DEF Tank Level (DEFTL).	Decision
A. Key OFF. B. Disconnect DEFTL connector. C. Check DEFTL and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Replace DEFTL sensor. After repairs are complete, retest for SPN 1761 FMI 17.
Are DEFTL connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 17.

End Diagnostic Steps
After performing diagnostic steps, if SPN 1761 FMI 17 remains, verify if step was completed correctly and proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 18 - DEF: TL Inducement Level 2

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Exhaust Fluid (DEF) level below critical threshold. Level 2 inducement.	DEF tank level ≤ 2.2% and > 0%.	Engine Running

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Level (DEFTL) is less than or equal to 2.2% and greater than 0% of being full. Engine torque will be reduced if fault is active for a limited period of time.

Lamp Reaction

No Malfunction Indicator Lamp (MIL) with active fault.

Associated Faults

SPN 1761 FMI 3, 4, and 19 (DEFTLT)			

Fault Facts

This fault usually indicates there is no DEF in the DEF tank. Refilling the DEF tank with approved DEF will cause the fault to go inactive. This fault may become active during control module programming. To fix this occurrence, finish programming, then cycle ignition switch.

Drive Cycle to Determine Fault Status

Road Test.

Possible Causes

- Low DEF tank level
- Failed DEFTLT sensor module

Step 1	Check for associated faults..	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 571).		Yes: Go to Step 2.
Is EST DTC list free of Associated Faults?		No: Repair Associated Faults. After repairs are complete, retest for SPN 1761 FMI 18.

Step 2	Check for damaged Diesel Exhaust Fluid (DEF) tank and DEF lines	Decision
Inspect DEF tank and lines for damage and leaks.		Yes: Go to Step 3.
Are the DEF tank and lines free of damage and not leaking?		No: Repair damaged or leaking DEF tank and lines. After repairs are complete, retest for SPN 1761 FMI 18.

Step 3	Check DEF tank level.	Decision
Read DEF level using the vehicle instrument panel gauge and perform a visual inspection of fluid level in the DEF tank.		Yes: Go to step 4.
Is DEF tank fluid level above 1/2 tank?		No: Fill DEF tank with appropriate diesel exhaust fluid. After repairs are complete, retest for SPN 1761 FMI 18.

Step 4	Inspect connections at DEF Tank Level (DEFTL).	Decision
A. Key OFF. B. Disconnect DEFTL connector. C. Check DEFTL and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Replace DEFTL sensor. After repairs are complete, retest for SPN 1761 FMI 18.
Are DEFTL connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 18.

End Diagnostic Steps
After performing diagnostic steps, if SPN 1761 FMI 18 remains, verify if step was completed correctly and proper decision was made. Notify supervisor for further action.

SPN 1761 FMI 19 - DEF: TL Not Detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEFTLT signal not detected on J1939 Controller Area Network (CAN).	ACM loses J1939 data link communications with DEFTLT sensor module	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

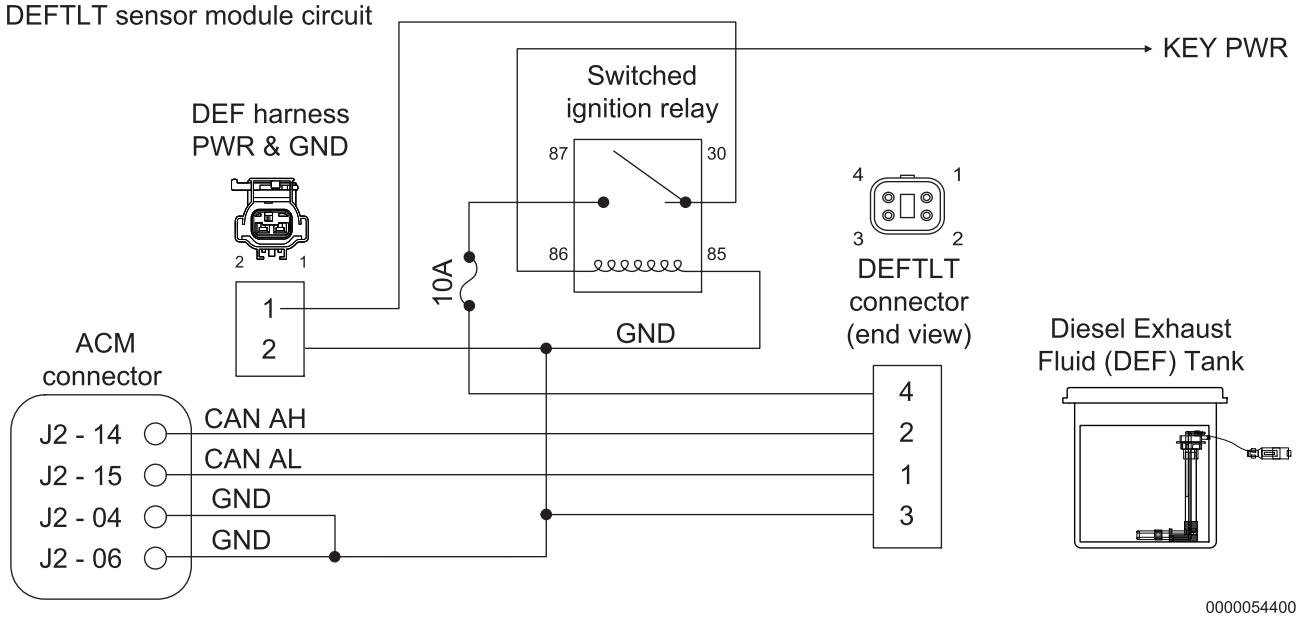

Figure 247 DEFTLT Sensor Module Circuit Diagram

Possible Cause

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND

- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed DEFTLT sensor module

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits: DOC / DPF temperature sensor module, SCR temperature sensor module, Ammonia Sensor Module, NOx OUT sensor module, NOx IN sensor module, and DEFTLT sensor module.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
2	Check voltage to the DEFTLT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between DEFTLT module pin-3 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between DEFTLT pin-4 and a known good ground. (wiggle test may be necessary if code is inactive or pending). Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between DEFTLT sensor module connector pin-3 and ground. After repairs are complete, retest for SPN 1761 FMI 19. No: Repair Open or high resistance between DEFTLT sensor module connector pin-4 and switched ignition relay pin 87. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between Breakout Harness pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between DEFTLT sensor module connector pin-2 and ACM connector J2-14. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between Breakout Harness pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 1761 FMI 19. No: Repair short to power between DEFTLT sensor module connector pin-2 and ACM connector J2-14. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between SCR temperature sensor module connector pin-1 and ACM connector J2-15. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure voltage between Breakout Harness pin-1 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between SCR temperature sensor module connector pin-1 and ACM connector J2-15. After repairs are complete, retest for SPN 1761 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-124-01 connected between DEFTLT sensor module and vehicle harness, use a DMM to measure resistance between Breakout Harness pin-1 and pin-2. Is resistance greater than 50 ohms?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 1761 FMI 19. No: Repair short between SCR temperature sensor module connector pin-1 and pin-2. After repairs are complete, retest for SPN 1761 FMI 19.

NOTE: After doing all diagnostic steps, if SPN 1761 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DEF: TLT (Diesel Exhaust Fluid Tank Level and Temperature) Sensor

Overview of DEF: TLT Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
3031	2	DEFTT signal erratic, intermittent or incorrect	• Failed DEFTLT sensor module • SWBAT circuit intermittent short to GND or high resistance • Power Distribution Module (PDM) loose fuse or relay • GND circuit intermittent high resistance	Step-Based Diagnostics (page 580)
3031	3	DEFTT signal Out of Range HIGH	• Failed DEFTLT sensor module	Step-Based Diagnostics (page 583)
3031	4	DEFTT signal Out of Range LOW	• Failed DEFTLT sensor module	Step-Based Diagnostics (page 584)

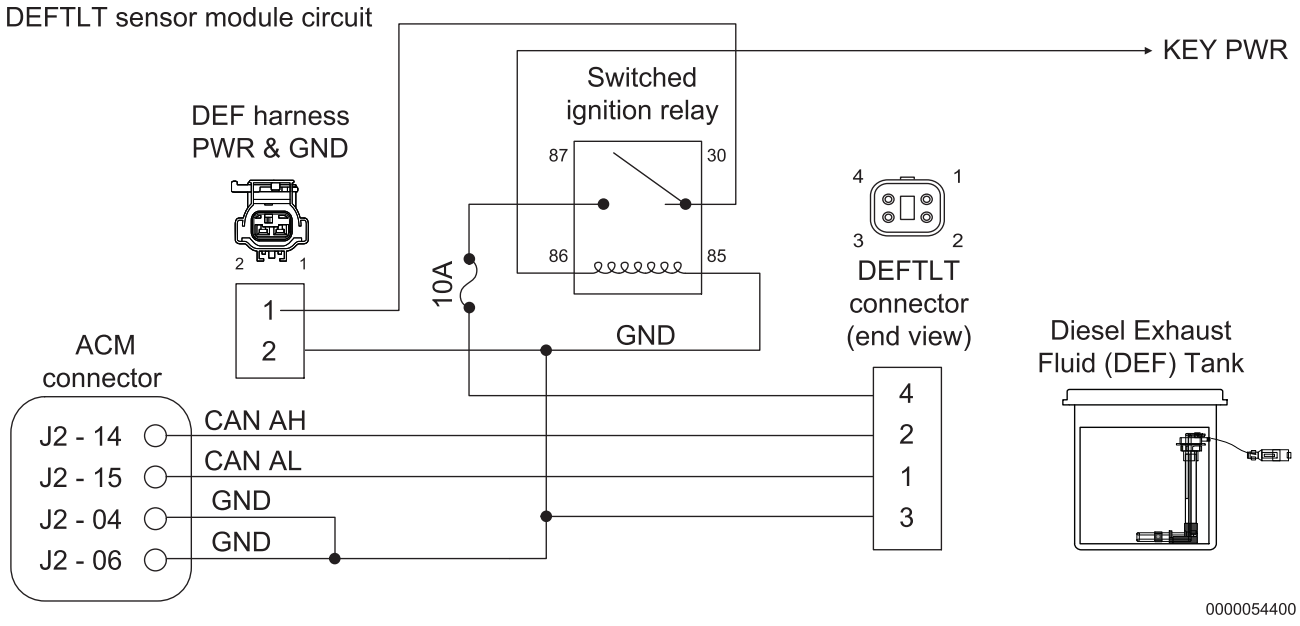

Figure 248 DEFTLT Sensor Module Circuit Diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module is a combination sensor used to monitor DEF tank level and temperature. The DEFTLT sensor module is installed inside the DEF tank and is a smart sensor that communicates to the Aftertreatment Control Module (ACM) through the J1939 Private CAN.

DEF Tank Level Inducement (Level 1–5).

- **Level 1**: SPN 1761 FMI 17 active, no lamp
- **Level 2**: SPN 1761 FMI 18 active, no lamp
- **Level 3**: SPN 1761 FMI 1 active, no lamp
- **Level 4–5** SPN 1761 FMI 1 active, Red Stop Lamp (RSL) active

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- Breakout Harness 18-124-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

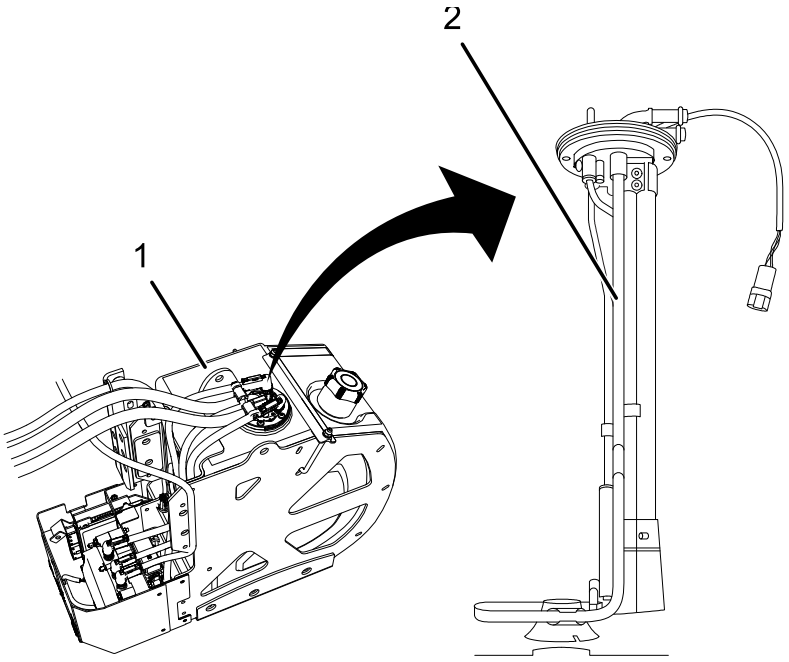

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Figure 249 DEFTLT location

1. Diesel Exhaust Fluid (DEF) tank
2. Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module

SPN 3031 FMI 2 - DEFTT Signal Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DEF tank temperature sensor is in range but not rational	Difference between the DEF tank temperature sensor and the Ambient Air Temperature (AAT) sensor is more than 54°F (30°C) at initial Key ON.	Key ON, after a 10 hour (engine off) cold soak Inactive: SPN 3031 FMI 3 and 4 (DEFTT)	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the DEF tank temperature sensor is in range but not rational.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3031 FMI 3 and 4 (DEFTLT), and SPN 171 (AAT).

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

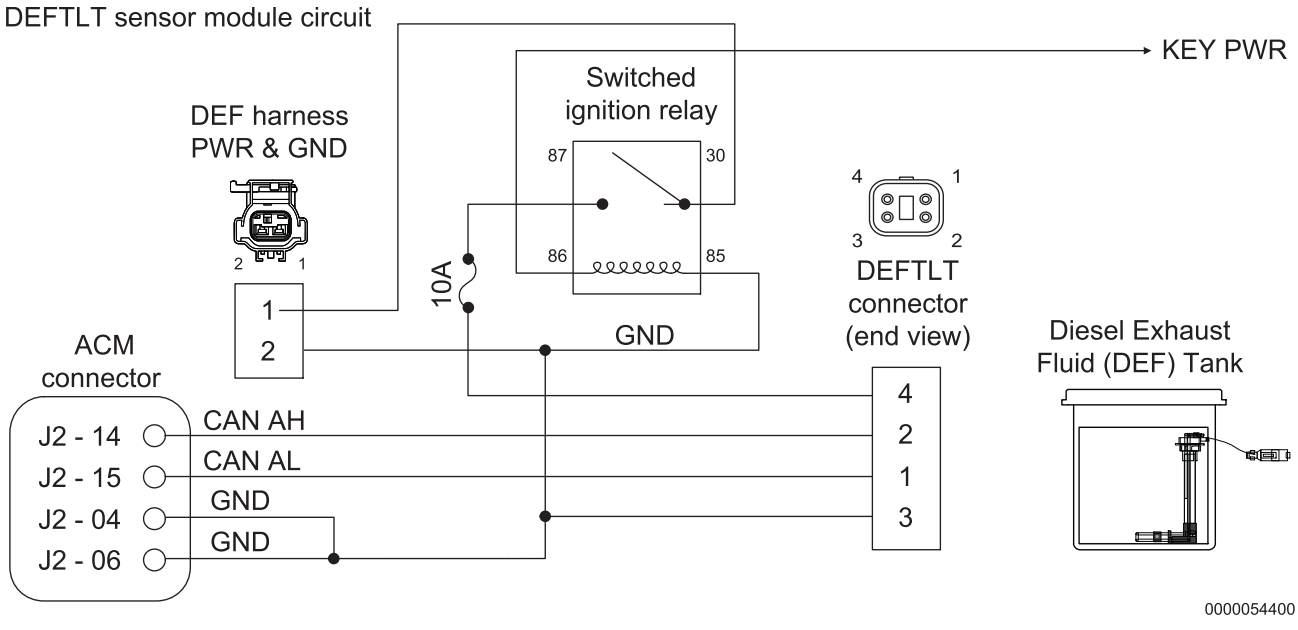


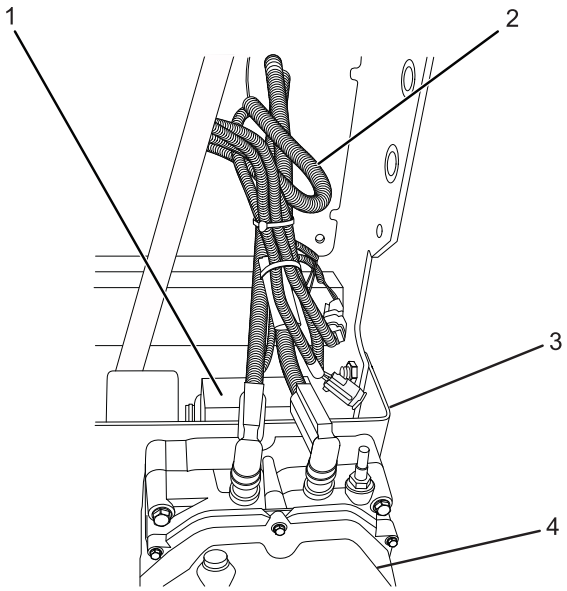
Figure 250 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

- SWBAT circuit intermittent short to GND or high resistance
- Power Distribution Module (PDM) loose fuse or relay
- GND circuit intermittent high resistance or Open

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3031 FMI 3 and 4 (DEFTLT); and SPN 171 (AAT). Is EST DTC list free of SPN 3031 FMI 3 and 4; and SPN 171 ?	Yes: Go to step 2. Repair SPN 3031 FMI 3 and 4; and SPN 171. After repairs are complete, retest for SPN 3031 FMI 2.



0000041928

Figure 251 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
2	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 3. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN retest for SPN 3031 FMI 2.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3031 FMI 2.

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits with the DEFTLT sensor module:

- NOx OUT sensor module
- NOx IN sensor module
- Ammonia (NH_3) Sensor Module
- SCR Temperature Sensor Module
- DOC / DPF temperature sensor module

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
4	Check voltage to the DEFTLT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-124-01 connected to DEFTLT sensor module, use a DMM to measure voltage between DEFTLT sensor module pin-3 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 3031 FMI 2. No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for intermittent high resistance or short to ground. Connect Breakout Harness 18–124–01 and leave DEFTLT sensor module disconnected. KOEO, measure voltage between Breakout Harness 18-124-01 pin-4 and a known good ground (wiggle test may be necessary if code is inactive or pending). Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between DEFTLT sensor module pin-3 and ground. After repairs are complete, retest for SPN 3031 FMI 2. No: Repair high resistance or short to ground between DEFTLT sensor module pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 3031 FMI 2.

NOTE: After doing all diagnostic steps, if SPN 3031 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3031 FMI 3 - DEFTT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank temperature sensor circuit voltage above normal or shorted to high source.	The Aftertreatment Control Module (ACM) detects the DEF tank temperature sensor voltage is greater than 4.7 V for more than 1 seconds.	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Temperature (DEFTT) signal voltage is greater than 4.5 volts for more than 1 second. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced after extended engine operation with the fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

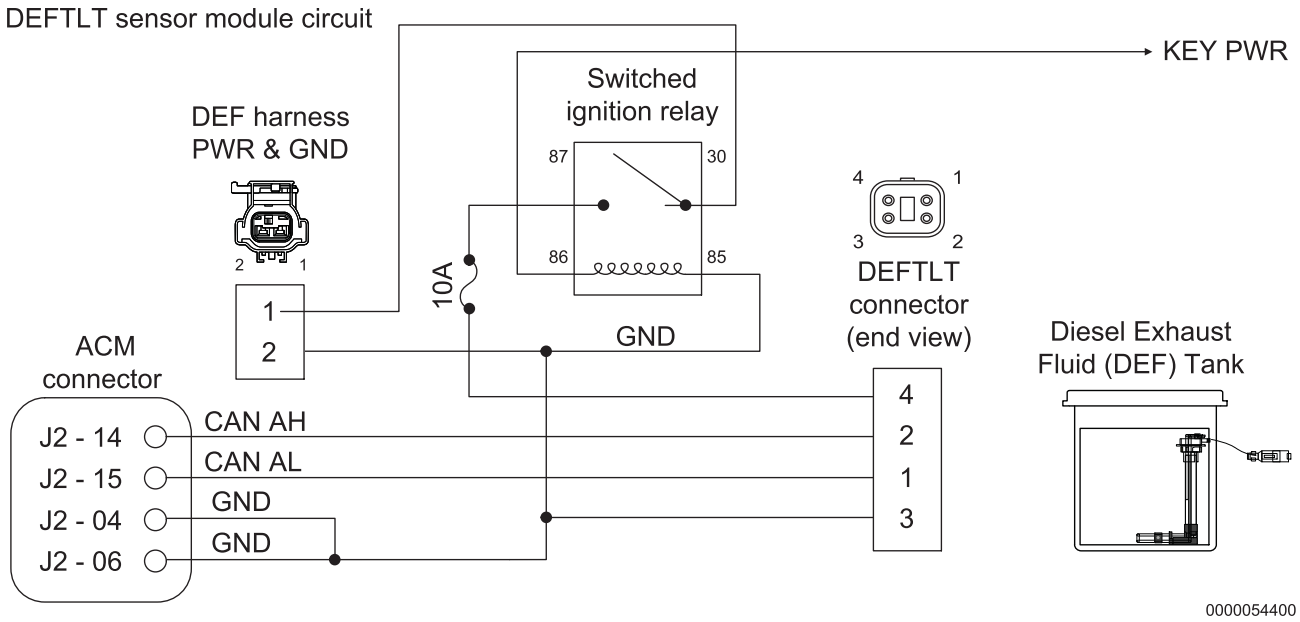


Figure 252 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 3031 FMI 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3031 FMI 3.

NOTE: After doing all diagnostic steps, if SPN 3031 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3031 FMI 4 - DEFTT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Exhaust Fluid (DEF) tank temperature sensor circuit voltage below normal or shorted to low source.	The Aftertreatment Control Module (ACM) detects the DEF tank temperature signal voltage is less than 0.2 V for more than 1 second.	Key ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Exhaust Fluid Tank Temperature (DEFTT) signal voltage is less than 0.2 volts for more than 1 second. Engine torque will be reduced if fault is active for a limited period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

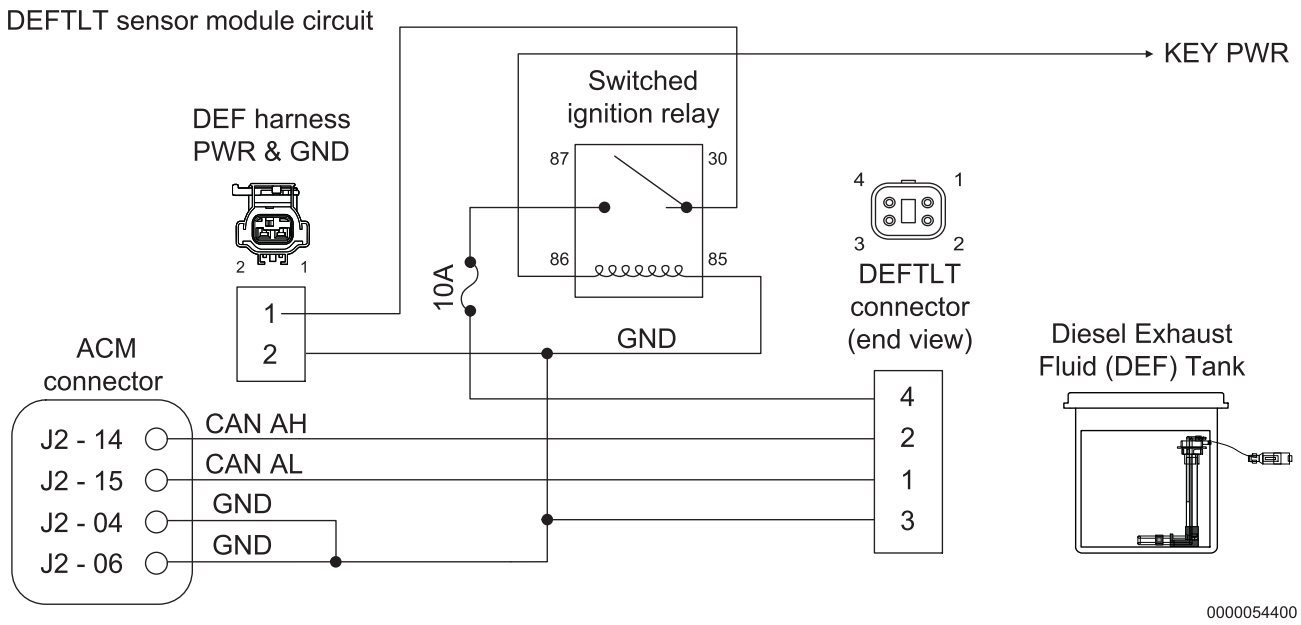


Figure 253 DEFTLT Sensor Module Circuit Diagram

Possible Causes

- Failed DEFTLT sensor module

Step	Action	Decision
1	Inspect connections at Diesel Exhaust Fluid Tank Level Temperature (DEFTLT) sensor module. Key OFF, disconnect DEFTLT sensor module. Check DEFTLT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEFTLT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace DEFTLT sensor module. After repairs are complete, retest for SPN 3031 FMI 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3031 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 3031 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DOCIT (Diesel Oxidation Catalyst Inlet Temperature) Sensor

Overview of DOCIT Sensor Group

SPN	FMI	Description
4765	0	DOCIT above Critical Temperature (page 587)
4765	2	DOCIT Signal erratic, intermittent, or incorrect (page 590)
4765	3	DOCIT signal Out of Range HIGH (page 592)
4765	4	DOCIT signal Out of Range LOW (page 593)
4765	16	DOCIT Above Maximum Temperature (page 594)

Overview

The Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor measures the exhaust temperature at the inlet of the DOC. The DOC / DPF temperature sensor module is a smart device that communicates with the Aftertreatment Control Module (ACM) via the Controller Area Network (CAN). The DOCIT sensor is part of the DOC / DPF temperature sensor module and is not serviceable individually.

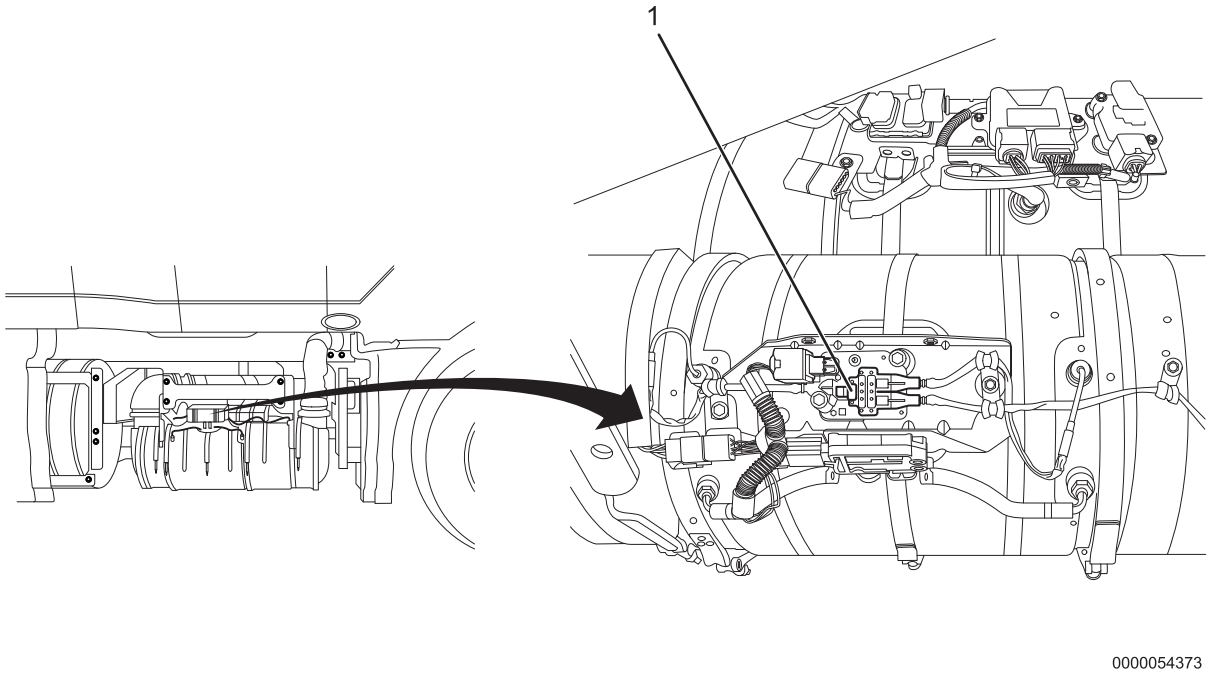


Figure 254 DOC / DPF Temperature Sensor Module Location

1. DOC / DPF Temperature Sensor Module

SPN 4765 FMI 0 - DOCIT Above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor has exceeded maximum temperature limit.	DOCIT > 1268°F (687°C) for more than 20 seconds.	Key-On Engine-Running (KOER)	25 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) reading is greater than 1268°F (687°C) for more than 20 seconds.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 4765 FMI 2, 3, and 4 (DOCIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DOCIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 4765 FMI 2, 3, and 4 (DOCIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 4765 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 4765 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 4765 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test . Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4765 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4765 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 4765 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust , and see Lube Oil to Exhaust . After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged component. Refer to Fault Facts. After repairs are complete, retest for SPN 4765 FMI 0.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4765 FMI 0.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4765 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 4765 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4765 FMI 2 - DOCIT Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values
The Diesel Oxidation Catalyst Intake Temperature (DOCIT) is not changing with engine operating conditions (in-range but not rational).	Average temperature difference across Diesel Oxidation Catalyst (DOC) between -76°F (-60°C) and 131°F (55°C)	Key-On Engine-Running (KOER) Time since last active regeneration > 600 seconds Exhaust flow between 200 g / sec and 1,000 g / sec DOCIT between 217°F (103°C) and 1112°F (600°C) Inactive: SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFT: FP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module)

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the difference between the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) and Diesel Particulate Filter Inlet Temperature (DPFIT) readings do not match expected values for engine operating conditions. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled. Active and parked regeneration of the DPF will be disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module)

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed DOC / DPF temperature sensor module

Step 1	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 2, 3, 4, and 17 (AFT: FP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4, and 7 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT System); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module). Is EST DTC list free of SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 3480 FMI 2, 3, 4, and 17; SPN 3482 FMI 2, 3, 4, and 7; SPN 3490 FMI 3, 4, and 7; SPN 3556 FMI 2 and 5; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16?		Yes: Go to Step 2. No: Repair SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 3480 FMI 2, 3, 4, and 17; SPN 3482 FMI 2, 3, 4, and 7; SPN 3490 FMI 3, 4, and 7; SPN 3556 FMI 2 and 5; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 4765 FMI 2.

Step 2	Check Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor and connector inspection.	Decision
A. Key OFF. B. Disconnect DOCIT sensor. C. Check DOCIT sensor and connector terminals for: damaged or pinched wires; wet or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DOCIT sensor connector, harness, and terminals clean and undamaged?		Yes: Release vehicle to customer. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4765 FMI 2.

End Diagnostic Steps
After performing all diagnostic steps, if SPN 4765 FMI 2 remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4765 FMI 3 - DOCIT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module detects short to power, or Open in Diesel Oxidation Catalyst Inlet Temperature (DOCIT) circuit.	DOCIT sensor input voltage ≥ 5 volts OR DOCIT ≥ 10 Ohms	Key-On Engine-Running (KOER)	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor signal voltage is greater than expected. Diesel Exhaust Fluid (DEF) injection into

the aftertreatment system is disabled. Active and parked regeneration of the DPF will be disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1		

NOTE: After performing all diagnostic steps, if SPN 4765 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4765 FMI 4 - DOCIT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module detects short to ground in Diesel Oxidation Catalyst Inlet Temperature (DOCIT) circuit.	DOCIT signal ≤ 1 volt	Key-On Engine-Running (KOER)	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor signal voltage is less than 1 volt for more than 2 seconds. Active and parked regeneration of the DPF will be disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 4765 FMI 4.
		No: Repair SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 4765 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4765 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4765 FMI 16 - DOCIT Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor has exceeded the maximum temperature limit (moderately severe level).	DOCIT > 1274°F (690°C) for 60 seconds.	Key-On Engine-Running (KOER)	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) reading is greater than 1274°F (690°C) for 60 seconds. Active and parked regeneration will be disabled. Engine shutdown will occur 30 seconds after the fault becomes active (except emergency vehicle calibrations).

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 4765 FMI 2, 3, and 4 (DOCIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DOCIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 4765 FMI 2, 3, and 4 (DOCIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 4765 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 4765 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 4765 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Using (EST) with ServiceMaxx™ software, perform Hot Run Sensor Comparison Test . Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4765 FMI 16. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4765 FMI 16.
		No: Repair failed valve train components. After repairs are complete retest for SPN 4765 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7.
		No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust , and see Lube Oil to Exhaust . After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8.
		No: Replace AFTFSV. After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 9.
		No: Replace AFTFI. After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10.
		No: Replace AFTFI. After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11.
		No: Inspect DOC/DPF system for failed or damaged component. After repairs are complete, retest for SPN 4765 FMI 16.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Check the DOC face for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4765 FMI 16.
		No: Clean or replace DOC. After repairs are complete, retest for SPN 4765 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 4765 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DPF (Diesel Particulate Filter) System

Overview of DPF Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
3719	0	DPF Soot Load - Highest (level 3/3)	• Engine performance problem • Engine mechanical • Regen inhibited • Failed DPFDP / outlet pressure sensor module • Restricted DPFDP / outlet pressure sensor hose(s)	Step-Based Diagnostics (page 600)
3719	15	DPF Soot Load - Lowest (level 1/3)	• Engine performance problem • Engine mechanical • Regen inhibited • Failed DPFDP / outlet pressure sensor module • Restricted DPFDP / outlet pressure sensor hose(s)	Step-Based Diagnostics (page 604)
3719	16	DPF Soot Load - Moderate (level 2/3)	• Engine performance problem • Engine mechanical • Regen inhibited • Failed DPFDP / outlet pressure sensor module • Restricted DPFDP / outlet pressure sensor hose(s)	Step-Based Diagnostics (page 608)
3936	0	DPF Soot Load - Severe De-Rate	• Engine performance problem • Failed fuel injector • Engine mechanical fault • Regen inhibited • Restricted DPFDP hoses • Failed DPFDP sensor	Step-Based Diagnostics (page 612)
3936	15	DPF System above Warning Pressure	• Engine performance problem • Failed fuel injector • Engine mechanical fault • Regen inhibited • Restricted DPFDP hoses • Failed DPFDP sensor	Step-Based Diagnostics (page 616)

4795	31	DPFDP excessively LOW (Sensor / Circuit Fault or Missing DPF)	• Missing DPFDP • DPF damaged or failed • DPFDP sensor hoses reversed or damaged • Exhaust leak before DPF • Failed DPFDP sensor	Step-Based Diagnostics(page 620)
5319	31	DPF incomplete Regeneration	• Low engine performance • Failed fuel injector • Engine mechanical • Oil leak to exhaust • Failed DPFDP / outlet pressure sensor • Restricted DPFDP / outlet pressure sensor hose(s) • Damaged or failed Diesel Oxidation Catalyst (DOC) • Restricted DOC (soot accumulation) • Failed AFTFI • Failed AFTFSV	Step-Based Diagnostics (page 624)

Overview

The Diesel Particulate Filter (DPF) system is used to reduce soot released into the exhaust aftertreatment system. The DPF is used in conjunction with the Diesel Oxidation Catalyst (DOC) to reduce soot. The process of reducing soot to ash is called regeneration (regen). Regen can be active, stationary, or passive. Passive regen needs no input from the ACM to work. Active happens when the ACM commands the truck to regen, and the truck goes into a regen strategy. Stationary regen is used when an operator manually tells the ACM to begin the regen process. This can be accomplished by either manually pushing an override button inside the cab, or through the use of ServiceMaxx. The DOC and DPF can be serviced separately.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

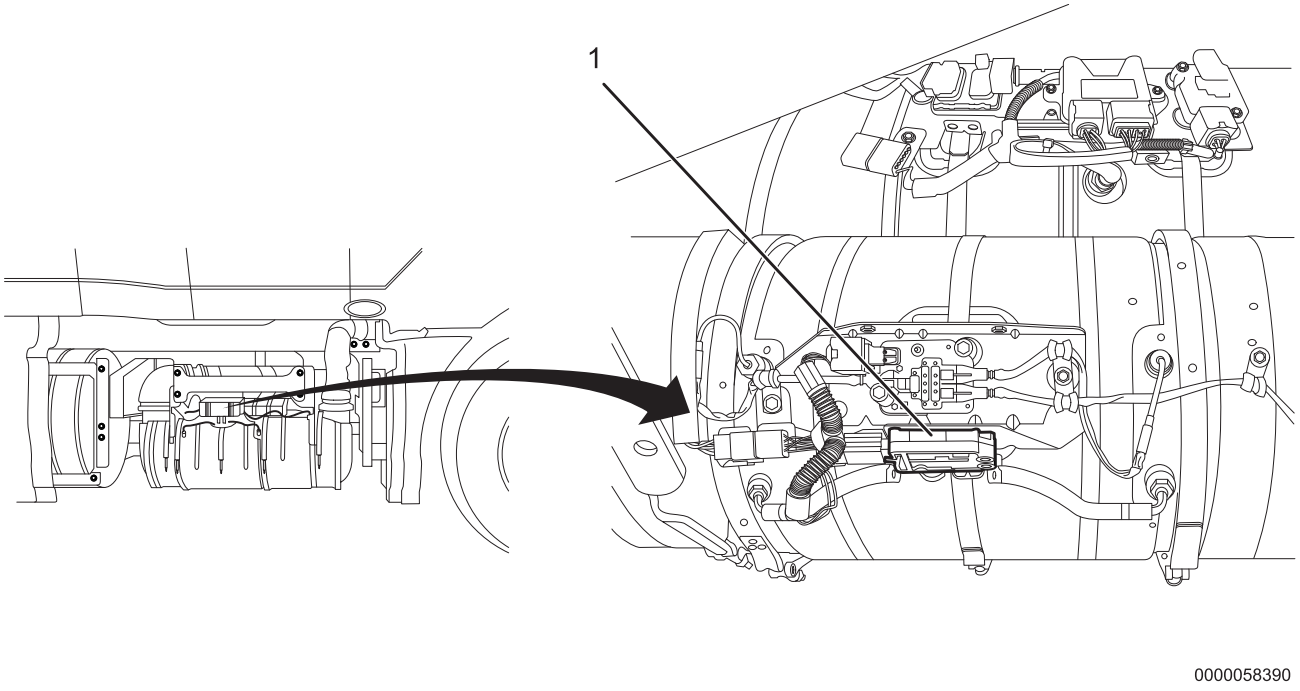


Figure 255 DPFDP / Outlet Pressure Sensor Module Location

1. DPFDP / outlet pressure sensor module

SPN 3719 FMI 0 - DPF Soot Load - Highest (level 3/3)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Differential Pressure (DPFDP) sensor data valid, but above normal operating range (most severe level).	DPFDP sensor has exceeded the recommended pressure limits.	Key-ON Engine-Running (KOER) Engine Speed > 500 rpm	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) has exceeded the maximum operating limits. Torque output of the engine will be reduced as soot load increases. Active and parked regeneration of the aftertreatment system will be disabled. See AFT System Overview (page 124) for additional information.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ/CYL); SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5541 (TC1TOP)

Drive Cycle to Determine Fault Status

Drive Cycle 25 then 1 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

This fault code may indicate exhaust temperature exiting the turbocharger are not high enough to actively regenerate the aftertreatment system. Driving the vehicle with long-term increased load may increase exhaust temperatures and decrease aftertreatment regeneration frequency.

Possible Causes

- Engine performance problem
- Engine mechanical
- Regen inhibited
- Failed DPFDP / outlet pressure sensor module
- Restricted DPFDP / outlet pressure sensor hose(s)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 3719 FMI 0.

Step	Action	Decision
2	Check for engine performance problems. Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP), SPN 102 (IMP), SPN 157 (FRP), SPN 651-656 (INJ / CYL), and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541. After repairs are complete, retest for SPN 3719 FMI 0.

Step	Action	Decision
3	Determine if a regen inhibitor is inhibiting regeneration of the aftertreatment system. Using EST with ServiceMaxx software, go to Procedures > KOER Aftertreatment Procedures > DPF Filter Regeneration > Inhibitors > and click Begin Test. Does DPF Filter Regeneration procedure run without any active Inhibitors?	Yes: Retest for SPN 3719 FMI 0. Go to step 4. No: Correct active regen inhibitors ((page 129) and ServiceMaxx Aftertreatment DPF Filter Regeneration Inhibitors tab). After repairs are complete, retest for SPN 3719 FMI 0.

Step	Action	Decision
4	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3719 FMI 0.

Step	Action	Decision
5	Monitor DPFDP / outlet pressure sensor signal. Key-On Engine-Running, using EST with ServiceMaxx software, load the Signals session and monitor DPFDP.	Yes: Go to step 7. No: Go to step 6.

	Is DPFDP below 0.5 psi (normal operation)?	

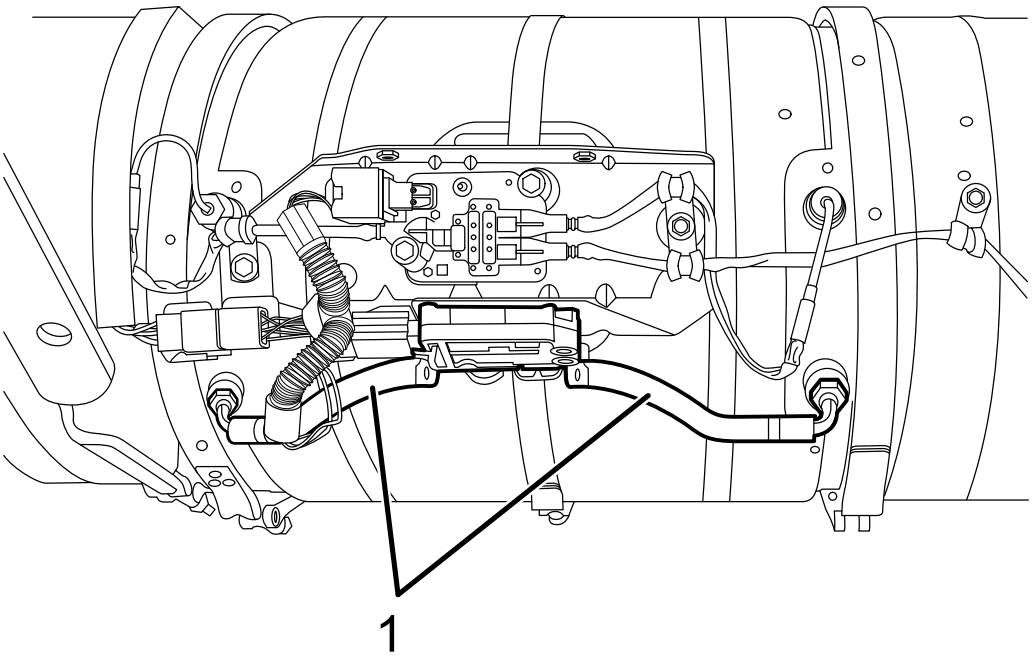


Figure 256 DPFDP / Outlet Pressure Sensor Hoses Location

1. DPFDP / outlet pressure sensor hoses

Step	Action	Decision
6	Check DPFDP / outlet pressure sensor hoses for correct routing and restrictions. Inspect the DPFDP / outlet pressure sensor hoses for improper routing, restrictions, or damage. Are the DPFDP / outlet pressure sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPFDP / outlet pressure sensor. After repairs are complete, retest for SPN 3719 FMI 0.
		No: Repair or replace DPFDP / outlet pressure sensor hose(s). After repairs are complete, retest for SPN 3719 FMI 0.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3719 FMI 0.
		No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3719 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 3719 FMI 0.

Step	Action	Decision
10	Determine if vehicle has an engine performance related driveability problem. Test drive the vehicle. Does engine have a performance problem.	Yes: Perform Engine Performance Diagnostics. After repairs are complete, retest for SPN 3719 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 3719 FMI 0 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3719 FMI 15 - DPF Soot Load - Lowest (level 1/3)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF Differential Pressure / outlet pressure sensor data valid, but above normal operating range (least severe level).	DPF Differential Pressure / outlet pressure sensor has exceeded the recommended limits.	Key-On Engine-Running (KOER) Engine Speed > 500 rpm	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) has exceeded operating limits. Torque output of the engine will be reduced as soot load increases. See AFT System Overview (page 124) for additional information.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ/CYL); SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5541 (TC1TOP)

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

This fault code may indicate exhaust temperature exiting the turbocharger are not high enough to actively regenerate the aftertreatment system. Driving the vehicle with long-term increased load may increase exhaust temperatures and decrease aftertreatment regeneration frequency.

Possible Causes

- Engine performance problem
- Engine mechanical
- Regen inhibited
- Failed DPFDP / outlet pressure sensor module
- Restricted DPFDP / outlet pressure sensor hose(s)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 2, 3, and 4. After repairs are complete, retest for SPN 3719 FMI 15.

Step	Action	Decision
2	Check for engine performance problems. Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP), SPN 102 (IMP), SPN 157 (FRP), SPN 651-656 (INJ / CYL), and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541. After repairs are complete, retest for SPN 3719 FMI 15.

Step	Action	Decision
3	Determine if a regen inhibitor is inhibiting regeneration of the aftertreatment system. Using EST with ServiceMaxx software, go to Procedures > KOER Aftertreatment Procedures > DPF Filter Regeneration > Inhibitors > and click Begin Test. Does DPF Filter Regeneration procedure run without any active Inhibitors?	Yes: Retest for SPN 3719 FMI 15. Go to step 4. No: Correct active regen inhibitors ((page 129) and ServiceMaxx Aftertreatment DPF Filter Regeneration Inhibitors tab). After repairs are complete, retest for SPN 3719 FMI 15.

Step	Action	Decision
4	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3719 FMI 15.

Step	Action	Decision
5	Monitor DPFDP / outlet pressure sensor signal. Key-On Engine-Running, using EST with ServiceMaxx software, load the Signals session and monitor DPFDP.	Yes: Go to step 7. No: Go to step 6.

	Is DPFDP below 0.5 psi (normal operation)?	

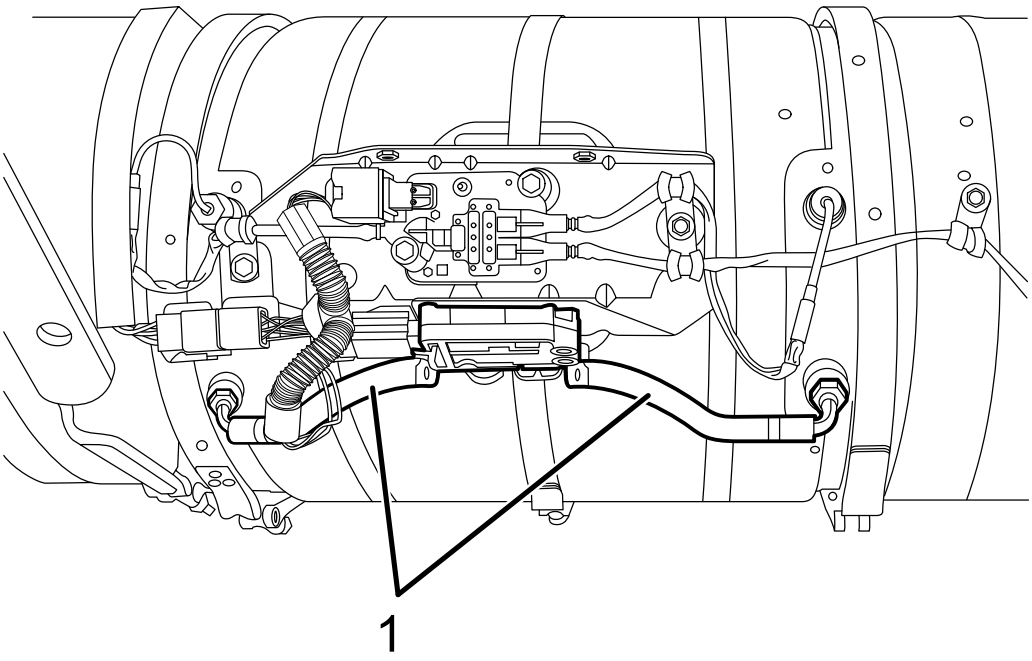


Figure 257 DPFDP / Outlet Pressure Sensor Hoses Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hoses

Step	Action	Decision
6	Check DPFDP / outlet pressure sensor hoses for correct routing and restrictions. Inspect the DPFDP / outlet pressure sensor hoses for improper routing, restrictions, or damage. Are the DPFDP / outlet pressure sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPFDP / outlet pressure sensor. After repairs are complete, retest for SPN 3719 FMI 15.
		No: Repair or replace DPFDP / outlet pressure sensor hose(s). After repairs are complete, retest for SPN 3719 FMI 15.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3719 FMI 15.
		No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3719 FMI 15. No: Repair failed valve train components. After repairs are complete retest for SPN 3719 FMI 15.

Step	Action	Decision
10	Determine if vehicle has an engine performance related driveability problem. Test drive the vehicle. Does engine have a performance problem.	Yes: Perform Engine Performance Diagnostics. After repairs are complete, retest for SPN 3719 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 3719 FMI 15 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3719 FMI 16 - DPF Soot Load - Moderate (level 2/3)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF Differential Pressure / outlet pressure sensor data valid, but above normal operating range (moderately severe level).	DPF Differential Pressure / outlet pressure sensor has exceeded the recommended limits.	Key-On Engine-Running (KOER) Engine Speed > 500 rpm	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) has exceeded operating limits. Torque output of the engine will be reduced as soot load increases. Active and parked regeneration of the aftertreatment system will be disabled. See AFT System Overview (page 124) for additional information.

Lamp Reaction

This fault does not illuminate the MIL when active.

Associated Faults

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ/CYL); SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5541 (TC1TOP)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Fault Facts

This fault code may indicate exhaust temperature exiting the turbocharger are not high enough to actively regenerate the aftertreatment system. Driving the vehicle with long-term increased load may increase exhaust temperatures and decrease aftertreatment regeneration frequency.

Possible Causes

- Engine performance problem
- Engine mechanical
- Regen inhibited
- Failed DPFDP / outlet pressure sensor module
- Restricted DPFDP / outlet pressure sensor hose(s)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 3719 FMI 16.

Step	Action	Decision
2	Check for engine performance problems. Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP), SPN 102 (IMP), SPN 157 (FRP), SPN 651-656 (INJ / CYL), and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541. After repairs are complete, retest for SPN 3719 FMI 16.

Step	Action	Decision
3	Determine if a regen inhibitor is inhibiting regeneration of the aftertreatment system. Using EST with ServiceMaxx software, go to Procedures > KOER Aftertreatment Procedures > DPF Filter Regeneration > Inhibitors > and click Begin Test. Does DPF Filter Regeneration procedure run without any active Inhibitors?	Yes: Retest for SPN 3719 FMI 15. Go to step 4. No: Correct active regen inhibitors ((page 129) and ServiceMaxx Aftertreatment DPF Filter Regeneration Inhibitors tab). After repairs are complete, retest for SPN 3719 FMI 16.

Step	Action	Decision
4	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3719 FMI 16.

Step	Action	Decision
5	Monitor DPFDP / outlet pressure sensor signal. Key-On Engine-Running, using EST with ServiceMaxx software, load the Signals session and monitor DPFDP.	Yes: Go to step 7. No: Go to step 6.

	Is DPFDP below 0.5 psi (normal operation)?	

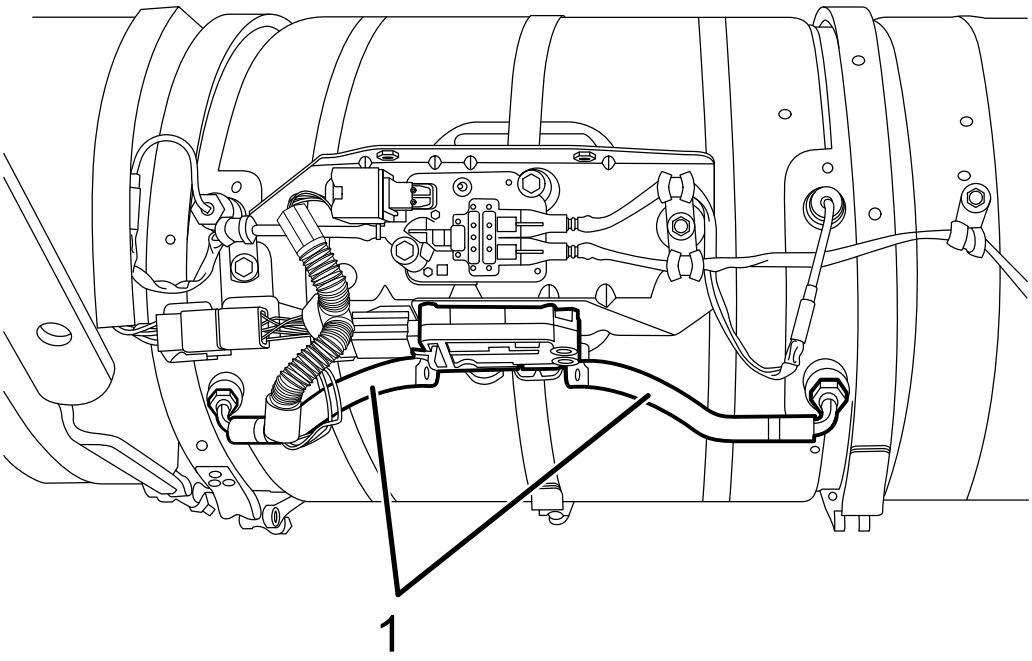


Figure 258 DPFDP / Outlet Pressure Sensor Hoses Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hoses

Step	Action	Decision
6	Check DPFDP / outlet pressure sensor hoses for correct routing and restrictions. Inspect the DPFDP / outlet pressure sensor hoses for improper routing, restrictions, or damage. Are the DPFDP / outlet pressure sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPFDP / outlet pressure sensor. After repairs are complete, retest for SPN 3719 FMI 16.
		No: Repair or replace DPFDP / outlet pressure sensor hose(s). After repairs are complete, retest for SPN 3719 FMI 16.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3719 FMI 16.
		No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3719 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 3719 FMI 16.

Step	Action	Decision
10	Determine if vehicle has an engine performance related driveability problem. Test drive the vehicle. Does engine have a performance problem.	Yes: Perform Engine Performance Diagnostics. After repairs are complete, retest for SPN 3719 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 3719 FMI 16 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 3936 FMI 0 - DPF Soot Load - Severe De-Rate

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF Differential Pressure / Outlet Pressure sensor data valid, but above normal operating range (severe de-rate).	DPF Differential Pressure / Outlet Pressure sensor has exceeded the recommended limits.	Key-On Engine-Running (KOER)	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) has exceeded the maximum operating limits for an extended period of time. Torque output of the engine will be reduced as soot load increases. Active regeneration of the aftertreatment system will be disabled.

Lamp Reaction

Red Stop Lamp Active

Associated Faults

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ / CYL); SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 5541 (TC1TOP)

Fault Facts

This fault code indicates exhaust temperatures exiting the turbocharger are Not high enough. Repeated occurrences of this fault code may indicate the engine requires frequent regeneration of the aftertreatment system. To passively regenerate the aftertreatment system, operate the engine under higher load and higher rpm.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Engine performance problem
- Failed fuel injector
- Engine mechanical fault
- Regen inhibited
- Restricted DPFDP hoses
- Failed DPFDP sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 3936 FMI 0.

Step	Action	Decision
2	Check for engine performance problems. Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP), SPN 102 (IMP), SPN 157 (FRP), SPN 651-656 (INJ / CYL), and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541. After repairs are complete, retest for SPN 3936 FMI 0.

Step	Action	Decision
3	Determine if a regen inhibitor is inhibiting regeneration of the aftertreatment system. Using EST with ServiceMaxx software, go to Procedures > KOER Aftertreatment Procedures > DPF Filter Regeneration > Inhibitors > and click Begin Test. Does DPF Filter Regeneration procedure run without any active Inhibitors?	Yes: Go to step 4. No: Correct active regen inhibitors ((page 129) and ServiceMaxx Aftertreatment DPF Filter Regeneration Inhibitors tab). After repairs are complete, retest for SPN 3936 FMI 0.

Step	Action	Decision
4	Inspect connections at DPF Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3936 FMI 0.

Step	Action	Decision
5	Monitor DPFDP / outlet pressure sensor signal. Key-On Engine-Off, using EST with ServiceMaxx software, load the Signals session and monitor DPFDP.	Yes: Go to step 7. No: Go to step 6.

	Is DPFDP below 0.5 psi? (normal operation)	

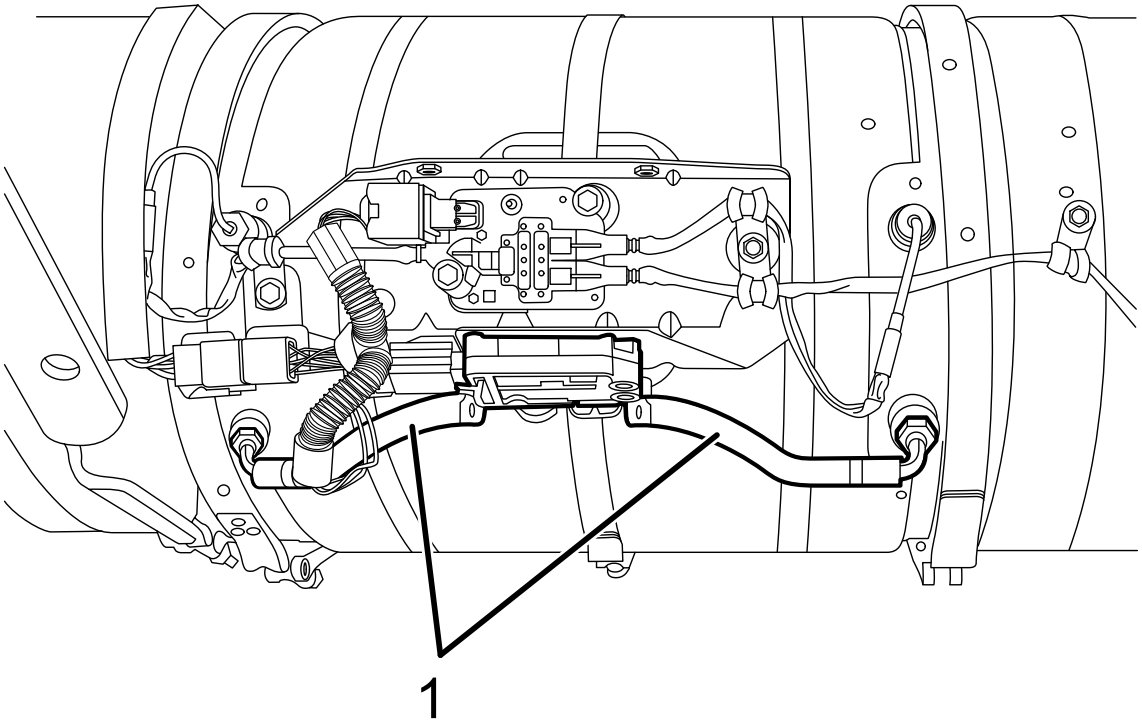


Figure 259 DPFDP Sensor and Hoses

1. DPFDP / outlet pressure hoses

Step	Action	Decision
6	Check DPFDP sensor hoses for correct routing and restrictions. Inspect the DPFDP sensor hoses for kinks, improper hose routing, restrictions, or damage. Are the DPFDP sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPF Differential Pressure / Outlet Pressure sensor. After repairs are complete, retest for SPN 3936 FMI 0.
		No: Repair or replace DPFDP sensor hose(s). After repairs are complete, retest for SPN 3936 FMI 0.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3936 FMI 0.
		No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3936 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 3936 FMI 0.

Step	Action	Decision
10	Determine if vehicle has an engine performance related driveability problem. Test drive the vehicle. Does engine have a performance problem?	Yes: Perform engine Performance Diagnostics . After repairs are complete, retest for SPN 3936 FMI 0 No: Retest for SPN 3936 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 3936 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3936 FMI 15 - DPF System above Warning Pressure

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF Differential Pressure / Outlet Pressure sensor signal in range, but above normal (least severe level).	DPF Differential Pressure / Outlet Pressure sensor has exceeded the recommended limits.	Key-On Engine-Running (KOER). Inactive: SPN 3251 FMI 2, 3, and 4. Engine Speed > 500 rpm.	30 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) has exceeded the maximum operating limits. The Exhaust Gas Recirculation (EGR) valve will be disabled.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ / CYL); SPN 5541 (TC1TOP): SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 2, 3, and 4 (DPFOT); SPN 4765 2, 3, and 4 (DOCIT); SPN 3251 FMI 2, 3, and 4 (DPFDP / Outlet Pressure)

Fault Facts

This fault code indicates exhaust temperatures exiting the turbocharger are Not high enough to actively regenerate the aftertreatment system due to light load.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Engine performance problem
- Failed fuel injector
- Engine mechanical fault
- Regen inhibited
- Restricted DPFDP hoses
- Failed DPFDP sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); 3480 (AFTFP1); SPN 3482 (AFTFSV); SPN 3556 (AFT); and SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3242 FMI 2, 3, and 4; SPN 3246 FMI 2, 3, and 4; SPN 3480; SPN 3482; SPN 3556; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 3936 FMI 15.

Step	Action	Decision
2	Check for engine performance problems. Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP), SPN 102 (IMP), SPN 157 (FRP), SPN 651-656 (INJ / CYL), and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94, SPN 102, SPN 157, SPN 651-656, and SPN 5541. After repairs are complete, retest for SPN 3936 FMI 15.

Step	Action	Decision
3	Determine if a regen inhibitor is inhibiting regeneration of the aftertreatment system. Using EST with ServiceMaxx software, go to Procedures > KOER Aftertreatment Procedures > DPF Filter Regeneration > Inhibitors > and click Begin Test. Does DPF Filter Regeneration procedure run without any active Inhibitors?	Yes: Go to step 4. No: Correct active regen inhibitors ((page 129) and ServiceMaxx Aftertreatment DPF Filter Regeneration Inhibitors tab). After repairs are complete, retest for SPN 3936 FMI 15.

Step	Action	Decision
4	Inspect connections at DPF Differential Pressure (DPFDP) / outlet pressure sensor. Key OFF, disconnect DPFDP / outlet pressure sensor. Check DPFDP / outlet pressure sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3936 FMI 15.

Step	Action	Decision
5	Monitor DPFDP / outlet pressure sensor signal. Key-On Engine-Off (KOEO), using EST with ServiceMaxx software, load the Signals session and monitor DPFDP.	Yes: Go to step 7. No: Go to step 6.

	Is DPFDP below 0.5 psi? (normal operation)	

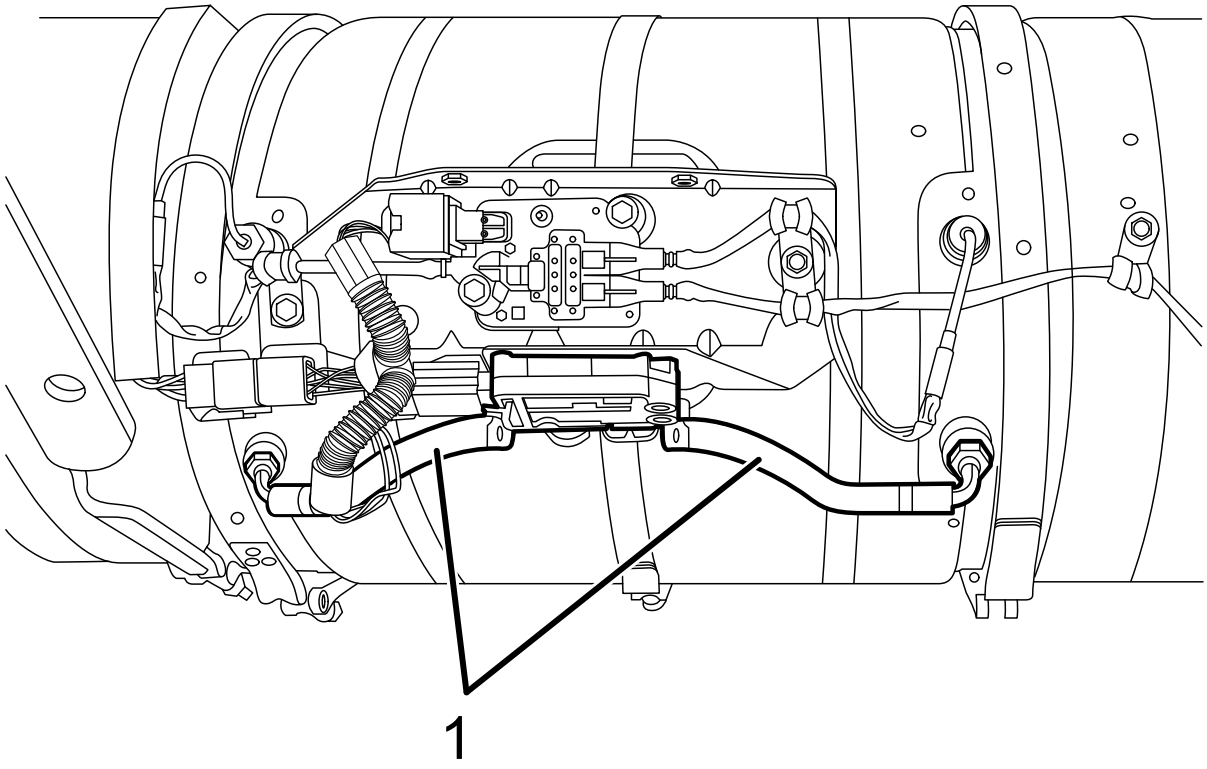


Figure 260 DPFDP Sensor and Hoses

1. DPFDP / outlet pressure hoses

Step	Action	Decision
6	Check DPFDP sensor hoses for correct routing and restrictions. Inspect the DPFDP sensor hoses for kinks, improper hose routing, restrictions, or damage. Are the DPFDP sensor hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPF Differential Pressure / Outlet Pressure sensor. After repairs are complete, retest for SPN 3936 FMI 15.
		No: Repair or replace DPFDP sensor hose(s). After repairs are complete, retest for SPN 3936 FMI 15.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3936 FMI 15.
		No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9.
		No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3936 FMI 15.
		No: Repair failed valve train components. After repairs are complete retest for SPN 3936 FMI 15.

Step	Action	Decision
10	Determine if vehicle has an engine performance related driveability problem. Test drive the vehicle. Does engine have a performance problem?	Yes: Perform engine Performance Diagnostics . After repairs are complete, retest for SPN 3936 FMI 15
		No: Retest for SPN 3936 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 3936 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4795 FMI 31 - DPFDP excessively LOW (Sensor / Circuit Fault or Missing DPF)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter (DPF) is not present in the exhaust system.	Diesel Particulate Filter Differential Pressure (DPFDP) does not meet Aftertreatment Control Module (ACM) predetermined value.	Key-On Engine-Running (KOER)	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Differential Pressure (DPFDP) is below a minimum value, and exhaust flow rate is above a minimum flow rate. Active and parked regeneration of the DPF will be disabled. The Exhaust Gas Recirculation (EGR) valve will be closed, and engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3251 FMI 3 and 4 (DPFDP)

Drive Cycle to Determine Fault Status

Drive Cycle 31 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Missing DPF
- DPF damaged or failed
- DPFDP sensor hoses reversed or damaged
- Exhaust leak before DPF
- Failed DPFDP sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3251 FMI 3 and 4 (DPFDP). Is EST DTC list free of SPN 3251 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 3251 FMI 3 and 4. After repairs are complete, retest for SPN 4795 FMI 31.

Step	Action	Decision
2	Check the exhaust system for an installed Diesel Particulate Filter (DPF). Is a DPF installed in the exhaust system?	Yes: Go to step 3. No: Install proper DPF. After repairs are complete, retest for SPN 4795 FMI 31.

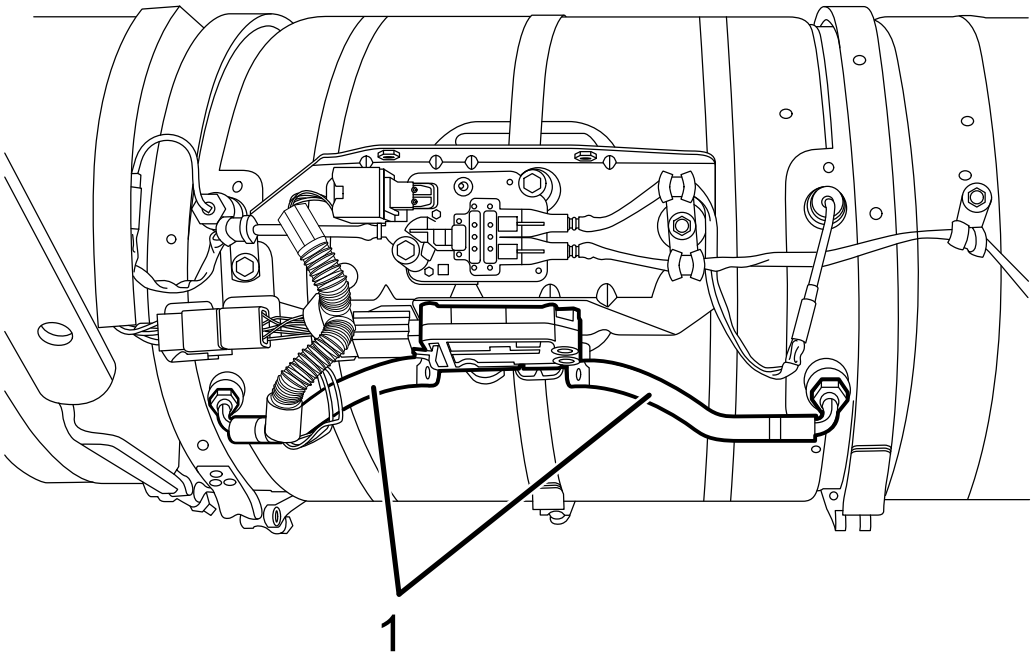


Figure 262 DPFDP / Outlet Pressure Sensor Hoses Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hoses (2)

Step	Action	Decision
3	Check Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hoses for correct routing and restrictions. Inspect the DPFDP / outlet pressure sensor hoses for kinks, improper hose routing, plugged hoses, reversed hoses, or damage. Are the DPFDP / outlet pressure sensor hoses routed correctly and free of damage and debris?	Yes: Go to Step 4. No: Reroute or replace DPFDP / outlet pressure sensor hoses. After repairs are complete, retest for SPN 4795 FMI 31.

Step	Action	Decision
4	Inspect exhaust system for missing Diesel Particulate Filter (DPF), leaks, or physical damage. Is DPF in place, and exhaust system free of leaks and physical damage?	Yes: Go to Step 5. No: Replace DPF, repair exhaust leaks, or repair physical damage. After repairs are complete, retest for SPN 4795 FMI 31.

Step 5	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) sensor.	Decision
A. Key OFF. B. Disconnect DPFDP connector. C. Check DPFDP and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DPFDP connector, harness, and terminals clean and undamaged?		Yes: Go to Step 6. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4795 FMI 31.

Step	Action	Decision
7	Remove DPF and inspect outlet of DPF for damage and soot leakage. Is DPF free of damage and soot leakage?	Yes: Go to Step 8. No: Replace DPF. After repairs are complete, retest for SPN 4795 FMI 31.

Step	Action	Decision
8	Check for biased Diesel Particulate Filter Differential Pressure (DPFDP) sensor. Do DPFDP sensor KOEO check (xref). Are DPFDP sensor and circuits within specification?	Yes: Go to Step 9. No: Repair DPFDP sensor or circuits. After repairs are complete, retest for SPN 4795 FMI 31.

Step	Action	Decision
9	Using Electronic Service Tool (EST) with ServiceMaxx™ software, calibrate MAF sensor. Do MAF Calibration Procedure (xref). Did MAF calibration complete successfully?	Yes: Repair X. After repairs are complete, retest for SPN 4795 FMI 31. No: Refer to MAF/AIT sensor diagnostics, SPN 132 FMI 14, MAF sensor calibration failed. After repairs are complete, retest for SPN 4795 FMI 31.

End Diagnostic Tests
After performing all tests, if no problem is found, verify each step was completed correctly and the proper decision was made. Return to SPN 1173 FMI 2 fault code diagnostics.

SPN 5319 FMI 31 - DPF Incomplete Regeneration

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Incomplete regeneration of the aftertreatment system has been detected.	Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor module has exceeded the recommended limits after successful completion of an active regeneration.	Key-On Engine-Running (KOER) Inactive: SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 3251 FMI 2, 3, and 4 (DPFDP / outlet pressure); SPN 3480 FMI 2, 3, 4, and 17 (AFTFP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3, 4 (AFTPAV); SPN 3556 FMI 2 and 5 (AFT); SPN 3610 FMI 2, 3, and 4 (DPFDP / outlet pressure); SPN 4765 FMI 2, 3, and 4(DOCIT); SPN 5742 3, 4, and 11(DOC / DPF temp sensor module) Active regeneration of the aftertreatment system is requested DPF was not recently replaced	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the soot load of the Diesel Particulate Filter (DPF) is too high following successful active regeneration of the aftertreatment system.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 27 (EGR), SPN 1173 (TC2CIT), SPN 1177 (TC2CIP), SPN 1189 (TC2WC)

SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ/CYL); SPN 3055 (FRP); SPN 3482 FMI 7 (AFTFSV); SPN 5541 (TC1TOP)

SPN 3251 FMI 2, 3, and 4 (DPFDP / outlet pressure); SPN 3482 FMI 2 (AFTFSV); SPN 3556 FMI 18 (AFTFP1)

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. Excessive ash accumulation in the Diesel Particulate Filter (DPF) will cause frequent regenerations of the aftertreatment system. If all step-based diagnostics have been completed with no failure found, inspect the ash load of the DPF.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low engine performance
- Failed fuel injector
- Engine mechanical
- Oil leak to exhaust
- Failed Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor
- Restricted DPFDP / outlet pressure sensor hose(s)
- Damaged or failed Diesel Oxidation Catalyst (DOC)
- Restricted DOC (soot accumulation)
- Failed AFTFI
- Failed AFTFSV

Step	Action	Decision
1	Using EST, check DTC list for SPN 27 (EGR); SPN 1173 (TC2CIT); SPN 1177 (TC2CIP); and SPN 1189 (TC2WC). Is EST DTC list free of SPN 27; SPN 1173; SPN 1177; and SPN 1189?	Yes: Go to step 2. No: Repair SPN 27; SPN 1173; SPN 1177; and SPN 1189. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
2	Using EST with ServiceMaxx™ software, check DTC list for SPN 94 (FDP); SPN 102 (IMP); SPN 157 (FRP); SPN 651-656 (INJ / CYL); SPN 3482 FMI 7; and SPN 5541 (TC1TOP). Is EST DTC list free of SPN 94; SPN 102; SPN 157; SPN 651-656; SPN 3055; SPN 3482 FMI 7; and SPN 5541?	Yes: Go to step 3. No: Repair SPN 94; SPN 102; SPN 157; SPN 651-656; SPN 3482 FMI 7; and SPN 5541. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
3	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3251 FMI 2, 3, and 4 (DPFDP / outlet pressure sensor); SPN 3482 FMI 2 (AFTFSV); and SPN 3556 FMI 18 (AFTFP1). Is EST DTC list free of SPN 3251 FMI 2, 3, and 4; SPN 3482 FMI 2; and SPN 3556 FMI 18?	Yes: Go to step 4. No: Repair SPN 3251 FMI 2, 3, and 4; SPN 3482 FMI 2; and SPN 3556 FMI 18. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
4	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor module. Key OFF, disconnect DPFDP / outlet pressure sensor module. Check DPFDP / outlet pressure sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
5	Monitor DPFDP signal following active regeneration of the aftertreatment system. Key-On Engine-Off (KOEO), using EST with ServiceMaxx software, load the Signals session and monitor DPFDP. Is DPFDP below 0.5 psi?	Yes: Go to step 7. No: Go to step 6.

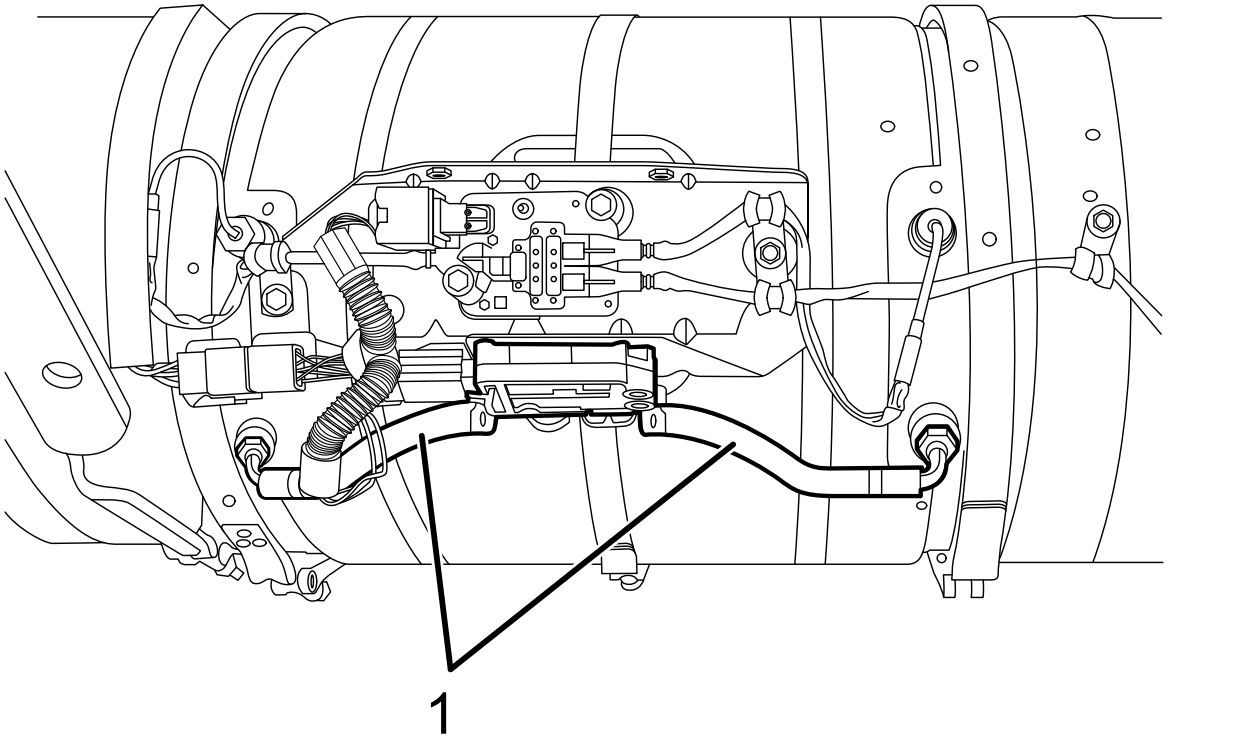


Figure 263 DPFDP / Outlet Pressure Sensor Hoses Locations

1. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor hoses (2)

Step	Action	Decision
6	Check DPFDP / outlet pressure sensor module hoses for correct routing and restrictions. Inspect the DPFDP / outlet pressure sensor module hoses for kinks, improper hose routing, restrictions, or damage. Are the DPFDP / outlet pressure sensor module hoses routed correctly, free of damage, and unrestricted?	Yes: Replace DPFDP / outlet Pressure sensor. After repairs are complete, retest for SPN 5319 FMI 31. No: Repair or replace DPFDP / outlet pressure sensor hose(s). After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
7	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 5319 FMI 31. No: Go to step 8

Step	Action	Decision
8	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 9. No: Go to step 10.

Step	Action	Decision
9	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 5319 FMI 31. No: Repair failed valve train components. After repairs are complete retest for SPN 5319 FMI 31.

Step	Action	Decision
10	Check for lube oil leak to exhaust. Perform Lube Oil Leak to Exhaust . Was the exhaust free of lube oil contamination?	Yes: Go to step 11. No: Repair lube oil leak to exhaust. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
11	Check for failed Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 12. No: Replace AFTFSV. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
12	Check for failed AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 13. No: Replace AFTFI. After repairs are complete, retest for SPN 5319 FMI 31.

Step	Action	Decision
13	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 ml to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Clean or replace DOC. Refer to fault facts. After repairs are complete, retest for SPN 5319 FMI 31. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 5319 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 5319 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

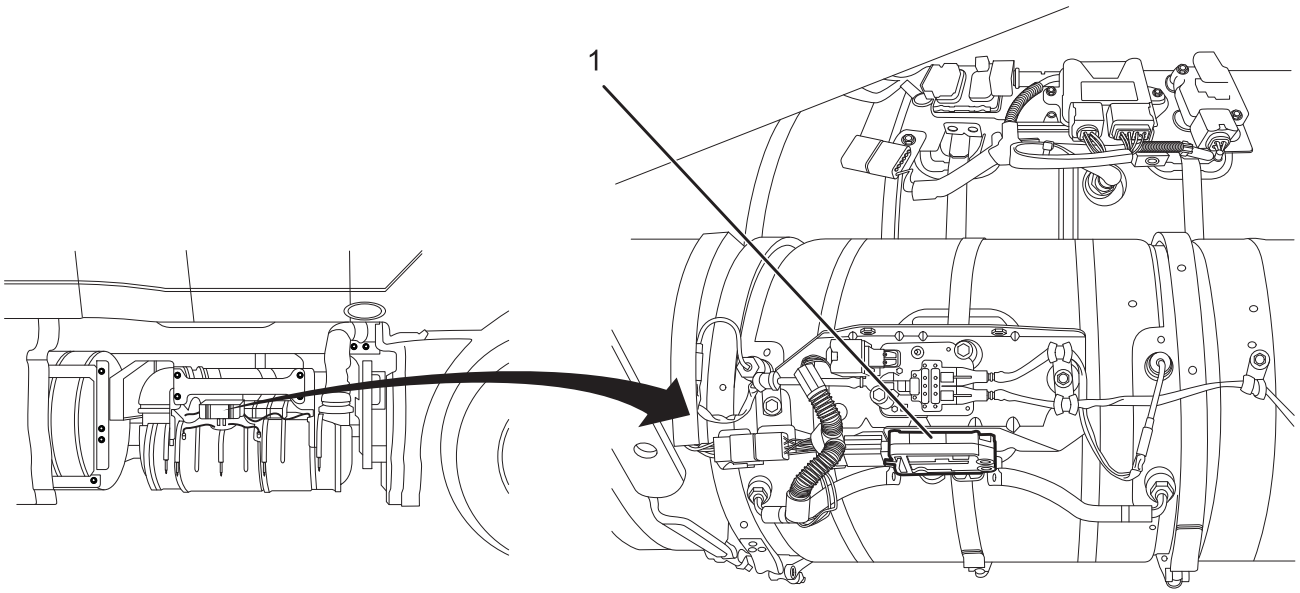
DPFDP (Diesel Particulate Filter Differential Pressure) Sensor

Overview of DPFDP Sensor Group

SPN	FMI	Description
3251	2	DPFDP signal erratic, intermittent, or incorrect (page 631)
3251	3	DPFDP signal Out of Range HIGH (page 633)
3251	4	DPFDP signal Out of Range LOW (page 639)

Overview

The Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor module measures the pressure difference between the inlet pressure and outlet pressure of the DPF, and the outlet pressure of the DPF. Aftertreatment regeneration will not run with DPFDP / outlet pressure sensor module fault codes present.



0000058390

Figure 264 DPFDP / DPFOP Sensor Module Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / DPF Outlet Pressure (DPFOP) sensor module

SPN 3251 FMI 2 - DPFDP Signal Erratic, Iintermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Differential Pressure (DPFDP) sensor Key ON check indicates signal in-range but not rational or stuck in range.	Absolute value of DPFDP > 0.25 psi (1.5 kPa) Range of DPFDP since last monitor decision when Enable Conditions are met < 0.15 psi (1 kpa)	Inactive: SPN 3251 FMI 3, 4 Engine Speed ≤ 200 RPM Elapsed time since key ON > 1 sec Range of exhaust volumetric flow since last monitor > 0.4 m3/sec DPFDP sensor signal not saturated at high exhaust flow: (DPFDP <= 5.1 psi (35 kpa) OR (Exhaust flow <= 1 m3/sec) Key-On Engine-Running (KOER)	Immediate

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the aftertreatment Diesel Particulate Filter Differential Pressure (DPFDP) is greater than 0.25 psi (1.5 kpa), is not changing with engine conditions, or range since last monitor < 0.15 psi (1 kpa).

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3251 FMI 3, 4 (DPFDP); SPN 5217 FMI 14 (VREF9)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

DPF Differential Pressure / Outlet Pressure circuit

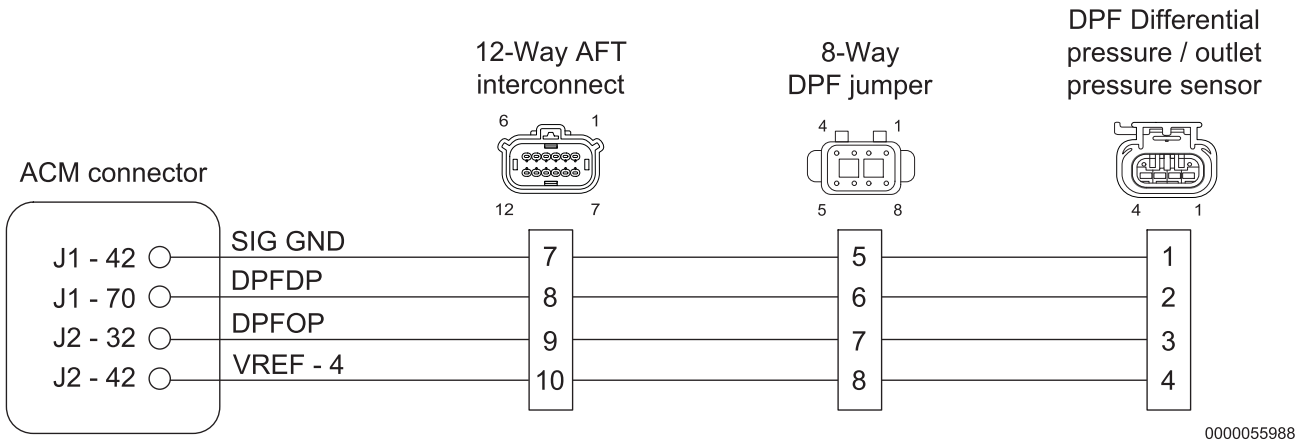


Figure 265 DPFDP / Outlet Pressure Sensor Module Circuit Diagram

Possible Causes

- DPFDP circuit high resistance
- Leaking or Restricted DPFDP / outlet pressure sensor module hoses
- Failed DPFDP / outlet pressure sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3251 FMI 3 and 4 (DPFDP); SPN 5217 FMI 14 (VREF9). Is EST DTC list free of SPN 3251 FMI 3 and 4; SPN 5217 FMI 14?	Yes: Go to step 2. No: Repair SPN 3251 FMI 3 and 4; SPN 5217 FMI 14. After repairs are complete, retest for SPN 3251 FMI 2.

Step	Action	Decision
2	Inspect hoses and tube connections at the DPFDP / outlet pressure sensor module. Check sensor, tubes, and passages for leaks, restrictions, and damage. Are the DPFDP / outlet pressure sensor module connections free of leaks, restrictions, and damage?	Yes: Go to step 3. No: Repair leaking, restricted or damaged hoses and connections. After repairs are complete, retest for SPN 3251 FMI 2.

Step	Action	Decision
3	Inspect connections at DPFDP / outlet pressure sensor module. Key OFF, disconnect DPFDP / outlet pressure sensor module. Check DPFDP / outlet pressure sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DPFDP / outlet pressure sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3251 FMI 2.

Step	Action	Decision
4	Inspect connections at Aftertreatment Control Module (ACM). Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3251 FMI 2.

Step	Action	Decision
5	Check DPFDP circuit for high resistance. Connect Breakout Harness 12-575-01 to DPFDP / outlet pressure sensor module connector and leave sensor disconnected. Connect 180-Pin Breakout Box and Breakout Harness 18-537-01(96-pin) to ACM and leave disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-2 and Breakout Box pin J1-70. Is resistance less than 5 ohms?	Yes: Replace the DPFDP / outlet pressure sensor module. After repairs are complete retest for SPN 3251 FMI 2. No: Repair the high resistance between the DPFDP / outlet pressure sensor module connector pin-2 and ACM connector pin J1-70. After repairs are complete retest for SPN 3251 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3251 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3251 FMI 3 - DPFDP Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Particulate Filter Differential Pressure (DPFDP) sensor reading greater than specified operating range	Aftertreatment DPFDP sensor value > 4.75 volts	Key ON

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the aftertreatment Diesel Particulate Filter Differential Pressure signal voltage is greater than 4.75 volts for more than 2 seconds.

Lamp Reaction

MIL will illuminate when this fault is detected during one consecutive drive cycles.

Associated Fault

SPN 5217 FMI 14 (VREF 9)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- SIG GND circuit Open or high resistance
- DPFDP short to PWR
- Failed DPFDP / DPFOP module

Step 1	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for 3512 FMI 14 (VREF 9). Is EST DTC list free of SPN 5217 FMI 14?		Yes: Go to Step 2. No: Repair SPN 5217 FMI 14. After repairs are complete, retest for SPN 3251 FMI 3.

Step 2	Inspect connections at DPFDP / DPF Outlet Pressure (DPFOP) sensor.	Decision
A. Key OFF. B. Disconnect DPFDP / DPFOP sensor connector. C. Check DPFDP / DPFOP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DPFDP / DPFOP sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests (SPN 3251 FMI 3) . Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3251 FMI 3.

Pin-Point Tests (SPN 3251 FMI 3)

Figure 266 DPFDP / DPFOP Sensor Circuit Diagram

NOTE: See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form XX for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 12-575-01
- Breakout Harness 18-537-01
- Digital Multimeter (DMM)

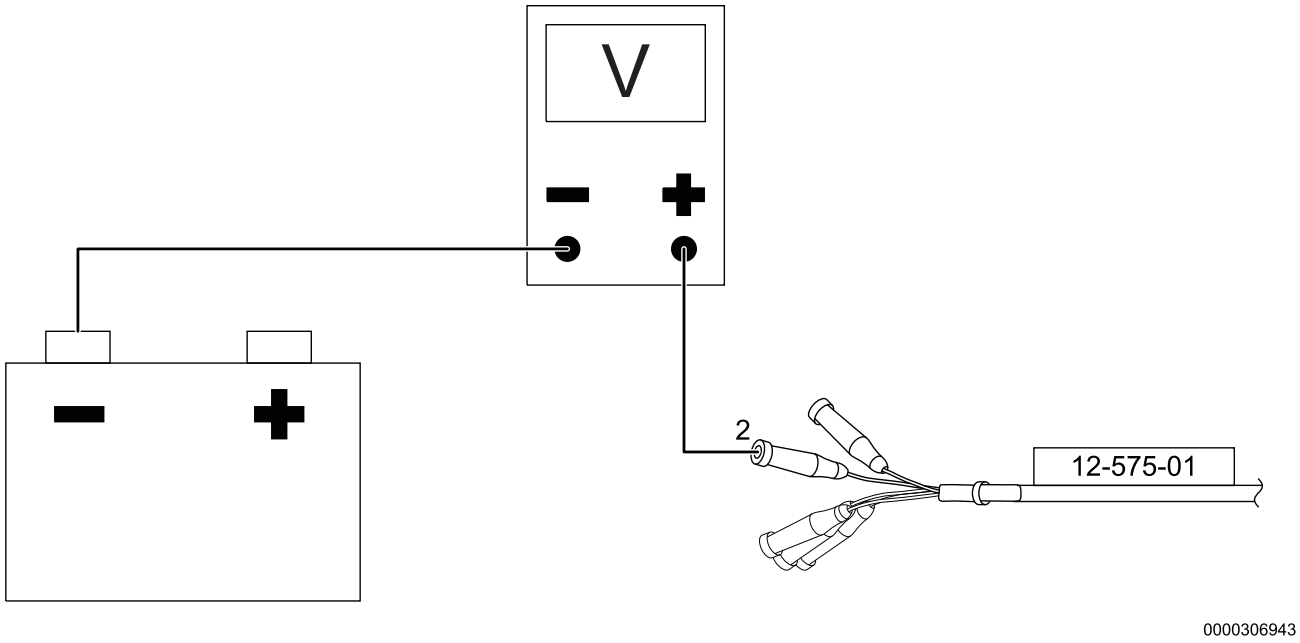


Figure 267 Pin-Point Test 1 DPFDP Circuit Voltage Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness 12-575-01 to vehicle harness and leave Diesel Particulate Filter Differential Pressure (DPFDP) / DPF Outlet Pressure (DPFOP) disconnected. C. Key ON.

Test 1	Specification
Use DMM to measure voltage between Breakout Harness 12-575-01 pin-2 and known good ground.	Less than 4.7 volts
Decision	
Is voltage less than 4.7 volts?	Yes: Go to Test 2.
	No: Repair short to PWR between DPFDP / DPFOP pin-2 and Aftertreatment Control Module (ACM) pin J1-70. After repairs are complete, retest for SPN 3251 FMI 3.

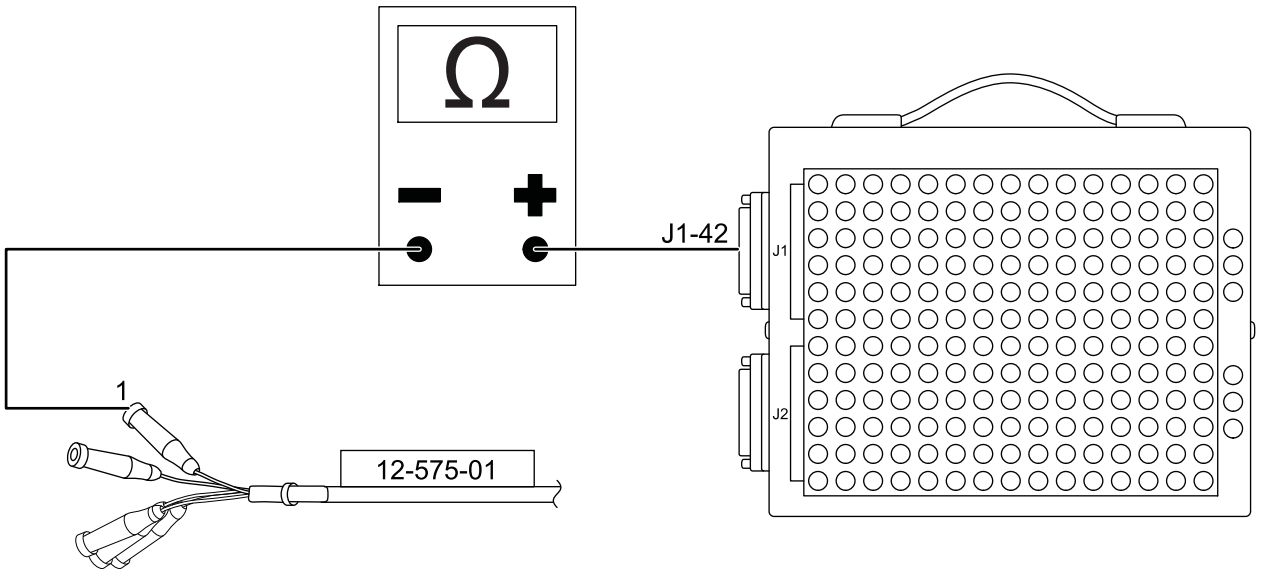


Figure 268 Pin-Point Test 2 SIG GND Circuit Resistance Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness 12-575-01 to vehicle harness connector and leave DPFDP / DPFOP disconnected. C. Connect Breakout Harness 18-537-01 to 180-pin Breakout Box 00-00956-08. D. Connect Breakout Harness 18-537-01 to vehicle harness and leave ACM disconnected.

Test 2	Specification
Use DMM to measure resistance between Breakout Harness 12-575-01 pin-1 and 180-pin Breakout Box 00-00956-08 pin J1-42.	Less than 5 ohms
Decision	
Is resistance less than 5 ohms?	Yes: Replace DPFDP/ DPFOP sensor. After repairs are complete, retest for SPN 3251 FMI 3.
	No: Repair high resistance between the DPFDP / DPFOP sensor pin-1 and ACM pin J1-42. After repairs are complete, retest for SPN 3251 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify each step was completed correctly and proper decision was made. Return to SPN 3251 FMI 3 fault code diagnostics.

SPN 3251 FMI 4 - DPFDP Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Particulate Filter Differential Pressure (DPFDP) sensor signal voltage is < than 0.25 volts for more than 2 seconds.	DPFDP sensor value < 0.25 volts	Key ON

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects Diesel Particulate Filter Differential Pressure (DPFDP) signal voltage is less than specification for more than 2 seconds.

Lamp Reaction

MIL will illuminate when this fault is detected during one consecutive drive cycle.

Associated Faults

SPN 5217 FMI 14 (VREF 9)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- VREF 9 circuit Open or high resistance
- DPFDP circuit short to GND
- DPFDP circuit Open or high resistance
- Failed DPFDP / DPFOP sensor module

Step 1	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for 5217 FMI 14 (VREF 9). Is EST DTC list free of SPN 5217 FMI 14?		Yes: Go to Step 2. No: Repair SPN 5217 FMI 14. After repairs are complete, retest for SPN 3251 FMI 4.

Step 2	Inspect connections at DPFDP / DPFOP sensor.	Decision
A. Key OFF. B. Disconnect DPFDP / DPFOP sensor connector. C. Check DPFDP / DPFOP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DPFDP / DPFOP sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3251 FMI 4.

Pin-Point Tests (SPN 3251 FMI 4)

DPFDP Sensor Circuit

Figure 269 DPFDP / DPFOP Sensor Circuit Diagram

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form XX for additional circuit information.

Tools Required

- Breakout Harness 12-575-01
- Breakout Harness 18-537-01
- Digital Multimeter (DMM)
- 180-pin Breakout Box 00-00956-08

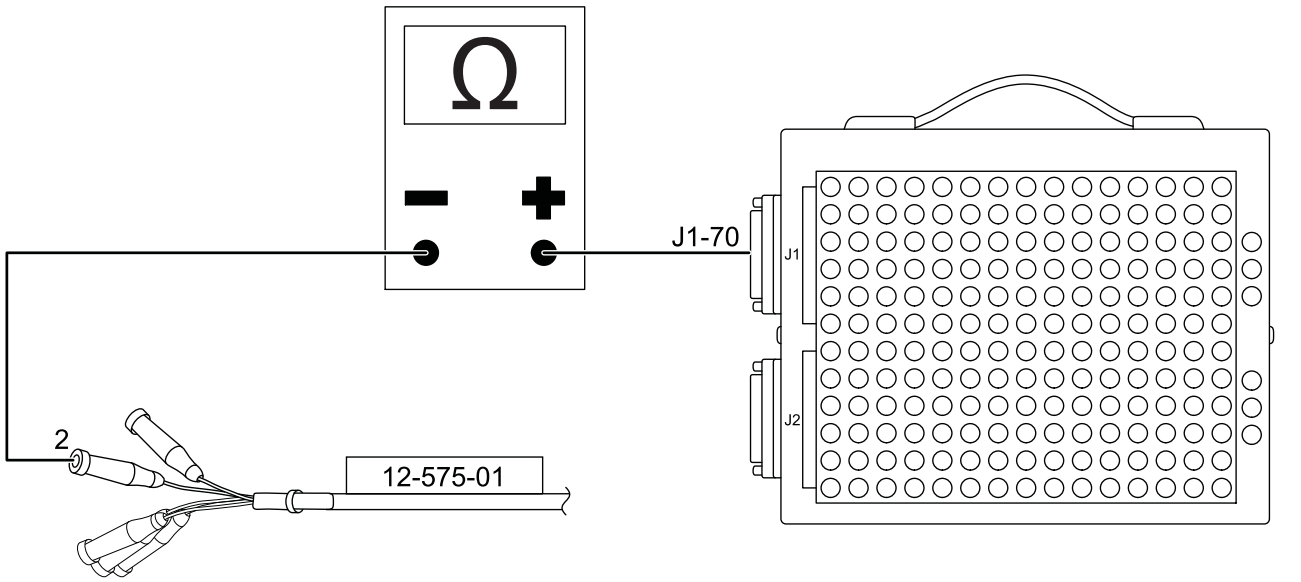


Figure 270 Pin-Point Test 1 DPFDP Circuit Resistance Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness 12-575-01 to vehicle harness and leave Diesel Particulate Filter Differential Pressure (DPFDP) / DPF Outlet Pressure (DPFOP) sensor disconnected.

Test 1	Specification
Use DMM to measure resistance between Breakout Harness 12-575-01 pin-2 and known good ground.	Greater than 1000 ohms
Decision	
Is resistance greater than 1000 ohms?	Yes: Go to Test 2.
	No: Repair short to GND between DPFDP / DPFOP pin-2 and ACM pin J1-70. After repairs are complete, retest for SPN 3251 FMI 4.

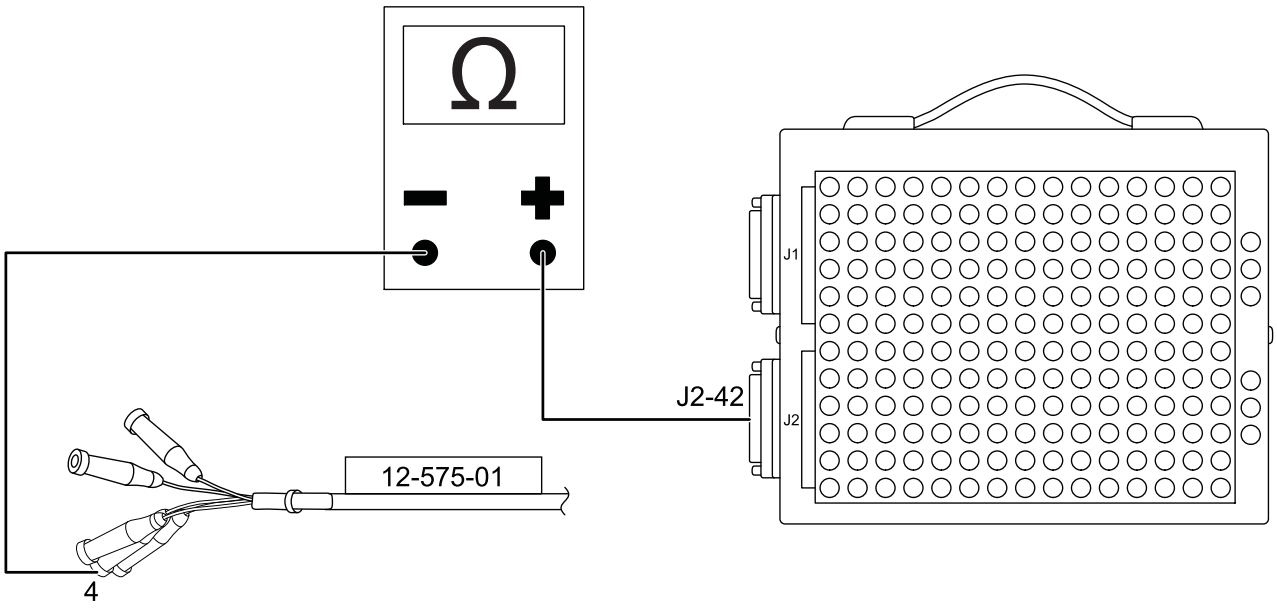


Figure 271 Pin-Point Test 2 DPFDP Circuit Resistance Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness 12-575-01 to vehicle harness connector and leave DPFDP / DPFOP disconnected. C. Connect Breakout Harness 18-537-01 to 180-pin Breakout Box 00-00956-08. D. Connect Breakout Harness 18-537-01 to vehicle harness and leave ACM disconnected.

Test 2	Specification
Use DMM to measure resistance between Breakout Harness 12-575-01 pin-4 and 180-pin Breakout Box pin J2-42.	Less than 5 ohms
Decision	
Is resistance less than 5 ohms?	Yes: Go to Test 3
	No: Repair Open or high resistance between DPFDP / DPFOP pin-4 and ACM pin J2-42. After repairs are complete, retest for SPN 3251 FMI 4.

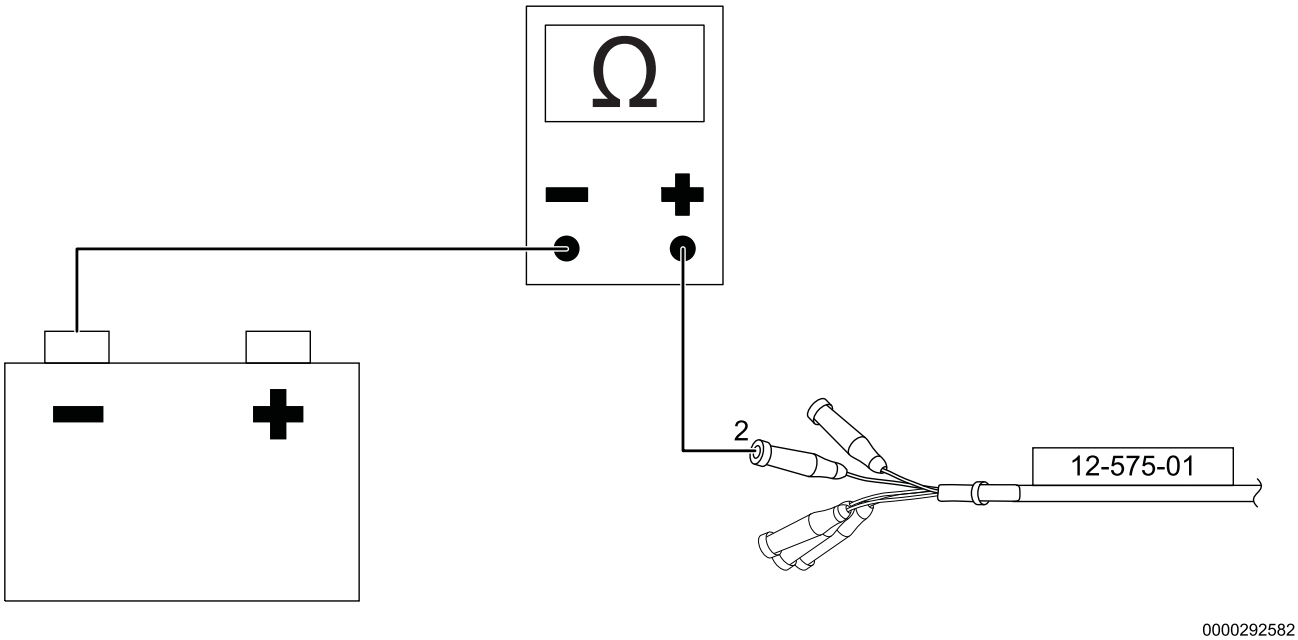


Figure 272 Pin-Point Test 3 DPFDP Circuit Resistance Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness 12-575-01 to vehicle harness and leave DPFDP / DPFOP disconnected. C. Connect Breakout Harness 18-537-01 to 180-pin Breakout Box 00-00956-08. D. Connect Breakout Harness 18-537-01 to vehicle harness and leave ACM disconnected.

Test 3	Specification
Use DMM to measure resistance between Breakout Harness 12-575-01 pin-2 and 180-pin Breakout Box 00-00956-08 pin J1-70.	Less than 5 ohms
Decision	
Is resistance less than 5 ohms?	Yes: Replace DPFDP / DPFOP sensor. After repairs are complete, retest for SPN 3251 FMI 4.
	No: Repair Open or high resistance between DPFDP / DPFOP pin-2 and ACM pin J1-70. After repairs are complete, retest for SPN 3251 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and proper decision was made. Return to SPN 3251 FMI 4 fault code diagnostics.

DPFIT (Diesel Particulate Filter Intlet Temperature) Sensor

Overview of DPFIT Sensor Group

SPN	FMI	Condition
3242	0	DPFIT above Critical (page 646)
3242	2	DPFIT signal erratic, intermittent, or incorrect (page 649)
3242	3	DPFIT signal Out of Range HIGH (page 652)
3242	4	DPFIT signal Out of Range LOW (page 653)
3242	16	DPFIT above Maximum Temperature (page 654)

Overview

The Diesel Particulate Filter Inlet Temperature (DPFIT) sensor measures the exhaust temperature at the inlet of the DPF. The DOC / DPF temperature sensor module is a smart device that communicates with the Aftertreatment Control Module (ACM) via the Controller Area Network (CAN). The DPFIT sensor is part of the DOC / DPF temperature sensor module and is not serviceable individually.

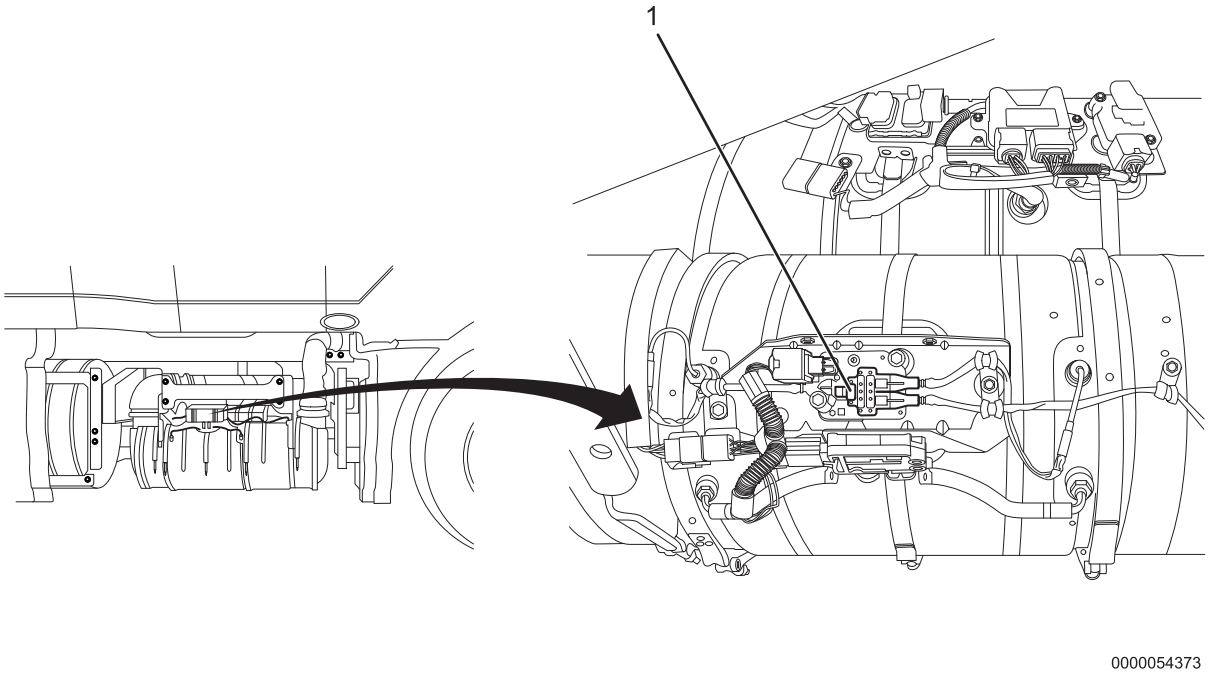


Figure 273 DOC / DPF Temperature Sensor Module Location

1. DOC / DPF Temperature Sensor Module

SPN 3242 FMI 0 - DPFIT Above Critical

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Inlet Temperature (DPFIT) sensor reading has exceeded maximum temperature.	DPFIT > 1472°F (800°C) for more than 20 seconds.	Key-On Engine-Running (KOER)	25 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Inlet Temperature (DPFIT) reading is greater than 1472°F (800°C) for more than 20 seconds. Active and parked aftertreatment diesel particulate filter regeneration will be disabled.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temperature sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DPFIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test . Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3242 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3242 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 3242 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust , and see Lube Oil to Exhaust . After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged components. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 0.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face of the for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 3242 FMI 0.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 3242 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3242 FMI 2 - DPFIT Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Diesel Particulate Filter Intake Temperature (DPFIT) is not changing with engine operating conditions (in-range but not rational).	Average temperature drop across Diesel Oxidation Catalyst (DOC) > 99°F (55°C) or < -108°F (-60°C) Average temperature drop across Diesel Particulate Filter (DPF) > 99°F (55°C) or < -108°F (-60°C)	Key-On Engine-Running (KOER) Time since last active regeneration > 600 seconds Exhaust flow between 200 g/sec and 1,000 g/sec DPFIT between 217°F (103°C) and 1112°F (600°C) Inactive: SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 3, 4, and 17 (AFT: FP1); SPN 3482 FMI 3, 4, and 7 (AFT: FSV); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temperature Sensor Module)

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects difference between Diesel Particulate Filter Inlet Temperature (DPFIT) sensor and Diesel Particulate Filter Outlet Temperature (DPFOT) sensor readings do not match expected values for engine operating conditions.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 3, 4, and 17 (AFT: FP1); SPN 3482 FMI 3, 4, and 7 (AFT: FSV); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temperature Sensor Module)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed DOC / DPF temperature sensor module

Step 1	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temperature Sensor Module) Is EST DTC list free of SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16?		Yes: Go to Step 2. No: Repair SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 2.

Step 2	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3480 FMI 3, 4, and 17 (AFT: FP1); SPN 3482 FMI 3, 4, and 7 (AFT: FSV). Is EST DTC list free of SPN 3480 FMI 3, 4, and 17; SPN 3482 FMI 3, 4, and 7?		Yes: Go to Step 3. No: Repair SPN 3480 FMI 3, 4, and 17; SPN 3482 FMI 3, 4, and 7. After repairs are complete, retest for SPN 3242 FMI 2.

Step 3	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 3242 FMI 2. Is EST DTC list SPN 3242 FMI 2 active or pending?		Yes: Go to Step 4. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 4	Diesel Particulate Filter Intake Temperature (DPFIT) sensor and connector inspection.	Decision
A. Key OFF. B. Disconnect DPFIT sensor. C. Check DPFIT sensor and connector terminals for: damaged or pinched wires; wet or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DPFIT sensor connector, harness, and terminals clean and undamaged?		Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3242 FMI 2.

End Diagnostic Steps
After performing all diagnostic steps, if SPN 3242 FMI 2 remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3242 FMI 3 - DPFIT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module detects short to power or Open in Diesel Particulate Filter Inlet Temperature (DPFIT) circuit.	DPFIT sensor input voltage ≥ 5 volts OR DPFIT impedance ≥ 10 Ohms	Key ON	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Diesel Particulate Filter Inlet Temperature (DPFIT) sensor signal voltage is greater than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temperature sensor module).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 3.
		No: Repair SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3242 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3242 FMI 4 - DPFIT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module short to ground Diesel Particulate Filter Inlet Temperature (DPFIT) sensor circuit.	DPFIT sensor signal ≤ 1 volt	Key-On Engine-Running (KOER)	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Inlet Temperature (DPFIT) sensor signal voltage is less than 1 volt for more than 2 seconds.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temperature sensor module).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, 11, and 12 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 3.
		No: Repair SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3242 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3242 FMI 16 - DPFIT Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Inlet Temperature (DPFIT) sensor reading has exceeded maximum temperature (moderately severe level).	DPFIT > 1202°F (650°C) for 85 seconds OR Difference between the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) and the DPFIT is greater than 689°F (365°C) for 50 seconds.	Key-On Engine-Running (KOER)	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Inlet Temperature (DPFIT) reading is greater than 1269°F (687°C) for 90 seconds on five separate occasions. Active and parked regeneration will be disabled.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module)

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before reinstalling. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the DPFIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3242 FMI 2, 3, and 4 (DPFIT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3242 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test . Is the DOCIT, DPFIT, and DPFOT difference within 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3242 FMI 16. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3242 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 3242 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust , and see Lube Oil to Exhaust . After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged components. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 16.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the intake face of the DOC for soot accumulation, face plugging, or damage. Are less than 50 percent of the cells on the intake face completely blocked by soot or damaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 3242 FMI 16.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 3242 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 3242 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

DPFOP (Diesel Particulate Filter Outlet Pressure) Sensor

SPN	FMI	Description
3610	2	DPFOP signal erratic, intermittent or incorrect (page 659)
3610	3	DPFOP signal Out of Range HIGH (page 664)
3610	4	DPFOP signal Out of Range LOW (page 669)

Overview

The Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor module measures the pressure difference between the inlet pressure and outlet pressure of the DPF, and the outlet pressure of the DPF. Aftertreatment regeneration will not run with DPFDP / outlet pressure sensor module fault codes present.

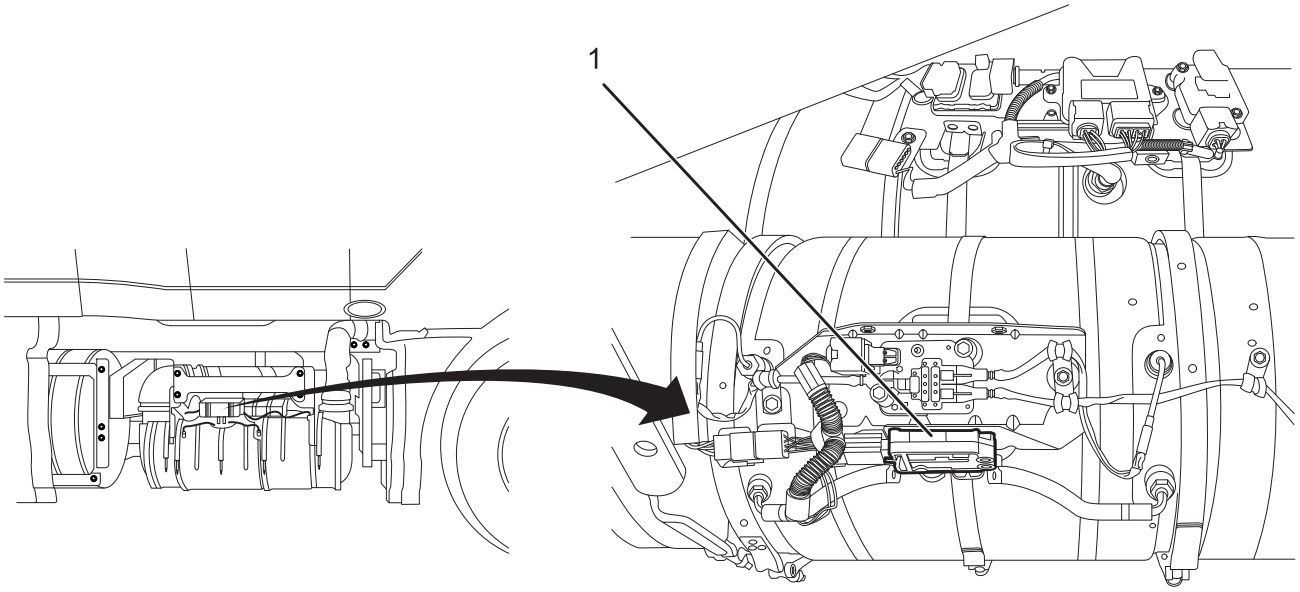


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Figure 274 DPFDP / DPFOP Sensor Module Location

1. Diesel Particulate Filter Differential Pressure (DPFDP) / DPF Outlet Pressure (DPFOP) sensor module

SPN 3610 FMI 2 - DPFOP Signal Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Particulate Filter Outlet Pressure (DPFOP) sensor stuck in-range, in-range but not rational, or in-range but reading inappropriately high.	Range of DPFOP since last monitor decision when Enable Conditions are met < 0.15 psi (1 kPa) DPFOP > 0.2 psi (1.5 kPa) or < -0.2 psi (-1.5 kPa) DPF outlet pressure between 0.2 psi (1.5 kPa) and -0.2 psi (-1.5 kPa)	Range of exhaust volumetric flow since last decision > 0.55 m3/sec DPFOP sensor signal not saturated at high exhaust flow: (DPFOP ≤ 35 kPa) or (Exhaust flow ≤ 1 m3/sec) Engine is Running Engine speed ≤ 200 RPM Elapsed time since Key ON > 1 sec. Exhaust flow > 0.4 m3/sec or Exhaust flow ≥ 0.35 m3/sec and increasing DPFOP between 0.2 psi (1.5 kPa) and -0.2 psi (-1.5 kPa) Inactive: SPN 3610 FMI 3 and 4

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects Diesel Particulate Filter Outlet Pressure (DPFOP) is greater than 0.22 psi (1.51 kPa) or less than -0.22 psi (-1.51 kPa) at initial Key ON, stuck in-range, in-range but not rational, or in-range but reading inappropriately high for 30 seconds. Engine torque will be reduced if engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3251 FMI 2, 3, and 4 (DPFDP); SPN 5127 FMI 14 (VREF9); and SPN 3610 FMI 3 and 4 (DPFOP)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- DPFOP circuit high resistance
- Leaking or Restricted DPFDP / DPFOP sensor module hoses
- Failed DPF Differential Pressure (DPFDP) / DPFOP sensor module

Step 1	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3251 FMI 2, 3, and 4 (DPFDP); SPN 5127 FMI 14 (VREF9); and SPN 3610 FMI 3 and 4 (DPFOP). Is EST DTC list free of SPN 3251 FMI 2, 3, and 4; SPN 5127 FMI 14; and SPN 3610 FMI 3 and 4?		Yes: Go to Step 2. No: Repair SPN 3251 FMI 2, 3, and 4; SPN 5127 FMI 14; and SPN 3610 FMI 3 and 4. After repairs are complete, retest for SPN 3610 FMI 2.

Step 2	Inspect hoses and tube connections at Diesel Particulate Filter Differential Pressure (DPFDP) / Diesel Particulate Filter Outlet Pressure (DPFOP) sensor.	Decision
Check DPFDP / DPFOP sensor, tubes, and passages for leaks, restrictions, and damage. Are DPFDP / DPFOP sensor connections free of leaks, restrictions, and damage?		Yes: Go to Step 3. No: Repair leaking, restricted, or damaged hoses and connections. After repairs are complete, retest for SPN 3610 FMI 2.

Step 3	Inspect connections at DPFDP / DPFOP sensor.	Decision
A. Key OFF. B. Disconnect DPFDP / DPFOP sensor connector. C. Check DPFDP / DPFOP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DPFDP / DPFOP sensor module connector, harness, and terminals clean and undamaged?		Yes: Go to Step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3610 FMI 2.

Step 4	Inspect connections at ACM.	Decision
A. Key OFF. B. Disconnect ACM connector. C. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are ACM connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests . No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3610 FMI 2.

Pin-Point Tests (SPN 3610 FMI 2)

DPFDP/DPFOP Circuit

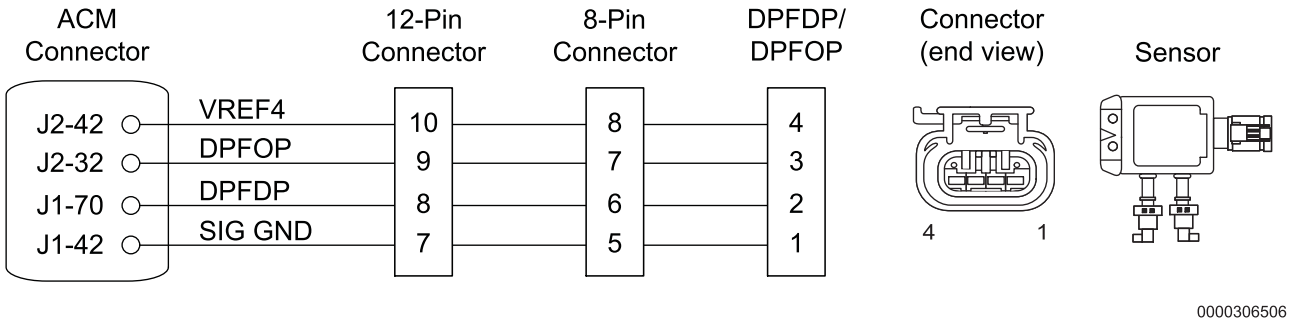

Figure 275 Diesel Particulate Filter Differential Pressure (DPFDP) / Diesel Particulate Filter Outlet Pressure (DPFOP) Sensor Circuit Diagram

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Tools Required

- Breakout Harness 12-575-01
- Breakout Harness 18-537-01
- Digital Multimeter (DMM)
- 180-pin Breakout Box

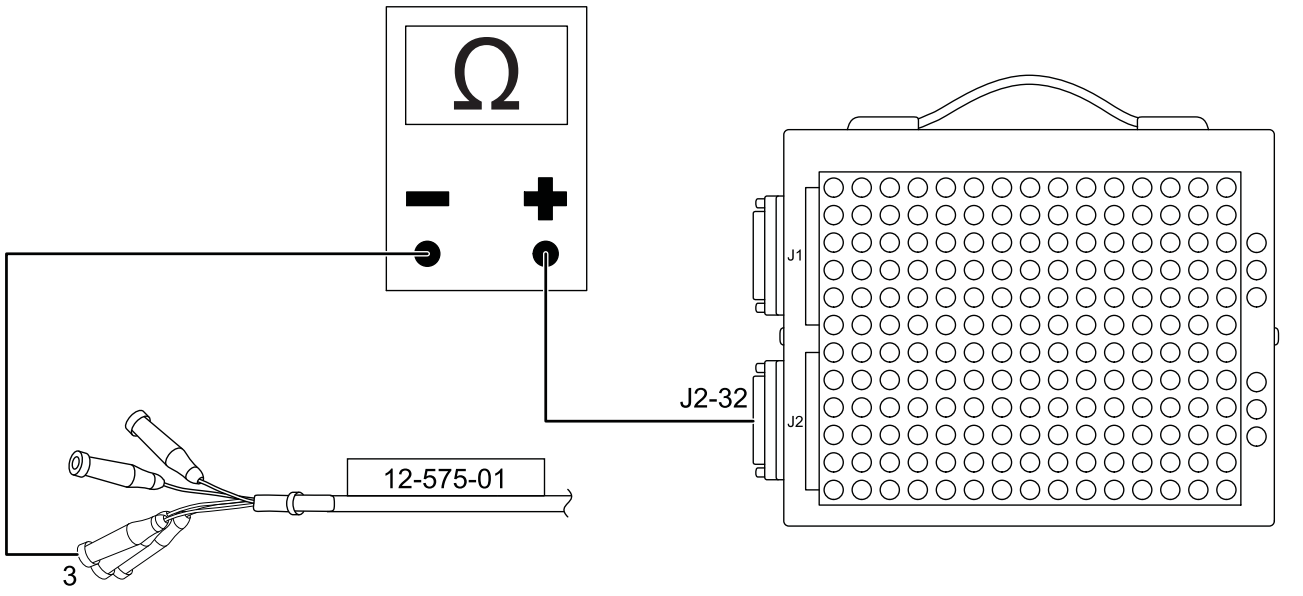

Figure 276 Test 1 DPFOP Sensor Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness 12-575-01 to vehicle harness and leave Diesel Particulate Filter Differential Pressure (DPFDP) / Diesel Particulate Filter Outlet Pressure (DPFOP) sensor disconnected. C. Connect Breakout Harness 18-537-01 to 180-pin Breakout Box. D. Connect Breakout Harness 18-537-01 to vehicle harness and leave Aftertreatment Control Module (ACM) disconnected.

Test 1	Specification
Use DMM to measure resistance between Breakout Harness 12-575-01 pin-3 and Breakout Box pin J2-32.	Less than 5 ohms
Decision	
Is resistance less than 5 ohms?	Yes: Replace DPFDP / DPFOP sensor. After repairs are complete, retest for SPN 3610 FMI 2.
	No: Repair Open or high resistance between DPFDP / DPFOP pin-3 and ACM pin J2-32. After repairs are complete, retest for SPN 3610 FMI 2.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and proper decision was made. Return to SPN 3610 FMI 2 fault code diagnostics.

SPN 3610 FMI 3 - DPFOP Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Particulate Filter Outlet Pressure (DPFOP) sensor reading is greater than specified operating range for a specified time, or shorted to high source.	Aftertreatment DPFOP sensor value > 4.75 volts	Key ON

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects Diesel Particulate Filter Outlet Pressure (DPFOP) signal voltage is greater than specification for more than 2 seconds.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during first drive cycle.

Associated Faults

SPN 5127 FMI 14 (VREF 9)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- SIG GND circuit Open or high resistance
- DPFOP signal circuit short to PWR
- Failed DPF Differential Pressure (DPFDP) / DPFOP sensor

Step 1	Check for associated fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5127 FMI 14 (VREF 9). Is EST DTC list free of SPN 5127 FMI 14?		Yes: Go to Step 2. No: Repair SPN 5127 FMI 14. After repairs are complete, retest for SPN 3610 FMI 3.

Step 2	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 3610 FMI 3. Is EST DTC list SPN 3610 FMI 3 active?		Yes: Go to Step 3. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 3	Inspect connections at Diesel Particulate Filter Differential Pressure (DPFDP) / Diesel Particulate Filter Outlet Pressure (DPFOP) sensor.	Decision
A. Key OFF. B. Disconnect DPFDP / DPFOP sensor connector. C. Check DPFDP / DPFOP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DPFDP / DPFOP sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests . No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3610 FMI 3.

Pin-Point Tests (SPN 3610 FMI 3)

DPFDP/DPFOP Circuit

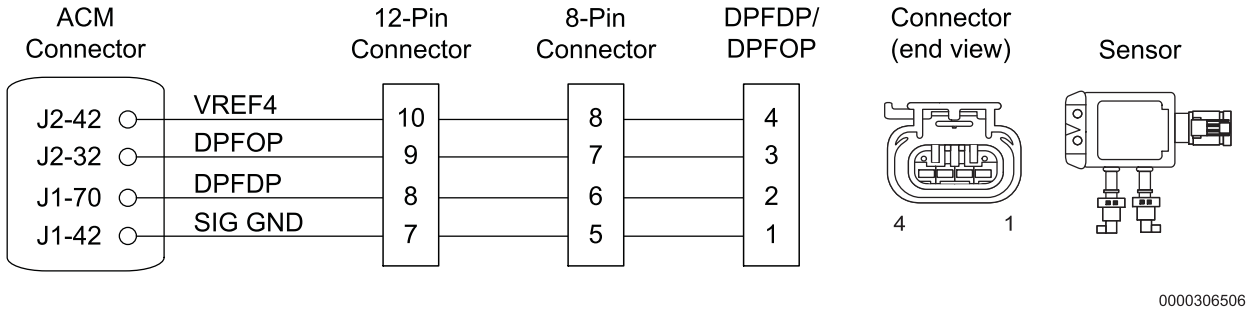

Figure 277 Diesel Particulate Filter Differential Pressure (DPFDP) / Diesel Particulate Filter Outlet Pressure (DPFOP) Sensor Circuit Diagram

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness 12-575-01

- Breakout Harness 18-537-01
- Digital Multimeter (DMM)
- 180-pin Breakout Box 00-00956-08

Test 1 Setup
A. Key OFF. B. Disconnect Diesel Particulate Filter Differential Pressure (DPFDP) / Diesel Particulate Filter Outlet Pressure (DPFOP). C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). D. Key ON. Log in to ServiceMaxx™ software, perform Continuous Monitor Test(page 1588).

Test 1	Specification
Monitor DPFOP Voltage using continuous monitor session in ServiceMaxx™ software.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Go to Test 2.
	No: Repair short to PWR between DPFDP / DPFOP pin-3 and Aftertreatment Control Module (ACM) connector pin J2-32. After repairs are complete, retest for SPN 3610 FMI 3.

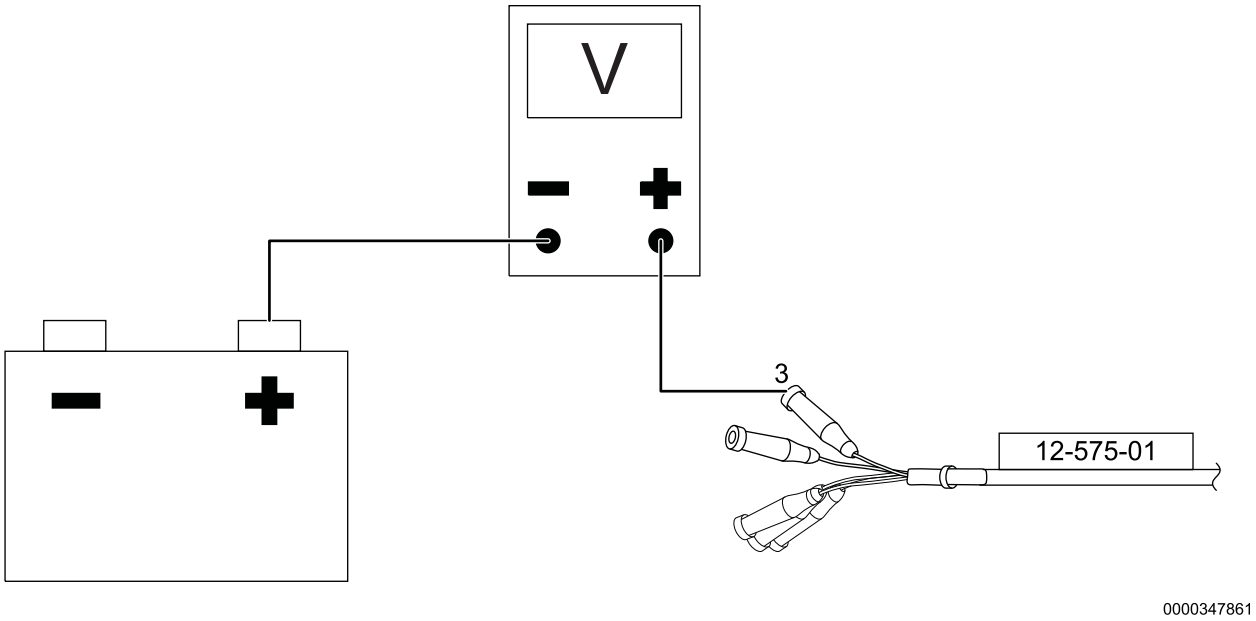

Figure 278 Test 2 SIG GND Circuit Resistance Check

Test 2 Setup
A. Key OFF. B. Disconnect Diesel Particulate Filter Differential Pressure (DPFDP) / Diesel Particulate Filter Outlet Pressure (DPFOP) sensor module C. Connect Breakout Harness 12-575-01 to vehicle harness and leave DPFDP / DPFOP sensor module disconnected. D. Key ON.

Test 2	Specification
Use DMM to measure voltage between Breakout Harness 12-575-01 pin-1 and B+.	B+ ± 0.5 volts
Decision	
Is voltage B+ ± 0.5 volts?	Yes: Replace DPFDP / DPFOP sensor module. After repairs are complete, retest for SPN 3610 FMI 3.
	No: Repair Open or high resistance between DPFDP / DPFOP pin-1 and ACM pin J1-42. After repairs are complete, retest for SPN 3610 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and proper decision was made. Return to SPN 3610 FMI 3 fault code diagnostics.

SPN 3610 FMI 4 - DPFOP Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Particulate Filter Outlet Pressure (DPFOP) sensor reading is less than specified operating range for a specified time.	Aftertreatment DPFOP sensor value < 0.25 volts	Key ON

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects aftertreatment Diesel Particulate Filter Outlet Pressure (DPFOP) signal voltage is greater than specification for more than 2 seconds.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during first drive cycle.

Associated Faults

SPN 5127 FMI 14 (VREF 9)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- VREF 9 circuit Open or high resistance
- VREF 9 circuit short to GND
- DPFOP circuit short to GND
- DPFOP circuit Open or high resistance
- Failed DPFDP / DPFOP sensor

Step 1	Check for associated fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5127 FMI 14 (VREF 9). Is EST DTC list free of SPN 5127 FMI 14?		Yes: Go to Step 2. No: Repair SPN 5127 FMI 14. After repairs are complete, retest for SPN 3610 FMI 4.

Step 2	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 3610 FMI 3. Is EST DTC list SPN 3610 FMI 4 active?		Yes: Go to Step 3. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 3	Inspect connections at DPFDP / DPFOP sensor.	Decision
A. Key OFF. B. Disconnect Diesel Particulate Filter Differential Pressure / Diesel Particulate Filter Outlet Pressure (DPFDP / DPFOP) sensor connector. C. Check DPFDP / DPFOP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DPFDP / DPFOP sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests . No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3610 FMI 4.

Pin-Point Tests (SPN 3610 FMI 4)

DPFDP/DPFOP Circuit

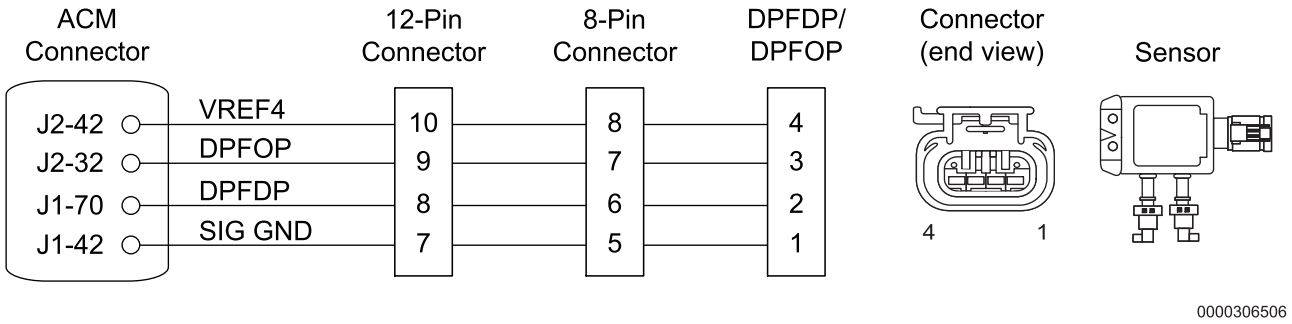

Figure 279 Diesel Particulate Filter Differential Pressure (DPFDP) / Diesel Particulate Filter Outlet Pressure (DPFOP) Sensor Circuit Diagram

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 12-575-01
- Breakout Harness 18-537-01
- Digital Multimeter (DMM)

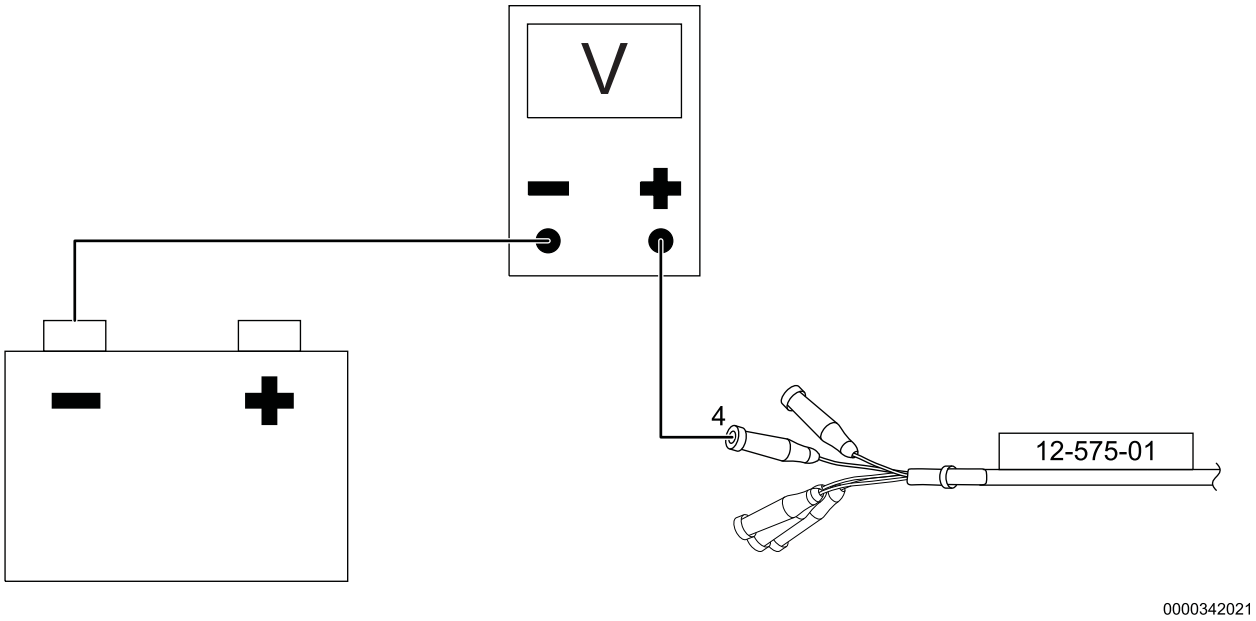

Figure 280 Test 1 DPFOP Sensor Circuit Voltage Check

Test 1 Setup
A. Key OFF. B. Disconnect Diesel Particulate Filter Differential Pressure (DPFDP) / Diesel Particulate Filter Outlet Pressure (DPFOP) sensor. C. Connect Breakout Harness 12-575-01 to vehicle harness and leave DPFDP / DPFOP sensor disconnected. D. Key ON.

Test 1	Specification
Use DMM to measure voltage between Breakout Harness 12-575-01 pin-4 and known good GND.	B+ ± 0.5 volts
Decision	
Is voltage within specification?	Yes: Go to Test 2.
	No: Repair Open between DPFDP / DPFOP pin-4 and ACM pin J2-42. After repairs are complete retest for SPN 3610 FMI 4.

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness 12-575-01 to vehicle harness and leave DPFDP / DPFOP sensor disconnected. C. Connect 3-Banana Plug Harness ZTSE4498 to short Breakout Harness 12-575-01 pin-4 to pin-2 together. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON. Log in to ServiceMaxx™ software, perform Continuous Monitor Test(page 1588).

Test 2	Specification
Monitor DPFOP Voltage using continuous monitor session in ServiceMaxx™ software.	B+ ± 0.5 volts
Decision	
Is resistance less than 5 ohms?	Yes: Replace DPFDP / DPFOP sensor. After repairs are complete, retest for SPN 3610 FMI 4.
	No: Go to Test 3.

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness 12-575-01 to vehicle harness and leave DPFDP / DPFOP sensor disconnected. C. Connect 3-Banana Plug Harness ZTSE4498 to short Breakout Harness 12-575-01 pin-4 to pin-2 together. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON. Log in to ServiceMaxx™ software, clear codes. F. Key OFF, wait for EST screens to clear. G. Key ON.

Test 3	Specification
Check DTC list for new codes.	No DTC code set.
Decision	
Does SPN 5127 FMI 14 (VREF 9) set?	Yes: Repair short to GND in SIG circuit. After repairs are complete, retest for SPN 3610 FMI 4.
	No: Repair Open or high resistance in SIG circuit. After repairs are complete, retest for SPN 3610 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and proper decision was made. Return to SPN 3610 FMI 4 fault code diagnostics.

DPFOT (Diesel Particulate Filter Outlet Temperature) Sensor

Overview of DPFOT Sensor Group

SPN	FMI	Condition
3246	0	DPFOT above Critical Temperature (page 676)
3246	2	DPFOT signal erratic, intermittent, or incorrect (page 680)
3246	3	DPFOT signal Out of Range HIGH (page 682)
3246	4	DPFOT signal Out of Range LOW (page 683)
3246	16	DPFOT above Maximum Temperature (page 685)

Overview

The Diesel Particulate Filter Outlet Temperature (DPFOT) sensor measures the exhaust temperature at the outlet of the DPF. The DOC / DPF temperature sensor module is a smart device that communicates with the Aftertreatment Control Module (ACM) via the Controller Area Network (CAN). The DPFOT sensor is part of the DOC / DPF temperature sensor module and is not serviceable individually.

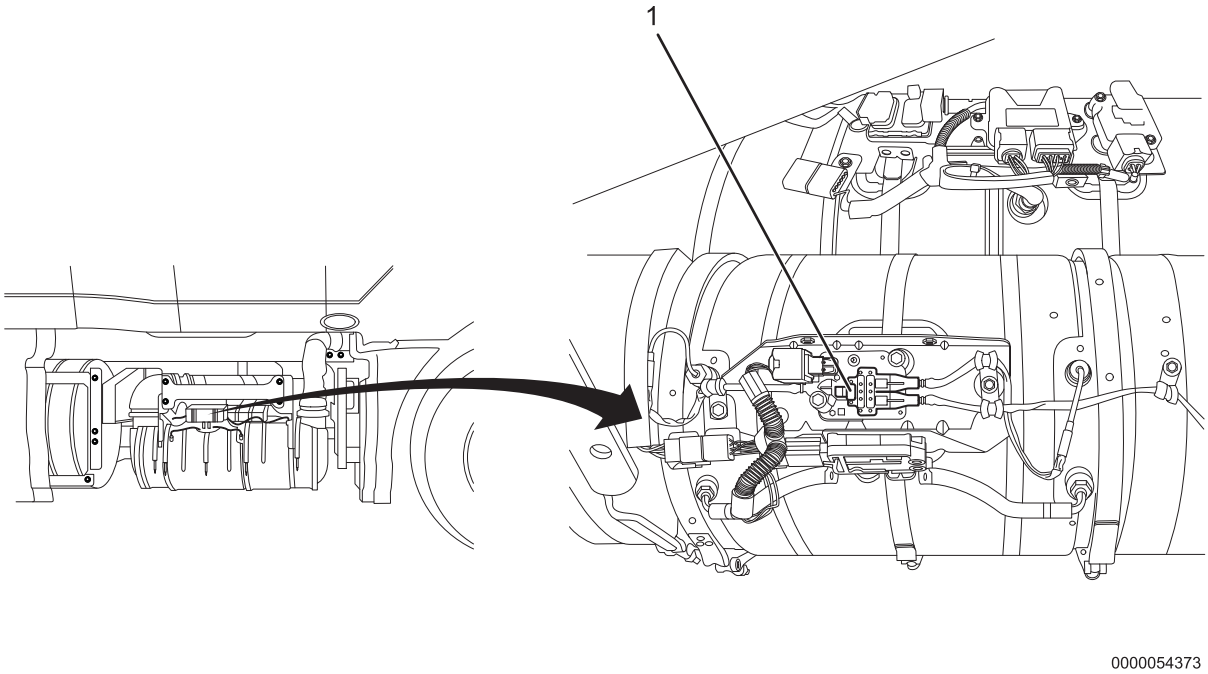

Figure 281 DOC / DPF Temperature Sensor Module Location

1. DOC / DPF Temperature Sensor Module

SPN 3246 FMI 0 - DPFOT Above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Outlet Temperature (DPFOT) sensor reading has exceeded maximum temperature limit.	DPFOT > 1472°F (800°C) for more than 20 seconds.	Key-On Engine-Running (KOER)	25 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) reading is greater than 1472°F (800°C) for more than 20 seconds.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3246 FMI 2, 3, and 4; SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before re-installing.

Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

This fault will go inactive after the DPFOT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3246 FMI 2, 3, and 4 (DPFOT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3246 FMI 2, 3, and 4; SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3246 FMI 2, 3, and 4; SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test . Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3246 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3246 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 3246 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust , and see Lube Oil to Exhaust . After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged components. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 0.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face for soot accumulation, face plugged, or damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 3246 FMI 0.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 3246 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3246 FMI 2 - DPFOT Signal Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values
Diesel Particulate Filter Outlet Temperature (DPFOT) is not changing with engine operating conditions (in-range but not rational).	Average temperature drop across Diesel Oxidation Catalyst (DOC) > 99°F (55°C) or < -108°F (-60°C) Average temperature drop across Diesel Particulate Filter (DPF) > 99°F (55°C) or < -108°F (-60°C)	Key-On Engine-Running (KOER) Time since last active regeneration > 600 seconds Exhaust flow between 200 g/sec and 1,000 g/sec DPFOT between 217°F (103°C) and 1112°F (600°C) Inactive: SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 3, 4, and 17 (AFT: FP1); SPN 3482 FMI 3, 4, and 7 (AFT: FSV); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temperature Sensor Module)

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects Diesel Particulate Filter Outlet Temperature (DPFOT) reading is not changing with engine operating conditions within 300 seconds.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 3, 4, and 17 (AFT: FP1); SPN 3482 FMI 3, 4, and 7 (AFT: FSV); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temperature Sensor Module)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) temperature sensor module

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 3246 FMI 2. Is EST DTC list SPN 3246 FMI 2 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3242 FMI 3 and 4 (DPFIT); SPN 3246 FMI 3 and 4 (DPFOT); SPN 3480 FMI 3, 4, and 17 (AFT: FP1); SPN 3482 FMI 3, 4, and 7 (AFT: FSV); SPN 4765 FMI 3 and 4 (DOCIT); SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 3480 FMI 3, 4, and 17; SPN 3482 FMI 3, 4, and 7; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16?		Yes: Go to step 3. No: Repair SPN 3242 FMI 3 and 4; SPN 3246 FMI 3 and 4; SPN 3480 FMI 3, 4, and 17; SPN 3482 FMI 3, 4, and 7; SPN 4765 FMI 3 and 4; SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 2.

Step 3	Perform sensor and connector inspection	Decision
A. Key OFF. B. Disconnect Diesel Particulate Filter Outlet Temperature (DPFOT) sensor. C. Check DPFOT sensor and connector terminals for: damaged or pinched wires; wet or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are DPFOT sensor connector, harness, and terminals clean and undamaged?		Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3246 FMI 2.

End Diagnostic Steps
After performing all diagnostic steps, if SPN 3246 FMI 2 remains, verify if each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3246 FMI 3 - DPFOT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module detects short to power, or Open in Diesel Particulate Filter Outlet Temperature (DPFOT) sensor circuit.	DPFOT sensor input voltage ≥ 5 volts OR DPFOT ≥ 10 Ohms	Key-On Engine-Running (KOER)	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) sensor signal voltage is greater than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temperature sensor module).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 3.
		No: Repair SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 3246 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3246 FMI 4 - DPFOT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DOC / DPF temperature sensor module short to ground in Diesel Particulate Filter Outlet Temperature (DPFOT) sensor circuit.	DPFOT signal ≤ 1 V	Key-On Engine-Running (KOER)	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) sensor signal voltage is less than 1 volt for more than 2 seconds.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF Temp Sensor Module) Is EST DTC list free of SPN 5742 FMI 3, 4, 11, and 16?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 4.
		No: Repair SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3246 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3246 FMI 16 - DPFOT Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Diesel Particulate Filter Outlet Temperature (DPFOT) sensor reading has exceeded maximum temperature (moderately severe).	DPFOT > 1269°F (687°C) for 90 seconds.	Key ON Active regeneration not occurring	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Diesel Particulate Filter Outlet Temperature (DPFOT) reading is greater than 1269°F (687°C) for 90 seconds. Active and parked regeneration of the DPF will be disabled.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL Balance); SPN 3246 FMI 2, 3, and 4 (DPFOT); and SPN 5742 FMI 3, 4, 11, and 16 (DOC / DPF temp sensor module).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before re-installing.

Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

This fault will go inactive after the DPFOT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed DOC / DPF temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL Balance); SPN 3246 FMI 2, 3, and 4 (DPFOT); and SPN 5742 FMI 3, 4, 11, and 16 (DPF). Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3246 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3246 FMI 2, 3, and 4; and SPN 5742 FMI 3, 4, 11, and 16. After repairs are complete, retest for SPN 3246 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
2	Compare Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor to Diesel Particulate Filter Inlet (DPFIT) and DPF Outlet Temperature (DPFOT) sensor temperatures. Perform Hot Run Sensor Comparison Test . Is the DOCIT, DPFIT, and DPFOT difference with in 77°F (43°C) of each other?	Yes: Go to step 3. No: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 3246 FMI 16. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 3246 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 3246 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair fuel or lube oil leak to exhaust. See Fuel to Exhaust , and see Lube Oil to Exhaust . After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
10	Test for black smoke from the exhaust. Idle the engine, and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Go to step 11. No: Inspect DOC / DPF system for failed or damaged components. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 16.

Step	Action	Decision
11	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DOC. Check the DOC face for soot accumulation, face plugged, or damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 3246 FMI 16.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 3246 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 3246 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

EBP (Exhaust Back Pressure) Sensor

Overview of EBP Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
5542	16	EBP Above Desired during CSER	• Face plugged/damaged DPF • Face plugged/damaged DOC • Stuck or sticking EBPV • Failed ACV	Step-Based Diagnostics (page 691)
5542	18	EBP Below Desired during CSER	• Damaged / leaking exhaust system • Restricted / leaking air supply to Air Control Valve (ACV) • Restricted or leaking air supply to EBPV • Stuck or sticking EBPV • Failed EBPV actuator • Failed ACV	Step-Based Diagnostics (page 694)
5543	3	EBPV short to PWR	• EBPV circuit short to PWR • Failed EBPV	Step-Based Diagnostics (page 697)
5543	4	EBPV short to GND	• EBPV circuit short to GND • Failed EBPV	Step-Based Diagnostics
5543	5	EBPV open load/circuit	• EBPC circuit OPEN • Failed EBPV	Circuit Checks (page 1412)

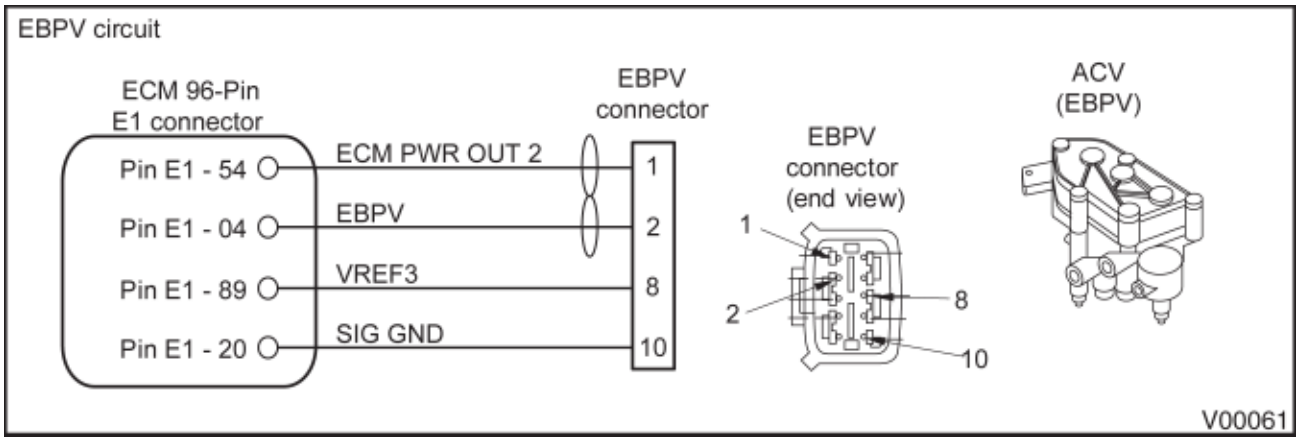

Figure 282 Exhaust Back Pressure Valve (EBPV) circuit diagram

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Exhaust Back Pressure Valve (EBPV) is used to increase exhaust back pressure and raise the exhaust temperature to aid in the regeneration process. During operation, the EBPV closes restricting exhaust flow. This increases the load on the engine and causes exhaust temperatures to rise. When the Electronic Control Module (ECM) wants to close the EBPV, a signal is sent to the Air Control Module (ACV), and air pressure is sent to the EBPV closing the valve. The ECM monitors the Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor, located within the ACV, to regulate air pressure to the EBPV.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6003 (EBPV)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Note: The EBPV, TC1TOP, and TC2WC circuits share the same connector to the ACV assembly.

SPN 5542 FMI 16 - EBP Above Desired during CSER

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Cold Start Emission Reduction Exhaust Back Pressure (EBP) Monitor - Exhaust Back Pressure Above Desired.	EBP greater than expected.	CSER Warm up: On Engine running Ambient Air Temp > 14°F (-10°C) Engine Coolant Temp > 14°F (-10°C) Exhaust Back Pressure Valve (EBPV) Set Point > 1%	10 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects EBP greater than expected during Cold Start Emission Reduction.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 108 (ECM SELF (BARO)); SPN 3719 (DPF Soot Load); SPN 3936 FMI 15 (DPF system); SPN 5541 (TC1TOP); SPN 5543 (EBPV)

Fault Facts

CSER is a strategy within the ECM that monitors the SCR catalyst brick temp and using various engine components, it works to keep the SCRIT above minimum temps for emission reduction through the catalyst.

Drive Cycle to Determine Fault Status

Drive Cycle 18 then 13 in 2013 HD-OBD Diagnostic Reference Manual.

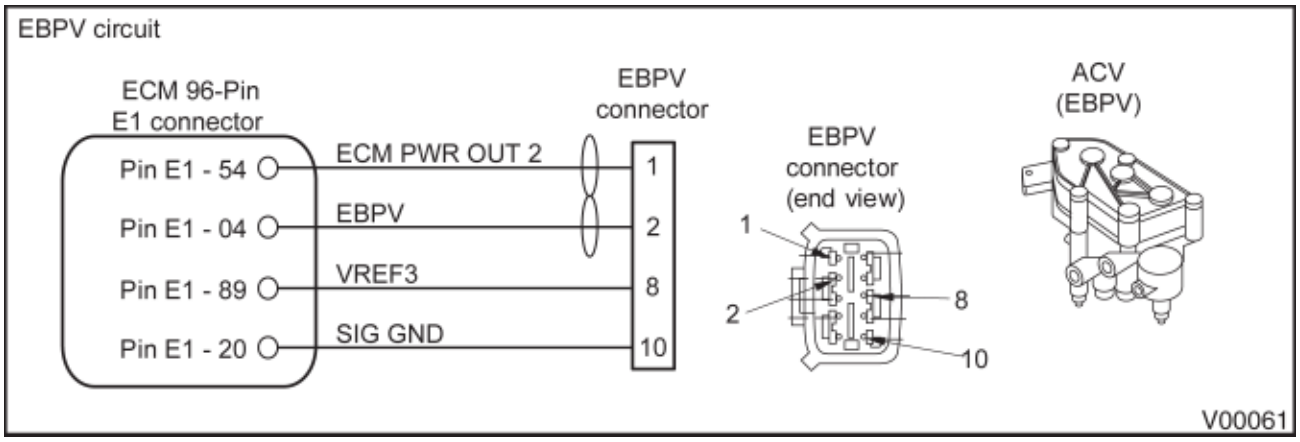

Figure 283 Exhaust Back Pressure Valve (EBPV) circuit diagram

Possible Causes

- Stuck or sticking EBPV
- Failed ACV

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 108 (ECM SELF [BARO]); SPN 3719 (DPF Soot Load); SPN 3936 FMI 15 (DPF system); SPN 5541 (TC1TOP); SPN 5543 (EBPV). Is EST DTC list free of SPN 108; SPN 3936 FMI 15; SPN 5541; SPN 5543?	Yes: Go to step 2. No: Repair SPN 108; SPN 3936 FMI 15; SPN 5541; SPN 5543. After repairs are complete, retest for SPN 5542 FMI 16.

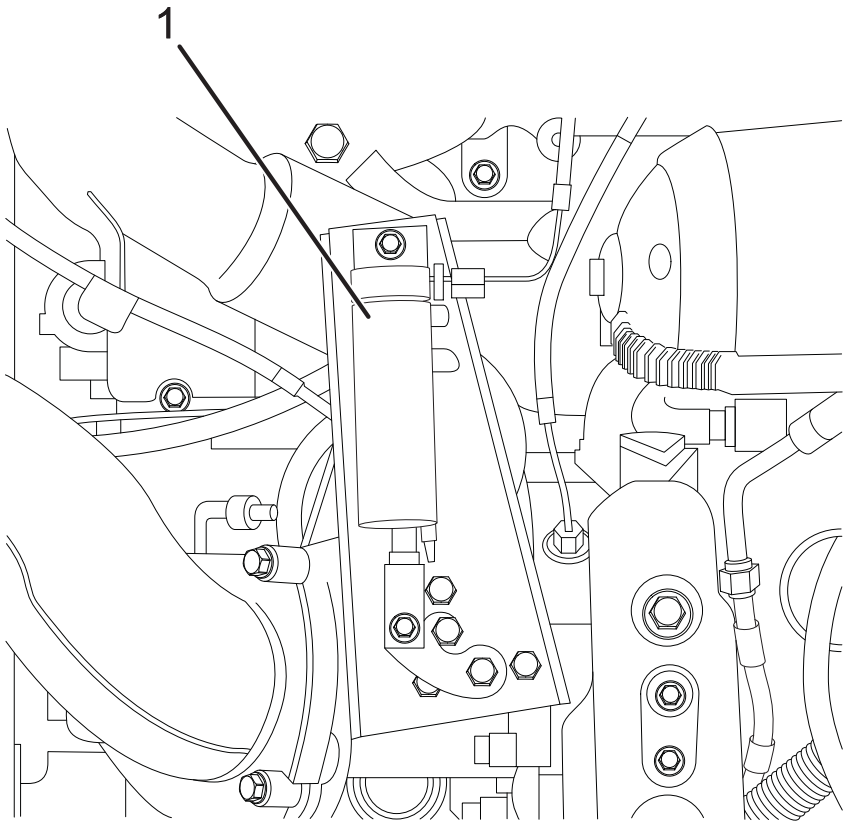

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Figure 284 EBPV location

1. Exhaust Back Pressure Valve (EBPV)

Step	Action	Decision
2	Check for Stuck or Sticking Exhaust Back Pressure Valve (EBPV). Perform Exhaust Back Pressure Valve (EBPV) test . Does EBPV pass the Exhaust Back Pressure Valve (EBPV) test?	Yes: Replace Air Control Valve (ACV). After repairs are complete, retest for SPN 5542 FMI 16.
		No: Repair EBPV assembly (according to the Exhaust Back Pressure Valve test). After repairs are complete, retest for SPN 5542 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 5542 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5542 FMI 18 - EBP Below Desired during CSER

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Exhaust Back Pressure (EBP) less than expected during Cold Start Emission Reduction (CSER).	EBP less than expected.	CSER Warm up: On Engine running Ambient Air Temp (AAT) > 14°F (-10°C) Engine coolant temp > 14°F (-10°C) EBP Set Point > 1%	20 seconds

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Exhaust Back Pressure (EBP) is less than expected during Cold Start Emission Reduction (CSER).

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 108 (ECM SELF (BARO)); SPN 5541 (TC1TOP); SPN 5543 (EBPV)

Fault Facts

CSER is a strategy within the ECM that monitors the SCR catalyst brick temp and using various engine components, it works to keep the SCRIT above minimum temps for emission reduction through the catalyst.

Drive Cycle to Determine Fault Status

Drive Cycle 18 then 13 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Damaged / leaking exhaust system
- Restricted / leaking air supply to Air Control Valve (ACV)
- Restricted or leaking air supply to EBPV
- Stuck or sticking EBPV
- Failed EBPV actuator
- Failed ACV

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 108 (ECM SELF [BARO]); SPN 5541 (TC1TOP); SPN 5543 (EBPV). Is EST DTC list free of SPN 108; SPN 5541; SPN 5543?	Yes: Go to step 2. No: Repair SPN 108; SPN 5541; SPN 5543. After repairs are complete, retest for SPN 5542 FMI 18.

Step	Action	Decision
2	Inspect exhaust system for leaks or damage. Inspect for cracked exhaust system welds, leaking exhaust system seams, or other damage. Is the exhaust system leaking or damaged?	Yes: Repair or replace leaking or damaged exhaust components. After repairs are complete, retest for SPN 5542 FMI 18.
		No: Go to step 3.

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

Step	Action	Decision
3	Inspect air supply to Air Control Valve (ACV). Inspect for leaking, restricted, or damaged air supply to the ACV. Is air supply to the ACV leaking, restricted, or damaged?	Yes: Repair or replace damaged air supply lines or components. After repairs are complete, retest for SPN 5542 FMI 18.
		No: Go to step 4.

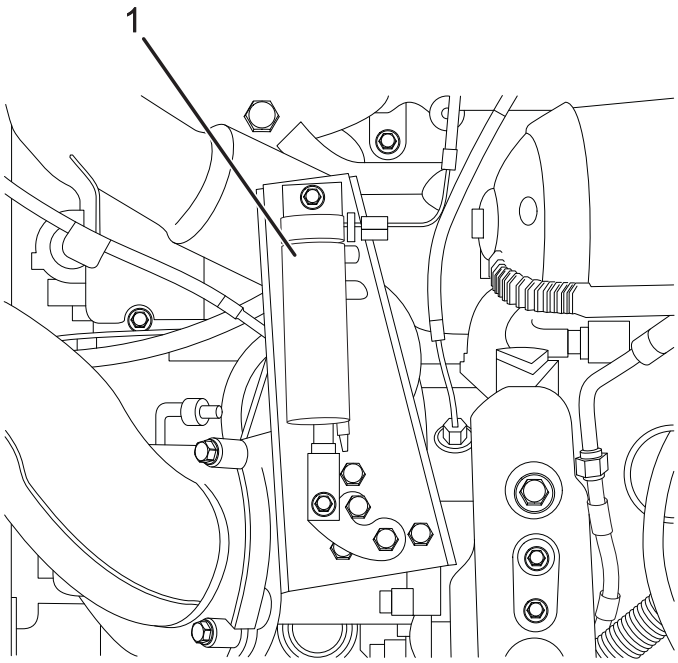

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Figure 285 EBPV location

1. Exhaust Back Pressure Valve (EBPV)

Step	Action	Decision
4	Check for Stuck or Sticking Exhaust Back Pressure Valve (EBPV). Perform Exhaust Back Pressure Valve Test . Does EBPV pass the EBPV test?	Yes: Replace Air Control Valve (ACV). After repairs are complete, retest for SPN 5542 FMI 18.
		No: Repair EBPV assembly (according to the Exhaust Back Pressure Valve Test). After repairs are complete, retest for SPN 5542 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 5542 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5543 FMI 3 - EBPC Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine Exhaust Brake Actuator Circuit Short to Power	Current on the driver > 8 A for 100 microseconds	Key ON Battery Voltage > 9 Volts Engine Exhaust Brake Actuator driver enabled SPN FMI's 158/15 and 158/17 are NOT active

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Exhaust Back Pressure Control (EBPC) Short to Power.

Lamp Reaction

Malfunction Indicator Lamp (MIL)will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 158 FMI 15 and 17 (ECM)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- EBPV circuit short to PWR
- Failed EBPV

Step 1	Check for associated fault codes.	Decision
Using EST with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 158 FMI 15 and 17 (ECM). Is EST DTC list free of SPN 158 FMI 15 and 17?		Yes: Go to Step 2. No: Repair SPN 158 FMI 15 and 17. After repairs are complete, retest for SPN 5543 FMI 3.

Step 2	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 5543 FMI 3. Is EST DTC list SPN 5543 FMI 3 active or pending?		Yes: Go to Step 3. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 3	Inspect connections at Exhaust Back Pressure Control (EBPC).	Decision
A. Key OFF. B. Disconnect EBPC sensor. C. Check CACOT sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the CACOT sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5543 FMI 3.

Pin-Point Tests (SPN 5543 FMI 3)

See latest version of Navistar® N9 and N10 Engine and Aftertreatment Wiring Schematic Form 0000003481 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4834
- Digital Multimeter (DMM) ZTSE4357

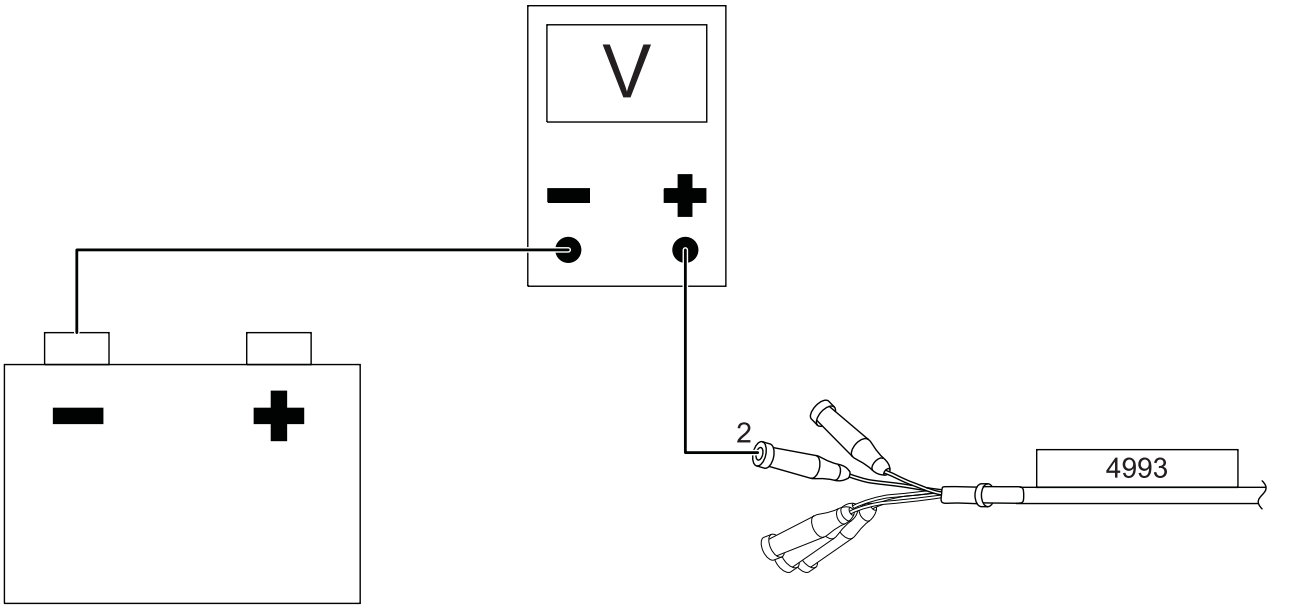
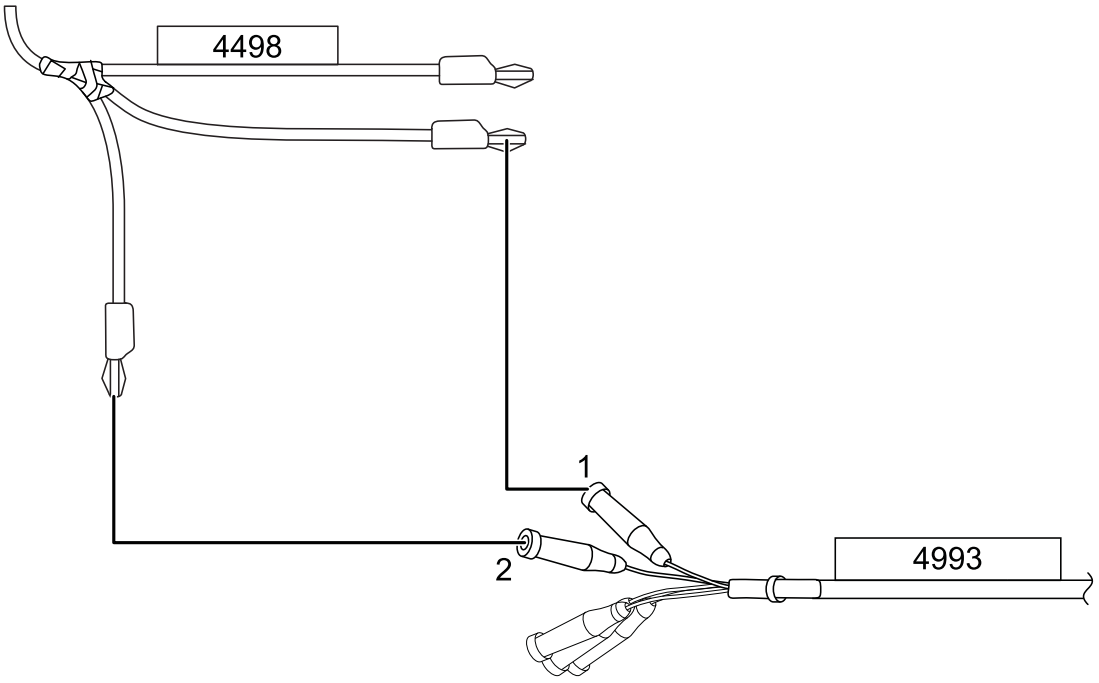


Figure 286 Test 1 CACOT Circuit Voltage Check

Test 1 Setup
A. Key OFF. B. Disconnect Charge Air Cooler Temperature (CACOT) sensor C. Connect Breakout Harness ZTSE4993 to vehicle harness connector and leave CACOT disconnected. D. Key ON.

Test 1	Specification
Use DMM to measure voltage between Breakout Harness ZTSE4993 pin-2 and known good GND.	Greater than 4.85 volts
Decision	
Is voltage greater than 4.85 volts?	Yes: Repair short to PWR between Engine Control Module (ECM) pin E1-13 and CACOT pin-2. After repairs are complete, retest for SPN 2630 FMI 3.
	No: Go to Test 2.



0000301703

Figure 287 Test 2 SIG GND Circuit Check

Test 2 Setup
A. Key OFF. B. Disconnect Charge Air Cooler Temperature (CACOT) sensor C. Connect Breakout Harness ZTSE4993 to vehicle harness connector and leave CACOT disconnected. D. Using 3-Banana Plug Harness ZTSE4498 short Breakout Harness ZTSE4993 pin-1 and pin-2 of together. E. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). F. Key ON. Log in to ServiceMaxx™ software.

Test 2	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor CACOT voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Replace CACOT sensor. After repairs are complete, retest for SPN 2630 FMI 3.
	No: Go to Test 3.

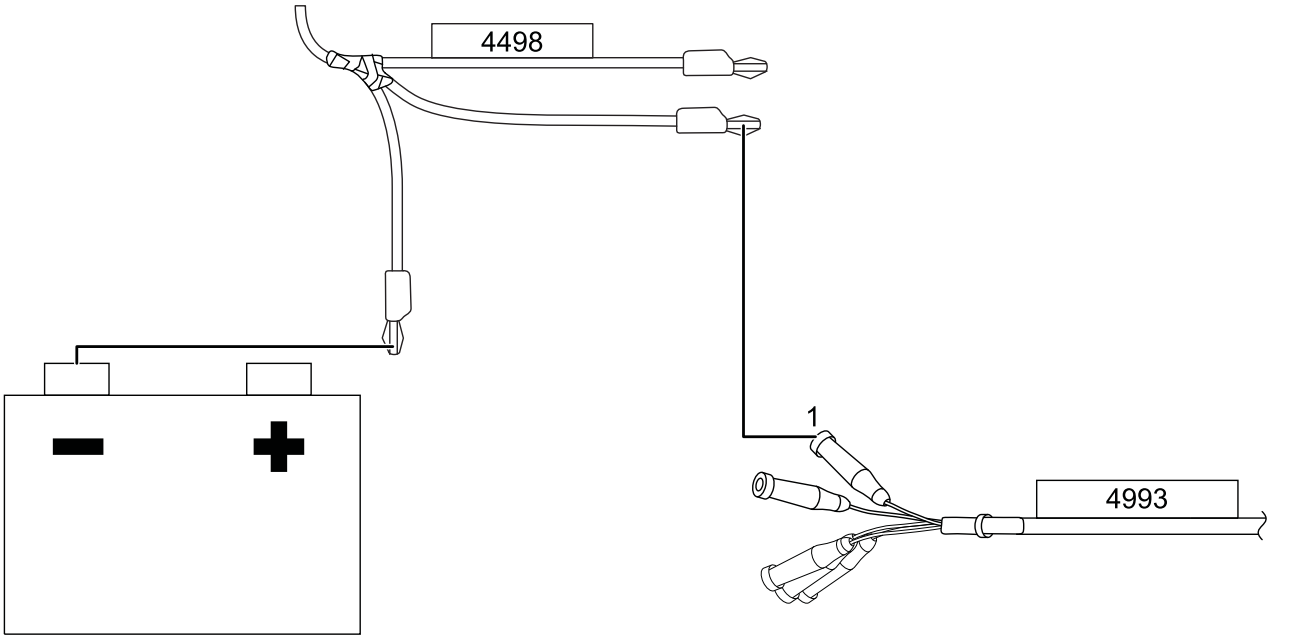


Figure 288 Test 3 CACOT Circuit Check

Test 3 Setup
A. Key OFF. B. Disconnect Charge Air Cooler Temperature (CACOT) sensor C. Connect Breakout Harness ZTSE4993 to vehicle harness connector and leave CACOT disconnected. D. Using 3-Banana Plug Harness ZTSE4498 short Breakout Harness ZTSE4993 pin-2 of to GND. E. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). F. Key ON. Log in to ServiceMaxx™ software.

Test 3	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor ECT1 voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Repair Open between CACOT pin-1 and ECM pin E1-43. After repairs are complete, retest for SPN 2630 FMI 3.
	No: Repair Open between CACOT pin-2 and ECM pin E1-13. After repairs are complete, retest for SPN 2630 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 2630 FMI 3 fault code diagnostics.

SPN 5543 FMI 4 - EBPC Short to GND

Connector Voltage Check – EBPV Disconnected

NOTE: Excessive backpressure in the exhaust system, such as a restricted Diesel Oxidation Catalyst (DOC), could set this fault. Check for exhaust system damage and proper aftertreatment system operation before performing electrical checks.

Connect Breakout Harness ZTSE6003 to EBPV engine harness, and leave EBPV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN or high resistance. Do Harness Resistance Check (page 1414).
2 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN or high resistance, Do Harness Resistance Check (page 1414).
8 to GND	5 V ± 0.5 V	If > 5.5 V, check VREF for short to PWR. If < 4.5 V, check VREF for OPEN or short to GND. Do Harness Resistance Check (page 1414).
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

1. Connect Breakout Harness ZTSE6003 between EBPV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Exhaust Back Pressure Valve from the drop-down menu.
3. Command Exhaust Back Pressure Valve to 5%.
4. Use DMM to measure voltage.
5. Command Exhaust Back Pressure Valve to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
2 to GND	95% = 1 V ± 1 V	If > 2 V, check for OPEN circuit or failed EBPV.

Actuator Resistance Check

Turn ignition switch to OFF. Connect Breakout Harness ZTSE6003 to EBPV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	4 Ω to 8 Ω	If not within specification, replace the EBPV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with Breakout Harness 00-01468-00 to ECM E1 connector and leave ECM disconnected. Connect Breakout Harness ZTSE6003 to vehicle harness and leave EBPV disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-04	< 5 Ω	If > 5 Ω, check for OPEN circuit.
8 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
8 to E1-89	< 5 Ω	If > 5 Ω, check for OPEN circuit.
10 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
10 to E1-20	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace EBPV.		

SPN 5543 FMI 5 - EBPC Open Load / Circuit

Connector Voltage Check – EBPV Disconnected

NOTE: Excessive backpressure in the exhaust system, such as a restricted Diesel Oxidation Catalyst (DOC), could set this fault. Check for exhaust system damage and proper aftertreatment system operation before performing electrical checks.

Connect Breakout Harness ZTSE6003 to EBPV engine harness, and leave EBPV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN or high resistance. Do Harness Resistance Check (page 1414).
2 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN or high resistance, Do Harness Resistance Check (page 1414).
8 to GND	5 V ± 0.5 V	If > 5.5 V, check VREF for short to PWR. If < 4.5 V, check VREF for OPEN or short to GND. Do Harness Resistance Check (page 1414).
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

1. Connect Breakout Harness ZTSE6003 between EBPV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Exhaust Back Pressure Valve from the drop-down menu.
3. Command Exhaust Back Pressure Valve to 5%.
4. Use DMM to measure voltage.
5. Command Exhaust Back Pressure Valve to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
2 to GND	95% = 1 V ± 1 V	If > 2 V, check for OPEN circuit or failed EBPV.

Actuator Resistance Check

Turn ignition switch to OFF. Connect Breakout Harness ZTSE6003 to EBPV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	6.0 Ω +10%, -5% at 68°F (20°C)	If not within specification, replace the EBPV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with Breakout Harness 00-01468-00 to ECM E1 connector and leave ECM disconnected. Connect Breakout Harness ZTSE6003 to vehicle harness and leave EBPV disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-04	< 5 Ω	If > 5 Ω, check for OPEN circuit.
8 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
8 to E1-89	< 5 Ω	If > 5 Ω, check for OPEN circuit.
10 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
10 to E1-20	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace EBPV.		

ECB1 (Engine Compression Brake 1) Sensor

Overview of ECB1 Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
1072	3	ECB1 Control short to PWR	• ECB1 control circuit short to PWR • Failed ECB1 solenoid	Circuit Checks (page 711)
1072	4	ECB1 Control short to GND	• ECB1 control circuit short to GND • Failed ECB1 solenoid	Circuit Checks (page 711)
1072	5	ECB1 Control open load/circuit	• ECB1 control OPEN circuit • Failed ECB1 solenoid	Circuit Checks (page 711)

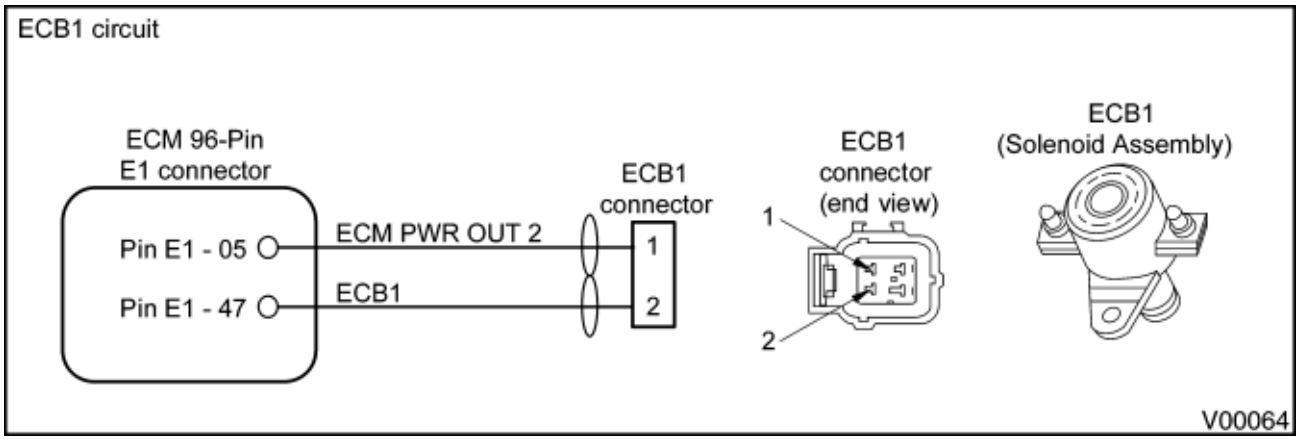


Figure 289 ECB1 circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6004 (ECB)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

SPN 1072 FMI 3 - ECB1 Control Short to PWR

Connector Voltage Check – ECB1 Disconnected

Connect Breakout Harness ZTSE6004 to ECB1 engine harness, and leave ECB1 disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
2 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6004 between ECB1 and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Engine Compression Brake 1 from the drop-down menu.
3. Command ECB1 to 5%.
4. Use DMM to measure voltage.
5. Command ECB1 to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
2 to GND	95% = 2.5 V ± 0.5 V	If > 3 V, check for OPEN circuit or failed ECB1.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE6004 to ECB1 and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	Coil Resistance at 77°F (25°C) - 8.7 Ω to 10.0 Ω	If not within specification, replace the ECB1.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6004 to ECB1 engine harness, and leave ECB1 disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-05	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-47	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace ECB1.		

SPN 1072 FMI 4 - ECB1 Control Short to GND

Connector Voltage Check – ECB1 Disconnected

Connect Breakout Harness ZTSE6004 to ECB1 engine harness, and leave ECB1 disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
2 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6004 between ECB1 and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Engine Compression Brake 1 from the drop-down menu.
3. Command ECB1 to 5%.
4. Use DMM to measure voltage.
5. Command ECB1 to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
2 to GND	95% = 2.5 V ± 0.5 V	If > 3 V, check for OPEN circuit or failed ECB1.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE6004 to ECB1 and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	Coil Resistance at 77°F (25°C) - 8.7 Ω to 10.0 Ω	If not within specification, replace the ECB1.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6004 to ECB1 engine harness, and leave ECB1 disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-05	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-47	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace ECB1.		

SPN 1072 FMI 5 - ECB1 Control Open Load / Circuit

Connector Voltage Check – ECB1 Disconnected

Connect Breakout Harness ZTSE6004 to ECB1 engine harness, and leave ECB1 disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
2 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6004 between ECB1 and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Engine Compression Brake 1 from the drop-down menu.
3. Command ECB1 to 5%.
4. Use DMM to measure voltage.
5. Command ECB1 to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
2 to GND	95% = 2.5 V ± 0.5 V	If > 3 V, check for OPEN circuit or failed ECB1.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE6004 to ECB1 and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	Coil Resistance at 77°F (25°C) - 8.7 Ω to 10.0 Ω	If not within specification, replace the ECB1.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6004 to ECB1 engine harness, and leave ECB1 disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-05	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-47	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace ECB1.		

ECL (Engine Coolant Level) Switch Sensor

Overview of ECL Switch Sensor

SPN	FMI	Description
111	1	Low Engine Coolant level (page 714)
111	31	Engine Coolant Level Low Repeated Occurrence (page 718)

Overview

Engine Coolant Level (ECL) sensor is used to detect low coolant level in the cooling system. There are two options for ECL sensor. Option one consists of a metal deairiation tank using a coolant level module and a separate ECL sensor to detect low coolant level. Option 2 is for a plastic deairiation tank using one ECL sensor and no module.

SPN 111 FMI 1 - ECL Below Warning / Critical Level

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Coolant Level (ECL) has fallen below minimum level.	ECL circuit detects low coolant level.	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Engine Coolant Level (ECL) sensor signal detects that coolant level is below minimum level

Lamp Reaction

Red Stop Lamp will illuminate when this fault is detected.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Low coolant level
- Engine cooling system mechanical failure
- Failed ECL sensor or circuit

Step 1	Check coolant level.	Decision
Perform Coolant Level Inspection (page 1786). Is Coolant level low, is there evidence of coolant loss, or does operator complain of coolant leaks or consumption?		Yes: Go to Step 2. No: Perform 5.0 - Cooling System Operational Checkout Procedure .

Step 2	Inspect connections at Engine Coolant Temperature 1 (ECT1) sensor.	Decision
A. Key OFF. B. Disconnect ECT1 sensor connector. C. Check ECT1 sensor and connector terminals for damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECT1 sensor, connector, harness, and terminals clean and undamaged?		Yes: Go to step 3 No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 111 FMI 1.

Step 3	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 111 FMI 1. A. Key ON, clear codes. B. Key OFF, wait for EST screen to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 111 FMI 1. Is EST DTC list SPN 111 FMI 1 active or pending?		Yes: Go to step 4. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 4	Check if SPN 111 FMI 1 is still active.	Decision
Perform Test 1 (page 717). Using Electronic Service Tool (EST) with ServiceMaxx™ software: A. Key ON, clear codes. B. Key OFF, wait for EST screen to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 111 FMI 1. Is EST DTC list SPN 111 FMI 1 still active?		Yes: Repair short between ECL and Engine Control Module (ECM) pin C2-49. After repairs are complete, retest for SPN 111 FMI 1. No: Replace ECL sensor. After repairs are complete, retest for SPN 111 FMI 1.

Pin-Point Tests (SPN 111 FMI 31)

Figure 290 ECL Sensor Circuit Diagram

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF. B. Disconnect Engine Coolant Level (ECL) sensor.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 111 FMI 1 fault code diagnostics.

SPN 111 FMI 31 - Engine Coolant Level Low Repeated Occurrence

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine coolant level has remained under minimum level for 24 hours.	Engine Coolant Level (ECL) sensor signal below expected repeatedly.	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Engine Coolant Level (ECL) sensor signal detects that the vehicle has operated with coolant level below minimum level for 24 hours. This may include combined time from multiple low coolant events.

Lamp Reaction

Red Stop Lamp will illuminate when this fault is detected.

Associated Faults

SPN 110 (ECT1); SPN 111 FMI 1 (ECL)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Low Coolant Level
- Improperly programmed ECL value.

Step 1	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 (ECT1) and SPN 111 FMI 1 (ECL). Is EST DTC list free of SPN 110 and SPN 111 FMI 1?		Yes: Go to Step 2. No: Repair SPN 110 and SPN 111 FMI 1. After repairs are complete, retest for SPN 111 FMI 31.

Step 2	Check coolant level.	Decision
Perform Coolant Level Inspection (page 1786). Is Coolant Level within specification and free of contaminants.		Yes: Perform Low Coolant Level Reset Request. After repairs are complete, retest for SPN 111 FMI 31 No: Perform Coolant Loss Symptom (page 1789). After repairs are complete, retest for SPN 111 FMI 31

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 111 FMI 31 fault code diagnostics.

ECM Power (Engine Control Module)

Overview of ECM Power Sensor

SPN	FMI	Description
158	15	ECM Switched voltage too HIGH (page 722)
158	17	ECM Switched voltage too LOW (page 724)
628	12	ECM Memory Error (page 736)
629	0	ECM Error - CPU Load Excessively HIGH
629	2	ECM Error –Level 2 Monitoring (page 739)
629	8	Engine Off timer fault (page 740)
629	12	ECM Internal chip Error (page 742)
629	14	ECM Internal component overtemperature (page 744)
1110	31	ECM Internal component (page 746)
3597	4	ECM Power Output 1 below normal ECM Pins: C1-31, C1-33, C1-54, C2-51, E1-01 and E1-51(page 747)
3598	4	ECM Power Output 2 below normal ECM Pins: C1-42, C2-06, E1-05, E1-28, E1-29 and E1-54(page 748)
3599	4	ECM Power Output 3 below normal ECM Pins: C1-30, C2-03, E1-24, E1-26, and E1-27 ECM Power Output 3 below normal ECM Pins: C1-30, C2-03, E1-24, E1-26, and E1-27(page 750)

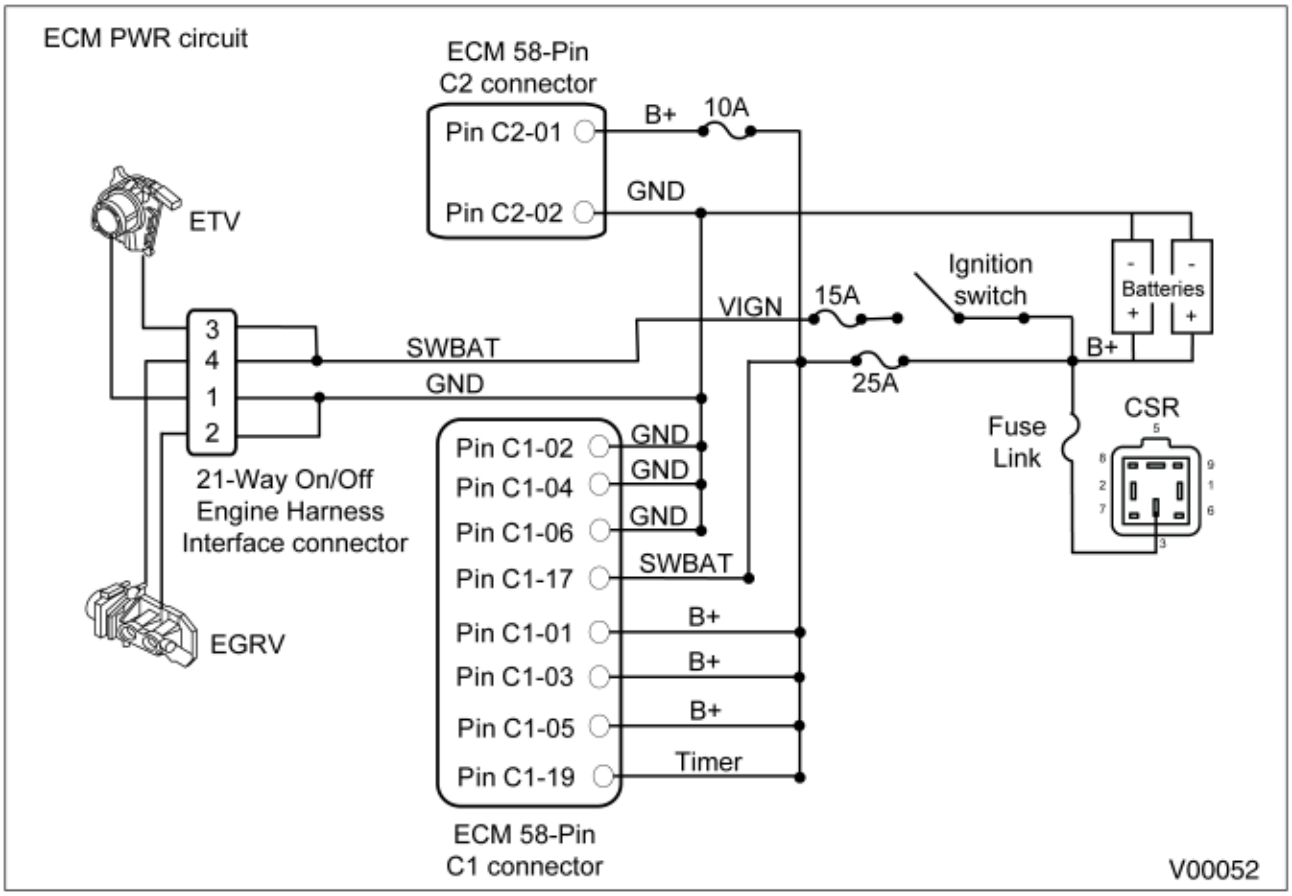


Figure 291 ECM PWR (Input Power) circuit diagram

SPN 158 FMI 15 - ECM Switched Voltage Too HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Control Module (ECM) switched voltage is greater than expected.	ECM battery voltage > 15 volts	Key-On Engine-Running (KOER) > 10 seconds Intake Air Heater (IAH) OFF > 10 seconds

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that battery voltage greater than 15 volts

Lamp Reaction

MIL will immediately illuminate when this fault is detected.

Associated Faults

None

Fault Facts

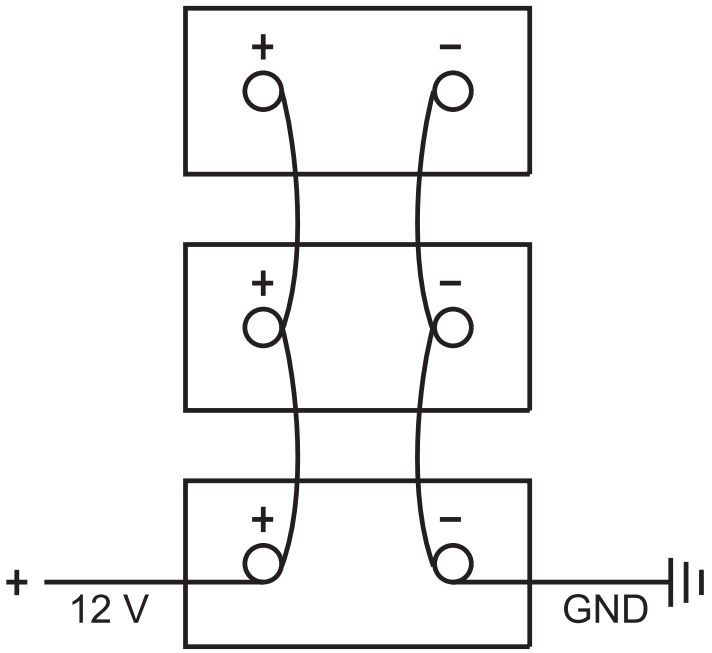
None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Charging voltage excessive
- Incorrect battery pack wiring (series instead of parallel



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Step 1	Check for active or pending fault codes.	Decision
Check for correct parallel battery pack wiring. Positive battery cable(s) should be connected from positive battery terminal to positive battery terminal. Negative battery cable(s) should be connected from negative battery terminal to negative battery terminal. Is battery pack correctly assembled (wired in parallel and Not in series)?		Yes: Replace alternator. After repairs are complete, retest for SPN 158 FMI 15.
		No: Reassemble battery pack. After repairs are complete, retest for SPN 158 FMI 15.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 158 FMI 15 fault code diagnostics.

SPN 158 FMI 17 - ECM Switched Voltage Too LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Control Module (ECM) switched voltage is less than expected.	ECM battery voltage < 10.7 volts	Key-On Engine-Running (KOER) > 10 seconds Intake Air Heater (IAH) OFF > 10 seconds

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that battery voltage less than 10.7 volts

Lamp Reaction

MIL will immediately illuminate when this fault is detected.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Low charging voltage
- Low battery voltage
- B+ circuits Open or high resistance
- SWBAT circuit Open or high resistance
- GND circuits Open or high resistance

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 158 FMI 17. Is EST DTC list SPN 158 FMI 17 active?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Check battery and electrical system.	Decision
Perform battery and electrical system inspections. Are batteries and charging system operating properly?		Yes: Go to Step 3. No: Repair or replace batteries and/or charging system components as necessary. After repairs are complete, retest for SPN 158 FMI 17.

Step 3	Check for high resistance on SWBAT circuit.	Decision
Perform Test 1 (page 728). Using DMM, measure voltage from Breakout Harness 00-01462-00 pin C1-18 to GND. Is Voltage B+ ± 0.5 volts?		Yes: Go to step 4. No: Repair OPEN or high resistance between ECM C1-18 and battery PWR. After repairs are complete, retest for SPN 158 FMI 17.

Step 4	Check for high resistance on B+ circuit.	Decision
Perform Test 2 (page 729). Using a DMM, measure voltage from Breakout Harness 00-01462-00 Pin C1-01 to GND. Is Voltage B+ ± 0.5 volts?		Yes: Go to step 5. No: Repair OPEN or high resistance between ECM C1-01 and battery PWR. After repairs are complete, retest for SPN 158 FMI 17.

Step 5	Check for high resistance on B+ circuit.	Decision
Perform Test 3 (page 730). Using a DMM, measure voltage from Breakout Harness 00-01462-00 Pin C1-03 to GND. Is Voltage B+ ± 0.5 volts?		Yes: Go to step 6. No: Repair OPEN or high resistance between ECM C1-03 and battery PWR. After repairs are complete, retest for SPN 158 FMI 17.

Step 6	Check for high resistance on B+ circuit.	Decision
Perform Test 4 (page 731). Using a DMM, measure voltage from Breakout Harness 00-01462-00 Pin C1-05 to GND. Is Voltage B+ ± 0.5 volts?		Yes: Go to step 7. No: Repair OPEN or high resistance between ECM C1-05 and battery PWR. After repairs are complete, retest for SPN 158 FMI 17.

Step 7	Check for high resistance on B+ circuit.	Decision
Perform Test 5 (page 732). Using a DMM, measure voltage from Breakout Harness 00-01462-00 Pin C2-01 to GND. Is Voltage B+ ± 0.5 volts?		Yes: Go to step 8. No: Repair OPEN or high resistance between ECM C2-01 and battery PWR. After repairs are complete, retest for SPN 158 FMI 17.

Step 8	Check for high resistance on GND circuit.	Decision
Perform Test 6 (page 733). Using a DMM, measure voltage from Breakout Harness 00-01462-00 Pin C1-02 to PWR. Is Voltage B+ ± 0.5 volts?		Yes: Go to step 9. No: Repair OPEN or high resistance between ECM C1-02 and battery PWR. After repairs are complete, retest for SPN 158 FMI 17.

Step 9	Check for high resistance on GND circuit.	Decision
Perform Test 7 (page 734). Using a DMM, measure voltage from Breakout Harness 00-01462-00 Pin C1-04 to PWR. Is Voltage B+ ± 0.5 volts?		Yes: Go to step 10. No: Repair OPEN or high resistance between ECM C1-04 and battery PWR. After repairs are complete, retest for SPN 158 FMI 17.

Step 10	Check for high resistance on GND circuit.	Decision
Perform Test 8 (page 735). Using a DMM, measure voltage from Breakout Harness 00-01462-00 Pin C1-06 to PWR. Is Voltage B+ ± 0.5 volts?		Yes: Repair OPEN or high resistance between ECM C2-02 and battery PWR. After repairs are complete, retest for SPN 158 FMI 17. No: Repair OPEN or high resistance between ECM C1-06 and battery PWR. After repairs are complete, retest for SPN 158 FMI 17.

Pin-Point Test SPN 158 FMI 17

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01462-00
- Digital Multimeter (DMM)

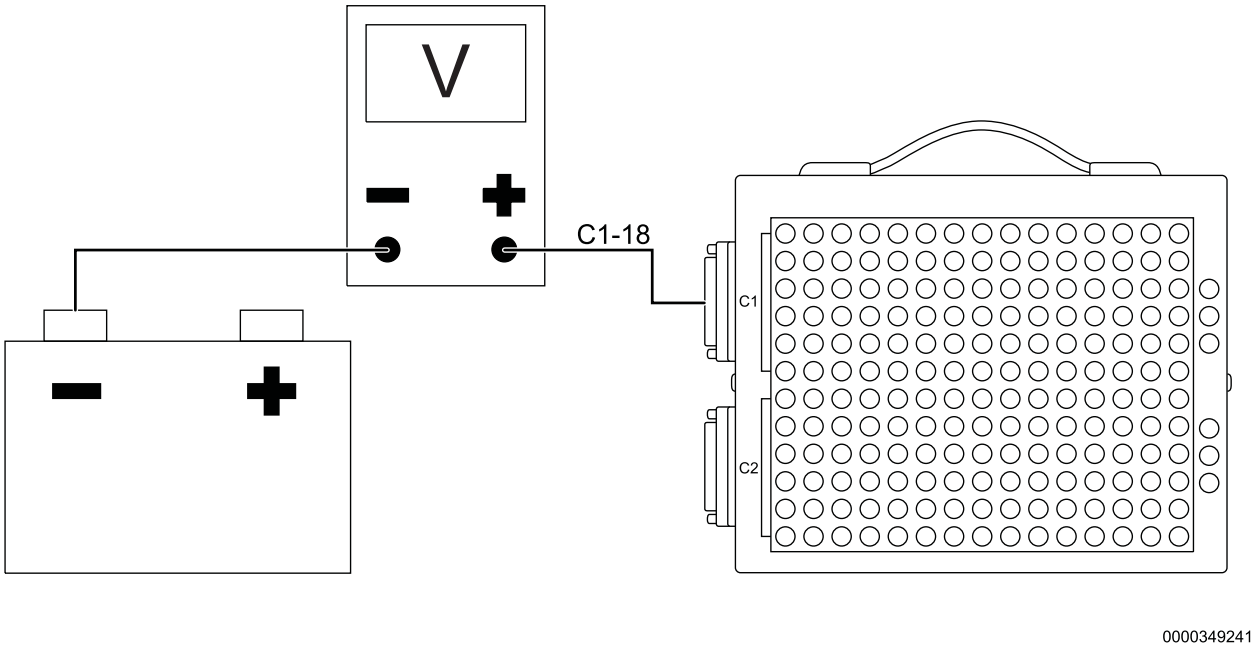

Figure 293 SWBAT Circuit Check

Test 1
A. Key OFF B. Connect 180-Pin Breakout Box to Breakout Harness 00-01462-00. C. Connect Breakout Harness 00-01462-00 to vehicle harness, and leave ECM C1 and C2 connectors disconnected D. Key ON

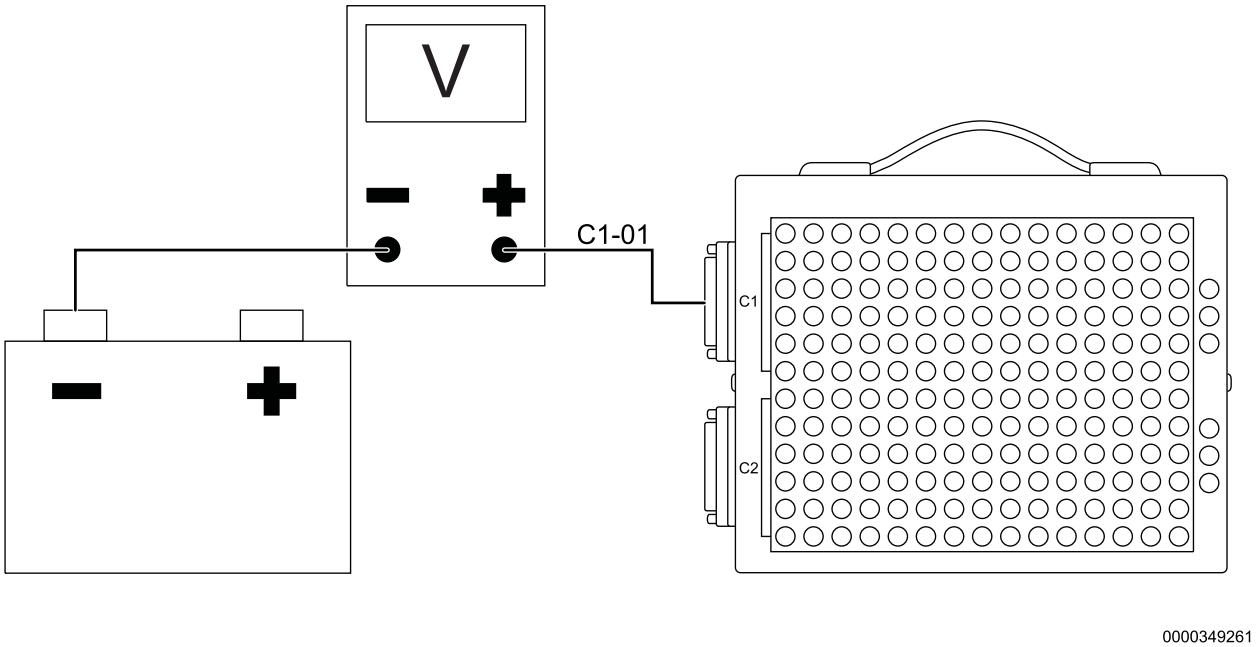

Figure 294 B+ Circuit Check

Test 2
A. Key OFF B. Connect 180-Pin Breakout Box to Breakout Harness 00-01462-00. C. Connect Breakout Harness 00-01462-00 to vehicle harness, and leave ECM C1 and C2 connectors disconnected D. Key ON

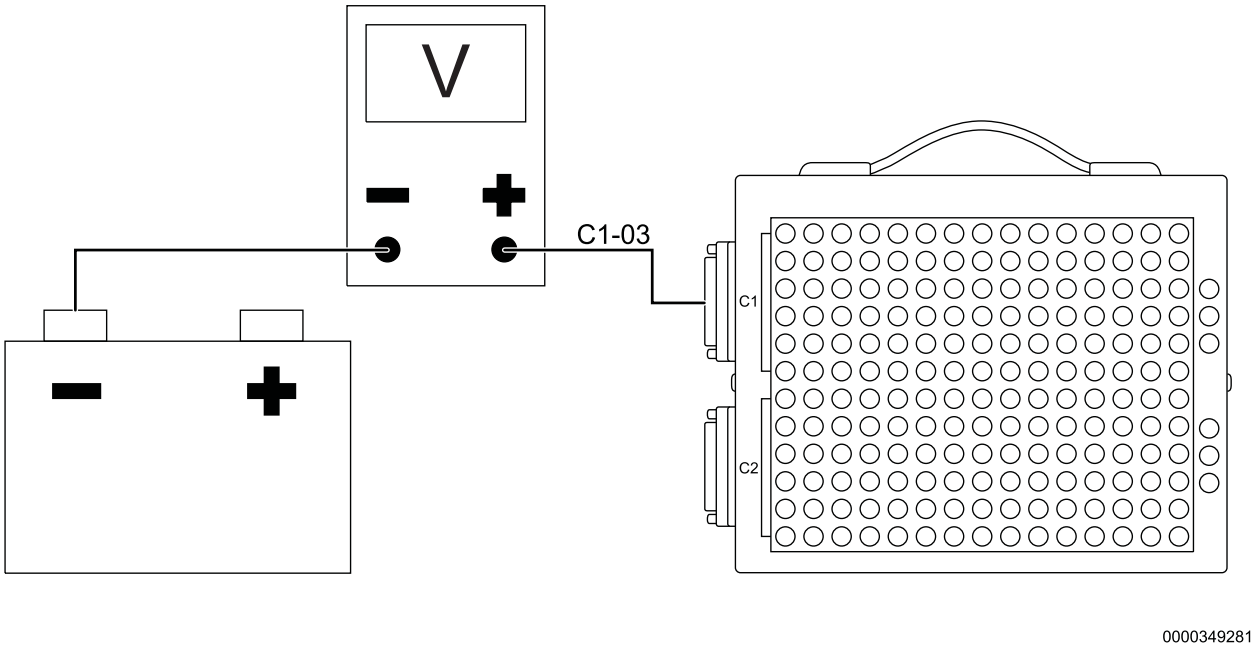

Figure 295 B+ Circuit Check

Test 3
A. Key OFF B. Connect 180-Pin Breakout Box to Breakout Harness 00-01462-00. C. Connect Breakout Harness 00-01462-00 to vehicle harness, and leave ECM C1 and C2 connectors disconnected D. Key ON

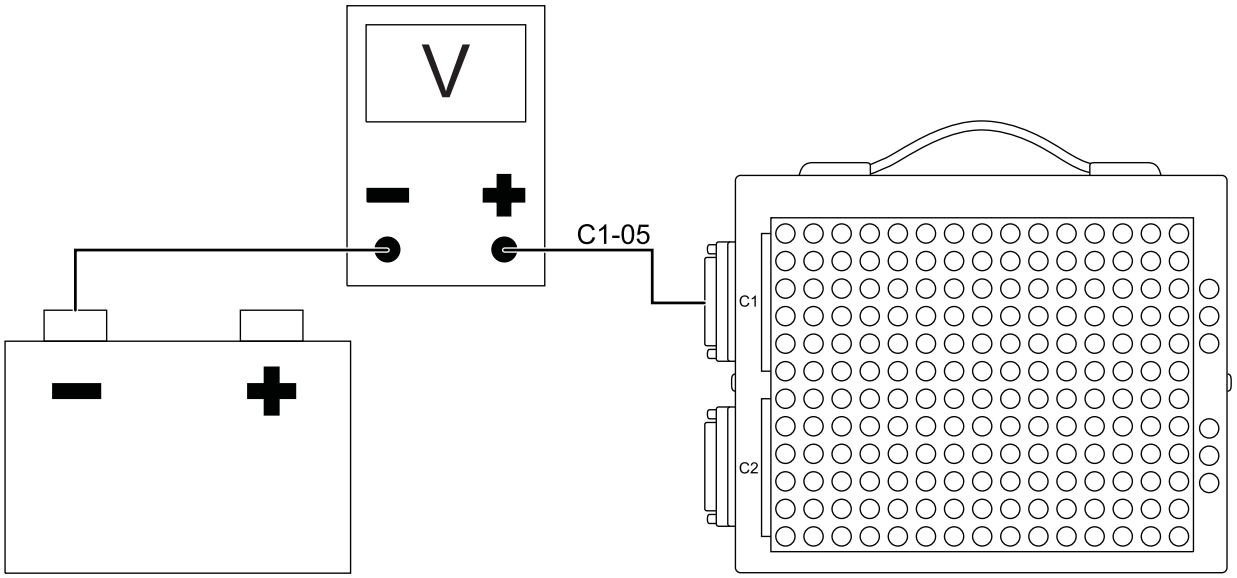

Figure 296 B+ Circuit Check

Test 4
A. Key OFF B. Connect 180-Pin Breakout Box to Breakout Harness 00-01462-00. C. Connect Breakout Harness 00-01462-00 to vehicle harness, and leave ECM C1 and C2 connectors disconnected D. Key ON

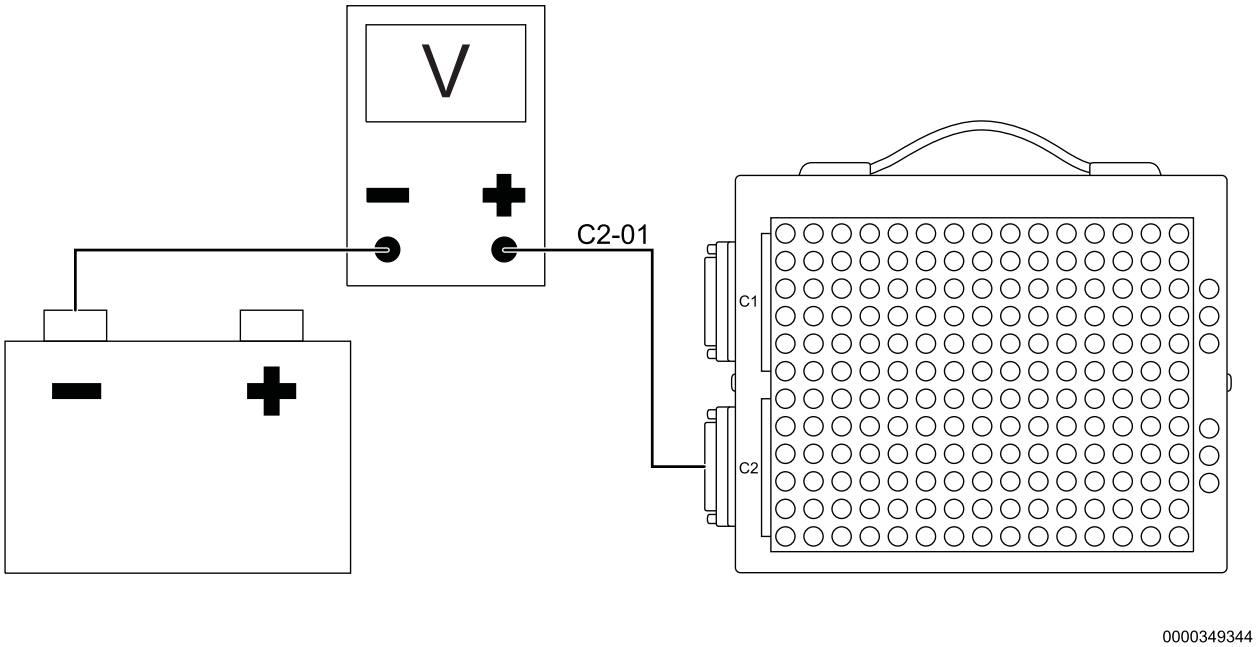

Figure 297 B+ Circuit Check

Test 5
A. Key OFF B. Connect 180-Pin Breakout Box to Breakout Harness 00-01462-00. C. Connect Breakout Harness 00-01462-00 to vehicle harness, and leave ECM C1 and C2 connectors disconnected D. Key ON

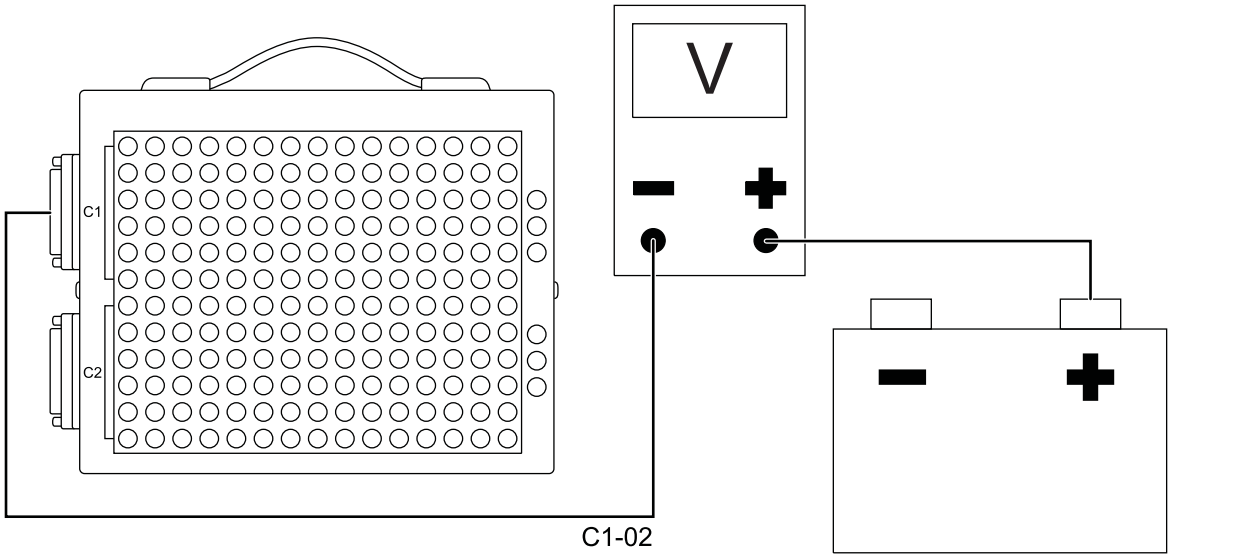

Figure 298 GND Circuit Check

Test 6
A. Key OFF B. Connect 180-Pin Breakout Box to Breakout Harness 00-01462-00. C. Connect Breakout Harness 00-01462-00 to vehicle harness, and leave ECM C1 and C2 connectors disconnected D. Key ON

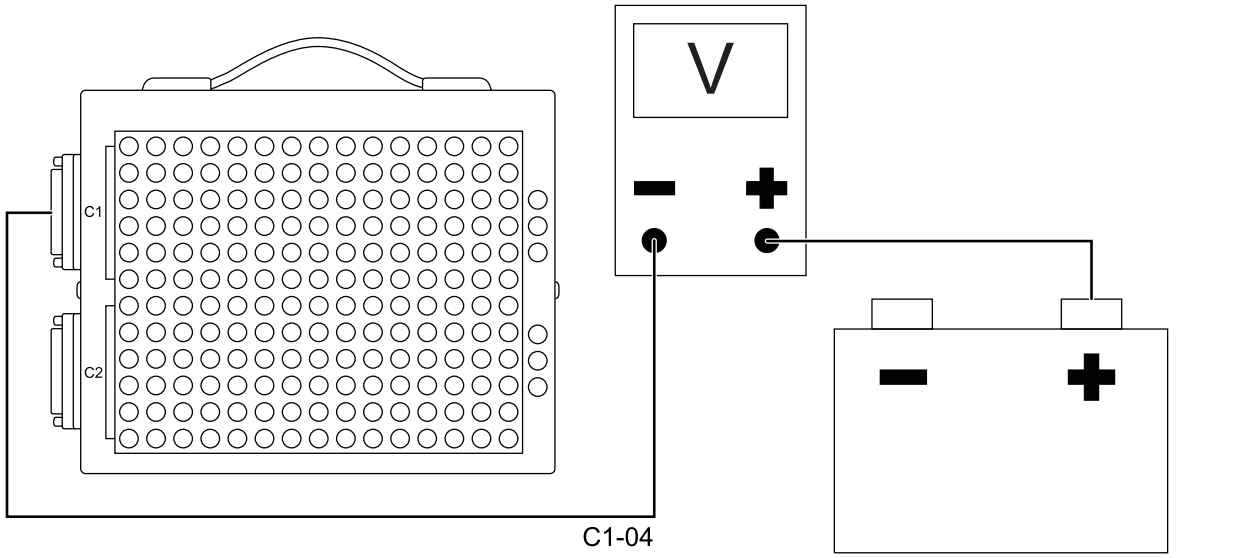

Figure 299 GND Circuit Check

Test 7
A. Key OFF B. Connect 180-Pin Breakout Box to Breakout Harness 00-01462-00. C. Connect Breakout Harness 00-01462-00 to vehicle harness, and leave ECM C1 and C2 connectors disconnected D. Key ON

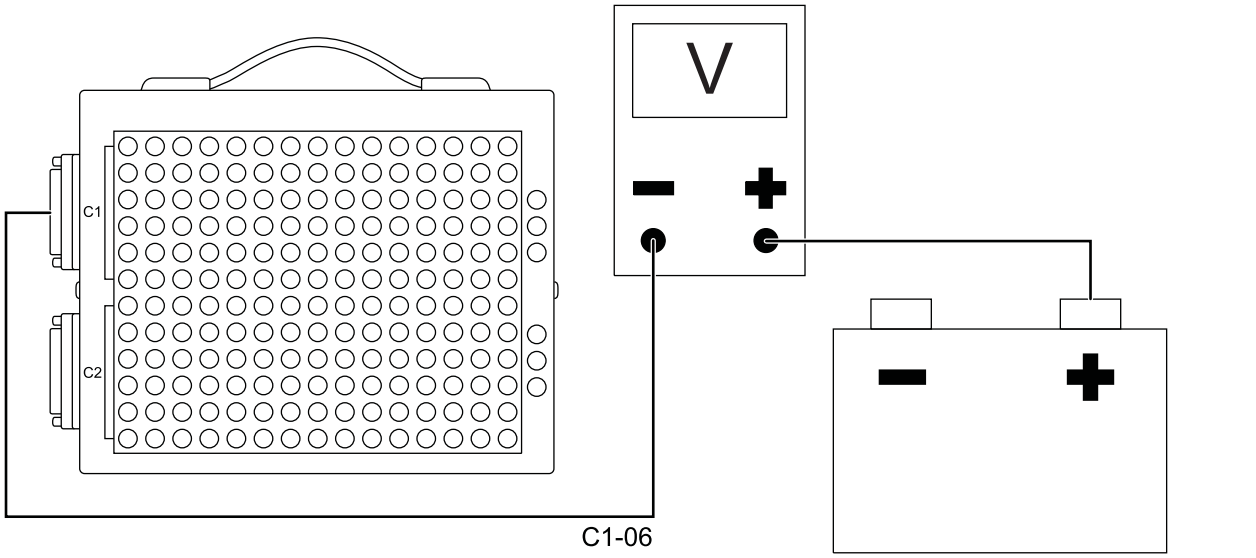

Figure 300 GND Circuit Check

Test 8
A. Key OFF B. Connect 180-Pin Breakout Box to Breakout Harness 00-01462-00. C. Connect Breakout Harness 00-01462-00 to vehicle harness, and leave ECM C1 and C2 connectors disconnected D. Key ON

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 158 FMI 17 fault code diagnostics.

SPN 628 FMI 12 - ECM Memory Error

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Control Module (ECM) memory error.	Memory error detected in ECM > 3 error events	Key ON

Fault Overview

Fault Code sets when Engine Control Module (ECM) detects ECM memory error has occurred greater than 3 times in one key cycle.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed ECM

Step 1	Obtain vehicle health report and check for current Engine Control Module (ECM) calibration.	Decision
Perform Obtain Vehicle Health Report(page 1540).		Yes: Go to Step 2.
Is ECM calibration current?		No: Ensure vehicle has latest ECM calibration. After repairs are complete, retest for SPN 628 FMI 12.

Step 2	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 628 FMI 12.		Yes: Replace Engine Control Module (ECM), following approved warranty procedures, and perform Crankshaft Position Sensor Relearn Procedure . After repairs are complete, retest for SPN 628 FMI 12.
Is EST DTC list SPN 628 FMI 12 active or pending?		No: Release vehicle to customer.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 628 FMI 12 fault code diagnostics.

SPN 629 FMI 0 - ECM Error

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 629 FMI 2 - ECM Error - Level 2 Monitoring

Pin-point ECM Self-Diagnostic Fault
1. Clear DTC, cycle ignition switch.
2. If DTC is still active, replace ECM and perform CKP relearn procedure .

SPN 629 FMI 8 - ECM Error - Engine Off Timer Fault

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine off timer does Not agree with Engine Control Module (ECM) timer count.	Difference between engine OFF timer count and ECM timer count > 6%	Key ON

Fault Overview

Fault Code sets when Engine Control Module (ECM) detects that difference between engine OFF timer count and ECM timer count is greater than 6%.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two trips.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed ECM

Step 1	Obtain vehicle health report and check for current Engine Control Module (ECM) calibration.	Decision
Perform Obtain Vehicle Health Report(page 1540).		Yes: Go to Step 2.
Is ECM calibration current?		No: Ensure vehicle has latest ECM calibration. After repairs are complete, retest for SPN 629 FMI 8.

Step 2	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 629 FMI 8.		Yes: Replace Engine Control Module (ECM), following approved warranty procedures, and perform Crankshaft Position Sensor Relearn Procedure . After repairs are complete, retest for SPN 629 FMI 8.
Is EST DTC list SPN 629 FMI 8 active or pending?		No: Release vehicle to customer.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 629 FMI 8 fault code diagnostics.

SPN 629 FMI 12 - ECM Error - Level 2 Monitoring

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Internal error detected within Engine Control Module (ECM).	ECM detects an internal error	Key ON

Fault Overview

Fault Code sets when Engine Control Module (ECM) detects an internal error within ECM.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two trips.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed ECM

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 629 FMI 12. Is EST DTC list SPN 629 FMI 12 active or pending?		Yes: Replace Engine Control Module (ECM) and perform Crankshaft Position Sensor Relearn Procedure . After repairs are complete, retest for SPN 629 FMI 12. No: Release vehicle to customer.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 629 FMI 12 fault code diagnostics.

SPN 629 FMI 14 - ECM Internal Component Over Temperature

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Internal over temperature detected within Engine Control Module (ECM).	ECM detects an internal over temperature.	Key ON

Fault Overview

Fault Code sets when Engine Control Module (ECM) detects an internal over temperature within ECM.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed ECM

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 629 FMI 14. Is EST DTC list SPN 629 FMI 14 active or pending?		Yes: Replace Engine Control Module (ECM) and perform Crankshaft Position Sensor Relearn Procedure. After repairs are complete, retest for SPN 629 FMI 14. No: Release vehicle to customer.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 629 FMI 14 fault code diagnostics.

SPN 1110 FMI 31 - ECM Detect Fueling Without Driver Demand

1. Clear DTC, cycle ignition switch.
2. If DTC is still active, replace ECM and perform CKP relearn procedure .

SPN 3597 FMI 4 - ECM Power Output 1 Below Normal

Voltage Check

Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
C1-31 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
C1-33 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
C1-54 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
C2-51 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
E1-01 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-51 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Harness Resistance Check

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-31 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C1-33 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C1-54 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C2-51 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-01 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-51 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

SPN 3598 FMI 4 - ECM Power Output 2 Below Normal

Voltage Check

Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
C1-42 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
C2-06 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
E1-05 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-28 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-29 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-54 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Harness Resistance Check

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-42 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C2-06 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-05 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-28 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-29 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-54 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-05 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-28 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-29 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-54 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

SPN 3599 FMI 4 - ECM Power Output 3 Below Normal

Voltage Check

Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
C1-30 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
C2-03 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
E1-24 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-26 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.
E1-27 to GND	B+	If < B+, check for short to GND or internally shorted component. Do Harness Resistance Check.

Harness Resistance Check

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-30 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C2-03 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-24 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-26 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-27 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

ECT1 (Engine Coolant Temperature 1) Sensor

Overview of ECT1 Sensor Group

SPN	FMI	Description
110	2	ECT1 signal erratic, intermittent, or incorrect (page 752)
110	3	ECT1 signal Out of Range HIGH (page 770)
110	4	ECT1 signal Out of Range LOW (page 764)

Overview

The ECT1 sensor is a thermistor that is supplied 5 V VREF at pin-1 from ECM pin E1-14. The sensor is grounded at pin-3 from ECM pin E1-68. As the coolant temperature increases the resistance of the thermistor decreases, causing the signal voltage to decrease.

SPN 110 FMI 2 - ECT1 Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Coolant Temperature 1 (ECT1) does not agree with other sensors	Difference between ECT1 and other temperature sensors > 59°F (15°C)	Key ON Battery voltage > 10.7 volts and < 15 volts Engine is cold soaked CACOT, TC2CIT, IMT, IAT, and EOT are all within 59°F (15°C) of each other

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Engine Coolant Temperature 1 (ECT1) differs from other temperature sensors by greater than 59°F (15°C) after a cold soak.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two trips.

Associated Faults

SPN 110 FMI 3 and 4 (ECT1)

Fault Facts

Diagnostic runs at initial Key ON after a minimum of an 8 hour cold soak.

Drive Cycle to Determine Fault Status

Continuous (After Cold Soak)

Possible Causes

- High resistance in ECT1 circuit
- High resistance in SIG GND circuit
- Failed ECT1 sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 110 FMI 2. Is EST DTC list SPN 110 FMI 2 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 3 and 4 (ECT1). Is EST DTC list free of SPN 110 FMI 3 and 4?		Yes: Go to Step 3. No: Repair SPN 110 FMI 3 and 4. After repairs are complete, retest for SPN 110 FMI 2.

Step 3	Inspect connections at Engine Coolant Temperature 1 (ECT1) connector.	Decision
A. Key OFF. B. Disconnect ECT1 connector. C. Check ECT1 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are ECT1 connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests . No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 110 FMI 2.

Pin-Point Tests (SPN 110 FMI 2)

Figure 302 Engine Coolant Temperature 1 (ECT1) Sensor Circuit Diagram

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4602
- 500 Ohm Resistor Harness ZTSE4497
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

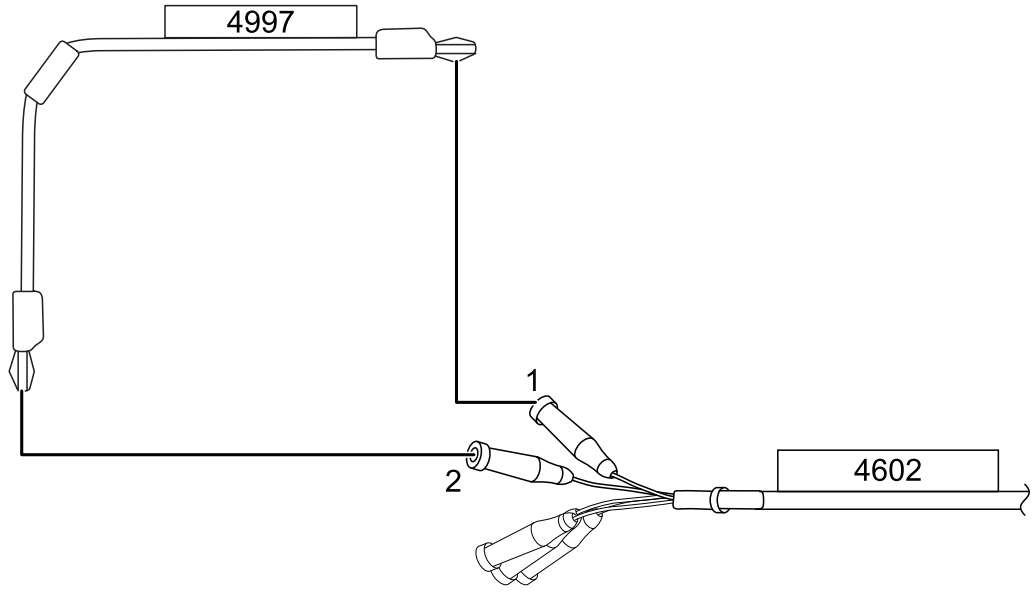

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Figure 303 Test 1 Signal Circuit Check

Test 1 Setup
A. Key OFF. B. Disconnect Engine Coolant Temperature 1 (ECT1) sensor. C. Connect Breakout Harness ZTSE4602 to vehicle harness connector and leave ECT1 sensor disconnected. D. Connect Resistor Harness ZTSE4497 between Breakout Harness ZTSE4602 pin-1 and pin-2. E. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). F. Key ON. Log in to ServiceMaxx™ software.

Test 1	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor ECT1 voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Replace ECT1 sensor. After repairs are complete, retest for SPN 110 FMI 2.
	No: Go to Test 2.

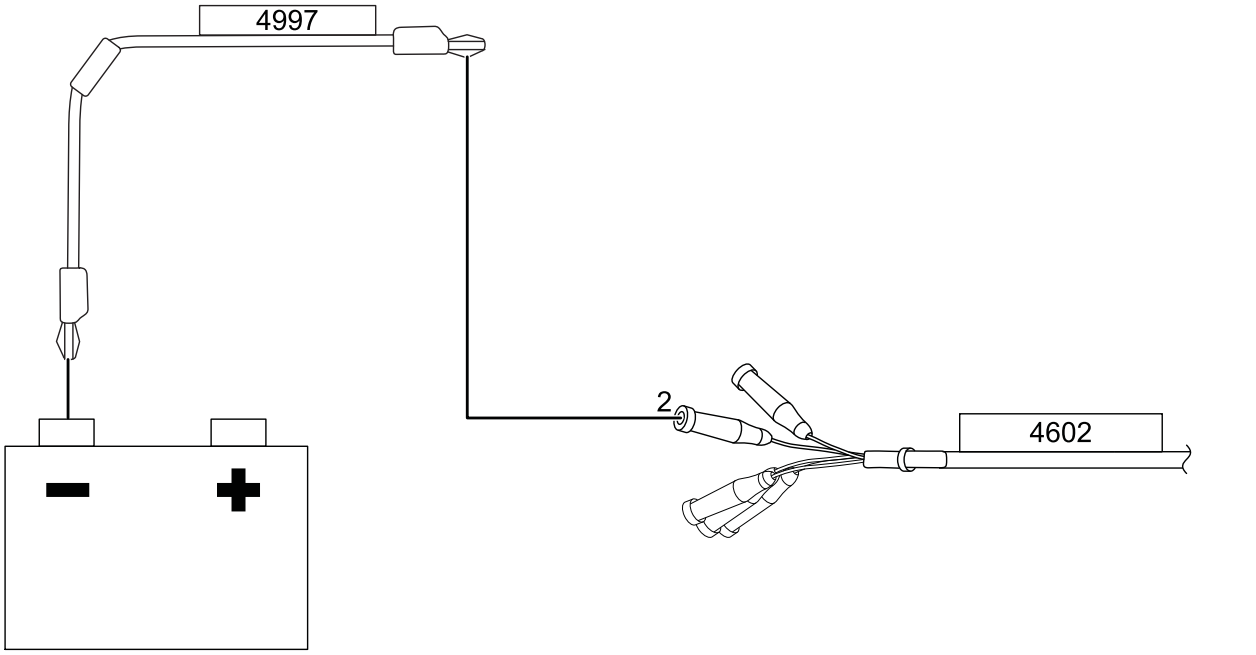

Figure 304 Test 2 ECT1 Signal Circuit Check

Test 2 Setup
A. Key OFF. B. Disconnect Engine Coolant Temperature 1 (ECT1) sensor. C. Connect Breakout Harness ZTSE4602 to vehicle harness connector and leave ECT1 sensor disconnected. D. Connect Resistor Harness ZTSE4497 between Breakout Harness ZTSE4602 pin-2 and known good GND. E. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). F. Key ON. Log in to ServiceMaxx™ software.

Test 2	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor ECT1 voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Repair Open or high resistance between ECT1 pin-1 and ECM pin E1-68. After repairs are complete, retest for SPN 110 FMI 2.
	No: Replace Open or high resistance between ECT1 pin-2 and ECM pin E1-14. After repairs are complete, retest for SPN 110 FMI 2.

End Diagnostic Tests
After performing all tests, if no problem is found, verify each step was completed correctly and the proper decision was made. Return to SPN 110 FMI 2 fault code diagnostics.

SPN 110 FMI 3 - ECT1 Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Coolant Temperature 1 (ECT1) sensor signal reading is greater than expected.	ECT1 sensor voltage > 4.80 Volts	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects ECT1 signal is greater than 4.80 volts.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- ECT1 circuit Open
- ECT1 circuit short to PWR
- SIG GND circuit Open
- Failed ECT1 sensor

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 3. Is EST DTC list SPN 110 FMI 3 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at ECT1 sensor.	Decision
A. Key OFF. B. Disconnect ECT1 sensor connector. C. Check ECT1 sensor and connector terminals for damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECT1 sensor, connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests . No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 110 FMI 3.

Pin-Point Tests (SPN 110 FMI 3)

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4602
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM) ZTSE4357
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

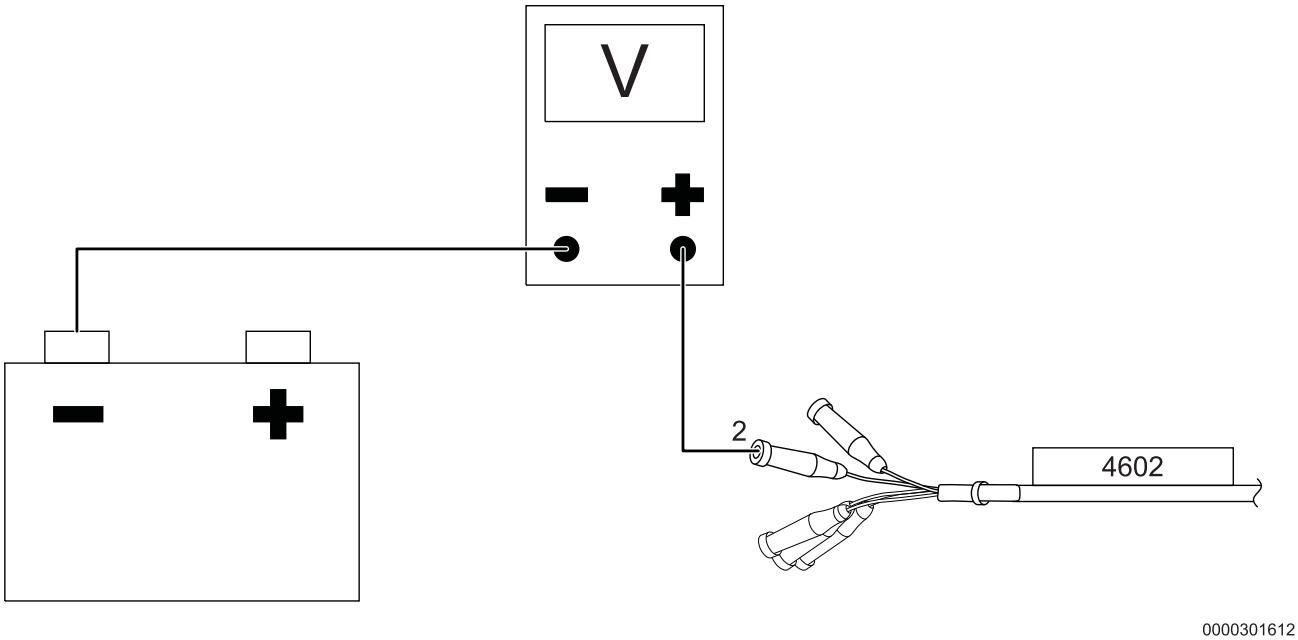

Figure 306 Test 1 ECT1 Sensor Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4602 to vehicle harness and leave Engine Coolant Temperature 1 (ECT1) sensor disconnected. C. Key ON.

Test 1	Specification
Use a Digital Multimeter (DMM) to measure voltage between Breakout Harness ZTSE4602 pin-2 and known good ground.	< 4.85 volts
Decision	
Is voltage greater than 4.85 volts?	Yes: Repair short to PWR between ECT1 pin-2 and Engine Control Module (ECM) pin E1-14. After repairs are complete, retest for SPN 110 FMI 3.
	No: Go to Test 2.

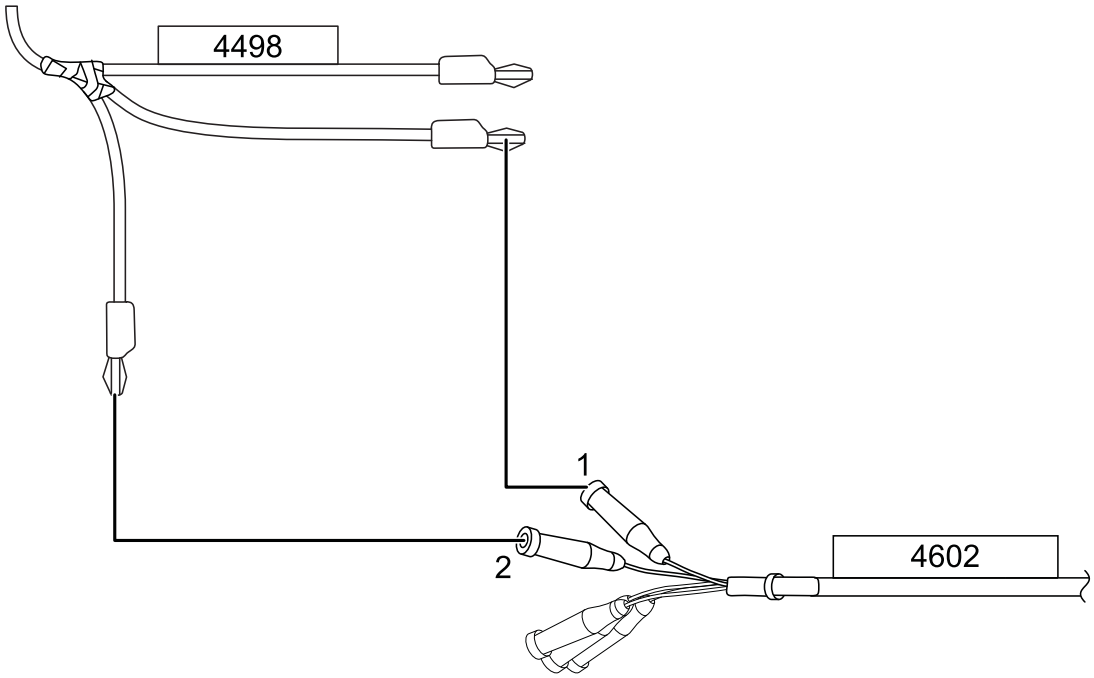

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Figure 307 Test 2 ECT1 Sensor Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4602 to vehicle harness and leave ECT1 sensor disconnected. C. Using Breakout Harness ZTSE4498, short pin-1 and pin-2 of Breakout Harness ZTSE4602 together. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON. Log in to ServiceMaxx™

Test 2	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor ECT1 voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Replace ECT1 sensor. After repairs are complete, retest for SPN 110 FMI 3.
	No: Go to Step 3.

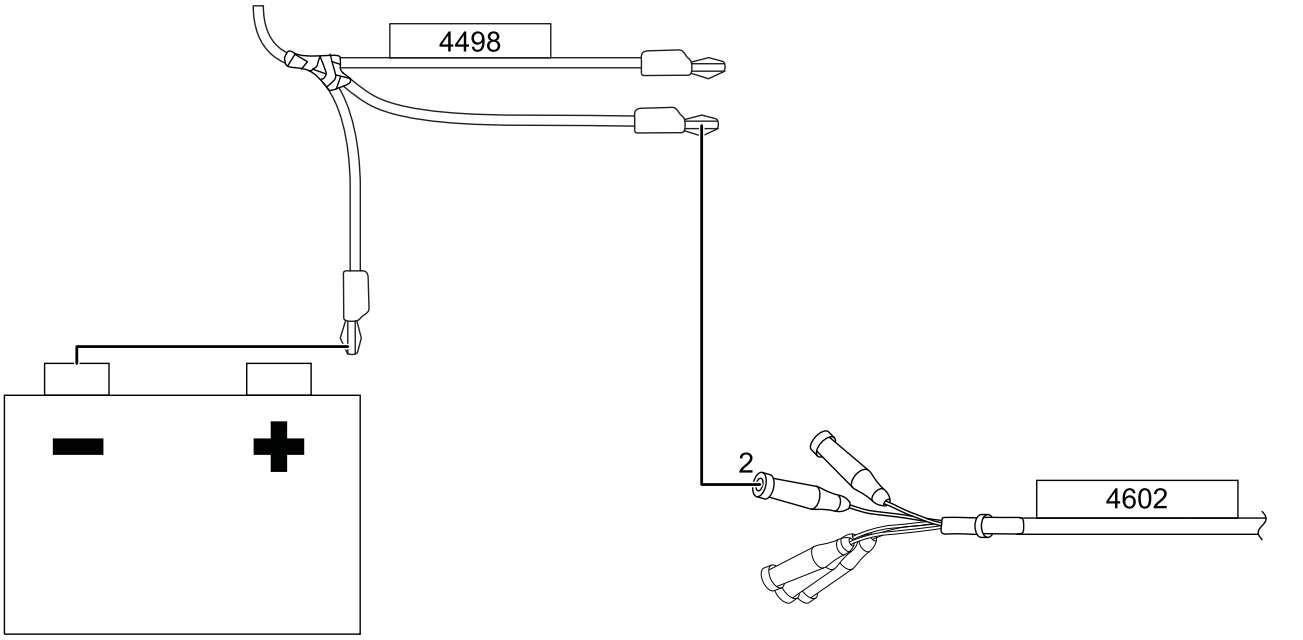


Figure 308 Test 3 ECT1 Sensor Circuit Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4602 to vehicle harness and leave ECT1 sensor disconnected. C. Using Breakout Harness ZTSE4498, short pin-2 of Breakout Harness ZTSE4602 to ground. D. Connect EST to vehicle Diagnostic Connector. E. Key ON. Log in to ServiceMaxx™

Test 3	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor ECT1 voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Repair Open between ECT1 pin-1 and ECM pin E1-68. After repairs are complete, retest for SPN 110 FMI 3.
	No: Repair Open between ECT1 pin-2 and ECM pin E1-14. After repairs are complete, retest for SPN 110 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 110 FMI 3 fault code diagnostics.

SPN 110 FMI 4 - ECT1 Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine Coolant Temperature 1 (ECT1) sensor signal lower than expected	ECT1 sensor voltage < 0.25 Volts	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Engine Coolant Temperature 1 (ECT1) sensor signal voltage is less than 0.25 volts.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Key ON.

Possible Causes

- ECT1 circuit short to GND
- Failed ECT1 sensor

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 4. Is EST DTC list SPN 110 FMI 4 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Engine Coolant Temperature 1 (ECT1) sensor.	Decision
A. Key OFF. B. Disconnect ECT1 sensor connector. C. Check ECT1 sensor and connector terminals for damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECT1 sensor, connector, harness, and terminals clean and undamaged?		Yes: Perform pin-point tests. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 110 FMI 4.

Pin-Point Tests (SPN 110 FMI 4)

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4827
- Digital Multimeter (DMM) ZTSE4357

Test 1 Setup
A. Key OFF. B. Disconnect Engine Coolant Temperature 1 (ECT1) electrical connector. C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). D. Key ON. Log into ServiceMaxx™ software.

Test 1	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test(page 1588).	4.85 ± 0.05 volts
Decision	
Is voltage 4.85 ± 0.05 volts?	Yes: Replace ECT1 sensor. After repairs are complete, retest for SPN 110 FMI 4.
	No: Repair short to GND between ECT1 pin-2 and ECM pin E1-14. After repairs are complete, retest for SPN 110 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 110 FMI 4 fault code diagnostics.

ECT2 Sensor (Engine Coolant Temperature 2)

Overview of ECT2 Sensor Group

SPN	FMI	Description
4076	2	ECT2 signal erratic, intermittent, or incorrect (page 768)
4076	3	ECT2 signal Out of Range HIGH
4076	4	ECT2 signal Out of Range LOW (page 776)
4076	17	ECT2 signal stuck low, not warming up (page 779)

SPN 4076 FMI 2 - ECT2 Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine Coolant Temperature 2 (ECT2) does not agree with other sensors.	ECT2 difference from Inlet Air Temp (IAT) > 10°F (6°C)	Key-On Engine is cold soaked Difference between Engine Coolant Temperature 1 (ECT1), Ambient Air Temperature (AAT), and Exhaust Gas Temperature 1 (EGT1) at Key on < 27°F (15°C)	Immediate

Fault Overview

Fault code sets when Engine Coolant Temperature 2 (ECT2) differs from Inlet Air Temp (IAT) > 10°F (6°C) after a cold soak.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Fault Facts

Diagnostic runs at initial Key-On after a minimum of an 8 hour cold soak.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Aftermarket block heater installed
- Failed ECT2 sensor
- High resistance in ECT2 circuit
- High resistance in SIG GND circuit

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 105 FMI 3, 4 and SPN 4076 FMI 0, 3, 4, 15, 17(ECT2). Is EST DTC list free of SPN 105 FMI 3, 4 and SPN 4076 FMI 0, 3, 4, 15, 17?	Yes: Go to step 2. No: Repair SPN 105 FMI 3, 4 and SPN 4076 FMI 0, 3, 4, 15, 17. After repairs are complete, retest for SPN 4076 FMI 2.

Step	Action	Decision
2	Check ECT2 circuit for high resistance. Connect Breakout Harness ZTSE4827 to ECT2 harness and leave ECT2 disconnected. Connect 180-pin Breakout Box with ECM Breakout Harness 00-01468-00 to ECM E1 harness, and leave ECM disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4827 pin-1 and 180-pin Breakout Box pin E1-71. Is resistance less than 5 ohms?	Yes: Go to step 3. No: Repair high resistance between ECT2 connector pin-1 and ECM connector pin E1-71. After repairs are complete, retest for SPN 4076 FMI 2.

Step	Action	Decision
3	Check SIG GND circuit for high resistance. Connect Breakout Harness ZTSE4827 to ECT2 harness and leave ECT2 disconnected. Connect 180-pin Breakout Box with ECM Breakout Harness 00-01468-00 to ECM E1 harness , and leave ECM disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4827 pin-3 and 180-pin Breakout Box pin E1-44. Is resistance less than 5 ohms?	Yes: Go to step 4. No: Repair high resistance between ECT2 connector pin-3 and ECM connector pin E1-44. After repairs are complete, retest for SPN 4076 FMI 2.

NOTE: An aftermarket block heater could set this fault.

Step	Action	Decision
4	Check for a failed ECT2 sensor. If installed, disconnect aftermarket block heater. After performing drive cycle 10, using ServiceMaxx™ software, open the Continuous Monitor session. Compare ECT2 with Inlet Air Temp (IAT). Is the ECT2 difference greater than 10°F (6°C) of IAT value?	Yes: Replace ECT2 sensor. After repairs are complete, retest for SPN 4076 FMI 2. No: Aftermarket block heater causing fault code to set.

NOTE: After performing all diagnostic steps, if SPN 4076 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4076 FMI 3 - ECT2 Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Coolant Temperature 2 (ECT2) sensor signal reading is greater than expected.	ECT2 sensor voltage > 4.80 Volts	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Engine Coolant Temperature 2 (ECT2) signal is greater than 4.80 volts.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- ECT2 circuit Open
- ECT2 circuit short to PWR
- SIG GND circuit Open
- Failed ECT2 sensor

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4076 FMI 3. Is EST DTC list SPN 4076 FMI 3 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at ECT2 sensor.	Decision
A. Key OFF. B. Disconnect ECT2 sensor connector. C. Check ECT2 sensor and connector terminals for damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECT2 sensor, connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests . No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 110 FMI 3.

Pin-Point Tests (SPN 4076 FMI 3)

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4602
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM) ZTSE4357
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

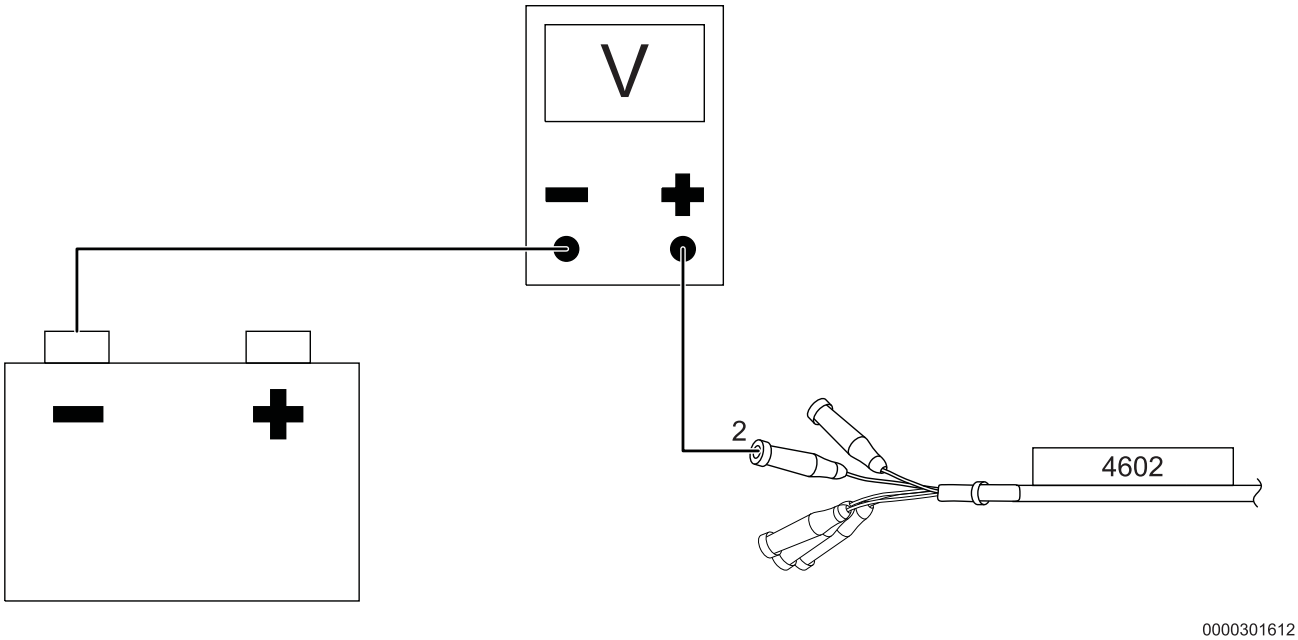
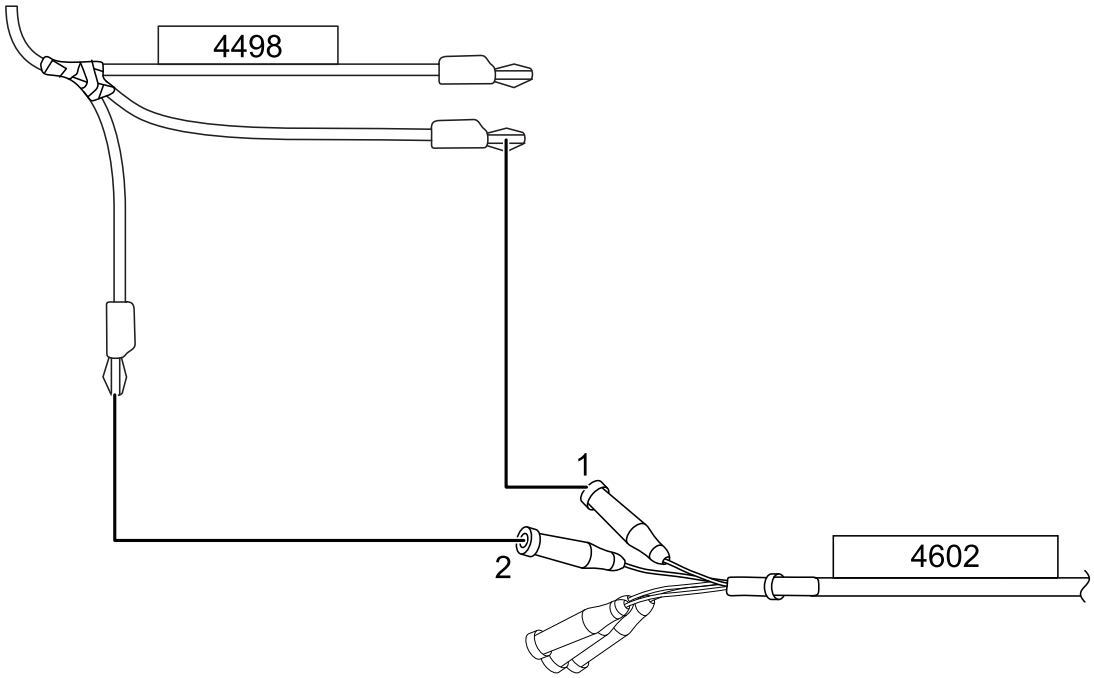


Figure 309 Test 1 ECT1 Sensor Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4602 to vehicle harness and leave Engine Coolant Temperature 2 (ECT2) sensor disconnected. C. Key ON.

Test 1	Specification
Use a Digital Multimeter (DMM) to measure voltage between Breakout Harness ZTSE4602 pin-2 and known good ground.	< 4.85 volts
Decision	
Is voltage greater than 4.85 volts?	Yes: Repair short to PWR between ECT2 pin-2 and Engine Control Module (ECM) pin E1-71. After repairs are complete, retest for SPN 4076 FMI 3.
	No: Go to Test 2.



0000303783

Figure 310 Test 2 ECT1 Sensor Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4602 to vehicle harness and leave ECT2 sensor disconnected. C. Using Breakout Harness ZTSE4498, short pin-1 and pin-2 of Breakout Harness ZTSE4602 together. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON. Log in to ServiceMaxx™

Test 2	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor ECT2 voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Replace ECT2 sensor. After repairs are complete, retest for SPN 4076 FMI 3.
	No: Go to Step 3.

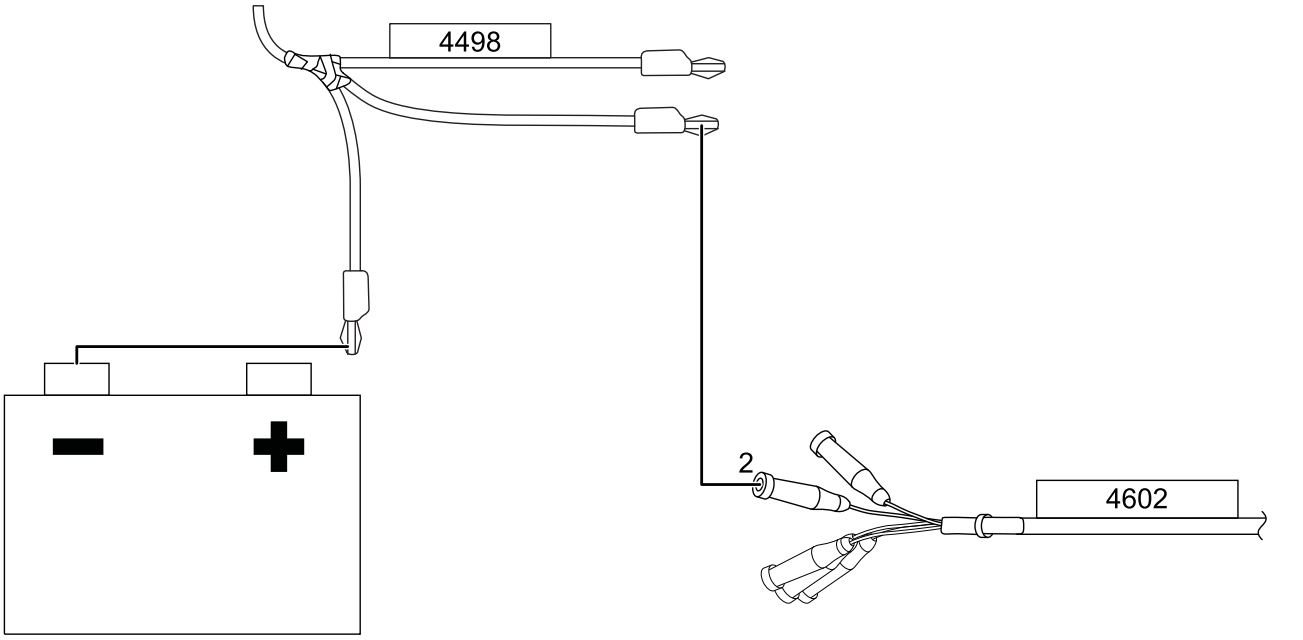


Figure 311 Test 3 ECT1 Sensor Circuit Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4602 to vehicle harness and leave ECT2 sensor disconnected. C. Using Breakout Harness ZTSE4498, short pin-2 of Breakout Harness ZTSE4602 to ground. D. Connect EST to vehicle Diagnostic Connector. E. Key ON. Log in to ServiceMaxx™

Test 3	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor ECT2 voltage.	0 volts
Decision	
Is voltage approximately 0 volts?	Yes: Repair Open between ECT2 pin-1 and ECM pin E1-44. After repairs are complete, retest for SPN 4076 FMI 3.
	No: Repair Open between ECT2 pin-2 and ECM pin E1-71. After repairs are complete, retest for SPN 4076 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 4076 FMI 3 fault code diagnostics.

SPN 4076 FMI 4 - ECT2 Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine Coolant Temperature 2 (ECT2) sensor signal lower than expected	ECT2 sensor voltage < 0.246 Volts	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Engine Coolant Temperature 2 (ECT2) sensor signal voltage is less than 0.246 volts.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Key ON.

Possible Causes

- ECT2 circuit short to GND
- Failed ECT2 sensor

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4076 FMI 4. Is EST DTC list SPN 4076 FMI 4 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Engine Coolant Temperature 2 (ECT2) sensor.	Decision
A. Key OFF. B. Disconnect ECT2 sensor connector. C. Check ECT2 sensor and connector terminals for damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECT2 sensor, connector, harness, and terminals clean and undamaged?		Yes: Perform pin-point tests. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4076 FMI 4.

Pin-Point Tests (SPN 4076 FMI 4)

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF. B. Disconnect Engine Coolant Temperature 2 (ECT2) electrical connector. C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). D. Key ON. Log into ServiceMaxx™ software.

Test 1	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test(page 1588).	4.85 ± 0.05 volts
Decision	
Is voltage 4.85 ± 0.05 volts?	Yes: Replace ECT2 sensor. After repairs are complete, retest for SPN 4076 FMI 4.
	No: Repair short to GND between ECT2 pin-2 and ECM pin E1-71. After repairs are complete, retest for SPN 4076 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 4076 FMI 4 fault code diagnostics.

SPN 4076 FMI 17 - ECT2 Signal Stuck Low, Not Warming Up

Pinpoint Diagnostics With ServiceMaxx™ Software

Figure 312 ECT2 sensor circuit diagram

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Cold Soak Sensor Compare Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 4076 FMI 16 – ECT2 signal does not agree with other sensors (Cold soak)

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare ECT2, Engine Coolant Temperature 1 (ECT1), and Engine Oil Temperature (EOT). Sensor temperatures should be within 5 °C (10 °F) of each other.
   - If ECT2 is 5 °C (10 °F) above or below the ECT1 or EOT, check for poor circuitry going to the ECT2 sensor.
   - If circuits are within specification, replace ECT2 sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to ECT2 connector and leave sensor disconnected. Connect 180-pin Breakout Box with ECM E1 and E2 harness between ECM E1 and E2 connectors and ECM. Turn ignition ON. Use a DMM to measure voltage.

Test Point	Specification	Comment– < Less than, > Greater than
Measure pin E1-14 to GND	4.5 V to 5 V	If <4.5 V, check ECT2 signal circuit for short to GND.
Measure pin E1-14 to GND Short ECT2 pin-1 to GND	0 V	If > 0.25 V, check ECT2 signal circuit for OPEN. Do Harness Resistance Check (page 781).
Measure pin E1-14 to GND Short ECT2 pin-1 to pin-3	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check (page 781).
Measure pin E1-14 to GND Short 500 Ω resistor between ECT2 pin-1 and pin-3	< 1.0 V	If > 1.0 V, check ECT2 signal circuit for short to PWR.
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace ECT2 sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to ECT2 engine harness, and leave ECT2 sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	4.5 V to 5 V	If < 4.5 V, check for short to GND.
3 to B+	B+	If < B+, check for short to PWR.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to ECT2 engine harness, and leave ECT2 sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-71	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-44	< 5 Ω	If > 5 Ω, check for OPEN circuit.

EFC (Engine Fan Control) – Two Speed and Variable

Overview of EFC Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
647	3	EFC short to PWR	• EFC circuit short to PWR	Circuit Checks (page 788)
647	4	EFC short to GND	• EFC circuit short to GND	Circuit Checks (page 788)
647	5	EFC open load/circuit	• EFC circuit OPEN • EFC failure	Circuit Checks (page 788)

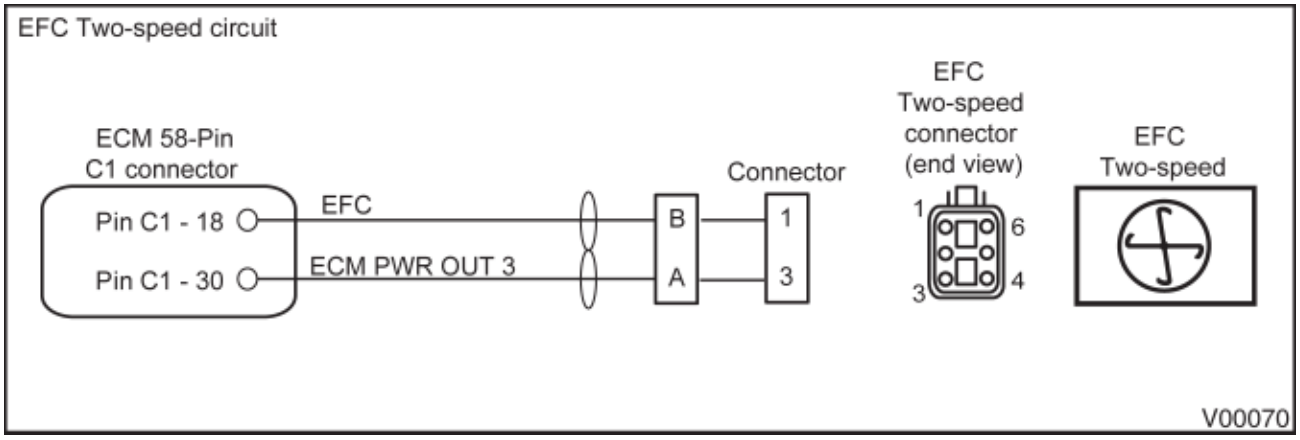


Figure 313 Two-Speed EFC circuit diagram

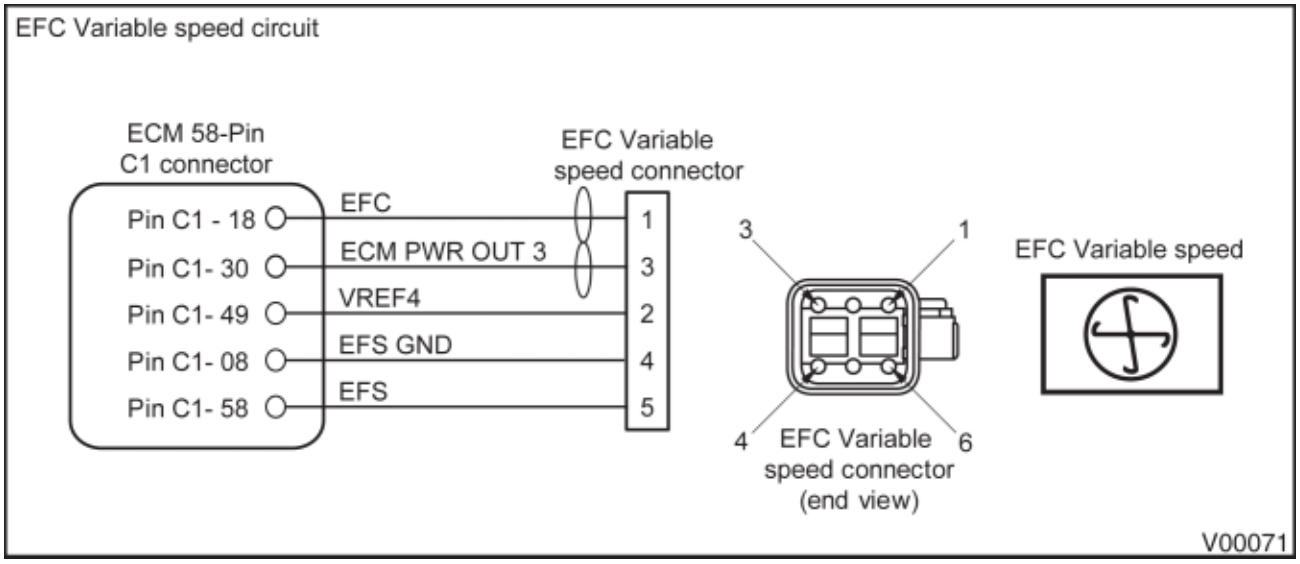


Figure 314 Variable EFC circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4844 (EFAN)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 647 FMI 3 - EFC Short to PWR

Function Two-Speed EFC

The purpose of the engine fan is to force a higher airflow through the radiator when the A/C is on or the ECT goes above a set temperature.

The single-speed EFC is an air-actuated belt-driven on-off design. When engaged the fan runs at input sheave speed, and when disengaged the fan speed is close to zero.

The two-speed EFC is an air actuated belt-driven two-speed drive. When engaged the fan runs at input sheave speed, and when the air clutch releases, the fan runs at a nominal speed driven by a magnetic eddy current system that produces 300-400 rpm at idle and 700-900 rpm at when the engine rpm is 1900. This provides improved cooling and delays the fan coming on in high ambient temperatures or at high loads.

The difference between the single speed and two-speed EFCs is internal to the fan hub; both fans have identical external circuitry.

Function Variable EFC

The purpose of the variable electronic engine fan is to force a higher airflow through the radiator when the A/C is on or when the ECT goes above a set temperature.

The variable EFC is a direct-driven electronically controlled viscous fan drive. The fan has a number of operating regions.

- From 300 to 1100 engine rpm it is an on-off drive. Off is under 300 rpm, on is 99% of input speed.
- From 1100 to 1750 engine rpm it is a variable speed drive with an effective range of 800 rpm to 99% of input speed.
- From 1750 to 2150 engine rpm it is on-off again.
- From 2150 to 2450 engine rpm it is either off or 2625 rpm.
- Above 2450 engine rpm it is off.

EFC – Two Speed Sensor Circuit Operation

The default state of the EFC is ON. B+ is needed to turn the fan OFF.

ECM Pin C1-18 controls the EFC to shut off by supplying PWR to the EFC deactivating it.

EFC – Variable Sensor Circuit Operation

The default state of the EFC is ON. B+ is needed to turn the fan OFF.

ECM Pin C1-18 controls the EFC to shut off by supplying B+ to the EFC, deactivating it.

ECM Pin C1-58 controls EFC speed by supplying a Pulse Width Modulated (PWM) signal to the EFC.

Voltage Check at Single or Two-Speed EFC Connector - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4844 to single or two-speed EFC 2-pin connector, and leave EFC disconnected.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Engine Fan Control from the drop-down menu.
3. Command Engine Fan Control to 5%.
4. Use DMM to measure voltage.
5. Command Engine Fan Control to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
A to GND	B+	If < B+, check for open in ECM PWR OUT 3.
B to GND	0 V to 0.25 V	If > 0.25 V, check for short to PWR.
Actuator Test - at 5% state		
B to GND	0 V to 0.25 V	If > 0.25 V, check for short to PWR.
Actuator Test - at 95% state		
B to GND	B+	If < B+, check EFC circuit for OPEN or short to GND. Do Harness Resistance Check.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4484 to EFC vehicle harness, and leave EFC disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-30 to A	< 5 Ω	If > 5 Ω, check for OPEN circuit between ECM pin C1-30 and EFC pin A.
C1-18 to B	< 5 Ω	If > 5 Ω, check for OPEN circuit between ECM pin C1-18 and EFC pin B.
If voltage and resistance measurements are within specification but DTC is still active, or EFC does not work, replace the EFC.		

SPN 647 FMI 4 - EFC Short to GND

Function Two-Speed EFC

The purpose of the engine fan is to force a higher airflow through the radiator when the A/C is on or the ECT goes above a set temperature.

The single-speed EFC is an air-actuated belt-driven on-off design. When engaged the fan runs at input sheave speed, and when disengaged the fan speed is close to zero.

The two-speed EFC is an air actuated belt-driven two-speed drive. When engaged the fan runs at input sheave speed, and when the air clutch releases, the fan runs at a nominal speed driven by a magnetic eddy current system that produces 300-400 rpm at idle and 700-900 rpm at when the engine rpm is 1900. This provides improved cooling and delays the fan coming on in high ambient temperatures or at high loads.

The difference between the single speed and two-speed EFCs is internal to the fan hub; both fans have identical external circuitry.

Function Variable EFC

The purpose of the variable electronic engine fan is to force a higher airflow through the radiator when the A/C is on or when the ECT goes above a set temperature.

The variable EFC is a direct-driven electronically controlled viscous fan drive. The fan has a number of operating regions.

- From 300 to 1100 engine rpm it is an on-off drive. Off is under 300 rpm, on is 99% of input speed.
- From 1100 to 1750 engine rpm it is a variable speed drive with an effective range of 800 rpm to 99% of input speed.
- From 1750 to 2150 engine rpm it is on-off again.
- From 2150 to 2450 engine rpm it is either off or 2625 rpm.
- Above 2450 engine rpm it is off.

EFC – Two Speed Sensor Circuit Operation

The default state of the EFC is ON. B+ is needed to turn the fan OFF.

ECM Pin C1-18 controls the EFC to shut off by supplying PWR to the EFC deactivating it.

EFC – Variable Sensor Circuit Operation

The default state of the EFC is ON. B+ is needed to turn the fan OFF.

ECM Pin C1-18 controls the EFC to shut off by supplying B+ to the EFC, deactivating it.

ECM Pin C1-58 controls EFC speed by supplying a Pulse Width Modulated (PWM) signal to the EFC.

Voltage Check at Single or Two-Speed EFC Connector - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4844 to single or two-speed EFC 2-pin connector, and leave EFC disconnected.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Engine Fan Control from the drop-down menu.
3. Command Engine Fan Control to 5%.
4. Use DMM to measure voltage.
5. Command Engine Fan Control to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
A to GND	B+	If < B+, check for open in ECM PWR OUT 3.
B to GND	0 V to 0.25 V	If > 0.25 V, check for short to PWR.
Actuator Test - at 5% state		
B to GND	0 V to 0.25 V	If > 0.25 V, check for short to PWR.
Actuator Test - at 95% state		
B to GND	B+	If < B+, check EFC circuit for OPEN or short to GND. Do Harness Resistance Check.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4484 to EFC vehicle harness, and leave EFC disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-30 to A	< 5 Ω	If > 5 Ω, check for OPEN circuit between ECM pin C1-30 and EFC pin A.
C1-18 to B	< 5 Ω	If > 5 Ω, check for OPEN circuit between ECM pin C1-18 and EFC pin B.

If voltage and resistance measurements are within specification but DTC is still active, or EFC does not work, replace the EFC.

SPN 647 FMI 5 - EFC Open Load / Circuit

Function Two-Speed EFC

The purpose of the engine fan is to force a higher airflow through the radiator when the A/C is on or the ECT goes above a set temperature.

The single-speed EFC is an air-actuated belt-driven on-off design. When engaged the fan runs at input sheave speed, and when disengaged the fan speed is close to zero.

The two-speed EFC is an air actuated belt-driven two-speed drive. When engaged the fan runs at input sheave speed, and when the air clutch releases, the fan runs at a nominal speed driven by a magnetic eddy current system that produces 300-400 rpm at idle and 700-900 rpm at when the engine rpm is 1900. This provides improved cooling and delays the fan coming on in high ambient temperatures or at high loads.

The difference between the single speed and two-speed EFCs is internal to the fan hub; both fans have identical external circuitry.

Function Variable EFC

The purpose of the variable electronic engine fan is to force a higher airflow through the radiator when the A/C is on or when the ECT goes above a set temperature.

The variable EFC is a direct-driven electronically controlled viscous fan drive. The fan has a number of operating regions.

- From 300 to 1100 engine rpm it is an on-off drive. Off is under 300 rpm, on is 99% of input speed.
- From 1100 to 1750 engine rpm it is a variable speed drive with an effective range of 800 rpm to 99% of input speed.
- From 1750 to 2150 engine rpm it is on-off again.
- From 2150 to 2450 engine rpm it is either off or 2625 rpm.
- Above 2450 engine rpm it is off.

EFC – Two Speed Sensor Circuit Operation

The default state of the EFC is ON. B+ is needed to turn the fan OFF.

ECM Pin C1-18 controls the EFC to shut off by supplying PWR to the EFC deactivating it.

EFC – Variable Sensor Circuit Operation

The default state of the EFC is ON. B+ is needed to turn the fan OFF.

ECM Pin C1-18 controls the EFC to shut off by supplying B+ to the EFC, deactivating it.

ECM Pin C1-58 controls EFC speed by supplying a Pulse Width Modulated (PWM) signal to the EFC.

Voltage Check at Single or Two-Speed EFC Connector - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4844 to single or two-speed EFC 2-pin connector, and leave EFC disconnected.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Engine Fan Control from the drop-down menu.
3. Command Engine Fan Control to 5%.
4. Use DMM to measure voltage.
5. Command Engine Fan Control to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
A to GND	B+	If < B+, check for open in ECM PWR OUT 3.
B to GND	0 V to 0.25 V	If > 0.25 V, check for short to PWR.
Actuator Test - at 5% state		
B to GND	0 V to 0.25 V	If > 0.25 V, check for short to PWR.
Actuator Test - at 95% state		
B to GND	B+	If < B+, check EFC circuit for OPEN or short to GND. Do Harness Resistance Check.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4484 to EFC vehicle harness, and leave EFC disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-30 to A	< 5 Ω	If > 5 Ω, check for OPEN circuit between ECM pin C1-30 and EFC pin A.
C1-18 to B	< 5 Ω	If > 5 Ω, check for OPEN circuit between ECM pin C1-18 and EFC pin B.

If voltage and resistance measurements are within specification but DTC is still active, or EFC does not work, replace the EFC.

EGR (Exhaust Gas Recirculation) Valve Sensor

Overview of EGR Valve Sensor Group

SPN	FMI	Description
27	7	EGRP does not agree with commanded position
27	10	EGRP sensor feedback deviation during Cold Start Emissions Reduction (CSER) (page 793)
27	16	Position error Position sensor feedback deviation from control command (page 795)
27	18	Position error Position sensor feedback deviation from control command (page 796)
2791	0	EGRV Overtemperature (page 797)
2791	2	EGRC Temperature Signal Erratic, Intermittent or Incorrect
2791	3	EGRC short to PWR
2791	4	EGRC short to GND
2791	5	EGRC open load/circuit
2791	6	EGRV Over Current
2791	7	EGRC Stroke Check Fault
2791	8	EGR valve not receiving ECM PWM signal
2791	14	EGRV Error: Internal Processor failure
2791	19	EGRC Not Detected on J1939 (page 812)
3058	10	Engine did not go into Closed loop EGR control when expected (page 821) Engine did not go into Closed loop EGR control when expected
4752	4	EGR Cooler Efficiency: EGR Outlet Temp above expected (page 1231) EGR Cooler Efficiency: EGR Outlet Temp above expected

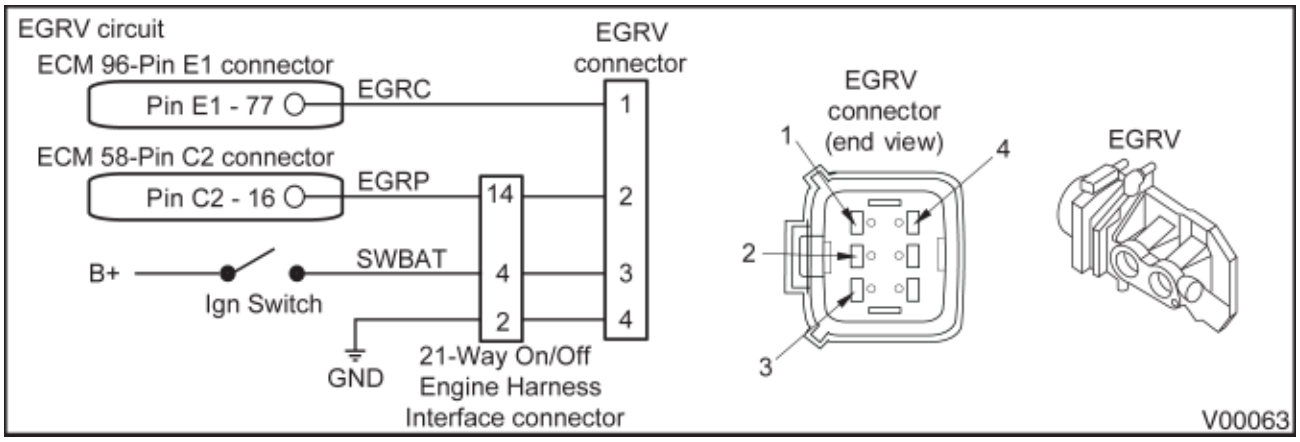


Figure 315 EGR Valve circuit diagram

Overview

The Exhaust Gas Recirculation (EGR) valve is used to control exhaust flow through the EGR cooler. The EGR valve contains a PWM controlled valve and Exhaust Gas Recirculation Position (EGRP) sensor. The Engine Control Module (ECM) sends a signal to the EGR valve to move to the desired position. The EGRP, located inside the EGR valve, monitors and provides an EGRV position signal to the ECM.

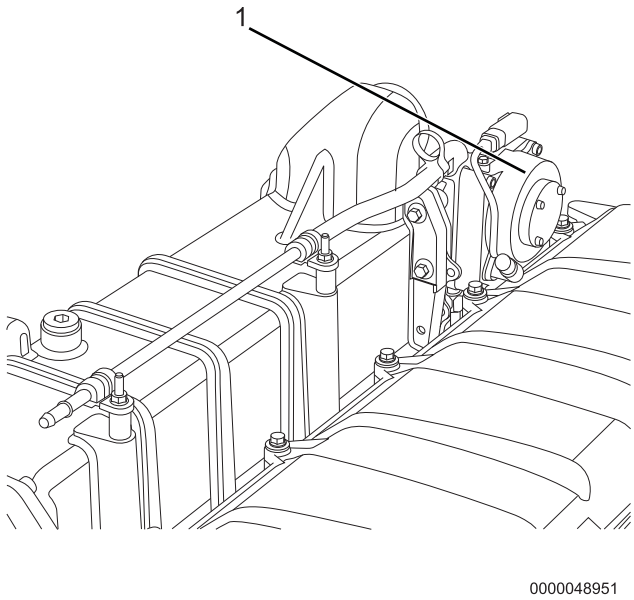


Figure 316 EGR Valve Location (Right Rear Engine)

1. Exhaust Gas Recirculation (EGR) valve

SPN 27 FMI 7 - EGRP Does Not Agree With Commanded Position

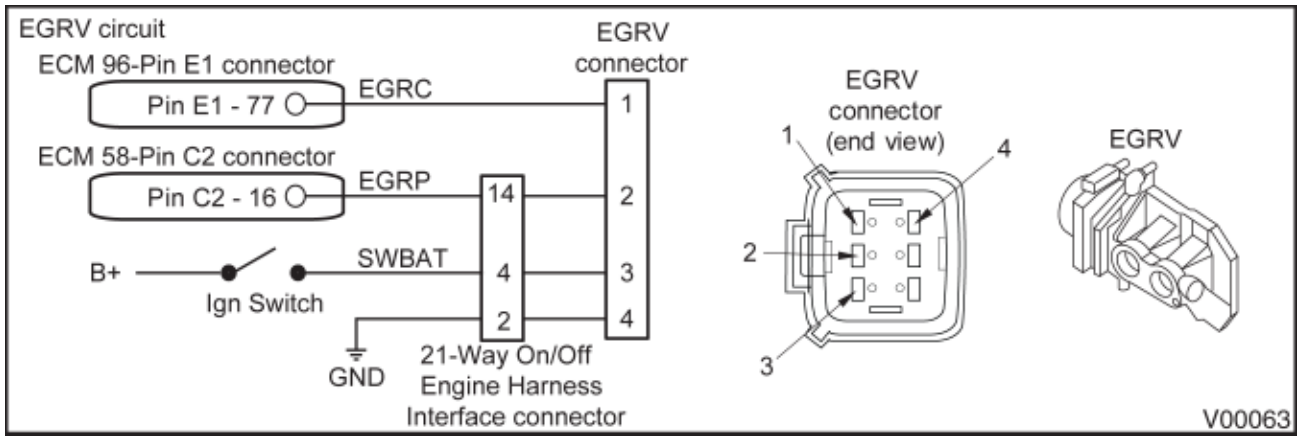


Figure 317 EGR Valve circuit diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the 2010 Actuator session.
2. Select EGR Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor EGR Position (EGRP) and EGR Valve CTL (EGRC).
   - If EGRP does not closely match EGRC, check EGR valve for mechanical problem.
   - If EGR valve does not move, continue to Connector Voltage Check.

Connector Voltage Check — EGR Valve Disconnected

Connect Breakout Harness ZTSE6016 to EGR valve engine harness, and leave EGR valve disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 809).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	5.0 V ± 1.0 V	If > 6 V, check for short to PWR. If < 4 V, check for OPEN or short to GND. Do Harness Resistance Check (page 809).
1 to GND	0 V to 1 V	If > 1 V, check for short to PWR.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between EGR valve and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select EGR Position from the drop-down menu.
3. Command EGRP to 5%.
4. Use DMM to measure voltage.
5. Command EGRP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR.
		If < 2.0 V, check for short circuit or failed EGR valve.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR.
		If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed EGR valve.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to EGR engine harness, and leave EGR valve disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-77	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to C2-16	< 5 Ω	If >5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the EGR valve.

SPN 27 FMI 10 - EGRP Sensor Feedback Deviation During CSER

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Exhaust Gas Recirculation (EGR) Valve position sensor does not a agree with ECM commanded position	EGR valve position > 10% from commanded position	Key ON	10 seconds

Fault Overview

Fault code sets when feedback from the Exhaust Gas Recirculation Position (EGRP) does not agree with the Engine Control Module (ECM) commanded position during Cold Start Emission Reduction (CSER).

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 27 FMI 7.

Drive Cycle to Determine Fault Status

Drive Cycle 18 then 4 in 2013 HD-OBD Diagnostic Reference Manual.

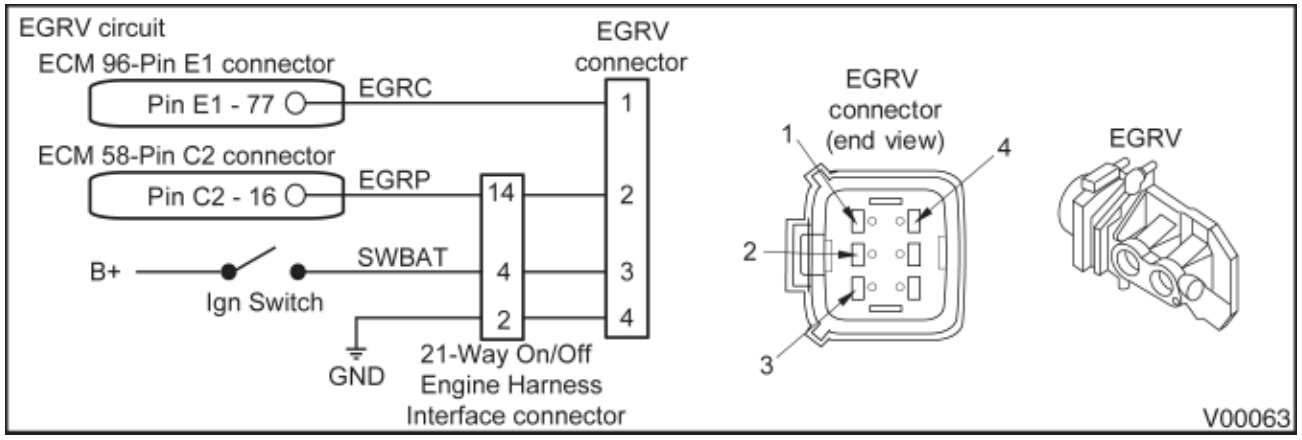


Figure 318 EGR Valve circuit diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 27 FMI 3, SPN 27 FMI 4, and SPN 2791. Is SPN 27 FMI 10 the only fault code active?	Yes: Do Operational Voltage Check (page 809). After repairs are complete, retest for SPN 27 FMI 10.
		No: Repair other fault code(s). After repairs are complete, retest for SPN 27 FMI 10.

NOTE: After doing all diagnostic steps, if SPN 27 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 27 FMI 16 - Position error Position sensor feedback deviation from control command

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Position error Position sensor feedback deviation from control command			

Fault Overview

Lamp Reaction

Associated Faults

Drive Cycle to Determine Fault Status

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 27 FMI 18 - Position error Position sensor feedback deviation from control command

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Position error Position sensor feedback deviation from control command			

Fault Overview

Lamp Reaction

Associated Faults

Drive Cycle to Determine Fault Status

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 2791 FMI 0 - EGRV fault: Overtemperature

Condition / Description	Setting Criteria	Enable Conditions / Values
Exhaust Gas Recirculation Valve (EGRV) is hotter than recommended.	EGRV temperature > 275°F (135°C)	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Exhaust Gas Recirculation Valve (EGRV) temperature is greater than 275°F (135°C).

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two trips.

Associated Faults

SPN 27 (EGR); SPN 1659 FMI 20 (ECS); SPN 2659 (EGR); SPN 2791 (EGR)

Fault Facts

Fault will most likely be inactive when truck is in shop.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Low coolant level
- Coolant contamination
- Immediate shut down after hard run
- Failed thermostat
- Failed EGRV

Step 1	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 27 (EGR); SPN 1659 FMI 20 (ECS); SPN 2659 (EGR); SPN 2791 (EGR). Is EST DTC list free of SPN 27; SPN 1659 FMI 20; SPN 2659; SPN 2791?		Yes: Go to Step 2. No: Repair SPN 27; SPN 1659 FMI 20; SPN 2659; SPN 2791. After repairs are complete, retest for SPN 2791 FMI 0.

Step 2	Check coolant quality.	Decision
Perform Coolant Quality Inspection (page 1788). Is coolant clean and free of contamination?		Yes: Go to Step 3. No: Repair source of coolant contamination. After repairs are complete, retest for SPN 2791 FMI 0.

Step 3	Check coolant level.	Decision
Perform Coolant Level Inspection (page 1786). Is coolant level within specification?		Yes: Go to Step 4. No: Fill coolant to specification. Repair cause of low coolant. After repairs are complete, retest for SPN 2791 FMI 0.

Step 4	Check engine thermostat operation.	Decision
Perform Thermostat Operational Test . Are engine thermostats operating within specification?		Yes: Go to Step 5. No: Replace both engine thermostats. After repairs are complete, retest for SPN 2791 FMI 0.

Step 5	Interview operator of vehicle.	Decision
Ask operator of vehicle if engine was shut down right after hard run. Was engine shut down right after hard run?		Yes: Instruct operator to let engine idle for 5 minutes before shutting down. After repairs are complete, retest for SPN 2791 FMI 0. No: Clear DTCs. If active code remains, replace Exhaust Gas Recirculation Valve (EGRV). After repairs are

	complete, retest for SPN 2791 FMI 0.

End Diagnostic Tests
After performing all tests, if no problem is found, verify each step was completed correctly and the proper decision was made. Return to SPN 2791 FMI 0 fault code diagnostics.

SPN 2791 FMI 2 - EGRC Temperatue Signal Erratic, Intermittent or Incorrect

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 2791 FMI 3 - EGRC Short to PWR

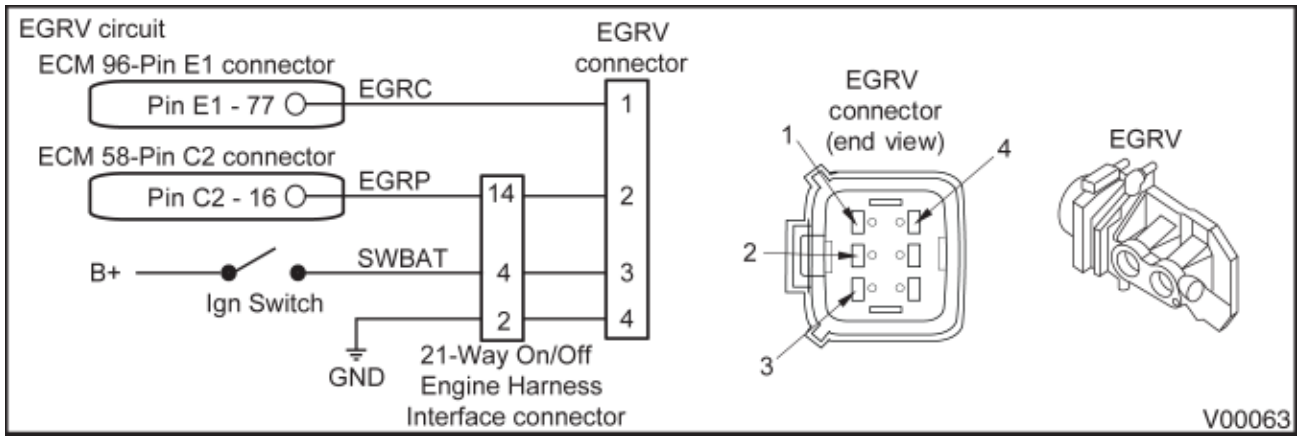


Figure 322 EGR Valve circuit diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the 2010 Actuator session.
2. Select EGR Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor EGR Position (EGRP) and EGR Valve CTL (EGRC).
   - If EGRP does not closely match EGRC, check EGR valve for mechanical problem.
   - If EGR valve does not move, continue to Connector Voltage Check.

Connector Voltage Check — EGR Valve Disconnected

Connect Breakout Harness ZTSE6016 to EGR valve engine harness, and leave EGR valve disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 809).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	5.0 V ± 1.0 V	If > 6 V, check for short to PWR. If < 4 V, check for OPEN or short to GND. Do Harness Resistance Check (page 809).
1 to GND	0 V to 1 V	If > 1 V, check for short to PWR.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between EGR valve and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select EGR Position from the drop-down menu.
3. Command EGRP to 5%.
4. Use DMM to measure voltage.
5. Command EGRP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR.
		If < 2.0 V, check for short circuit or failed EGR valve.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR.
		If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed EGR valve.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to EGR engine harness, and leave EGR valve disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-77	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to C2-16	< 5 Ω	If >5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the EGR valve.

SPN 2791 FMI 4 - EGRC Short to GND

SPN 2791 FMI 5 - EGRC Open Load / Circuit

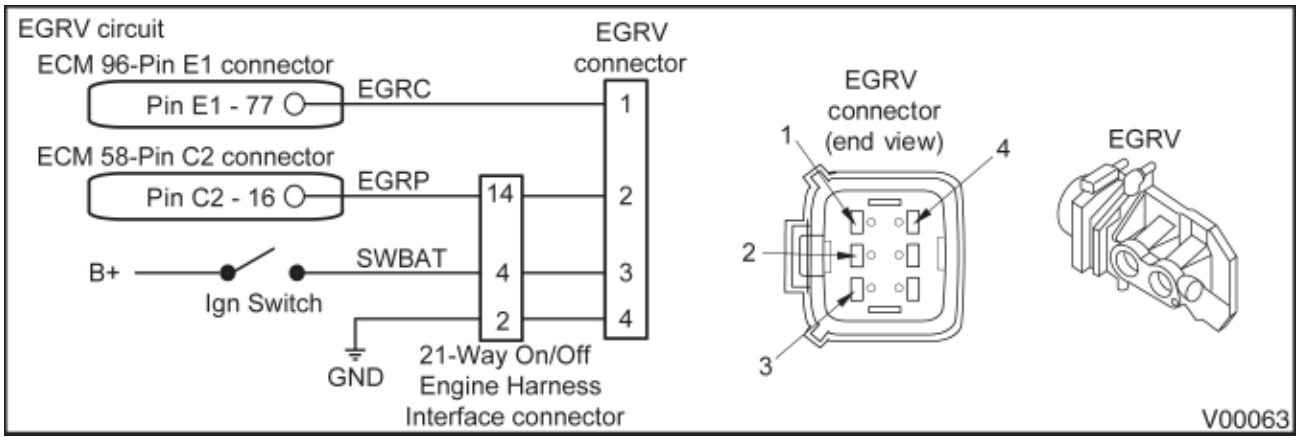


Figure 323 EGR Valve circuit diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the 2010 Actuator session.
2. Select EGR Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor EGR Position (EGRP) and EGR Valve CTL (EGRC).
   - If EGRP does not closely match EGRC, check EGR valve for mechanical problem.
   - If EGR valve does not move, continue to Connector Voltage Check.

Connector Voltage Check — EGR Valve Disconnected

Connect Breakout Harness ZTSE6016 to EGR valve engine harness, and leave EGR valve disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 809).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	5.0 V ± 1.0 V	If > 6 V, check for short to PWR. If < 4 V, check for OPEN or short to GND. Do Harness Resistance Check (page 809).
1 to GND	0 V to 1 V	If > 1 V, check for short to PWR.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between EGR valve and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select EGR Position from the drop-down menu.
3. Command EGRP to 5%.
4. Use DMM to measure voltage.
5. Command EGRP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR.
		If < 2.0 V, check for short circuit or failed EGR valve.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR.
		If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed EGR valve.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to EGR engine harness, and leave EGR valve disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-77	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to C2-16	< 5 Ω	If >5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the EGR valve.

SPN 2791 FMI 6 - EGRV Over Current

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 2791 FMI 7 - EGRC Stroke Check Fault

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 2791 FMI 8 - EGR Valve Not Receiving ECM PWM Signal

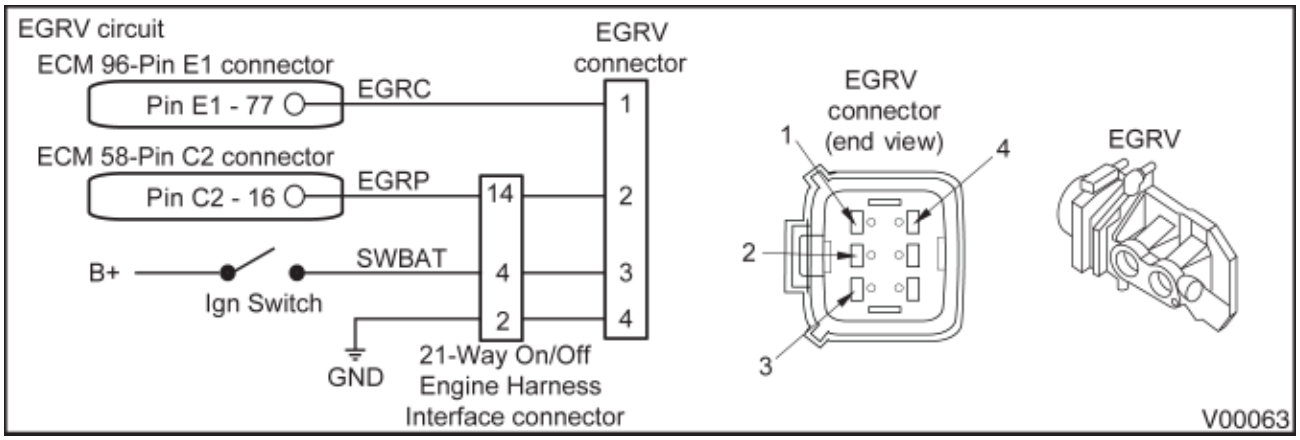


Figure 326 EGR Valve circuit diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the 2010 Actuator session.
2. Select EGR Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor EGR Position (EGRP) and EGR Valve CTL (EGRC).
   - If EGRP does not closely match EGRC, check EGR valve for mechanical problem.
   - If EGR valve does not move, continue to Connector Voltage Check.

Connector Voltage Check — EGR Valve Disconnected

Connect Breakout Harness ZTSE6016 to EGR valve engine harness, and leave EGR valve disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 809).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	5.0 V ± 1.0 V	If > 6 V, check for short to PWR. If < 4 V, check for OPEN or short to GND. Do Harness Resistance Check (page 809).
1 to GND	0 V to 1 V	If > 1 V, check for short to PWR.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between EGR valve and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select EGR Position from the drop-down menu.
3. Command EGRP to 5%.
4. Use DMM to measure voltage.
5. Command EGRP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR.
		If < 2.0 V, check for short circuit or failed EGR valve.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR.
		If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed EGR valve.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to EGR engine harness, and leave EGR valve disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-77	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to C2-16	< 5 Ω	If >5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the EGR valve.

SPN 2791 FMI 12 - EGRV position sensor failure

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 2791 FMI 14 - EGRV Error: Internal Processor failure

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 2791 FMI 19 - EGRV Not Detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values
Exhaust Gas Recirculation Valve (EGRV) is Not detected on J1939 CAN circuit.	EGRV Not detected on J1939	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) does Not detect the Exhaust Gas Recirculation Valve (EGRV) on J1939 CAN data link communications circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two trips.

Associated Faults

SPN 1761 FMI 19 (DEFTLT); SPN 3216 FMI 19 (NOx IN); SPN 3226 FMI 19 (NOx OUT); SPN 4360 FMI 19 (SCRIT); SPN 4363 FMI 19 (SCROT); SPN 5742 FMI 19 (DOC / DPF); SPN 5743 FMI 19 (SCR).

Fault Facts

If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits: DOC / DPF temperature sensor module, SCR temperature sensor module, EGR Valve, NOx OUT sensor module, NOx IN sensor module, and DEFTLT sensor module. Verify batteries are fully charged and connections are clean.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- ECM PWR OUT 3 circuit Open or high resistance
- EGRV GND circuit Open or high resistance
- CAN_AH circuit Open
- CAN_AH circuit short to GND
- CAN_AH circuit short to PWR
- CAN_AL circuit Open
- CAN_AL circuit short to GND
- CAN_AL circuit short to PWR
- CAN_AH shorted to CAN_AL
- Failed EGRV

Step 1	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1761 FMI 19 (DEFTLT); SPN 3216 FMI 19 (NOx IN); SPN 3226 FMI 19 (NOx OUT); SPN 4360 FMI 19 (SCRIT); SPN 4363 FMI 19 (SCROT); SPN 5742 FMI 19 (DOC / DPF); SPN 5743 FMI 19 (SCR). Is EST DTC list free of SPN 1761 FMI 19; SPN 3216 FMI 19; SPN 3226 FMI 19; SPN 4360 FMI 19; SPN 4363 FMI 19; SPN 5742 FMI 19; SPN 5743 FMI 19?		Yes: Go to Step 2. No: Repair SPN 1761 FMI 19; SPN 3216 FMI 19; SPN 3226 FMI 19; SPN 4360 FMI 19; SPN 4363 FMI 19; SPN 5742 FMI 19; SPN 5743 FMI 19. After repairs are complete, retest for SPN 2791 FMI 19 .

Step 2	Check coolant quality.	Decision
Inspect connections at Exhaust Gas Recirculation Valve (EGRV). Key OFF, disconnect EGRV connector. Check EGRV and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the EGRV sensor module connector, harness, and terminals clean and undamaged?		Yes: Perform Pin-Point Tests . No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 2791 FMI 19.

Pin-Point Test SPN 2791 FMI 19

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4948
- Digital Multimeter (DMM)

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4948 to vehicle harness and leave Exhaust Gas Recirculation Valve (EGRV) disconnected. C. Key ON.

Test 1	Specification
Using a Digital Multimeter (DMM), measure voltage between Breakout Harness ZTSE4948 pin-3 and pin-4.	B+ ± 0.5 volts
Decision	
Is voltage B+ ± 0.5 volts?	Yes: Go to test 3.
	No: Go to test 2.

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4948 to vehicle harness and leave EGRV disconnected. C. Key ON.

Test 2	Specification
Using a DMM, measure voltage between Breakout Harness ZTSE4948 pin-4 and a known good GND.	B+ ± 0.5 volts
Decision	
Is voltage B+ ± 0.5 volts?	Yes: Repair Open or high resistance between EGRV pin-3 and ground. After repairs are complete, retest for SPN 2791 FMI 19.
	No: Repair Open or high resistance between EGRV pin-4 and ECM pin E1-24 and E1-26. After repairs are complete, retest for SPN 2791 FMI 19.

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4948 to vehicle harness and leave EGRV disconnected. C. Key ON.

Test 3	Specification
Using a DMM, measure voltage between Breakout Harness ZTSE4948 pin-2 and a known good GND.	Greater than 1 volt
Decision	
Is voltage greater than 1 volt?	Yes: Go to test 4.
	No: Repair Open or short to GND between EGRV pin-2 and ECM pin E1-33. After repairs are complete, retest for SPN 2791 FMI 19.

Test 4 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4948 to vehicle harness and leave EGRV disconnected. C. Key ON.

Test 4	Specification
Using a DMM, measure voltage between Breakout Harness ZTSE4948 pin-2 and a known good GND.	Less than 4 volt
Decision	
Is voltage less than 4 volts?	Yes: Go to test 5.
	No: Repair short to PWR between EGRV pin-2 and ECM pin E1-33. After repairs are complete, retest for SPN 2791 FMI 19.

Test 5 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4948 to vehicle harness and leave EGRV disconnected. C. Key ON.

Test 5	Specification
Using a DMM, measure voltage between Breakout Harness ZTSE4948 pin-1 and a known good GND.	Greater than 1 volt
Decision	
Is voltage greater than 1 volt?	Yes: Go to test 6.
	No: Repair Open or short to GND between EGRV pin-1 and ECM pin E1-09. After repairs are complete, retest for SPN 2791 FMI 19.

Test 6 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4948 to vehicle harness and leave EGRV disconnected. C. Key ON.

Test 6	Specification
Using a DMM, measure voltage between Breakout Harness ZTSE4948 pin-1 and a known good GND.	Less than 4 volt
Decision	
Is voltage less than 4 volts?	Yes: Go to test 7.
	No: Repair short to PWR between EGRV pin-1 and ECM pin E1-09. After repairs are complete, retest for SPN 2791 FMI 19.

Test 7 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4948 to vehicle harness and leave EGRV disconnected. C. Key ON.

Test 7	Specification
Using a DMM, measure resistance between Breakout Harness ZTSE4948 pin-1 and pin-2.	greater than 50 ohms
Decision	
Is resistance greater than 50 ohms?	Yes: Replace EGRV. After repairs are complete, retest for SPN 2791 FMI 19.
	No: Repair short between EGRV pin-1 and pin-2. After repairs are complete, retest for SPN 2791 FMI 19.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 2791 FMI 19 fault code diagnostics.

SPN 3058 FMI 10 - Engine Did Not Go Into Close Loop EGR Control When Expected

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Monitor the time it takes for EGR to enter closed loop control	Time to warm-up > calculated time based on (Engine Coolant Temperature 1 (ECT1) sensor at engine start) x (barometric pressure)	Cold Ambient Protection (CAP) inactive Key ON Engine Compression brake inactive Engine in required speed / load operating conditions	0.05 Seconds

Fault Overview

Fault code sets when O_2 sensor is unable to reach required operating temperature or EGR valve failed to react to enter open loop operation. Open loop operation occurs when the engine operates the EGRV based on calculations rather than on feedback from the O_2. Operating the EGRV before the engine reaches operating temperature and establishes closed loop operation could cause performance issues.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 27, 51, 108, 724, 2791, 3223, 3464, 4765, 5542, and 5543.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 3058 FMI 10 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 3058 FMI 10.

Step	Action	Decision
2	Inspect air intake system, exhaust system, and air filter for restrictions, air leaks, or physical damage. Also, inspect the fuel system from fuel tank to AFTFI valve for leaks or physical damage. Is air intake system, exhaust system, fuel system and air filter free of restrictions, leaks, and physical damage?	Yes: Go to step 3. No: Repair restrictions, air leaks , fuel leaks or physical damage. After repairs are complete, retest for SPN 3058 FMI 10.

Step	Action	Decision
3	Using EST with ServiceMaxx™ software, run Continuous Monitor session and monitor Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor (wiggle test may be necessary if code is inactive or pending). Is DOCIT sensor within specifications?	Yes: Go to step 4. No: Do Hot Run Aftertreatment Sensor Compare Check Test . After repairs are complete, retest for SPN 3058 FMI 10.

Step	Action	Decision
4	Using EST with ServiceMaxx™ software, run Continuous Monitor session and monitor Oxygen (O2S) sensor (wiggle test may be necessary if code is inactive or pending). Is O2S sensor within specifications?	Yes: Go to step 5. No: Do O2S Biased Sensor or Circuit Check and retest for SPN 3058 FMI 10.

Step	Action	Decision
5	Using EST with ServiceMaxx™ software, run Continuous Monitor session and monitor Barometric Pressure (BARO) sensor. See Key-On Engine-Off (KOEO) Barometric Pressure (page 1831) for sensor value (wiggle test may be necessary if code is inactive or pending). Is the BARO sensor within specifications?	Yes: Go to step 6. No: Do ECM Self-Diagnostics and retest for SPN 3058 FMI 10.

Step	Action	Decision
6	Using EST with ServiceMaxx™ software, see Exhaust Gas Recirculation (EGR) Valve Pinpoint Diagnostics (page 808) for EGR Valve Actuator command test. Is EGR Valve within specifications?	Yes: Go to step 7. No: Correct EGR Valve issues and retest for SPN 3058 FMI 10.

Step	Action	Decision
7	Using EST with ServiceMaxx™ software, see Engine Throttle Valve (ETV) Pinpoint Diagnostics (page 894) for ETV Valve Actuator command test. Is ETV Valve within specifications?	Yes: Go to step 8. No: Correct ETV issues and retest for SPN 3058 FMI 10.

Step	Action	Decision
8	Using EST with ServiceMaxx™ software, do Exhaust Back Pressure Valve (EBPV) test for EBPV Actuator test. Is EBPV within specifications?	Yes: Verify each step was completed correctly and the proper decision was made. Notify supervisor for further action. No: Correct EBPV issues and retest for SPN 3058 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 3058 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4752 FMI 4 - EGR Cooler Efficiency: EGR Outlet Temp Above Expected

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare Engine Coolant Temperature 1 (ECT1) to Engine Coolant Temperature 2 (ECT2). Sensor temperatures should be within 10°F (6°C) of each other.
   - If ECT1 is 10°F (6°C) or more above or below ECT2, check for poor circuitry going to the ECT1 sensor.
4. Verify engine fan is not stuck ON. Using EST with ServiceMaxx™ software, run Tests > KOER Test > Engine Fan Test.
5. Remove thermostats using procedure in the *Engine Service Manual*.
   - If the thermostat assemblies are stuck open, damaged, cracked, or not operating properly, replace them.
   - If engine fan or thermostat are not the cause, verify if code was set due to extended idle time in very cold ambient temperatures while running a large cabin heater.

EGRGT (Exhaust Gas Recirculation Cooler Gas Temperature) Sensor

Overview of EGRGT Sensor Group

SPN	FMI	Actions
412	1	EGRGT signal stuck low, not warming up (page 835)
412	2	EGRGT signal does not agree with other sensors (page 835)
412	3	EGRGT signal Out of Range HIGH (page 837)
412	4	EGRGT signal Out of Range LOW (page 843)

SPN 412 FMI 1 - EGRGT Signal Stuck Low, Not Warming Up

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
EGRGT signal stuck low, not warming up	TBD	Key ON

Fault Overview

Fault sets when Engine Control Module (ECM) determines EGRGT signal value has been stuck in a certain range for an extended period of time.

Lamp Reaction

When fault is active, the Malfunction Indicator Lamp (MIL) will illuminate.

Associated Faults

Fault Facts

Drive Cycle to Determine Fault Status

Possible Causes

•

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 412 FMI 1. Is EST DTC list SPN 412 FMI 1 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Check for associated fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for . Is EST DTC list free of ?		Yes: Go to Step 3. No: Repair SPN FMI . After repairs are complete, retest for SPN 412 FMI 1.

Step 3	EGRGT sensor and connector inspection.	Decision
A. Key OFF. B. Disconnect EGRGT sensor. C. Check EGRGT sensor and connector terminals for: damaged or pinched wires; wet or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are EGRGT sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pinpoint Tests. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 412 FMI 1.

Pinpoint Tests (SPN 412 FMI 1)

Figure 329 EGRGT Sensor Circuit Diagram

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form XX for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Figure 330 Test 1 EGRGT Sensor Circuit Check

Test 1 Setup
A. Key OFF. B. Disconnect EGRGT sensor. C. Connect Breakout Harness X to vehicle harness connector and leave EGRGT sensor disconnected. D. Key ON.

Test 1	Specification
Using DMM, monitor voltage between.	
Decision	
Is voltage ?	Yes: Go to Test 2.
	No: Repair . After repairs are complete, retest for SPN 412 FMI 1.

End Diagnostic Tests
After performing all tests, if no problem is found, verify each step was completed correctly and the proper decision was made. Return to SPN 412 FMI 1 fault code diagnostics.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Cold Soak Sensor Compare Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 412 FMI 2 – EGRGT signal does not agree with other sensors

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare EGRGT, Engine Coolant Temperature 1 (ECT1), and Engine Coolant Temperature 2 (ECT2). Sensor temperatures should be within 9°F (5°C) of each other.
   - If EGRGT is 9°F (5°C) above or below the ECT1 and ECT2, check for poor circuitry going to the EGRGT sensor.
   - If circuits are within specification, replace EGRGT sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4760A to EGRGT engine harness, and leave EGRGT sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment– < Less than, > Greater than
EST – Monitor EGRGTv	4.5 – 5 V	If <4.5 V, check EGRGT signal circuit for short to GND.
EST – Monitor EGRGTv Short pin 1 to GND	0 V	If > 0.25 V, check EGRGT signal circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EGRGTv Short pin 1 to 2	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EGRGTv Short 500 Ω resistor across pins 1 and 2	< 1.0 V	If > 1.0 V, check EGRGT signal circuit for short to PWR.
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace EGRGT sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4760A to EGRGT engine harness, and leave EGRGT sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5 V	If < 4.5 V, check EGRGT signal circuit for short to GND.
2 to B+	B+	If < B+, check SIG GND for OPEN circuit.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4760A to EGRGT engine harness, and leave EGRGT sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-95	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-94	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 412 FMI 2 - EGRGT Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
EGRGT Signal Erratic, Intermittent, or Incorrect	TBD	Key ON

Fault Overview

Fault sets when Engine Control Module (ECM) determines EGRGT signal is erratic, intermittent, or incorrect.

Lamp Reaction

When fault is active, the Malfunction Indicator Lamp (MIL) will illuminate.

Associated Faults

Fault Facts

Drive Cycle to Determine Fault Status

Possible Causes

•

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 412 FMI 2. Is EST DTC list SPN 412 FMI 2 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Check for associated fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for . Is EST DTC list free of ?		Yes: Go to Step 3. No: Repair SPN FMI . After repairs are complete, retest for SPN 412 FMI 2.

Step 3	EGRGT sensor and connector inspection.	Decision
A. Key OFF. B. Disconnect EGRGT sensor. C. Check EGRGT sensor and connector terminals for: damaged or pinched wires; wet or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are EGRGT sensor connector, harness, and terminals clean and undamaged?		Yes: Perform Pinpoint Tests. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 412 FMI 2.

Pinpoint Tests (SPN 412 FMI 2)

Figure 331 EGRGT Sensor Circuit Diagram

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

See latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form XX for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Figure 332 Test 1 EGRGT Sensor Circuit Check

Test 1 Setup
A. Key OFF. B. Disconnect EGRGT sensor. C. Connect Breakout Harness X to vehicle harness connector and leave EGRGT sensor disconnected. D. Key ON.

Test 1	Specification
Using DMM, monitor voltage between.	
Decision	
Is voltage ?	Yes: Go to Test 2.
	No: Repair . After repairs are complete, retest for SPN 412 FMI 1.

End Diagnostic Tests
After performing all tests, if no problem is found, verify each step was completed correctly and the proper decision was made. Return to SPN 412 FMI 1 fault code diagnostics.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Cold Soak Sensor Compare Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 412 FMI 2 – EGRGT signal does not agree with other sensors

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare EGRGT, Engine Coolant Temperature 1 (ECT1), and Engine Coolant Temperature 2 (ECT2). Sensor temperatures should be within 5 °C (10 °F) of each other.
   - If EGRGT is 5 °C (10 °F) above or below the ECT1 and ECT2, check for poor circuitry going to the EGRGT sensor.
   - If circuits are within specification, replace EGRGT sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4760A to EGRGT engine harness, and leave EGRGT sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment– < Less than, > Greater than
EST – Monitor EGRGTv	4.5 – 5 V	If <4.5 V, check EGRGT signal circuit for short to GND.
EST – Monitor EGRGTv Short pin 1 to GND	0 V	If > 0.25 V, check EGRGT signal circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EGRGTv Short pin 1 to 2	0 V	If > 0.25 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EGRGTv Short 500 Ω resistor across pins 1 and 2	< 1.0 V	If > 1.0 V, check EGRGT signal circuit for short to PWR.
If checks are within specification, connect sensor and clear DTCs. If active code remains, replace EGRGT sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4760A to EGRGT engine harness, and leave EGRGT sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5 V	If < 4.5 V, check EGRGT signal circuit for short to GND.
2 to B+	B+	If < B+, check SIG GND for OPEN circuit.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4760A to EGRGT engine harness, and leave EGRGT sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-95	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-94	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 412 FMI 3 - EGRGT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Exhaust Gas Recirculation Cooler Gas Temperature (EGRGT) value greater than expected.	EGRGT sensor voltage > 4.95 volts.	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Exhaust Gas Recirculation Cooler Gas Temperature (EGRGT) voltage is greater than 4.95 volts.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate immediately when this fault is detected.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- SIG GND circuit Open or High resistance
- EGRGT circuit Open or high resistance
- EGRGT circuit short to PWR
- Failed EGRGT sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 412 FMI 3.		Yes: Go to Step 2.
Is EST DTC list SPN 412 FMI 3 active or pending?		No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Exhaust Gas Recirculation Cooler Gas Temperature (EGRGT) connector.	Decision
A. Key OFF. B. Disconnect EGRGT connector. C. Check EGRGT and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to Step 3.
Are EGRGT connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 171 FMI 3.

Step 3	Check for EGRGT circuit short to PWR.	Decision
Perform Test 1 (page 840). Using DMM, measure voltage between Breakout Harness ZTSE4760A pin-2 and a known good ground.		Yes: Repair short to PWR between EGRGT pin-2 and Engine Control Module (ECM) pin E1-95. After repairs are complete, retest for SPN 412 FMI 3.
Is voltage greater than 4.95 volts?		No: Go to Step 4.

Step 4	Check for failed EGRGT sensor.	Decision
Perform Test 2 (page 841). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor EGRGT voltage.		Yes: Replace EGRGT sensor. After repairs are complete, retest for SPN 412 FMI 3.
Is voltage approximately 0 volts?		No: Go to Step 5.

Step 5	Check for Open in EGRGT circuit.	Decision
Perform Test 3 (page 842). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor EGRGT voltage.		Yes: Repair Open between EGRGT pin-1 and ECM pin E1-94. After repairs are complete, retest for SPN 412 FMI 3.
Is voltage approximately 0 volts?		No: Repair Open between EGRGT pin-2 and ECM pin E1-95. After repairs are complete, retest for SPN 412 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 412 FMI 3 fault code diagnostics.

Pin-Point Test SPN 412 FMI 3

Figure 333 Exhaust Gas Recirculation Cooler Gas Temperature (EGRGT) Sensor Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4760A
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

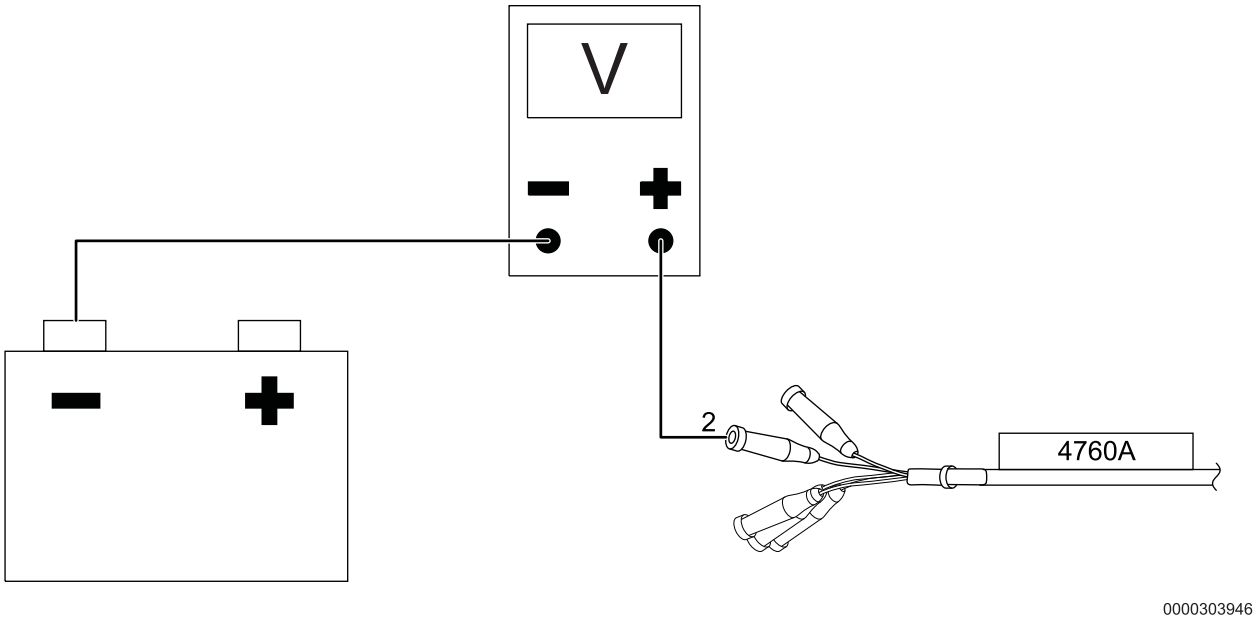


Figure 334 EGRGT Circuit Voltage Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4760A to vehicle harness and leave Exhaust Gas Recirculation Cooler Gas Temperature (EGRGT) sensor disconnected. C. Key ON.

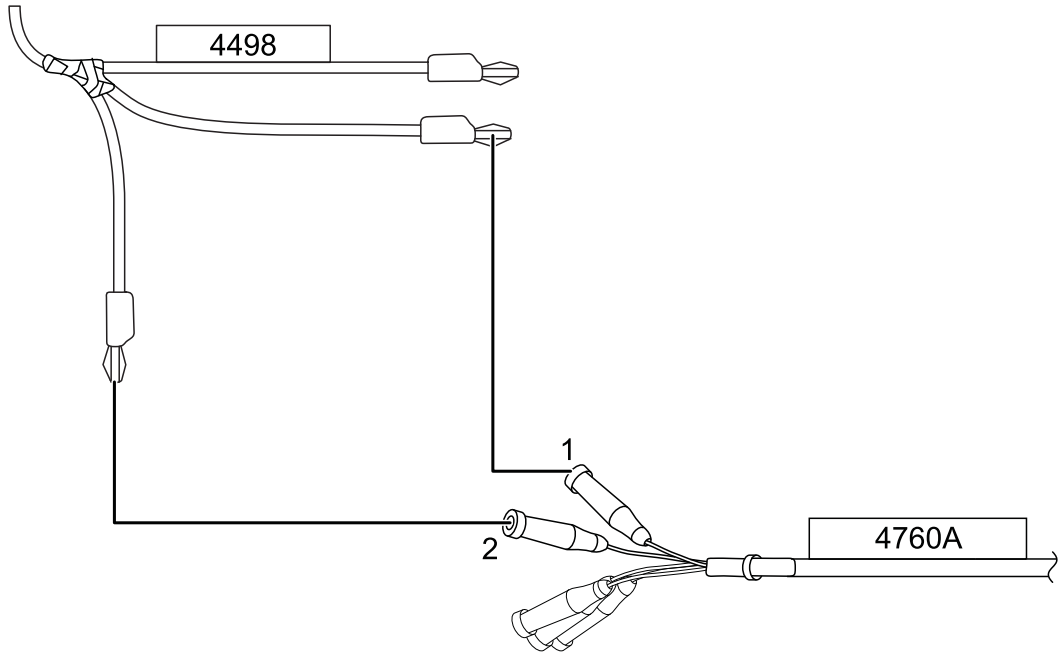


Figure 335 EGRGT Sensor Circuit Check

Test 2 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4760A to vehicle harness and leave EGRGT sensor disconnected.
C. Using Breakout Harness ZTSE4498 short pin-1 and pin-2 of Breakout Harness ZTSE4760A together.
D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
E. Key ON, log into ServiceMaxx™ software.

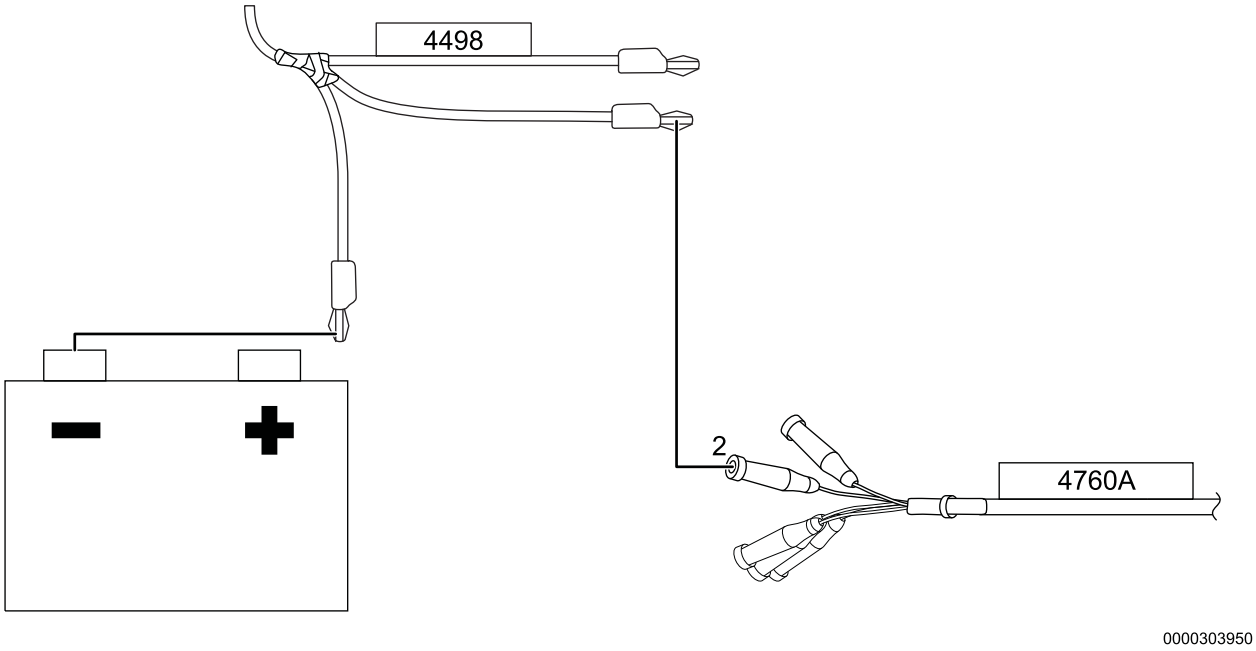


Figure 336 EGRGT Sensor Circuit Check

Test 3 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4760A to vehicle harness and leave EGRGT sensor disconnected.
C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4760A pin-2 to a known good GND.
D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
E. Key ON, log in to ServiceMaxx™ software.

SPN 412 FMI 4 - EGRGT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Exhaust Gas Recirculation Cooler Gas Temperature (EGRGT) sensor reading less than expected.	EGRGT sensor voltage < 0.05 volts.	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Exhaust Gas Recirculation Cooler Gas Temperature (EGRGT) signal voltage is less than expected.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate immediately when this fault is detected.

Associated Faults

None.

Fault Facts

None.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- EGRGT circuit short to GND
- Failed EGRGT sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 412 FMI 4. Is EST DTC list SPN 412 FMI 4 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Exhaust Gas Recirculation Cooler Gas Temperature (EGRGT) connector.	Decision
A. Key OFF. B. Disconnect EGRGT connector. C. Check EGRGT and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are EGRGT connector, harness, and terminals clean and undamaged?		Yes: Go to Step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 412 FMI 4.

Step 3	Check for Open in EGRGT circuit.	Decision
Perform Test 1 (page 846). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor EGRGT voltage.		Yes: Replace EGRGT sensor. After repairs are complete, retest for SPN 412 FMI 4.
Is voltage 4.85 volts ± 0.05 volts?		No: Repair short to GND between EGRGT pin-2 and Engine Control Module pin E1-95. After repairs are complete, retest for SPN 412 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 412 FMI 4 fault code diagnostics.

Pin-Point Test SPN 412 FMI 4

Figure 337 Exhaust Gas Recirculation Cooler Gas Temperature (EGRGT) Sensor Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF.
B. Disconnect Exhaust Gas Recirculation Cooler Gas Temperature (EGRGT) sensor
C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
D. Key ON, log into ServiceMaxx™ software.

Engine Brake

Overview of Engine Brake Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
1810	0	Hard Brake monitor, event log, extreme	• Incorrect programmable parameter value • Hard brake event	Pinpoint Diagnostics (page 847)
1810	15	Hard Brake monitor, even log non-extreme	• Incorrect programmable parameter value • Hard brake event	Pinpoint Diagnostics (page 847)

Overview

The hard brake monitor feature determines hard vehicle speed deceleration incidents. An incident occurs when programmable parameter 89052 Hard Brake Decel Rate Threshold is set at too low of a speed change. The incident is then reported to the ECM and stored as a vehicle event.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 1810 FMI 0 - Hard Brake Monitor, Event Log, Extreme

Pinpoint Diagnostics With ServiceMaxx™ Software

SPN 1810 FMI 0 - Hard Brake monitor, event log, extreme

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the Parameters session and adjust parameter ID 89052 Hard Brake Decel Rate Threshold to 5-9 mph/s.
2. Program engine and retest for 1810 FMI 0.

SPN 1810 FMI 15 - Hard Brake Monitor, Event Log Non-Extreme

Pinpoint Diagnostics With ServiceMaxx™ Software

SPN 1810 FMI 15- Hard Brake monitor, event log, non-extreme

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the Parameters session and adjust parameter ID 89052 Hard Brake Decel Rate Threshold to 5-9 mph/s.
2. Program engine and retest for 1810 FMI 15.

EOL (Engine Oil Level) Sensor

Overview of EOL Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
98	3	EOL signal Out of Range HIGH	• EOL signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed EOL sensor	Pin-Point Diagnostics (page 855)
98	4	EOL signal Out of Range LOW	• EOL signal circuit short to GND • Failed EOL sensor	Pin-Point Diagnostics (page 855)
1135	3	EOT2 signal Out of Range HIGH	• EOT2 signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed EOL sensor	Pin-Point Diagnostics (page 855)
1135	4	EOT2 signal Out-of-Range LOW	• EOL signal circuit short to GND • Failed EOL sensor	Pin-Point Diagnostics (page 855)

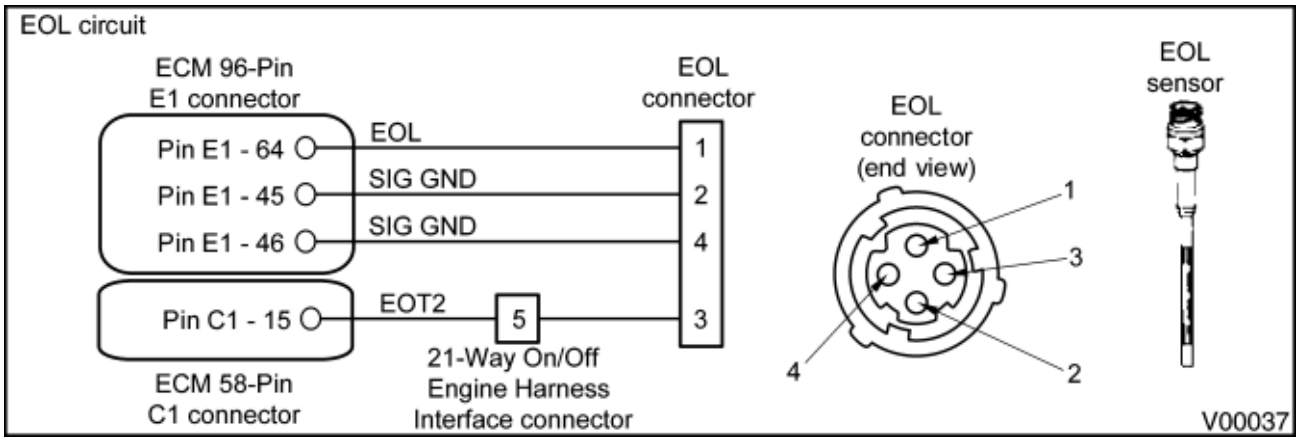


Figure 338 EOL sensor circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4827 (EOL)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 98 FMI 3 - EOL Signal Out of Range HIGH

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor session.
2. Monitor sensor voltage. Verify an active DTC for the sensor.
   - If DTC is inactive, monitor the signal while wiggling the connector and all wires at suspected location. If the circuit is interrupted, the signal will spike and the DTC will go active.
   - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, loose pins. Repair if necessary.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Turn ignition ON..

Test Point	Specification	Comment– < Less than, > Greater than
EST – Monitor EOLv	4.5 V – 5 V	If < 4.5 V, check EOL circuit for short to GND.
EST – Monitor EOT2v	4.5 V – 5 V	If < 4.5 V, check EOT2 circuit for short to GND.
EST – Monitor EOLv Short pin 1 to GND	0 V	If > 0.5 V, check EOL circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOLv Short pin 1 to 4	0 V	If > 0.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOT2v Short pin 3 to GND	0 V	If > 0.5 V, check EOT2 circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOT2v Short pin 2 to 3	0 V	If > 0.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.

If checks are within specification, connect sensor and clear DTCs. If active code remains, replace EOL sensor.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5 V ± 5 V	If > 5.5 V, check EOL for short to PWR. If < 4.5 V, check EOL for OPEN or short to GND. Do Harness Resistance Check.
3 to GND	5 V	If > 5.5 V, check EOT2 for short to PWR. If < 4.5 V, check EOT2 for OPEN or short to GND. Do Harness Resistance Check.
2 to B+	B+	If < B+, check SIG GND for OPEN circuit.
4 to B+	B+	If < B+, check SIG GND for OPEN circuit.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short GND in EOL circuit.
1 to E1-64	< 5 Ω	If > 5 Ω, check for OPEN in EOL circuit.
2 to E1-45	< 5 Ω	If > 5 Ω, check for OPEN in SIG GND circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND in EOT2 circuit.
3 to C1-15	< 5 Ω	If > 5 Ω, check for OPEN in EOT2 circuit.
4 to E1-46	< 5 Ω	If > 5 Ω, check for OPEN in SIG GND circuit.

SPN 98 FMI 4 - EOL Signal Out of Range LOW

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor session.
2. Monitor sensor voltage. Verify an active DTC for the sensor.
   - If DTC is inactive, monitor the signal while wiggling the connector and all wires at suspected location. If the circuit is interrupted, the signal will spike and the DTC will go active.
   - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, loose pins. Repair if necessary.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Turn ignition ON..

Test Point	Specification	Comment– < Less than, > Greater than
EST – Monitor EOLv	4.5 V – 5 V	If < 4.5 V, check EOL circuit for short to GND.
EST – Monitor EOT2v	4.5 V – 5 V	If < 4.5 V, check EOT2 circuit for short to GND.
EST – Monitor EOLv Short pin 1 to GND	0 V	If > 0.5 V, check EOL circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOLv Short pin 1 to 4	0 V	If > 0.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOT2v Short pin 3 to GND	0 V	If > 0.5 V, check EOT2 circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOT2v Short pin 2 to 3	0 V	If > 0.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.

If checks are within specification, connect sensor and clear DTCs. If active code remains, replace EOL sensor.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5 V ± 5 V	If > 5.5 V, check EOL for short to PWR. If < 4.5 V, check EOL for OPEN or short to GND. Do Harness Resistance Check.
3 to GND	5 V	If > 5.5 V, check EOT2 for short to PWR. If < 4.5 V, check EOT2 for OPEN or short to GND. Do Harness Resistance Check.
2 to B+	B+	If < B+, check SIG GND for OPEN circuit.
4 to B+	B+	If < B+, check SIG GND for OPEN circuit.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short GND in EOL circuit.
1 to E1-64	< 5 Ω	If > 5 Ω, check for OPEN in EOL circuit.
2 to E1-45	< 5 Ω	If > 5 Ω, check for OPEN in SIG GND circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND in EOT2 circuit.
3 to C1-15	< 5 Ω	If > 5 Ω, check for OPEN in EOT2 circuit.
4 to E1-46	< 5 Ω	If > 5 Ω, check for OPEN in SIG GND circuit.

SPN 1135 FMI 3 - EOT2 Signal Out of Range HIGH

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor session.
2. Monitor sensor voltage. Verify an active DTC for the sensor.
   - If DTC is inactive, monitor the signal while wiggling the connector and all wires at suspected location. If the circuit is interrupted, the signal will spike and the DTC will go active.
   - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, loose pins. Repair if necessary.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Turn ignition ON..

Test Point	Specification	Comment– < Less than, > Greater than
EST – Monitor EOLv	4.5 V – 5 V	If < 4.5 V, check EOL circuit for short to GND.
EST – Monitor EOT2v	4.5 V – 5 V	If < 4.5 V, check EOT2 circuit for short to GND.
EST – Monitor EOLv Short pin 1 to GND	0 V	If > 0.5 V, check EOL circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOLv Short pin 1 to 4	0 V	If > 0.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOT2v Short pin 3 to GND	0 V	If > 0.5 V, check EOT2 circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOT2v Short pin 2 to 3	0 V	If > 0.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.

If checks are within specification, connect sensor and clear DTCs. If active code remains, replace EOL sensor.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5 V ± 5 V	If > 5.5 V, check EOL for short to PWR. If < 4.5 V, check EOL for OPEN or short to GND. Do Harness Resistance Check.
3 to GND	5 V	If > 5.5 V, check EOT2 for short to PWR. If < 4.5 V, check EOT2 for OPEN or short to GND. Do Harness Resistance Check.
2 to B+	B+	If < B+, check SIG GND for OPEN circuit.
4 to B+	B+	If < B+, check SIG GND for OPEN circuit.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short GND in EOL circuit.
1 to E1-64	< 5 Ω	If > 5 Ω, check for OPEN in EOL circuit.
2 to E1-45	< 5 Ω	If > 5 Ω, check for OPEN in SIG GND circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND in EOT2 circuit.
3 to C1-15	< 5 Ω	If > 5 Ω, check for OPEN in EOT2 circuit.
4 to E1-46	< 5 Ω	If > 5 Ω, check for OPEN in SIG GND circuit.

SPN 1135 FMI 4 - EOT2 Signal Out of Range LOW

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor session.
2. Monitor sensor voltage. Verify an active DTC for the sensor.
   - If DTC is inactive, monitor the signal while wiggling the connector and all wires at suspected location. If the circuit is interrupted, the signal will spike and the DTC will go active.
   - If DTC is active, continue to Sensor Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, loose pins. Repair if necessary.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Turn ignition ON..

Test Point	Specification	Comment– < Less than, > Greater than
EST – Monitor EOLv	4.5 V – 5 V	If < 4.5 V, check EOL circuit for short to GND.
EST – Monitor EOT2v	4.5 V – 5 V	If < 4.5 V, check EOT2 circuit for short to GND.
EST – Monitor EOLv Short pin 1 to GND	0 V	If > 0.5 V, check EOL circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOLv Short pin 1 to 4	0 V	If > 0.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOT2v Short pin 3 to GND	0 V	If > 0.5 V, check EOT2 circuit for OPEN. Do Harness Resistance Check.
EST – Monitor EOT2v Short pin 2 to 3	0 V	If > 0.5 V, check SIG GND circuit for OPEN. Do Harness Resistance Check.

If checks are within specification, connect sensor and clear DTCs. If active code remains, replace EOL sensor.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5 V ± 5 V	If > 5.5 V, check EOL for short to PWR. If < 4.5 V, check EOL for OPEN or short to GND. Do Harness Resistance Check.
3 to GND	5 V	If > 5.5 V, check EOT2 for short to PWR. If < 4.5 V, check EOT2 for OPEN or short to GND. Do Harness Resistance Check.
2 to B+	B+	If < B+, check SIG GND for OPEN circuit.
4 to B+	B+	If < B+, check SIG GND for OPEN circuit.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to EOL vehicle harness, and leave EOL sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short GND in EOL circuit.
1 to E1-64	< 5 Ω	If > 5 Ω, check for OPEN in EOL circuit.
2 to E1-45	< 5 Ω	If > 5 Ω, check for OPEN in SIG GND circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND in EOT2 circuit.
3 to C1-15	< 5 Ω	If > 5 Ω, check for OPEN in EOT2 circuit.
4 to E1-46	< 5 Ω	If > 5 Ω, check for OPEN in SIG GND circuit.

EOP (Engine Oil Pressure) Sensor

Overview of EOP Sensor Group

SPN	FMI	Description
100	3	EOP signal Out of Range HIGH (page 859)
100	4	EOP signal Out of Range LOW (page 863)

Overview

Engine Oil Pressure (EOP) sensor provides feedback signal to Engine Control Module (ECM) indicating engine oil pressure. During engine operation, ECM will monitor EOP signal to determine if oil pressure is satisfactory. If oil pressure is below desired pressure, ECM will turn on red engine lamp. An optional feature, Engine Warning and Protection System (EWPS), can be enabled to warn engine operator and shut engine down when low engine oil pressure condition occurs.

SPN 100 FMI 3 - EOP Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Oil Pressure (EOP) signal Out of Range High	EOP signal voltage greater than expected	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Engine Oil Pressure (EOP) signal voltage is greater than expected

Lamp Reaction

Amber Warning Lamp (AWL) will illuminate immediately.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- EOP circuit short to PWR
- SIG GND circuit Open or high resistance
- Failed EOP sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 100 FMI 3. Is EST DTC list SPN 100 FMI 3 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Engine Oil Pressure (EOP) sensor.	Decision
A. Key OFF. B. Disconnect EOP connector. C. Check EOP and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are EOP connector, harness, and terminals clean and undamaged?		Yes: Perform Pin Point Test (page 860). No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 100 FMI 3.

Pin-Point Test SPN 100 FMI 3

Figure 339 Engine Oil Pressure (EOP) Sensor Circuit Diagram

See the latest version of Navistar®N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4850
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF. B. Disconnect Engine Oil Pressure (EOP) sensor C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). D. Key ON, log into ServiceMaxx™ software.

Test 1	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor EOP voltage.	0 volts ± 0.5 volts
Decision	
Is voltage 0 volts ± 0.5 volts?	Yes: Go to Test 2.
	No: Repair short to PWR between EOP pin-3 and Engine Control Module (ECM) pin E1-10. After repairs are complete, retest for SPN 100 FMI 3.

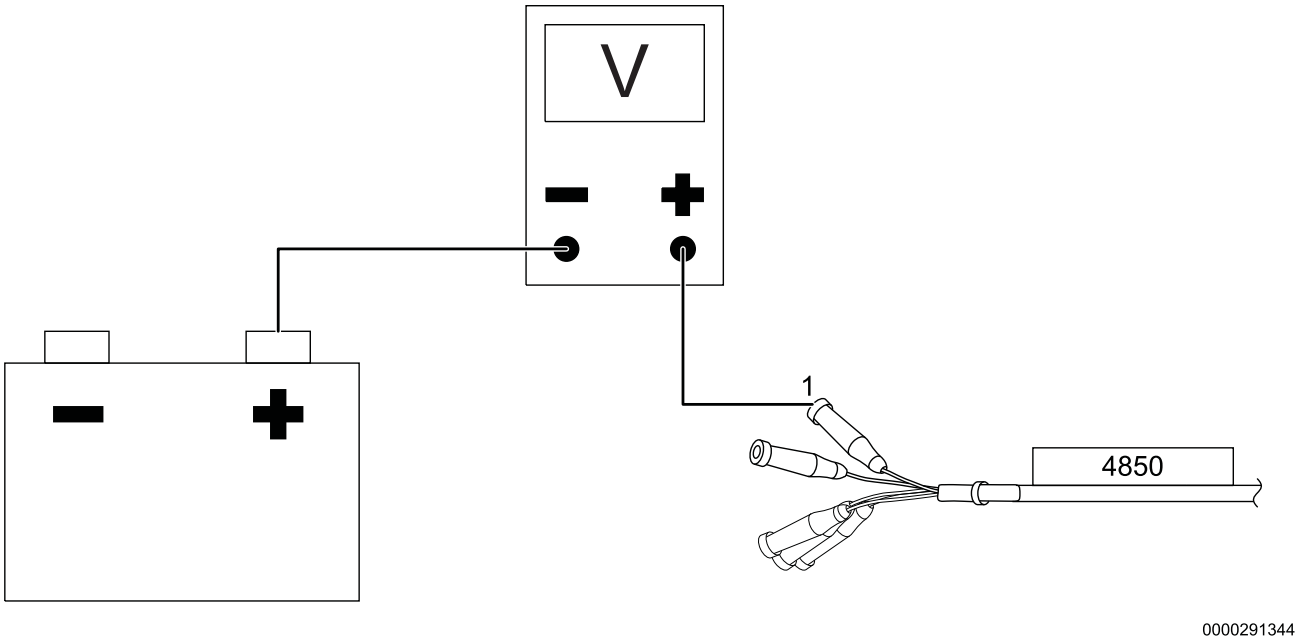


Figure 340 SIG GND Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave EOP sensor disconnected. C. Key ON.

Test 2 Clear DTC fault list.	Specification
Using a Digital Multi Meter, measure voltage between Breakout Harness ZTSE4850 pin-1 and PWR	B+ ± 0.5 volts
Decision	
Is voltage B+ ± 0.5 volts?	Yes: Replace EOP sensor. After repairs are complete, retest for SPN 100 FMI 3.
	No: Repair Open between EOP pin-1 and ECM pin E1-19. After repairs are complete, retest for SPN 100 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 100 FMI 3 fault code diagnostics.

SPN 100 FMI 4 - EOP Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Oil Pressure (EOP) signal Out of Range Low	EOP signal voltage less than expected	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Engine Oil Pressure (EOP) signal voltage is less than expected

Lamp Reaction

Amber Warning Lamp (AWL) will illuminate immediately.

Associated Faults

SPN 3513 FMI 14 (VREF 5)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- EOP circuit Open
- EOP circuit short to GND
- VREF5 circuit Open
- VREF5 circuit short to GND
- Failed EOP sensor

Step 1	Check for associated faults	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3513 FMI 14 (VREF 5). Is EST DTC list free of SPN 3513 FMI 14?		Yes: Go to Step 2. No: Repair SPN 3513 FMI 14. After repairs are complete, retest for SPN 100 FMI 4.

Step 2	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 100 FMI 4. Is EST DTC list SPN 100 FMI 4 active or pending?		Yes: Go to Step 3. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 3	Inspect connections at Engine Oil Pressure (EOP) sensor.	Decision
A. Key OFF. B. Disconnect EOP connector. C. Check EOP and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are EOP connector, harness, and terminals clean and undamaged?		Yes: Perform Pin Point Test (page 864). No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 100 FMI 4.

Pin-Point Test SPN 100 FMI 4

Figure 341 Engine Oil Pressure (EOP) Sensor Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4850
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

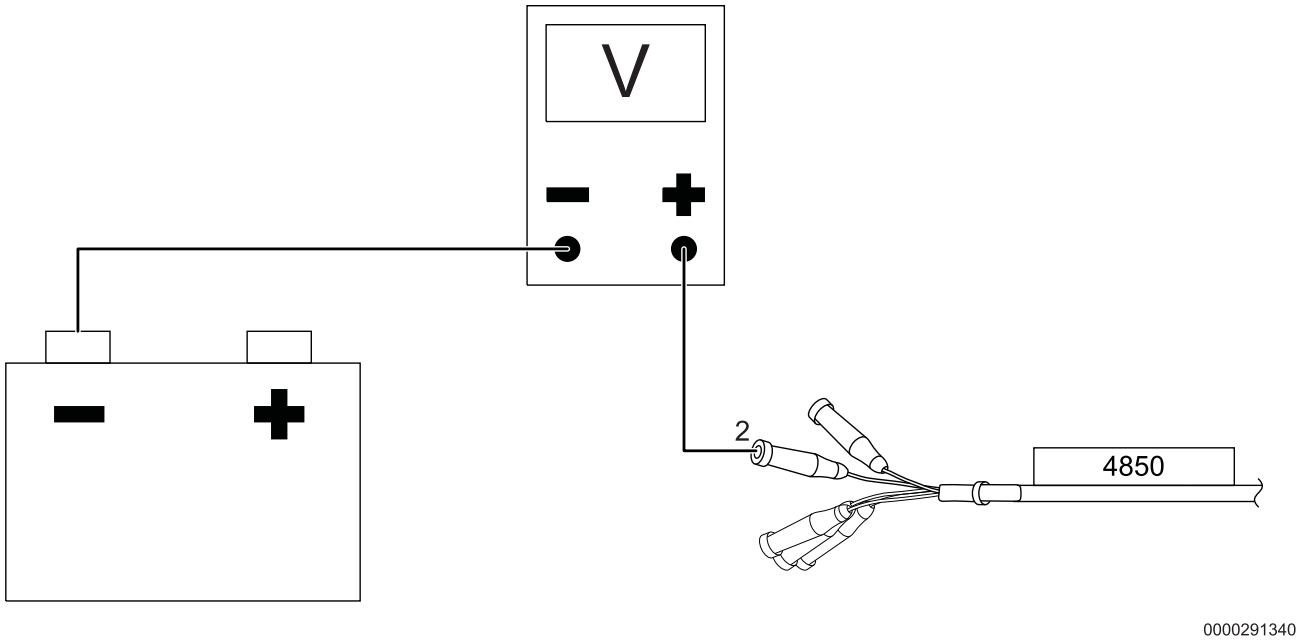


Figure 342 VREF 5 Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave Engine Oil Pressure (EOP) sensor disconnected. C. Key ON.

Test 1	Specification
Using a Digital Multimeter (DMM), measure voltage between Breakout Harness ZTSE4850 pin-2 and a known good GND	5 volts ± 0.5 volts
Decision	
Is voltage 5 volts ± 0.5 volts?	Yes: Go to Test 2.
	No: Repair Open or short to GND between EOP pin-2 and ECM pin E1-82. After repairs are complete, retest for SPN 100 FMI 4.

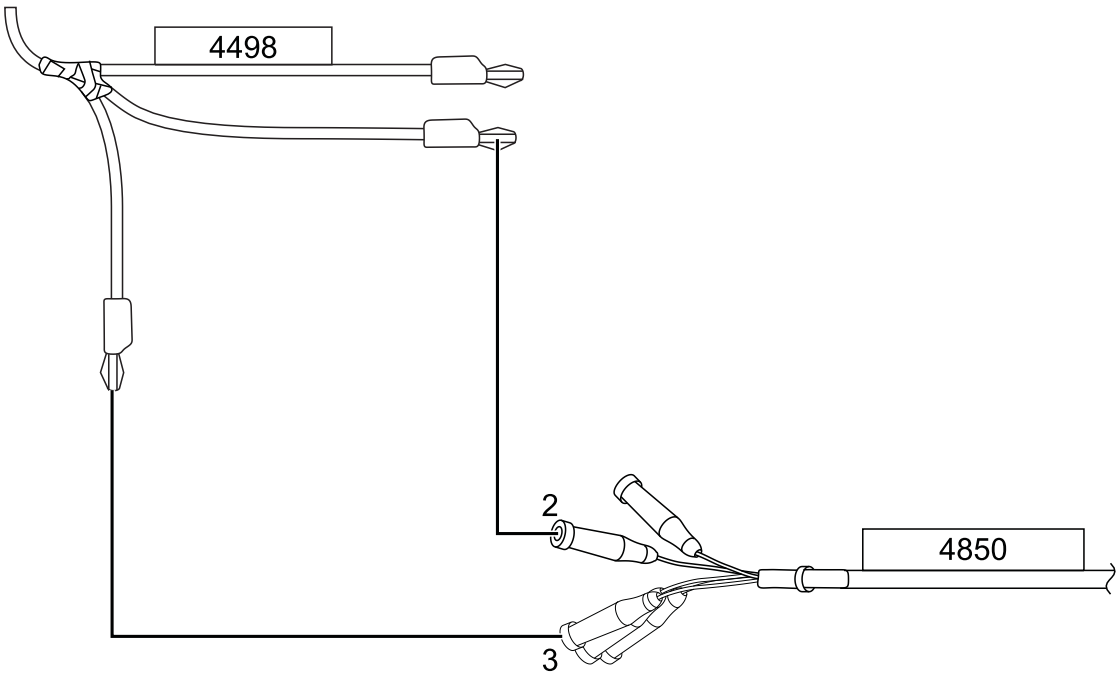


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Figure 343 EOP Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave EOP sensor disconnected. C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4850 pin-2 to pin-3. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON, log into ServiceMaxx™ software.

Test 2	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor EOP voltage.	5 volts ± 0.5 volts
Decision	
Is voltage 5 volts ± 0.5 volts?	Yes: Replace EOP sensor. After repairs are complete, retest for SPN 100 FMI 4.
	No: Go to Test 3.

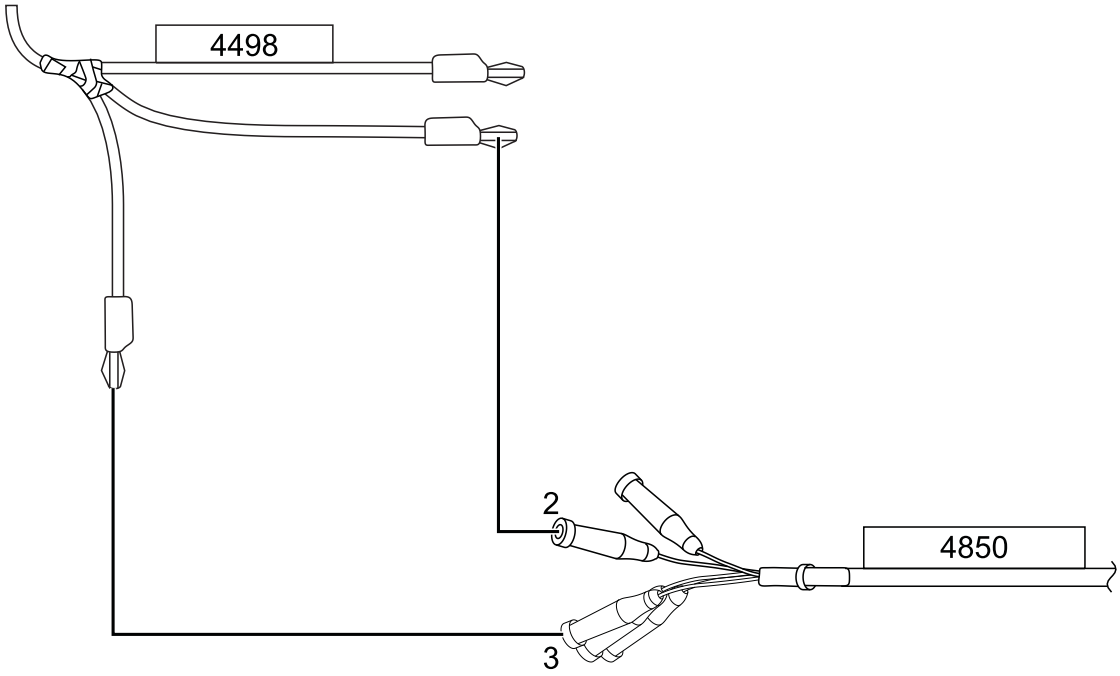

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Figure 344 EOP Circuit Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave EOP sensor disconnected. C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4850 pin-2 to pin-3. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON, log into ServiceMaxx™ software.

Test 3	Specification
Using EST with ServiceMaxx™ software, clear DTC list A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check DTC list for SPN 3513 FMI 14. Is EST DTC list SPN 3513 FMI 14 active?	SPN 100 FMI 3 sets in DTC list.
Decision	
Does SPN 3513 FMI 14 set in DTC list?	Yes: Repair short to GND between EOP pin-3 and ECM pin E1-10. After repairs are complete, retest for SPN 100 FMI 4.

	No: Repair Open between EOP pin-3 and ECM pin E1-10. After repairs are complete, retest for SPN 100 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 100 FMI 4 fault code diagnostics.

EOT (Engine Oil Temperature) Sensor

Overview of EOT Sensor Group

SPN	FMI	Action
175	3	EOT signal Out of Range High (page 870)
175	4	EOT signal Out of Range LOW (page 876)

SPN 175 FMI 3 - EOT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Oil Temperature (EOT) value greater than expected.	EOT sensor voltage > 4.5 volts.	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Ambient Air Temperature (EOT) voltage is greater than 4.5 volts.

Lamp Reaction

Amber Warning Lamp (AWL) will immediately illuminate when this fault is detected.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- SIG GND circuit Open or High resistance
- EOT circuit Open or high resistance
- EOT circuit short to PWR
- Failed EOT sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 175 FMI 3. Is EST DTC list SPN 175 FMI 3 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Engine Oil Temperature (EOT) connector.	Decision
A. Key OFF. B. Disconnect EOT connector. C. Check EOT and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are EOT connector, harness, and terminals clean and undamaged?		Yes: Perform Pin Point Test (page 110). No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 175 FMI 3.

Step 3	Check for short to PWR on EOT signal circuit.	Decision
Perform Test 1 (page 873). Use a Digital Multimeter (DMM) to measure voltage between Breakout Harness ZTSE4602 pin-2 and a known good ground. Is voltage greater than 4.85 volts?		Yes: Repair short to PWR between EOT pin-2 and Engine Control Module (ECM) pin E1-36. After repairs are complete, retest for SPN 175 FMI 3. No: Go to step 4.

Step 4	Check for failed EOT sensor	Decision
Perform Test 2 (page 873). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor EOT voltage. Is voltage approximately 0 volts?		Yes: Replace EOT sensor. After repairs are complete, retest for SPN 171 FMI 3. No: Go to step 5.

Step 5	Check for Open EOT signal circuit.	Decision
Perform Test 3 (page 875). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor EOT voltage. Is voltage approximately 0 volts?		Yes: Repair Open between EOT pin-1 and Engine Control Module (ECM) pin E1-63. After repairs are complete, retest for SPN 175 FMI 3. No: Repair Open between EOT pin-2 and Engine Control

	Module (ECM) pin E1-36. After repairs are complete, retest for SPN 175 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 175 FMI 3 fault code diagnostics.

Pin-Point Test SPN 175 FMI 3

Figure 345 Engine Oil Temperature (EOT) Sensor Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4602
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

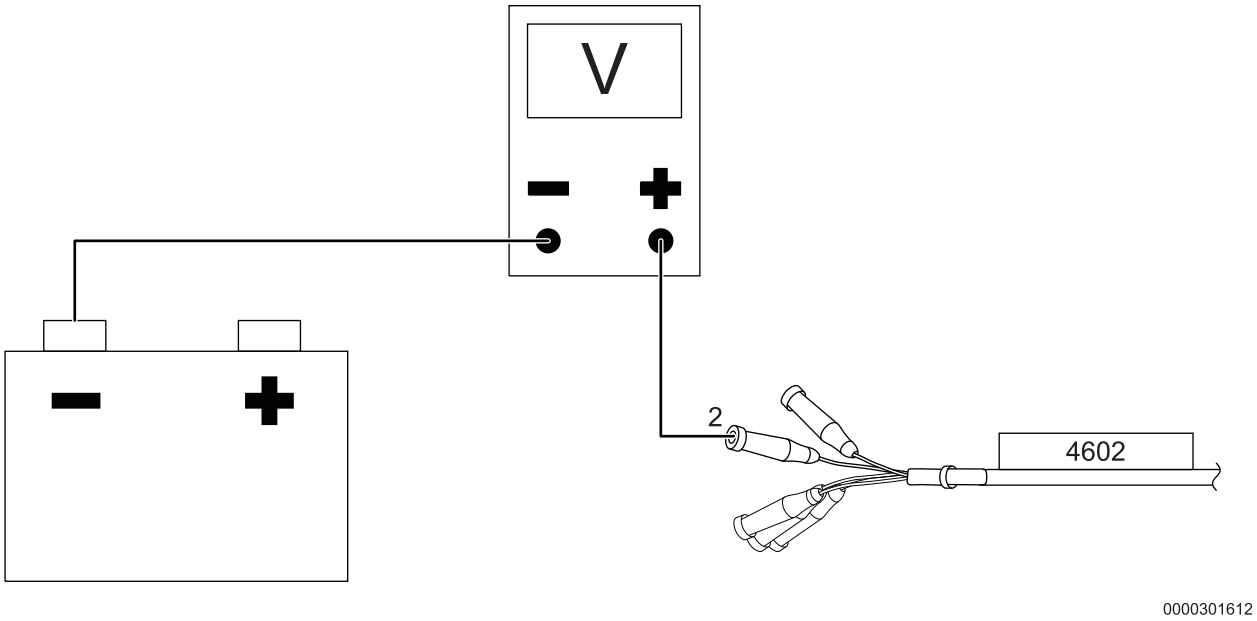


Figure 346 EOT Circuit Voltage Check

Test 1
A. Key OFF. B. Connect Breakout Harness ZTSE4602 to vehicle harness and leave Engine Oil Temperature (EOT) sensor disconnected. C. Key ON.

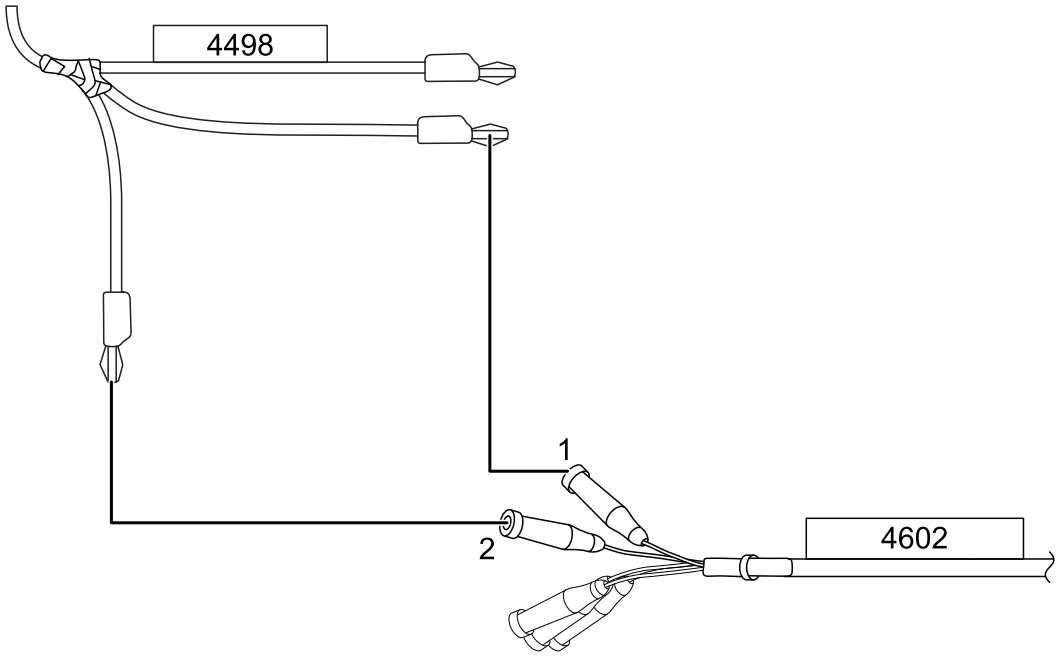


Figure 347 EOT Sensor Circuit Check

Test 2 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4602 to vehicle harness and leave EOT sensor disconnected.
C. Using Breakout Harness ZTSE4498 short pin-1 and pin-2 of Breakout Harness ZTSE4602 together.
D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
E. Key ON, log into ServiceMaxx™ software.

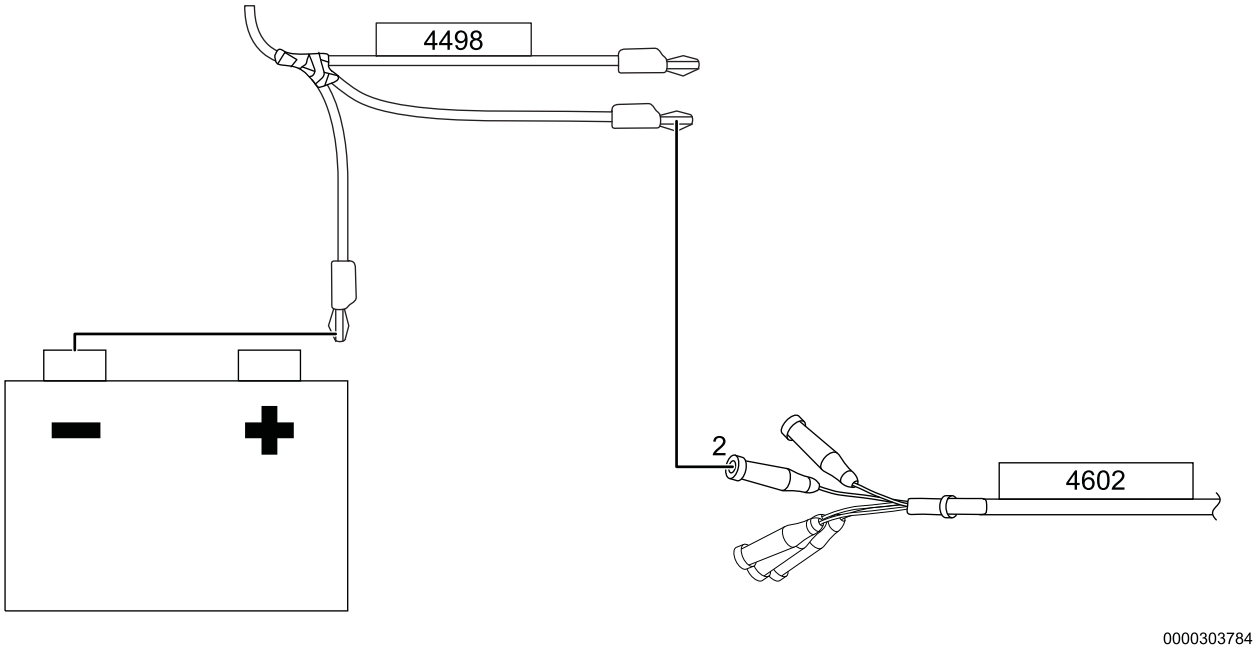


Figure 348 EOT sensor circuit check

Test 3 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4602 to vehicle harness and leave EOT sensor disconnected.
C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4602 pin-2 to GND.
D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector.
E. Key ON, log in to ServiceMaxx™ software.

SPN 175 FMI 4 - EOT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine Oil Temperature (EOT) sensor reading less than expected.	EOT sensor voltage < 0.25 volts.	Key ON

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects that the Engine Oil Temperature (EOT) signal voltage is less than expends.

Lamp Reaction

Amber Warning Lamp (AWL) will immediately illuminate when this fault is detected.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- EOT circuit short to GND
- Failed EOT sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 175 FMI 4. Is EST DTC list SPN 175 FMI 4 active or pending?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Engine Oil Temperature (EOT) connector.	Decision
A. Key OFF. B. Disconnect EOT connector. C. Check EOT and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are EOT connector, harness, and terminals clean and undamaged?		Yes: Go to step 3.. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 175 FMI 4.

Step 3	Check for EOT circuit short to GND..	Decision
Perform Test 1 (page 878). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor AAT voltage. Is voltage 4.85 volts ± 0.05 volts?		Yes: Replace EOT sensor. After repairs are complete, retest for SPN 175 FMI 4. No: Repair short to GND between EOT pin-2 and Engine Control Module (ECM) pin E1-36. After repairs are complete, retest for SPN 171 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 175 FMI 4 fault code diagnostics.

Pin-Point Test SPN 175 FMI 4

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1
A. Key OFF.
B. Disconnect Engine Oil Temperature (EOT) sensor
C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
D. Key ON, log into ServiceMaxx™ software.

ETV (Engine Throttle Valve) Sensor

Overview of ETV Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
51	0	ETP fault: over temperature	• ETV internal failure	Pin-Point Diagnostics (page 894)
51	1	ETP does not agree with commanded closed position	•	
51	3	ETP signal Out of Range HIGH	• ETP circuit short to PWR	Pin-Point Diagnostics (page 894)
51	4	ETP signal Out of Range LOW	• ETP Open Circuit • ETP circuit short to GND	Pin-Point Diagnostics (page 894)
51	7	ETP does not agree with commanded position	• Sticking or failed ETV • ETP circuit fault • ETC circuit fault	Pin-Point Diagnostics (page 894)
51	10	ETP sensor feedback deviation during Cold Start Emissions Reduction (CSER)	• Sticking or failed ETV • ETP circuit fault • ETC circuit fault	Step-Based Diagnostics (page 890)
3464	3	ETC short to PWR	• ETC circuit short to PWR • Failed ETV	Pin-Point Diagnostics (page 894)
3464	4	ETV short to GND	•	
3464	5	ETC open load/circuit	• ETC circuit OPEN • Failed ETV	Pin-Point Diagnostics (page 894)

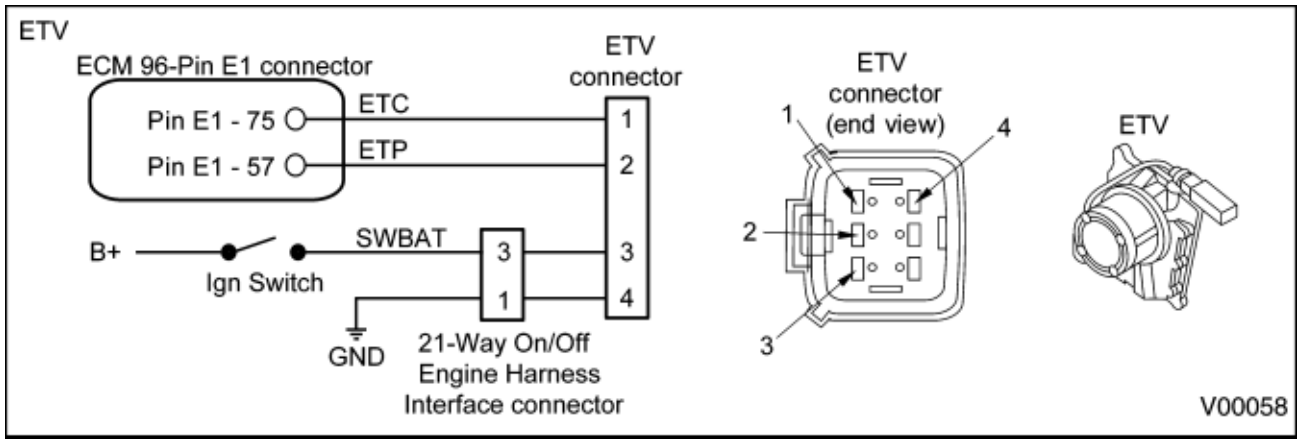


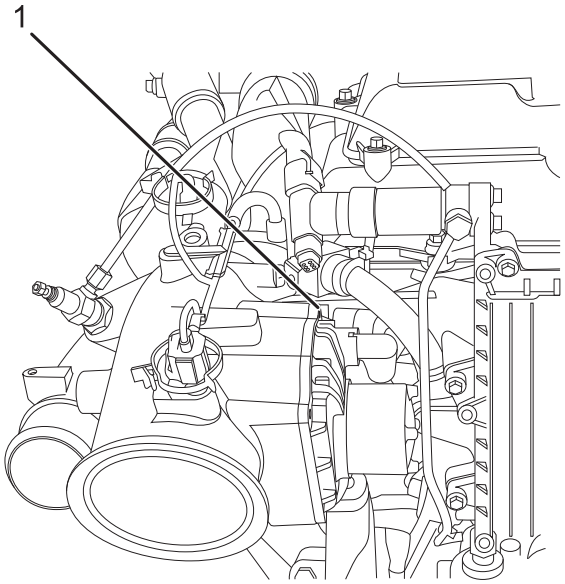
Figure 349 ETV valve circuit diagram

Overview

The Engine Throttle Valve (ETV) controls the flow of fresh air (boosted and cooled), and Exhaust Gas Recirculation (EGR) gases through the intake manifold. The ETV contains a variable-position actuator that moves an internal butterfly valve. The Engine Control Module (ECM) sends a signal to the ETV to move to the desired position through the Engine Throttle Control (ETC) circuit. The Engine Throttle Position (ETP) sensor, located inside the ETV, monitors ETV position and provides a signal to the ECM.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6016 (ETV)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)



0000048972

Figure 350 ETV Location

1. Engine Throttle Valve (ETV)

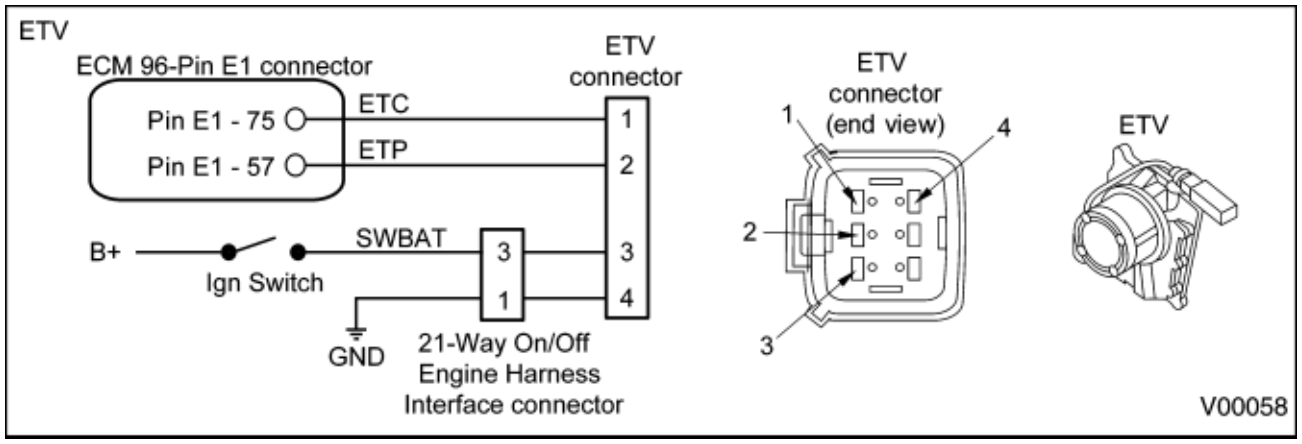


Figure 351 ETV valve circuit diagram

SPN 51 FMI 0 - ETP Fault: Over Temperature

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test.
2. Select ETV Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor Engine Throttle Position (ETP) and Engine Throttle CTL (ETC).
   - If ETP does not closely match ETC, check ETV for mechanical problem.
   - If ETV does not move, continue to Connector Voltage Check.

Connector Voltage Check — ETV Disconnected

Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave ETV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 896).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	12 V ± 2.0 V	If < 10 V, check for OPEN or short to GND. Do Harness Resistance Check (page 896).
1 to GND	0 V to 1 V	If > 1 V, check for short to power.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between ETV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select ETV Position from the drop-down menu.
3. Command ETVP to 5%.
4. Use DMM to measure voltage.
5. Command ETVP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR.
		If < 2.0 V, check for short circuit or failed ETV.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR.
		If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed ETV.

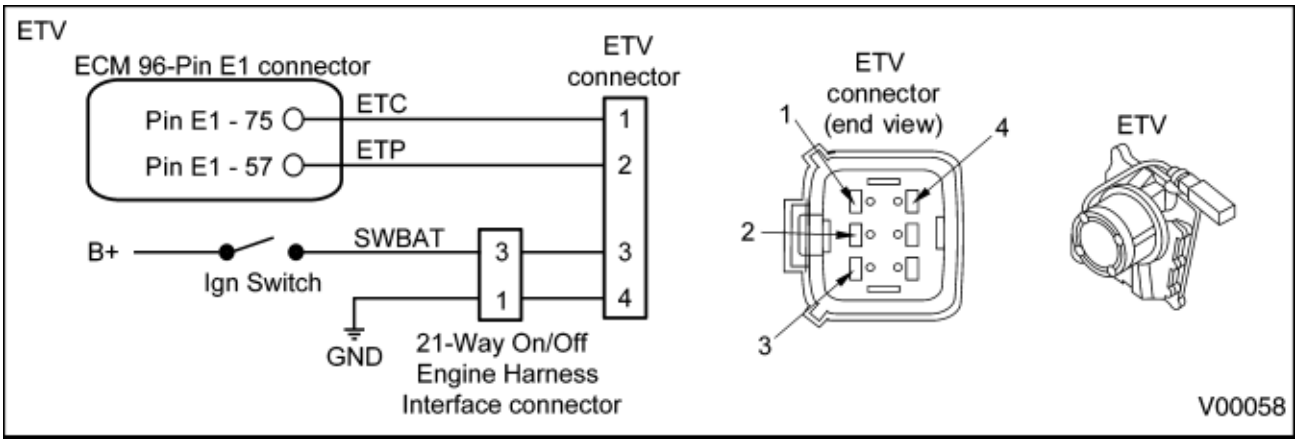


Figure 352 ETV valve circuit diagram

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-75	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-57	< 5 Ω	If > 5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the ETV.		

SPN 51 FMI 1 - Voltage at Closed Position Deviates Beyond an Allowable Range

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 51 FMI 3 - ETP Signal Out of Range HIGH

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test.
2. Select ETV Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor Engine Throttle Position (ETP) and Engine Throttle CTL (ETC).
   - If ETP does not closely match ETC, check ETV for mechanical problem.
   - If ETV does not move, continue to Connector Voltage Check.

Connector Voltage Check — ETV Disconnected

Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave ETV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 896).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	12 V ± 2.0 V	If < 10 V, check for OPEN or short to GND. Do Harness Resistance Check (page 896).
1 to GND	0 V to 1 V	If > 1 V, check for short to power.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between ETV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select ETV Position from the drop-down menu.
3. Command ETVP to 5%.
4. Use DMM to measure voltage.
5. Command ETVP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR. If < 2.0 V, check for short circuit or failed ETV.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR. If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed ETV.

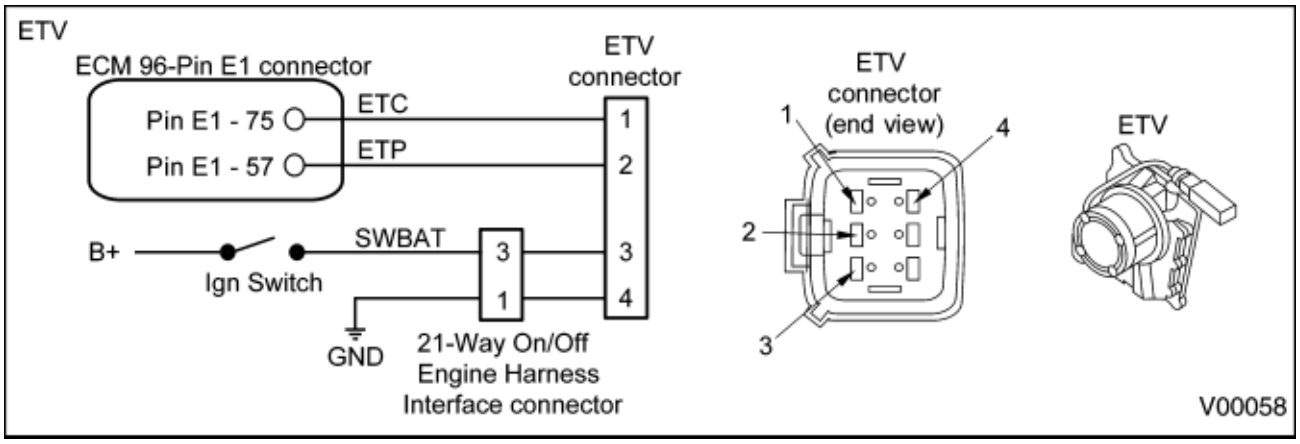


Figure 354 ETV valve circuit diagram

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-75	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-57	< 5 Ω	If > 5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the ETV.		

SPN 51 FMI 4 - ETP Signal Out of Range LOW

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test.
2. Select ETV Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor Engine Throttle Position (ETP) and Engine Throttle CTL (ETC).
   - If ETP does not closely match ETC, check ETV for mechanical problem.
   - If ETV does not move, continue to Connector Voltage Check.

Connector Voltage Check — ETV Disconnected

Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave ETV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 896).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	12 V ± 2.0 V	If < 10 V, check for OPEN or short to GND. Do Harness Resistance Check (page 896).
1 to GND	0 V to 1 V	If > 1 V, check for short to power.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between ETV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select ETV Position from the drop-down menu.
3. Command ETVP to 5%.
4. Use DMM to measure voltage.
5. Command ETVP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR. If < 2.0 V, check for short circuit or failed ETV.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR. If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed ETV.

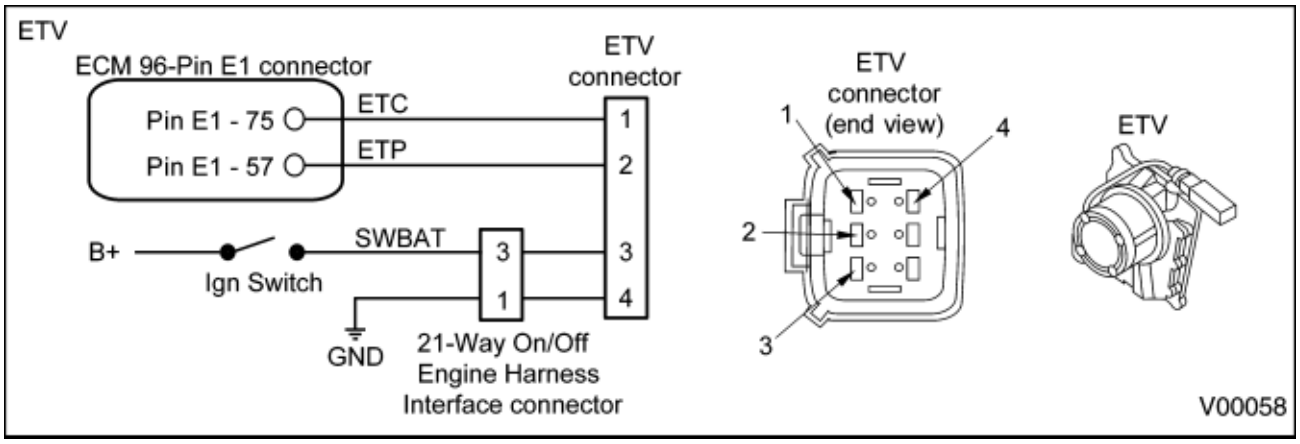


Figure 355 ETV valve circuit diagram

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-75	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-57	< 5 Ω	If > 5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the ETV.		

SPN 51 FMI 7 - ETP Does Not Agree with Commanded Position

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test.
2. Select ETV Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor Engine Throttle Position (ETP) and Engine Throttle CTL (ETC).
   - If ETP does not closely match ETC, check ETV for mechanical problem.
   - If ETV does not move, continue to Connector Voltage Check.

Connector Voltage Check — ETV Disconnected

Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave ETV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 896).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	12 V ± 2.0 V	If < 10 V, check for OPEN or short to GND. Do Harness Resistance Check (page 896).
1 to GND	0 V to 1 V	If > 1 V, check for short to power.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between ETV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select ETV Position from the drop-down menu.
3. Command ETVP to 5%.
4. Use DMM to measure voltage.
5. Command ETVP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR. If < 2.0 V, check for short circuit or failed ETV.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR. If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed ETV.

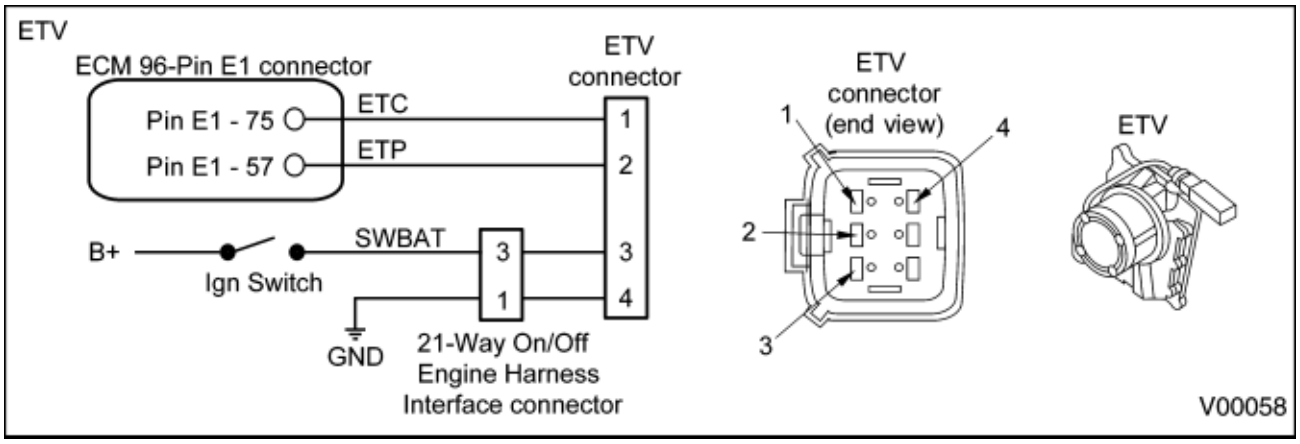


Figure 356 ETV valve circuit diagram

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-75	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-57	< 5 Ω	If > 5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the ETV.		

SPN 51 FMI 10 - ETP Sensor Feedback Deviation During CSER

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine Throttle Position (ETP) sensor does not a agree with ECM commanded position	Engine Throttle Valve (ETV) position > 10% from commanded position	Key ON	8 seconds

Fault Overview

Fault code sets when feedback from the Engine Throttle Position (ETP) sensor does not agree with the Engine Control Module (ECM) commanded position during Cold Start Emission Reduction (CSER).

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 51 FMI 7.

Drive Cycle to Determine Fault Status

Drive Cycle 18 then 4 in 2013 HD-OBD Diagnostic Reference Manual.

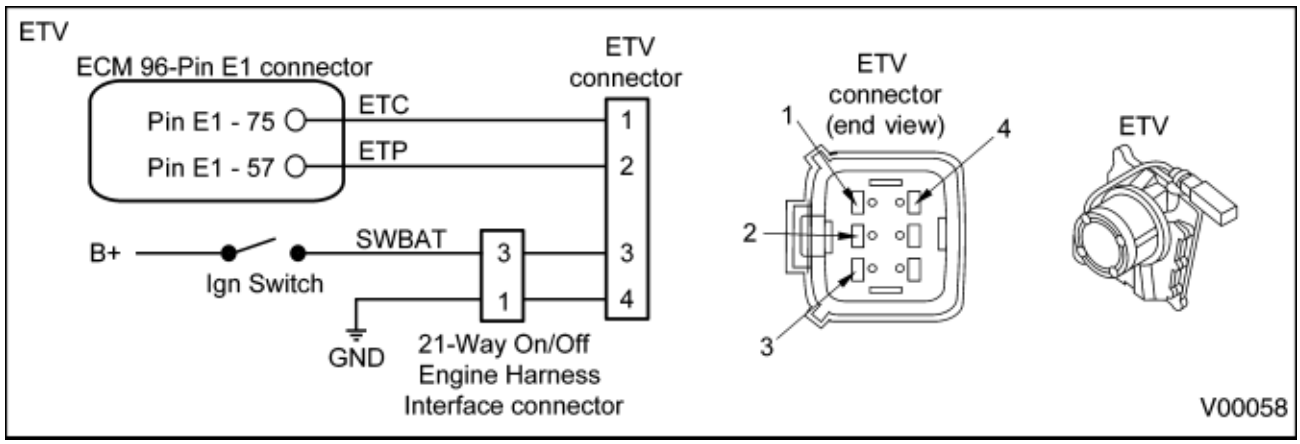


Figure 357 ETV valve circuit diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 51 FMI 3, SPN 51 FMI 4, SPN 3464 FMI 3, and SPN 3464 FMI 5. Is SPN 51 FMI 10 the only fault code active?	Yes: Do Operational Voltage Check (page 895). After repairs are complete, retest for SPN 51 FMI 10.
		No: Repair other fault code(s). After repairs are complete, retest for SPN 51 FMI 10.

NOTE: After doing all diagnostic steps, if SPN 51 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3464 FMI 3 - ETC Short to PWR

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test.
2. Select ETV Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor Engine Throttle Position (ETP) and Engine Throttle CTL (ETC).
   - If ETP does not closely match ETC, check ETV for mechanical problem.
   - If ETV does not move, continue to Connector Voltage Check.

Connector Voltage Check — ETV Disconnected

Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave ETV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 896).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	12 V ± 2.0 V	If < 10 V, check for OPEN or short to GND. Do Harness Resistance Check (page 896).
1 to GND	0 V to 1 V	If > 1 V, check for short to power.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between ETV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select ETV Position from the drop-down menu.
3. Command ETVP to 5%.
4. Use DMM to measure voltage.
5. Command ETVP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR.
		If < 2.0 V, check for short circuit or failed ETV.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR.
		If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed ETV.

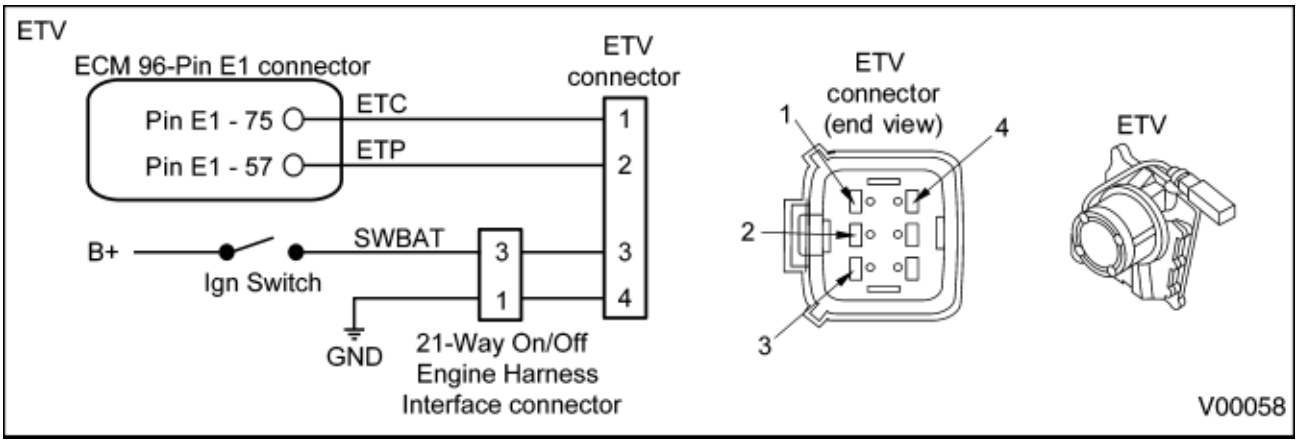


Figure 358 ETV valve circuit diagram

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-75	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-57	< 5 Ω	If > 5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the ETV.		

SPN 3464 FMI 4 - Intake Throttle Valve (Control pin 1) Chort to GND

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 3464 FMI 5 - ETC Open Load / Circuit

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test.
2. Select ETV Position from the Actuator drop-down menu on the right side.
3. Command actuator movement by clicking on the Start Test button. Monitor Engine Throttle Position (ETP) and Engine Throttle CTL (ETC).
   - If ETP does not closely match ETC, check ETV for mechanical problem.
   - If ETV does not move, continue to Connector Voltage Check.

Connector Voltage Check — ETV Disconnected

Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave ETV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
4 to battery positive	B+	If < B+, check for OPEN in GND circuit. Do Harness Resistance Check (page 896).
3 to GND	B+	If < B+, check for OPEN in SWBAT circuit or blown fuse.
2 to GND	12 V ± 2.0 V	If < 10 V, check for OPEN or short to GND. Do Harness Resistance Check (page 896).
1 to GND	0 V to 1 V	If > 1 V, check for short to power.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE6016 between ETV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select ETV Position from the drop-down menu.
3. Command ETVP to 5%.
4. Use DMM to measure voltage.
5. Command ETVP to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 3.0 V ± 1.0 V	If > 4.0 V, check for OPEN or short to PWR. If < 2.0 V, check for short circuit or failed ETV.
2 to GND	95% = 0.8 V ± 0.5 V	If > 1.3 V, check for OPEN or short to PWR.
1 to GND	5% = 7.5 V ± 1.0 V	If > 8.5 V, check for short to PWR. If < 6.5 V, check for short circuit.
1 to GND	95% = 0.5 V ± 0.5 V	If > 1.0 V, check for OPEN circuit or failed ETV.

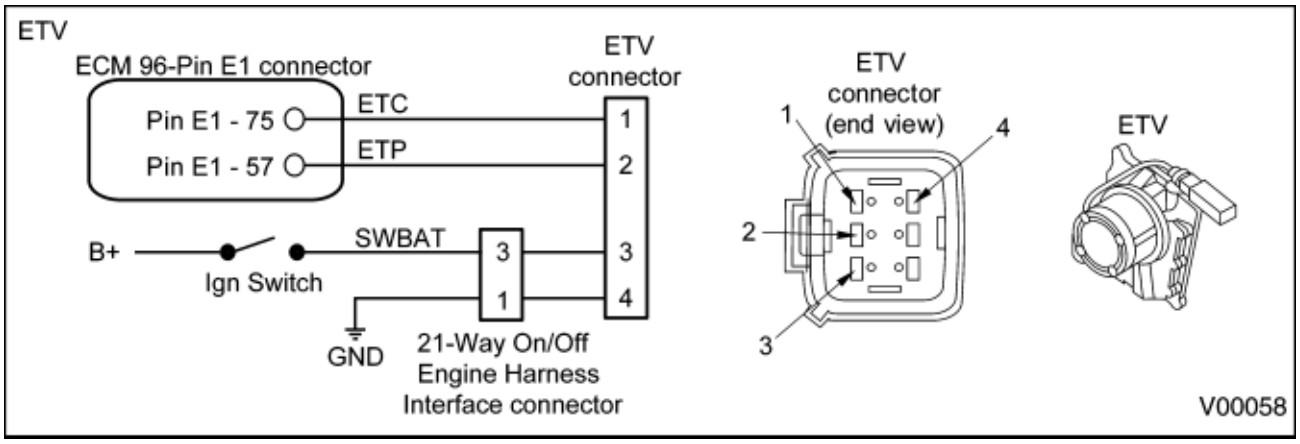


Figure 360 ETV valve circuit diagram

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6016 to ETV engine harness, and leave APP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-75	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-57	< 5 Ω	If > 5 Ω, check for OPEN circuit.
4 to GND	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If the DTC returns, replace the ETV.		

EWPS (Engine Warning Protection System) Sensor

Overview of EWPS Sensor Group

SPN	FMI	Description
84	2	Vehicle speed anti-tampering fault (page 900)
100	1	Engine Oil System below critical pressure (page 902)
100	11	Engine oil pressure below dealer programmed engine RPM value (page 905)
100	17	Low Oil Pressure vehicle event fault (page 908)
100	18	Engine Oil System below Warning Pressure (page 911)
110	0	Engine Coolant System above Critical Temperature (page 914)
110	11	Event Logger, Coolant Temp Hot, Extreme (page 916)
110	15	Engine Coolant System above Warning Temperature (page 918)
110	16	Engine Coolant System above OBD maximum temperature (page 958)
110	17	Engine Coolant System below OBD monitoring temperature (page 922)
110	18	Engine Coolant System below closed loop minimum Temperature (page 924)
175	0	Engine Coolant System above critical temperature (page 926)
175	11	Engine Oil System above critical temperature (page 929)
175	15	Engine Coolant System above warning temperature (page 932)
188	0	Engine unable to achieve desired idle speed (too high) (page 935)
188	1	Engine unable to achieve desired idle speed (too low) (page 938)
188	16	Engine unable to achieve desired speed: secondary fuel detected (page 941)
190	0	Engine overspeed most severe level (page 943)
190	11	Engine overspeed vehicle event fault (page 958)
190	15	Engine overspeed detected (page 958)
190	16	Engine above 2250 rpm (page 958)
731	16	Knock detected: Cylinder Acceleration Above Normal (page 949)
731	18	Knock Detected: Unexpected combustion without fueling (page 951)

2588	0	Vehicle overspeed 1, event log, extreme (page 952)
2588	15	Vehicle overspeed 1, event log, non extreme (page 954)
2589	0	Vehicle overspeed 2, event log, extreme (page 955)
2589	15	Vehicle overspeed 2, event log, non extreme (page 956)
4076	0	ECT2 above Critical (EWPS programmable limit) (page 958)
4076	15	ECT2 above Warning (EWPS programmable limit) (page 958)
5395	0	Engine unable to achieve desired idle torque (too high) (page 959)
5395	1	Engine unable to achieve desired idle torque (too low) (page 961)

Function

The EWPS warns the operator of conditions that can damage the engine.

The Standard Warning System is the base system in which all engines are equipped. If one of these faults are detected, the ECM illuminates the red engine lamp and sets a corresponding DTC.

The following optional features to this base system provide added warning or protection.

Standard Warning – No engine shutdown available.

- ECT - Engine overheat warning
- EOP - Low engine oil pressure warning

3-way Warning – No engine shutdown available.

- ECT - Engine overheat warning
- EOP - Low engine oil pressure warning
- ECL - Low engine coolant level warning

3-way Protection – Engine shutdown is available if critical condition is detected.

- ECT, EOP, ECL - Same as 3-way Warning
- ECT - Engine overheat critical protection
- EOP - Low engine oil pressure critical protection
- ECL - Low engine coolant level critical protection

Warning (Amber Triangle Light) – Temperature above specific threshold sounds a buzzer, illuminates the red OIL / WATER (OWL) lamp, and sets a DTC.

Critical (Exclamation Mark Stop Lamp) – Temperature above specific threshold shuts down the engine and sets a DTC.

Event log (if equipped) – This feature logs occurrences of the event according to the engine hours and odometer readings.

SPN 84 FMI 2 - Vehicle Speed Anti-Tampering

Pinpoint Diagnostics With ServiceMaxx™ Software

SPN 84 FMI 2 - Vehicle speed anti-tampering fault

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the Parameters session. Verify the correct value is selected under parameter ID 89003 Vehicle Speed Signal Mode (Hard wire sensor, Public J1939 / CAN OSS, or Public J1939 / Vehicle Speed Sensor).

   Is the correct value selected under parameter ID 89003 Vehicle Speed Signal Mode?

   - Yes: Retest for SPN 84 FMI 2.
   - No: Correct parameter ID 89003 and program engine. Retest for SPN 84 FMI 2.

TOSS / VSS Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4850 to TOSS/VSS vehicle harness, and leave TOSS/VSS sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
B to GND	2 V to 3 V	If no voltage is present, check for OPEN or short to GND.
A to GND	2 V to 3 V	If no voltage is present, check for OPEN or short to GND.

TOSS / VSS Sensor Continuity Check Without ServiceMaxx™ Software

Turn ignition switch to OFF. Connect Breakout Harness ZTSE4850 to TOSS/VSS sensor harness, and leave vehicle harness disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
B to GND	> 100 Ω	If < 100 Ω, check for short to GND.
A to GND	> 100 Ω	If > 100 Ω check for short to GND.
B to A	600 Ω to 800 Ω	If not within specification, replace VSS sensor.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4850 to TOSS/VSS vehicle harness, and leave TOSS/VSS sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-15 to B	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E1-39 to A	< 5 Ω	If > 5 Ω, check for OPEN circuit.
E1-15 to GND	> 100 Ω	If < 100 Ω, check for short to GND.
E1-39 to GND	> 100 Ω	If < 100 Ω, check for short to GND.

TOSS / VSS Operational Check Without ServiceMaxx™ Software

Turn ignition switch OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness between ECM E1 and E2 connectors and ECM. Turn ignition switch to ON. Use DMM to measure voltage or EST to read signal. Place rear axles on jack stands and block front wheels. Persuade an assistant to rotate drive wheels while performing test.

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

Test Point	Specification	Comment – < Less than, > Greater than
E1-15 to E1-39	> 2 V AC	If < 2 V AC, check sensor adjustment or replace defective sensor.

SPN 100 FMI 1 - Engine Oil System Below Critical Pressure

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine oil pressure is below critical pressure.	Engine oil pressure ≤ 7.5 psi at 600 rpm Engine oil pressure ≤ 12 psi at 800 rpm Engine oil pressure ≤ 15 psi at 1000 rpm	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Engine Oil Pressure (EOP) is below critical pressure. Stop engine immediately when this fault code is active.

Lamp Reaction

Red Stop Lamp (RSL) will illuminate immediately.

Associated Faults

SPN 100 FMI 3 and 4 (EOP)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed engine oil mechanical system
- Failed EOP gauge

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 100 FMI 3 and 4 (EOP). Is EST DTC list free of SPN 100 FMI 3 and 4?		Yes: Go to step 2. No: Repair SPN 100 FMI 3 and 4. After repairs are complete, retest for SPN 100 FMI 1.

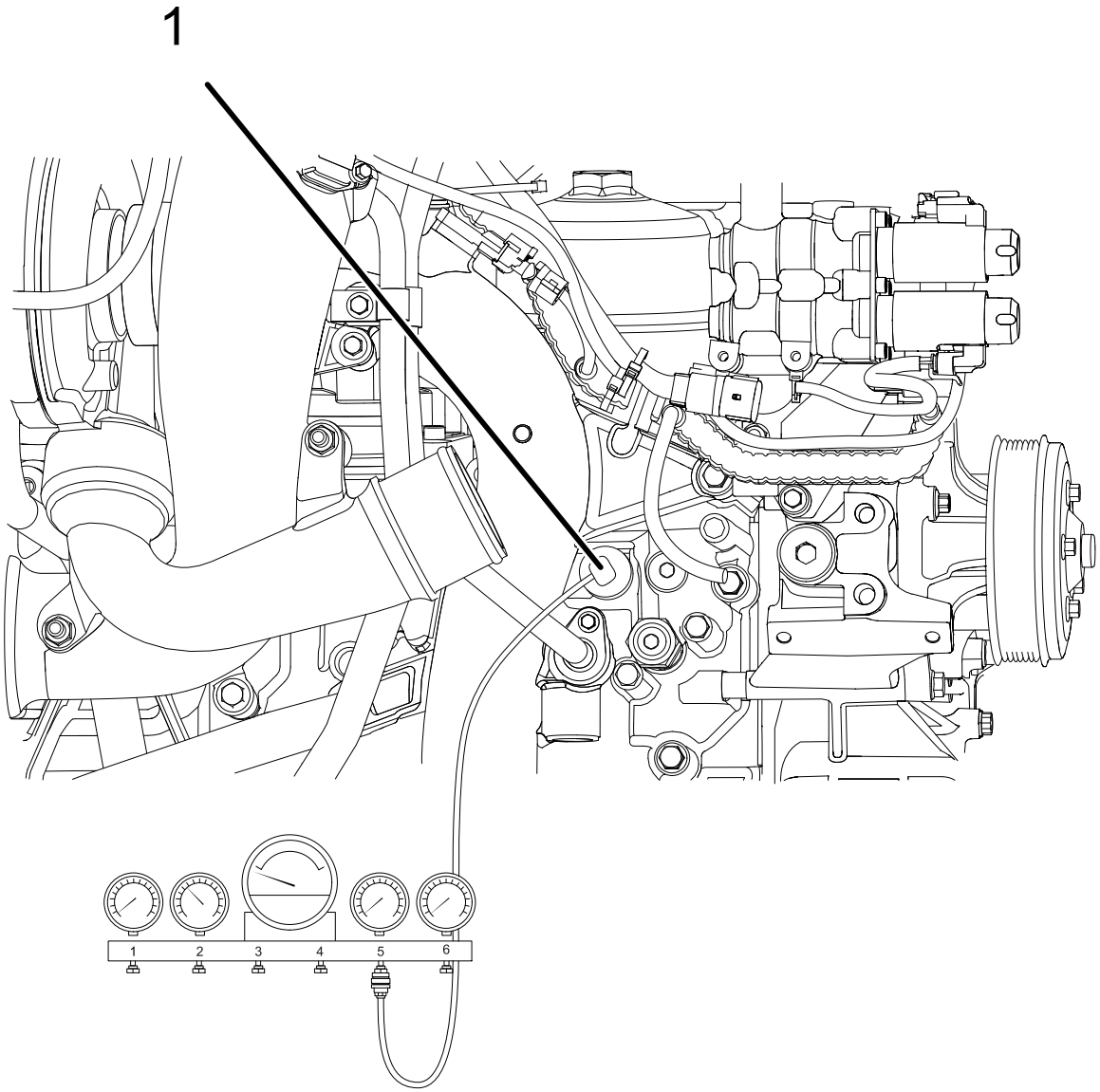


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Figure 361 Oil Pressure Verification Test Connection

Step 2	Check Engine Oil Pressure (EOP) using a mechanical gauge	Decision
Using Pressure Test Kit ZTSE4409 measure EOP. Remove EOP sensor from tee fitting on oil filter module and install Oil Pressure Test Fitting. Connect Pressure Test Kit ZTSE4409 to Oil Pressure Test Fitting. Is oil pressure within specification?		Yes: Go to step 3. No: Go to Low Oil Pressure (page 74) symptom diagnostics.

Step 3		Decision
Perform Oil Pressure Verification Test (page 1763). Is Servicemaxx™ software EOP reading within 5 psi of instrument panel gauge?		Yes: Diagnostics complete. Clear codes and release vehicle. No: Repair mechanical gauge or circuit. After repairs are complete, retest for SPN 100 FMI 1.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 100 FMI 1 fault code diagnostics.

SPN 100 FMI 11 - Low Oil Pressure Vehicle Event

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine oil pressure is below Critical pressure. Event Log	Engine oil pressure ≤ 7.5 psi at 600 rpm Engine oil pressure ≤ 12 psi at 800 rpm Engine oil pressure ≤ 15 psi at 1000 rpm	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Engine Oil Pressure (EOP) is below expected pressure. Event Log

Lamp Reaction

None

Associated Faults

SPN 100 FMI 1, 3, and 4 (EOP)

Fault Facts

This fault code is for vehicle event log only and will not illuminate a lamp.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed engine oil mechanical system
- Failed EOP gauge

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 100 FMI 1, 3, and 4 (EOP). Is EST DTC list free of SPN 100 FMI 1, 3, and 4?		Yes: Go to step 2. No: Repair SPN 100 FMI 1, 3, and 4. After repairs are complete, retest for SPN 100 FMI 11.

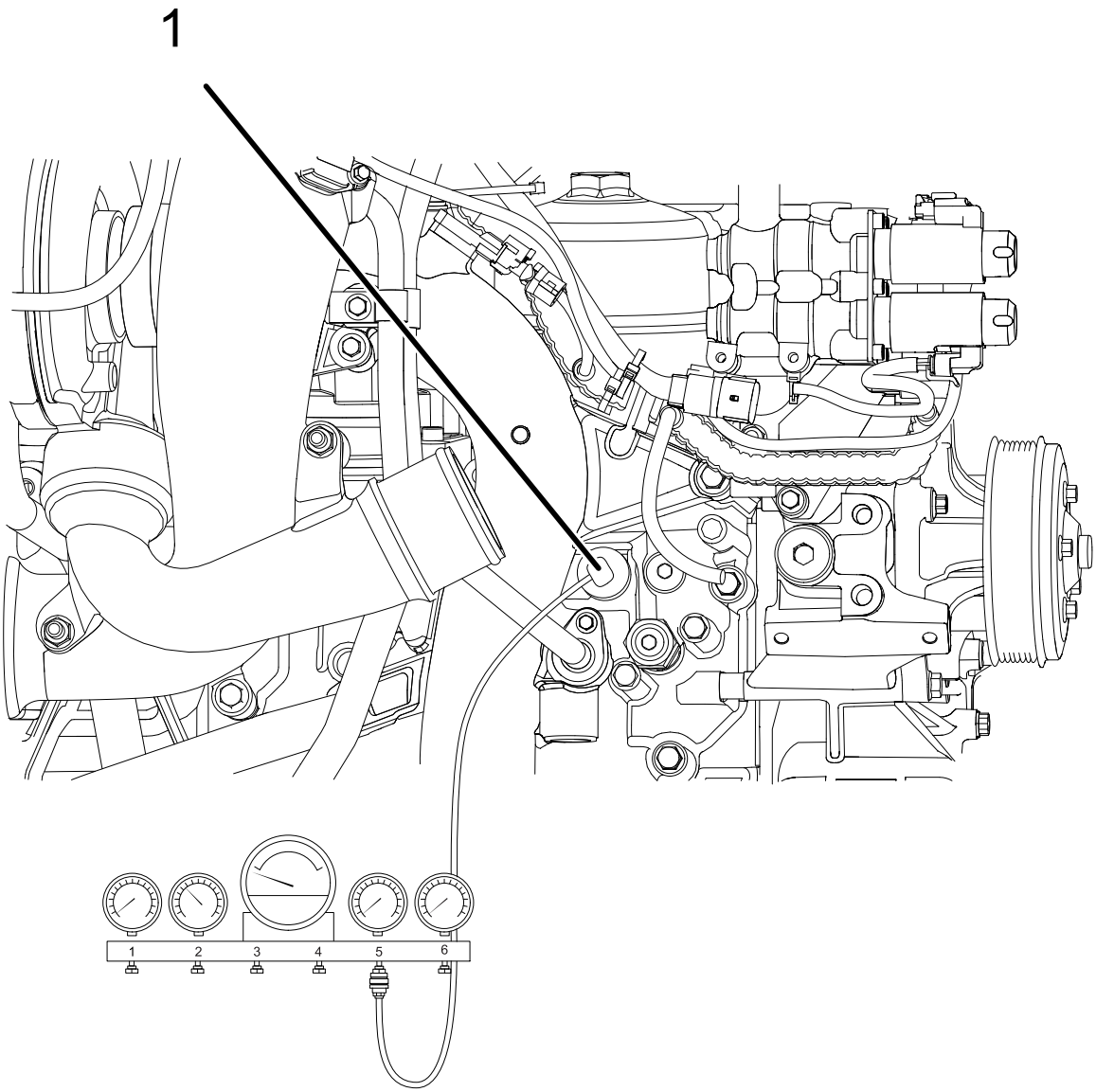

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Figure 362 Oil Pressure Verification Test Connection

Step 2	Check Engine Oil Pressure (EOP) using a mechanical gauge	Decision
Using Pressure Test Kit ZTSE4409 measure EOP. Remove EOP sensor from tee fitting on oil filter module and install Oil Pressure Test Fitting. Connect Pressure Test Kit ZTSE4409 to Oil Pressure Test Fitting. Is oil pressure within specification?		Yes: Go to step 3. No: Go to Low Oil Pressure (page 74) symptom diagnostics.

Step 3		Decision
Perform Oil Pressure Verification Test (page 1763). Is Servicemaxx™ software EOP reading within 5 psi of instrument panel gauge?		Yes: Diagnostics complete. Clear codes and release vehicle. No: Repair mechanical gauge or circuit. After repairs are complete, retest for SPN 100 FMI 11.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 100 FMI 11 fault code diagnostics.

SPN 100 FMI 17 - Low Engine Oil Pressure, Event Log

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine oil pressure is below Warning pressure. Event Log.	Engine oil pressure ≤ 10 psi at 600 rpm Engine oil pressure ≤ 16 psi at 800 rpm Engine oil pressure ≤ 20 psi at 1000 rpm	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Engine Oil Pressure (EOP) is below Warning pressure. Event Log.

Lamp Reaction

None

Associated Faults

SPN 100 FMI 1, 3, 4, and 18 (EOP)

Fault Facts

This fault code is for vehicle event log only and will not illuminate a lamp.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed engine oil mechanical system
- Failed EOP gauge

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 100 FMI 1, 3, 4, and 18 (EOP). Is EST DTC list free of SPN 100 FMI 1, 3, 4 and 18?		Yes: Go to step 2. No: Repair SPN 100 FMI 1, 3, 4, and 18. After repairs are complete, retest for SPN 100 FMI 17.

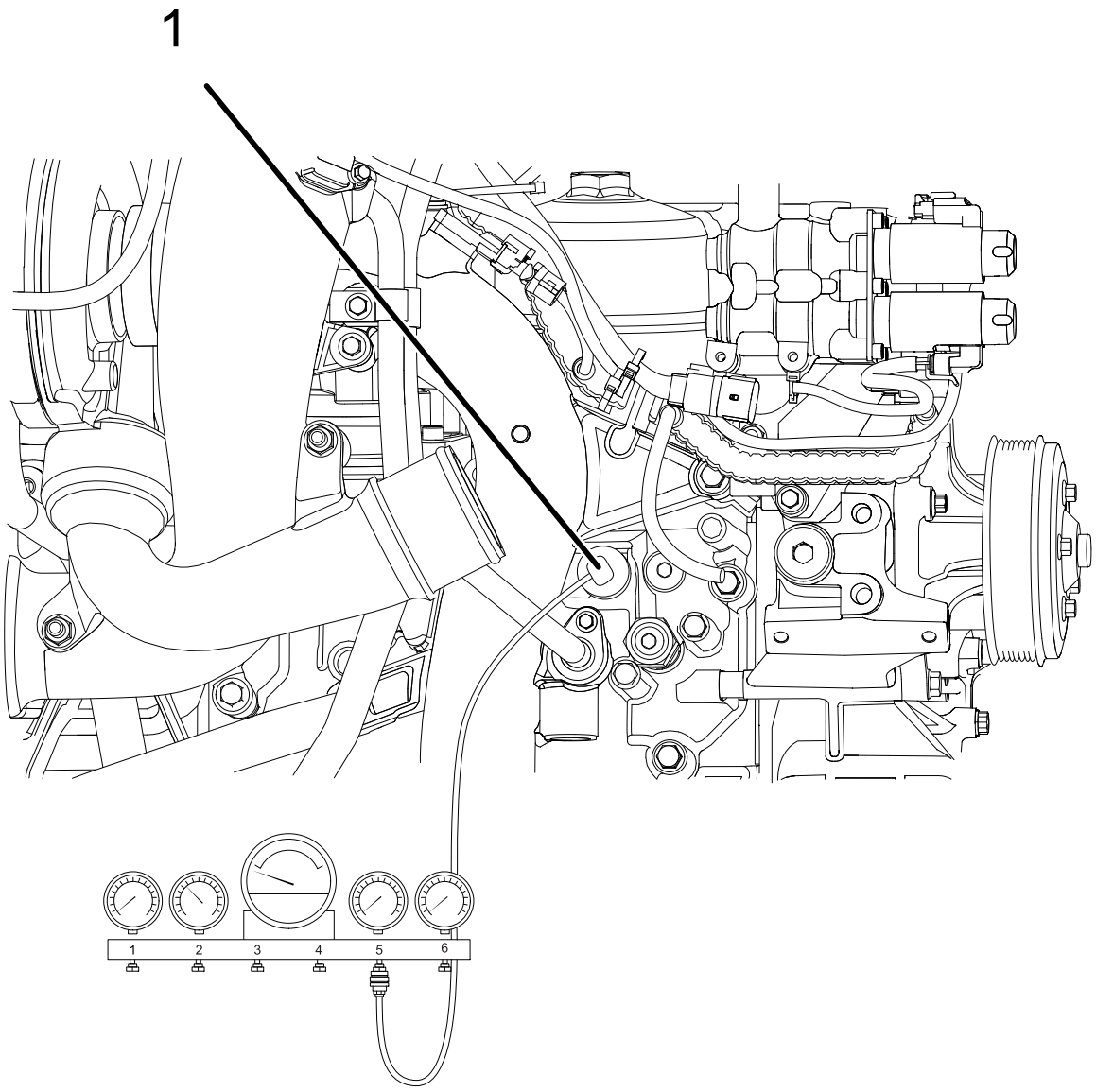

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Figure 363 Oil Pressure Verification Test Connection

Step 2	Check Engine Oil Pressure (EOP) using a mechanical gauge	Decision
Using Pressure Test Kit ZTSE4409 measure EOP. Remove EOP sensor from tee fitting on oil filter module and install Oil Pressure Test Fitting. Connect Pressure Test Kit ZTSE4409 to Oil Pressure Test Fitting. Is oil pressure within specification?		Yes: Go to step 3. No: Go to Low Oil Pressure (page 74) symptom diagnostics.

Step 3		Decision
Perform Oil Pressure Verification Test (page 1763). Is Servicemaxx™ software EOP reading within 5 psi of instrument panel gauge?		Yes: Diagnostics complete. Clear codes and release vehicle. No: Repair mechanical gauge or circuit. After repairs are complete, retest for SPN 100 FMI 17.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 100 FMI 17 fault code diagnostics.

SPN 100 FMI 18 - Engine Oil System Below Warning Pressure

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Engine oil pressure is below Warning pressure.	Engine oil pressure ≤ 10 psi at 600 rpm Engine oil pressure ≤ 16 psi at 800 rpm Engine oil pressure ≤ 20 psi at 1000 rpm	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Engine Oil Pressure (EOP) is below Warning pressure.

Lamp Reaction

Amber Warning Lamp (AWL) will illuminate immediately.

Associated Faults

SPN 100 FMI 3 and 4 (EOP)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed engine oil mechanical system
- Failed EOP gauge

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 100 FMI 3 and 4 (EOP). Is EST DTC list free of SPN 100 FMI 3 and 4?		Yes: Go to step 2. No: Repair SPN 100 FMI 3 and 4. After repairs are complete, retest for SPN 100 FMI 18.

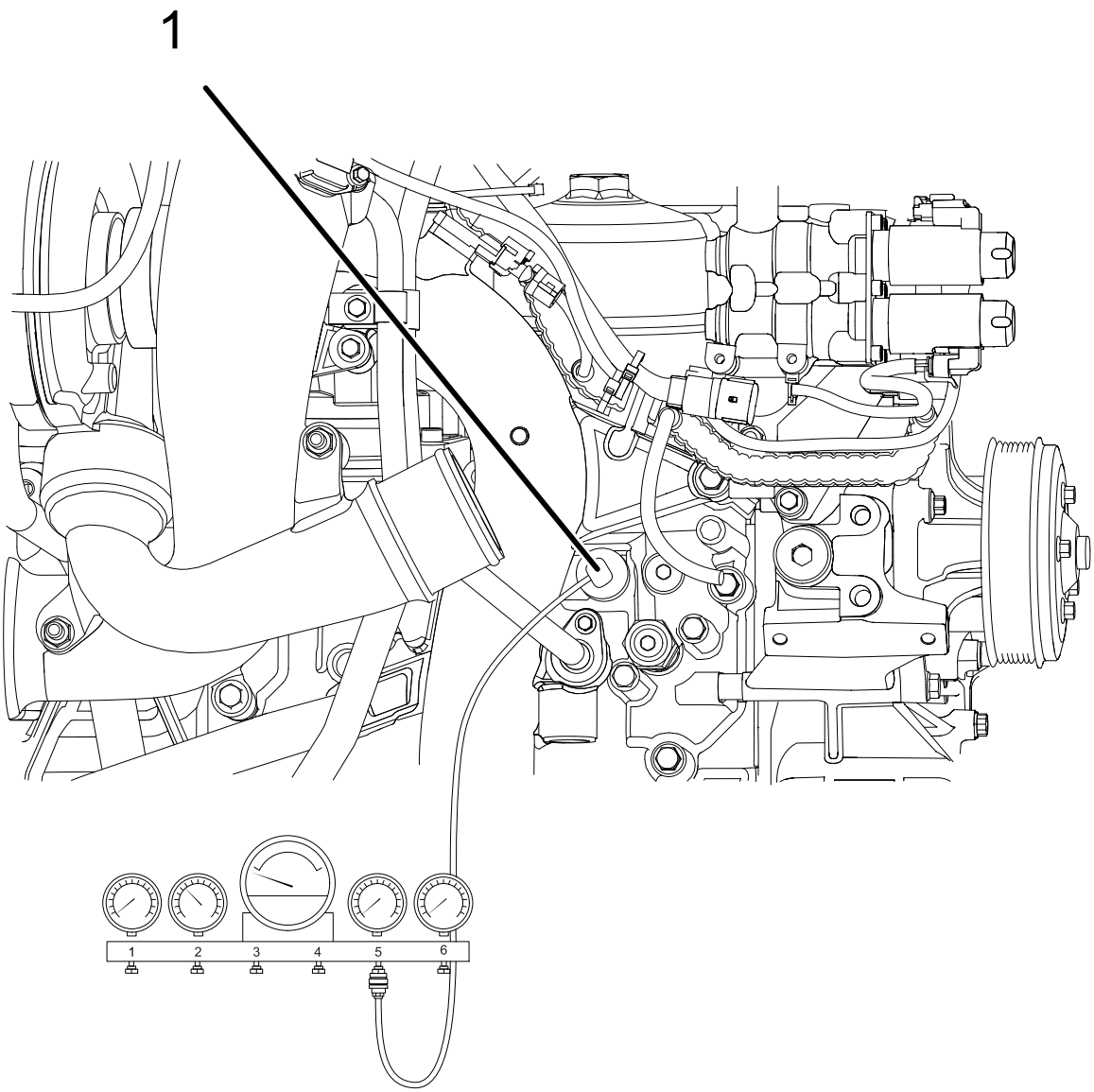

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Figure 364 Oil Pressure Verification Test Connection

Step 2	Check Engine Oil Pressure (EOP) using a mechanical gauge	Decision
Using Pressure Test Kit ZTSE4409 measure EOP. Remove EOP sensor from tee fitting on oil filter module and install Oil Pressure Test Fitting. Connect Pressure Test Kit ZTSE4409 to Oil Pressure Test Fitting. Is oil pressure within specification?		Yes: Go to step 3. No: Go to Low Oil Pressure (page 74) symptom diagnostics.

Step 3		Decision
Perform Oil Pressure Verification Test (page 1763). Is Servicemaxx™ EOP reading within 5 psi of instrument panel gauge?		Yes: Diagnostics complete. Clear codes and release vehicle. No: Repair mechanical gauge or circuit. After repairs are complete, retest for SPN 100 FMI 18.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 100 FMI 18 fault code diagnostics.

SPN 110 FMI 0 - Engine Coolant System Above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine Coolant Temperature 1 (ECT1) above critical temperature	ECT1 > value programmed into Programmable Parameter (PP) 77022	Key-On Engine-Running

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects that Engine Coolant Temperature 1 (ECT1) is above Programmable Parameter (PP) 77022.

Lamp Reaction

Engine shutdown is commanded and Red Stop Lamp (RSL) active.

Associated Faults

SPN 110 FMI 2, 3, 4 (ECT1)

Fault Facts

Air pockets in the cooling system can interfere with coolant flow or prevent the thermostats from opening when needed, resulting in this fault.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Cooling system overheating

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 2, 3, 4 (ECT1). Is EST DTC list free of SPN 110 FMI 2, 3, 4?		Yes: Go to Coolant Over-Temp diagnostics. No: Repair SPN 110 FMI 2, 3, 4. After repairs are complete, retest SPN 110 FMI 0.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 110 FMI 0 fault code diagnostics.

SPN 110 FMI 11 - Event Logger, Coolant Temp Hot, Extreme

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine coolant at Engine Coolant Temperature 1 (ECT1) is above critical temperature	ECT1 > 262°F (128°C)	Key-On Engine-Running

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects that engine coolant at Engine Coolant Temperature 1 (ECT1) is greater than 262°F (128°C)

Lamp Reaction

None

Associated Faults

SPN 110 FMI 0, 3, and 4 (ECT1)			

Fault Facts

Air pockets in the cooling system can interfere with coolant flow or prevent the thermostats from opening when needed, resulting in this fault.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Cooling system overheating

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults(page 916). Is EST DTC list free of Associated Faults?		Yes: Go to Coolant Over-Temp diagnostics. No: Repair Associated Faults. After repairs are complete, retest SPN 110 FMI 11.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 110 FMI 11 fault code diagnostics.

SPN 110 FMI 15 - Engine Coolant System Above Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine coolant at Engine Coolant Temperature 1 (ECT1) is above Warning temperature.	ECT1 > 232°F (111°C)	Key-On Engine-Running (KOER)

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects that engine coolant at Engine Coolant Temperature 1 (ECT1) is greater than 232°F (111°C).

Lamp Reaction

Amber Warning Lamp set, no buzzer.

Associated Faults

SPN 110 FMI 2, 3, 4 (ECT1)

Fault Facts

Air pockets in the cooling system can interfere with coolant flow or prevent the thermostats from opening when needed, resulting in this fault.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Cooling system overheating

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 FMI 2, 3, 4 (ECT1). Is EST DTC list free of SPN 110 FMI 2, 3, 4?		Yes: Go to Coolant Over-Temp diagnostics. No: Repair SPN 110 FMI 2, 3, 4. After repairs are complete, retest SPN 110 FMI 15.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 110 FMI 15 fault code diagnostics.

SPN 110 FMI 16 - Engine Coolant System Above OBD Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine coolant at Engine Coolant Temperature 1 (ECT1) is above Warning temperature.	ECT1 > 239°F (115°C) for more than 2 minutes	Key-On Engine-Running (KOER)

Fault Overview

Fault code sets when the Electronic Control Module (ECM) detects that engine coolant at Engine Coolant Temperature 1 (ECT1) is greater than 239°F (115°C) for more than 2 minutes.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 3 and 4 (ECT1)			

Fault Facts

Air pockets in the cooling system can interfere with coolant flow or prevent the thermostats from opening when needed, resulting in this fault.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Cooling system overheating

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults(page 920). Is EST DTC list free of Associated Faults?		Yes: Go to Coolant Over-Temp diagnostics. No: Repair Associated Faults. After repairs are complete, retest SPN 110 FMI 16.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 110 FMI 16 fault code diagnostics.

SPN 110 FMI 17 - Engine Coolant System Below OBD Monitoring Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values
Minimum Onboard Diagnostics (OBD) coolant temperature not reached.	Engine Coolant Temperature 1 (ECT1) < 122°F (50°C)	Expected Engine Coolant Temperature > 122°F (50°C) Limp home mode inactive DPF regeneration inactive Power Take Off (PTO) inactive Barometric (BARO) pressure > 11 psi (75 kPa) Key ON, Engine Running Ambient Air Temp (AAT) > -40°F (-40°C)

Fault Overview

Fault code sets when the signal from Engine Coolant Temperature 1 (ECT1) is not increasing as expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 2, 3, and 4 (ECT1)			

Fault Facts

In cold climates, operating the vehicle for extended periods of time at idle, or Without a winter front, may cause this fault to set.

Drive Cycle to Determine Fault Status

Road Test.

Possible Causes

- Low coolant level
- Failed Engine Coolant Temperature 1 (ECT1) sensor
- Failed engine cooling fan (stuck on)
- Failed thermostat (stuck Open)

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults(page 922). Is EST DTC list free of Associated Faults?		Yes: Go to step 2. No: Repair Associated Faults. After repairs are complete, retest for SPN 110 FMI 17.

Step 2	Check for correct coolant level.	Decision
Inspect coolant level. Check the coolant for correct level and condition. Is coolant filled to correct level?		Yes: Go to step 3. No: Perform Coolant Loss test. After repairs are complete, retest for SPN 110 FMI 17.

Step 3	Check for stuck on engine cooling fans.	Decision
Check for stuck on engine cooling fan. Using EST with ServiceMaxx™, go to Tests > KOER Tests > Engine Fan Test. Determine fans ability to maintain desired speeds. Is the fan operating properly?		Yes: Go to step 4. No: Repair or replace radiator fan assembly. After repairs are complete, retest for SPN 110 FMI 17.

Step 4	Check for failed ECT1 sensor.	Decision
Check for failed Thermostat. Perform Thermostat Operational Test. Did thermostats operate correctly and Open at specified temperature?		Yes: Replace Engine Coolant Temperature 1 (ECT1) sensor. After repairs are complete, retest for SPN 110 FMI 17. No: Replace Thermostats. After repairs are complete, retest for SPN 110 FMI 17.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 110 FMI 17 fault code diagnostics.

SPN 110 FMI 18 - Engine Coolant System Below Closed Loop Minimum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values
Minimum closed-loop coolant temperature not reached.	ECT1 < 50°F (10°C)	Calculated Engine Coolant Temperature > 50°F (10°C) Limp home mode inactive DPF regeneration inactive Power Take Off (PTO) inactive Barometric (BARO) pressure > 11 psi (75 kPa) Key ON, Engine Running Ambient Air Temp (AAT) > -40° F (-40°C)

Fault Overview

Fault code sets when signal from Engine Coolant Temperature 1 (ECT1) does not allow for closed-loop operation.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 110 FMI 2, 3, and 4 (ECT1)			

Fault Facts

In cold climates, operating the vehicle for extended periods of time at idle, or Without a winter front, may cause this fault to set.

Drive Cycle to Determine Fault Status

Road Test

Possible Causes

- Low coolant level
- Failed Engine Coolant Temperature 1 (ECT1) sensor
- Failed engine cooling fan (stuck on)
- Failed thermostat (stuck Open)

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults(page 924). Is EST DTC list free of Associated Faults?		Yes: Go to step 2. No: Repair Associated Faults. After repairs are complete, retest for SPN 110 FMI 18.

Step 2	Check for correct coolant level.	Decision
Inspect coolant level. Check the coolant for correct level and condition. Is coolant filled to correct level?		Yes: Go to step 3. No: Perform Coolant Loss test. After repairs are complete, retest for SPN 110 FMI 18.

Step 3	Check for stuck on engine cooling fans.	Decision
Check for stuck on engine cooling fan. Using EST with ServiceMaxx™, go to Tests > KOER Tests > Engine Fan Test. Determine fans ability to maintain desired speeds. Is the fan operating properly?		Yes: Go to step 4. No: Repair or replace radiator fan assembly. After repairs are complete, retest for SPN 110 FMI 18.

Step 4	Check for failed ECT1 sensor.	Decision
Check for failed Thermostat. Perform Thermostat Operational Test. Did thermostats operate correctly and Open at specified temperature?		Yes: Replace Engine Coolant Temperature 1 (ECT1) sensor. After repairs are complete, retest for SPN 110 FMI 18. No: Replace Thermostats. After repairs are complete, retest for SPN 110 FMI 18.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 110 FMI 18 fault code diagnostics.

SPN 175 FMI 0 - Engine Oil System Above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine Oil Temperature (EOT) is above critical temperature.	EOT signal is > than Programmable Parameter (PP) 77710	Key ON

Fault Overview

Fault code sets when the signal from Engine Oil Temperature (EOT) is greater than value in Programmable Parameter (PP) 77710

Lamp Reaction

Red Stop Lamp will illuminate immediately when this fault is active.

Associated Faults

SPN 175 FMI 3 and 4 (EOT)			

Fault Facts

This fault will most likely be Inactive when vehicle is in for service.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Low oil level
- Incorrectly programmed (PP) 77710
- Failed oil cooler assembly
- Failed EOT

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 926). Is EST DTC list free of Associated Faults?		Yes: Go to step 2. No: Repair Associated Faults. After repairs are complete, retest for SPN 175 FMI 0.

Step 2	Check for correctly programmed Programmable Parameter (PP) 77710.	Decision
A. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). B. Key ON, log into ServiceMaxx™ software. C. Select > Sessions > Parameters > Engine Warn Protection System. D. Check value of PP 77710, verify with customer desired temperature limit and compare to normal operating temperature of vehicle. Is PP 77710 programmed correctly?		Yes: Go to step 3. No: Program PP 77710 to correct value. After repairs are complete, retest for SPN 175 FMI 0.

Step 3	Check for low engine oil level.	Decision
Perform Engine Oil Level and Quality Inspection (page 1784). Is engine oil level within specification and Not contaminated?		Yes: Replace Engine Oil Temperature (EOT) sensor. After repairs are complete, retest for SPN 175 FMI 0. No: Go to step 4.

Step 4	Check for major oil leaks	Decision
Inspect for major oil leaks. Key-On Engine-Running (KOER) inspect under vehicle for continuous drips or continuous running of engine oil from vehicle. Is engine free of major oil leaks		Yes: Go to step 5. No: Repair cause for major oil leaks. After repairs are complete, retest for SPN 175 FMI 0.

Step 5	Inspect for signs of engine oil in coolant.	Decision
Perform Coolant Quality Inspection (page 1788). Is coolant free of oil contamination?		Yes: Retest for SPN 175 FMI 0. No: Go to step 6.

Step 6	Check for leaking Oil Cooler.	Decision
Perform Oil Cooler Pressure Test . Is oil cooler clean and free of leaks and debris?		Yes: Perform 7.2 - Engine Oil to Coolant (page 70) symptom based diagnostics. After repairs are complete, retest for SPN 175 FMI 0.
		No: Replace oil cooler assembly and fill oil and coolant system to specification. After repairs are complete, retest for SPN 175 FMI 0.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 175 FMI 0 fault code diagnostics.

SPN 175 FMI 11 - Oil Temperature Exceeds Limit By Large Amount

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine Oil Temperature (EOT) is above temperature by a large amount.	EOT signal is > than Programmable Parameter (PP) 77630	Key ON

Fault Overview

Fault code sets when the signal from Engine Oil Temperature (EOT) is greater than value in Programmable Parameter (PP) 77630

Lamp Reaction

None.

Associated Faults

SPN 175 FMI 3 and 4 (EOT)			

Fault Facts

This fault will most likely be Inactive when vehicle is in for service.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Low oil level
- Incorrectly programmed PP 77630
- Failed oil cooler assembly
- Failed EOT

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 929). Is EST DTC list free of Associated Faults?		Yes: Go to step 2. No: Repair Associated Faults. After repairs are complete, retest for SPN 175 FMI 11.

Step 2	Check for correctly programmed Programmable Parameter (PP) 77630.	Decision
A. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). B. Key ON, log into ServiceMaxx™ software. C. Select > Sessions > Parameters > Engine Warn Protection System. D. Check value of PP 77630, verify with customer desired temperature limit and compare to normal operating temperature of vehicle. Is PP 77630 programmed correctly?		Yes: Go to step 3. No: Program PP 77630 to correct value. After repairs are complete, retest for SPN 175 FMI 11.

Step 3	Check for low engine oil level.	Decision
Perform Engine Oil Level and Quality Inspection (page 1784). Is engine oil level within specification and Not contaminated?		Yes: Replace Engine Oil Temperature (EOT) sensor. After repairs are complete, retest for SPN 175 FMI 11. No: Go to step 4.

Step 4	Check for major oil leaks	Decision
Inspect for major oil leaks. Key-On Engine-Running (KOER) inspect under vehicle for continuous drips or continuous running of engine oil from vehicle. Is engine free of major oil leaks		Yes: Go to step 5. No: Repair cause for major oil leaks. After repairs are complete, retest for SPN 175 FMI 11.

Step 5	Inspect for signs of engine oil in coolant.	Decision
Perform Coolant Quality Inspection (page 1788). Is coolant free of oil contamination?		Yes: Retest for SPN 175 FMI 11. No: Go to step 6.

Step 6	Check for leaking Oil Cooler.	Decision
Perform Oil Cooler Pressure Test . Is oil cooler clean and free of leaks and debris?		Yes: Perform 7.2 - Engine Oil to Coolant (page 70) symptom based diagnostics. After repairs are complete, retest for SPN 175 FMI 11.
		No: Replace oil cooler assembly and fill oil and coolant system to specification. After repairs are complete, retest for SPN 175 FMI 11.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 175 FMI 11 fault code diagnostics.

SPN 175 FMI 15 - Engine Oil System Above Warning Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine Oil Temperature (EOT) is above warning temperature.	EOT signal is > than Programmable Parameter (PP) 77640	Key ON

Fault Overview

Fault code sets when the signal from Engine Oil Temperature (EOT) is greater than value in Programmable Parameter (PP) 77640

Lamp Reaction

Yellow Lamp will illuminate immediately when this fault is active.

Associated Faults

SPN 175 FMI 3 and 4 (EOT)			

Fault Facts

This fault will most likely be Inactive when vehicle is in for service.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Low oil level
- Incorrectly programmed PP 77640
- Failed oil cooler assembly
- Failed EOT

Step 1	Check for associated faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 932). Is EST DTC list free of Associated Faults?		Yes: Go to step 2. No: Repair Associated Faults. After repairs are complete, retest for SPN 175 FMI 15.

Step 2	Check for correctly programmed Programmable Parameter (PP) 77640.	Decision
A. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). B. Key ON, log into ServiceMaxx™ software. C. Select > Sessions > Parameters > Engine Warn Protection System. D. Check value of PP 77640, verify with customer desired temperature limit and compare to normal operating temperature of vehicle. Is PP 77640 programmed correctly?		Yes: Go to step 3. No: Program PP 77640 to correct value. After repairs are complete, retest for SPN 175 FMI 15.

Step 3	Check for low engine oil level.	Decision
Perform Engine Oil Level and Quality Inspection (page 1784). Is engine oil level within specification and Not contaminated?		Yes: Replace Engine Oil Temperature (EOT) sensor. After repairs are complete, retest for SPN 175 FMI 15. No: Go to step 4.

Step 4	Check for major oil leaks	Decision
Inspect for major oil leaks. Key-On Engine-Running (KOER) inspect under vehicle for continuous drips or continuous running of engine oil from vehicle. Is engine free of major oil leaks		Yes: Go to step 5. No: Repair cause for major oil leaks. After repairs are complete, retest for SPN 175 FMI 15.

Step 5	Inspect for signs of engine oil in coolant.	Decision
Perform Coolant Quality Inspection (page 1788). Is coolant free of oil contamination?		Yes: Retest for SPN 175 FMI 15. No: Go to step 6.

Step 6	Check for leaking Oil Cooler.	Decision
Perform Oil Cooler Pressure Test . Is oil cooler clean and free of leaks and debris?		Yes: Perform 7.2 - Engine Oil to Coolant (page 70) symptom based diagnostics. After repairs are complete, retest for SPN 175 FMI 15.
		No: Replace oil cooler assembly and fill oil and coolant system to specification. After repairs are complete, retest for SPN 175 FMI 15.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 175 FMI 15 fault code diagnostics.

SPN 188 FMI 0 - Engine Unable to Achieve Desired Idle Speed (Too High)

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine idle speed too high	Engine speed > 106.7% of desired idle speed	Key ON Engine Coolant Temperature 1 (ECT1) between 16°F (-9°C) and 248°F (120°C) Vehicle speed < 0.62 mph PTO not engaged Accelerator pedal position 0%

Fault Overview

Fault sets when vehicle is stationary and engine speed is greater than what is requested by the Engine Control Module (ECM).

Fault code sets when Engine Control Module (ECM) detects vehicle is stationary and engine speed is greater than what is requested.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

• SPN 110 FMI 2 (ECT1)	• SPN 5395 FMI 0 (EWPS)		

Fault Facts

None.

Drive Cycle to Determine Fault Status

Continuous

Possible Cause

- Engine over-fueling
- External fuel source
- Lube oil leak to intake
- Fuel leak to intake
- Contaminated fuel

Step 1	Check for Associated Faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 935). Is EST DTC list free of Associated Faults.		Yes: Go to step 2. No: Repair Associated Faults. After repairs are complete, retest for SPN 188 FMI 0.

Step 2	Check for airborne combustibles (such as propane saturated air, ether) near engine.	Decision
Inspect air filter and intake system for stains, concentrations of contaminants, odors / smells from external fuel sources, and modifications. Is the engine intake system intact and free from any external fuel sources?		Yes: Go to step 3. No: Repair source of combustibles. After repairs are complete, retest for SPN 188 FMI 0.

Step 3	Check for a lube oil leak to intake.	Decision
Perform Lube Oil to Intake leak test . Is lube oil leaking to intake?		Yes: Go to step 4. No: Repair lube oil leak to intake. After repairs are complete, retest for SPN 188 FMI 0.

Step 4	Check for a fuel leak to intake.	Decision
Perform Fuel to Intake leak test . Is fuel leaking to intake?		Yes: Go to step 5. No: Repair fuel leak to intake. After repairs are complete, retest for SPN 188 FMI 0.

Step 5	Check for contaminated fuel (alternate fuels other than Diesel fuel).	Decision
Perform Fuel Quality Check . Is diesel fuel in good condition and Not contaminated?		Yes: Go to step 6. No: Drain fuel tank, and fill with clean and / or known good diesel fuel. After repairs are complete, retest for SPN 188 FMI 0.

Step 6	Determine if engine has a fuel injector problem.	Decision
Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?		Yes: Replace fuel injector on suspected cylinder. After repairs are complete retest for SPN 188 FMI 0.
		No: Retest for SPN 188 FMI 0.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 188 FMI 0 fault code diagnostics.

SPN 188 FMI 1 - Engine Unable to Achieve Desired Idle Speed (Too Low)

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine idle speed too low	Engine speed < 93.3% of desired idle speed	Key ON Engine Coolant Temperature 1 (ECT1) between 16°F (-9°C) and 248°F (120°C) Vehicle speed < 0.62 mph PTO not engaged Accelerator pedal position 0%

Fault Overview

Fault code sets when Engine Control Module (ECM) detects vehicle is stationary and engine speed is less than expected.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

• SPN 651 (INJ) • SPN 655 (INJ)	• SPN 652 (INJ) • SPN 656 (INJ)	• SPN 653 (INJ) • SPN 5395 FMI 1 (EWPS)	• SPN 654 (INJ)

Fault Facts

None.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Low Fuel Rail Pressure (FRP)
- Low Fuel Delivery Pressure (FDP)
- Low cylinder compression
- Clutch or Power Take Off (PTO) engagement without command
- Injector or injector circuit fault

Step 1	Check for Associated Faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 938). Is EST DTC list free of Associated Faults.		Yes: Go to step 2. No: Repair Associated Faults. After repairs are complete, retest for SPN 188 FMI 1.

Step 2	Verify Fuel Delivery Pressure (FDP) is within specification.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, Key-On Engine-Running (KOER) monitor FDP sensor. Is FDP between 60 and 120 psi?		Yes: Go to step 3. No: Perform Fuel Delivery Pressure Test (page 1680). After repairs are complete, retest for SPN 188 FMI 1.

Step 3	Determine if Fuel Rail Pressure (FRP) is within specification.	Decision
Using EST with ServiceMaxx™ software, KOER monitor FRP sensor. Is FRP greater than 10,500 psi?		Yes: Go to step 4. No: Perform High-pressure Pump Inlet Pressure Test . After repairs are complete, retest for SPN 188 FMI 1.

Step 4	Determine if the engine has a mechanical cylinder balance problem (compression loss).	Decision
Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?		Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 188 FMI 1. No: Go to step 5.

Step 5	Determine if engine has a fuel injector problem.	Decision
Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?		Yes: Go to step 6. No: Go to step 7.

Step 6	Inspect for failed valve train components.	Decision
Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?		Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 188 FMI 1.
		No: Repair failed valve train components. After repairs are complete retest for SPN 188 FMI 1.

Step 7	Inspect for failed valve train components.	Decision
Check for Power Take Off (PTO) engagement without command. KOER, monitor PTO output shaft rotation. Is PTO output shaft rotating without throttle?		Yes: Repair PTO unit. After repairs are complete, retest for SPN 188 FMI 1.
		No: Retest for SPN 188 FMI 1.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 188 FMI 1 fault code diagnostics.

SPN 188 FMI 16 - Engine Overspeed Detected at Low Idle Condition Due to Oil Ingestion

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine unexpectedly accelerated due to an alternative fuel source.	Engine Speed greater than 2600 RPM	Key-On Engine-Running (KOER) Vehicle stationary

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects vehicle is stationary and engine speed is higher than 2600 rpm.

Lamp Reaction

Red Stop Lamp (RSL) is illuminated immediately when this fault is detected.

Associated Faults

SPN 731 FMI 16 and 18 (EWPS)			

Fault Facts

None.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- External fuel source
- Lube oil leak to intake
- Fuel leak to intake
- Contaminated fuel

Step 1	Check for Associated Faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 941). Is EST DTC list free of Associated Faults.		Yes: Go to step 2. No: Repair Associated Faults. After repairs are complete, retest for SPN 188 FMI 16.

Step 2	Check for airborne combustibles (such as propane saturated air, ether) near engine.	Decision
Inspect air filter and intake system for stains, concentrations of contaminants, odors / smells from external fuel sources, and modifications. Is the engine intake system intact and free from any external fuel sources?		Yes: Go to step 3. No: Repair source of combustibles. After repairs are complete, retest for SPN 188 FMI 16.

Step 3	Check for a lube oil leak to intake.	Decision
Perform Lube Oil to Intake leak test . Is lube oil leaking to intake?		Yes: Go to step 4. No: Repair lube oil leak to intake. After repairs are complete, retest for SPN 188 FMI 16.

Step 4	Check for a fuel leak to intake.	Decision
Perform Fuel to Intake leak test . Is fuel leaking to intake?		Yes: Go to step 5. No: Repair fuel leak to intake. After repairs are complete, retest for SPN 188 FMI 16.

Step 5	Check for contaminated fuel (alternate fuels other than Diesel fuel).	Decision
Perform Fuel Quality Check . Is diesel fuel in good condition and Not contaminated?		Yes: Go to step 6. No: Drain fuel tank, and fill with clean and / or known good diesel fuel. After repairs are complete, retest for SPN 188 FMI 16.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 188 FMI 16 fault code diagnostics.

SPN 190 FMI 0 - Engine Overspeed - Most Severe Level

Condition / Description	Setting Criteria	Enable Conditions / Values
Engine speed reaches most severe level with Accelerator Pedal Position (APP) and Vehicle Speed Sensor (VSS) at 0% or 0.	Engine speed exceeds 2600 rpm with no fuel being requested	Engine speed > 2600 rpm APP < 0.1% RAPP < 0.1%

Fault Overview

Fault sets only when a vehicle is stationary and engine speed reaches 2600 rpm with no fuel being requested by the Engine Control Module (ECM). Once conditions are met, the ECM will initiate a protection strategy. The Engine Throttle Valve (ETV) and Exhaust Gas Recirculation (EGR) valve will be closed and fuel injectors disabled. The Fuel Pressure Control Valve (FPCV) will open to relieve fuel rail pressure in case of injector tip damage. A full engine analysis needs to be completed to assess damage from excessive engine speed before the engine can be started.

CAUTION: To prevent engine damage, do not attempt to start engine until a full engine analysis and all diagnostic steps have been completed.

Lamp Reaction

Red Stop Lamp will illuminate immediately when this fault is detected.

Associated Faults

None

Fault Facts

Before beginning diagnosis:

- Take pictures of all damage / failure evidence
- Do not replace any parts until a full inspection has been completed.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Failed Injectors
- Failed Low Pressure Turbocharger
- Failed Engine

Step 1	Check for excessive oil in turbo outlet and Charge Air Cooler (CAC) piping.	Decision
Remove high pressure turbo outlet pipe and CAC piping (see Engine Service Manual). Inspect outlets for excessive oil. Is there excessive oil in high pressure turbo outlet pipe or CAC piping?		Yes: Go to step 2. No: Go to step 7.

Step 2	Check for external engine block damage.	Decision
Visually inspect engine block for external damage (holes or cracks in side of block). Is there any external engine block damage?		Yes: Replace engine, following warranty policies. After repairs are complete, retest for SPN 190 FMI 0. No: Go to step 3.

Step 3	Check Programmable Parameter (PP) 58071.	Decision
A. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). B. Key ON, log into ServiceMaxx™ software. C. Select > Sessions > Parameters > Engine Warn Protection System. D. Check value of PP 58071. Is PP 58071 above 3200 rpm?		Yes: Go to step 4. No: Go to step 5.

Step 4	Check for engine block or engine sleeve damage (engine speed greater than 3200 rpm).	Decision
Remove engine oil pan (see Engine Service Manual). Inspect for internal engine block or engine sleeve damage Is there any internal engine block or engine sleeve damage?		Yes: Repair or replace engine, following warranty policies. After repairs are complete, retest for SPN 190 FMI 0. No: Replace fuel injectors, Low pressure turbo cartridge, water pump, and clean Low Pressure Charge Air Cooler (LPCAC). Go to step 6.

Step 5	Check for engine block or engine sleeve damage (engine speed less than 3200 rpm and greater than 2600 rpm).	Decision
Remove engine oil pan (see Engine Service Manual). Inspect for internal engine block or engine sleeve damage Is there any internal engine block or engine sleeve damage?		Yes: Repair or replace engine, following warranty policies. After repairs are complete, retest for SPN 190 FMI 0.
		No: Replace fuel injectors, Low pressure turbo cartridge, and clean LPCAC. Go to step 6.

Step 6	Check for current Engine Control Module (ECM) calibration.	Decision
Using EST with ServiceMaxx™ software, check ECM calibration for updates. Is there an ECM calibration update available?		Yes: Update calibration. After repairs are complete, retest for SPN 190 FMI 0.
		No: Retest for SPN 190 FMI 0.

Step 7	Check for external engine block damage.	Decision
Visually inspect engine block for external damage (holes or cracks in side of block). Is there any external engine block damage?		Yes: Replace engine, following warranty policies. After repairs are complete, retest for SPN 190 FMI 0.
		No: Go to step 8.

Step 8	Check Programmable Parameter (PP) 58071.	Decision
A. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). B. Key ON, log into ServiceMaxx™ software. C. Select > Sessions > Parameters > Engine Warn Protection System. D. Check value of PP 58071. Is PP 58071 above 3200 rpm?		Yes: Go to step 9.
		No: Retest for SPN 190 FMI 0.

Step 9	Check for engine block or engine sleeve damage (engine speed greater than 3200 rpm).	Decision
Remove engine oil pan (see Engine Service Manual). Inspect for internal engine block or engine sleeve damage Is there any internal engine block or engine sleeve damage?		Yes: Repair or replace engine, following warranty policies. After repairs are complete, retest for SPN 190 FMI 0.
		No: Replace water pump. Go to step 10.

Step 10	Check for current Engine Control Module (ECM) calibration.	Decision
Using EST with ServiceMaxx™ software, check ECM calibration for updates. Is there an ECM calibration update available?		Yes: Update calibration. After repairs are complete, retest for SPN 190 FMI 0.
		No: Retest for SPN 190 FMI 0.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 190 FMI 0 fault code diagnostics.

SPN 190 FMI 11 - Engine Overspeed, Event Log

EWPS Programmable Parameters

- 1 = 3-way Warning
- 2 = 3-way Protection
- 3 = Standard Warning

ECT Warning Temperature – Specifies temperature threshold where the Triangle Warning light and warning buzzer are turned on.

ECT Critical Temperature – Specifies temperature threshold where an engine shutdown is commanded (Exclamation Engine Stop lamp).

EOP Engine Speed Region Boundary 1 (600 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 1) should be detected.

EOP Engine Speed Region Boundary 2 (800 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 2) should be detected.

EOP Engine Speed Region Boundary 3 (1000 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 3) should be detected.

EOP Warning Pressure for Region 1 (10 psi / 69 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Warning pressure for Region 2 (16 psi / 110 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1 but less than EOP Engine Speed Region Boundary 2. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Warning Pressure for Region 3 (20 psi / 138 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 2, but less than EOP Engine Speed Region Boundary 3. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Critical Pressure for Region 1 (7.5 psi / 52 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1. Failure to meet set point commands an engine shut down.

EOP Critical Pressure for Region 2 (12 psi / 83 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1, but less than EOP Engine Speed Region Boundary 2. Failure to meet set point commands an engine shutdown.

EOP Critical Pressure for Region 3. (15 psi / 103 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 2 but less than EOP Engine Speed Region Boundary 3. Failure to meet set point commands an engine shutdown.

SPN 190 FMI 15 - Engine Overspeed - Least Severe Level

EWPS Programmable Parameters

- 1 = 3-way Warning
- 2 = 3-way Protection
- 3 = Standard Warning

ECT Warning Temperature – Specifies temperature threshold where the Triangle Warning light and warning buzzer are turned on.

ECT Critical Temperature – Specifies temperature threshold where an engine shutdown is commanded (Exclamation Engine Stop lamp).

EOP Engine Speed Region Boundary 1 (600 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 1) should be detected.

EOP Engine Speed Region Boundary 2 (800 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 2) should be detected.

EOP Engine Speed Region Boundary 3 (1000 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 3) should be detected.

EOP Warning Pressure for Region 1 (10 psi / 69 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Warning pressure for Region 2 (16 psi / 110 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1 but less than EOP Engine Speed Region Boundary 2. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Warning Pressure for Region 3 (20 psi / 138 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 2, but less than EOP Engine Speed Region Boundary 3. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Critical Pressure for Region 1 (7.5 psi / 52 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1. Failure to meet set point commands an engine shut down.

EOP Critical Pressure for Region 2 (12 psi / 83 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1, but less than EOP Engine Speed Region Boundary 2. Failure to meet set point commands an engine shutdown.

EOP Critical Pressure for Region 3. (15 psi / 103 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 2 but less than EOP Engine Speed Region Boundary 3. Failure to meet set point commands an engine shutdown.

SPN 731 FMI 16 - Crankshaft Velocity Based Engine Oil Ingestion

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine Control Module (ECM) compares time between pulses of the Crankshaft Position (CKP) sensor after fuel injection to determine whether the engine has accelerated or decelerated.	Difference between desired crankshaft speed and actual crankshaft speed exceeds a predetermined threshold	Vehicle stationary Engine speed > 500 RPM Accelerator pedal position (APP) signal < 0.1% Clutch Not pressed Coolant temperature is between 15°F (-9°C) and 248°F (120°C) Inactive: SPN 110 (ECT1); SPN 191 (TOSS); SPN 560 (J1939); 1659 (ECS); 4076 (ECT2)	

Fault Overview

Fault code sets when an increase in engine speed is detected without a request for an increase in engine speed.

Lamp Reaction

Red Stop Lamp (RSL) illuminated.

Associated Faults

SPN 110 (ECT1), SPN 190 FMI 0 (EWPS), SPN 191 (TOSS), SPN 560 (J1939), SPN 637 (CKP); SPN 1659 (ECS), 4076 (ECT2)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Alternate fuel source (Oil)
- Vehicle Speed Sensor (VSS) or circuit fault

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 110 (ECT1); SPN 190 (EWPS); SPN 191 (TOSS); SPN 560 (J1939); SPN 637 (CKP); SPN 1659 (ECS); 4076 (ECT2). Is EST DTC list free of SPN 110; SPN 190 FMI 0; SPN 191; SPN 560; SPN 637; SPN 1659; SPN 4076?	Yes: Go to step 2. No: Repair SPN 110; SPN 190 FMI 0; SPN 191; SPN 560; SPN 637; SPN 1659; SPN 4076. After repairs are complete, retest for SPN 731 FMI 16.

Step	Action	Decision
2	Inspect for a lube oil leak to intake. Perform Lube Oil to Intake leak test . Is lube oil leaking to intake?	Yes: Repair lube oil leak to intake. After repairs are complete, retest for SPN 731 FMI 16 and go to Step 3.
		No: Troubleshoot VSS (page 1453). After repairs are complete, retest for SPN 731 FMI 16.

Crankshaft oil ingestion monitor may benefit from having similar diagnostic actions taken as engine over speed (SPN 190 FMI 0). Both faults are used to detect the same failure mode.

Step	Action	Decision
3	Inspect for contaminated fuel (alternate fuels other than Diesel fuel). Perform Fuel Quality Check . Is diesel fuel in good condition and Not contaminated?	Yes: Retest for SPN 731 FMI 16.
		No: Drain fuel tank, and fill with clean and / or known good diesel fuel. After repairs are complete, retest for SPN 731 FMI 16.

NOTE: After doing all diagnostic steps, if SPN 731 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 731 FMI 18 - Knock Detected: Unexpected Combustion without Fueling

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
ECM compares fuel quantity demand during idle to normal idle fueling to determine whether there are abnormal changes in fueling (unexpected combustion events).	Difference between fuel demanded and actual fuel injected exceeds a predetermined threshold.	Vehicle stationary Engine speed between 500 rpm and 1600 rpm AND No rapid rpm acceleration Accelerator Pedal Position (APP) stable signal Clutch not released for manual transmission Gear change not detected for automatic transmission Coolant temperature is between 15°F (-9°C) and 248°F (120°C) Inactive: SPN 91 (APP); SPN 110 (ECT1); SPN 191 (TOSS); SPN 560 (J1939); SPN 636 (CMP); SPN 637 (CKP); SPN 1659 (ECS); SPN 2623 (APP); SPN 4076 (ECT2)	

Fault Overview

Fault code sets when an increase in engine speed is detected without a change in fuel command.

Lamp Reaction

Red Stop Lamp (RSL) illuminated.

Associated Faults

SPN 91 (APP), SPN 110 (ECT1), SPN 190 FMI 0 (EWPS), SPN 191 (TOSS), SPN 560 (J1939), SPN 636 (CMP), SPN 637 (CKP), SPN 1659 (ECS), SPN 2623 (APP), SPN 4076 (ECT2)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Alternate fuel source (Oil)
- Vehicle Speed Sensor (VSS) or circuit fault
- Fuel injector leaking
- Flywheel fault

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 91 (APP); SPN 110 (ECT1); SPN 190 (EWPS); SPN 191 (TOSS); SPN 560 (J1939); SPN 636 (CMP); SPN 637 (CKP); SPN 1659 (ECS); SPN 2623 (APP); SPN 4076 (ECT2). Is EST DTC list free of SPN 91; SPN 110; SPN 190 FMI 0; SPN 191; SPN 560; SPN 636; SPN 637; SPN 1659; SPN 2623 (APP); SPN 4076?	Yes: Go to step 2. No: Repair SPN 91; SPN 110; SPN 190 FMI 0; SPN 191; SPN 560; SPN 636; SPN 637; SPN 1659; SPN 2623; SPN 4076. After repairs are complete, retest for SPN 731 FMI 18.

Step	Action	Decision
2	Inspect for a lube oil leak to intake. Perform Lube Oil to Intake leak test . Is lube oil leaking to intake?	Yes: Repair lube oil leak to intake. After repairs are complete, retest for SPN 731 FMI 18. No: Troubleshoot VSS (page 1453). After repairs are complete, retest for SPN 731 FMI 18.

Fuel quantity oil ingestion monitor may benefit from having similar diagnostic actions taken as engine over speed (SPN 190 FMI 0). Both faults are used to detect the same failure mode.

Step	Action	Decision
3	Inspect for contaminated fuel (alternate fuels other than Diesel fuel). Perform Fuel Quality Check . Is diesel fuel in good condition and Not contaminated?	Yes: Retest for SPN 731 FMI 18. No: Drain fuel tank, and fill with clean and / or known good diesel fuel. After repairs are complete, retest for SPN 731 FMI 18.

NOTE: After doing all diagnostic steps, if SPN 731 FMI 18 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2588 FMI 0 - Vehicle Overspeed 1, Event Log, Extreme

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Vehicle over-speed level 1: This occurs when vehicle speed is above value in Programmable Parameter (PP) 77232.	Vehicle speed is greater than the value of PP 77232	Key-On Engine-Running (KOER)	

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects vehicle speed exceeds the value set in Programmable Parameter (PP) 77232.

Lamp Reaction

9 - Special error class for VETS faults

Associated Faults

SPN 191 (VSS).

Fault Facts

This fault indicates vehicle speed has exceeded the value programmed in PP 77232. Depending on the value, fault may or may not indicate a vehicle problem.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Vehicle speed has exceeded the value set in PP 77232

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 191 (VSS). Is EST DTC list free of SPN 191?	Yes: Verify PP 77232 is set to appropriate speed value.
		No: Repair SPN 191. After repairs are complete, retest for SPN 2588 FMI 0.

NOTE: After doing all diagnostic steps, if SPN 2588 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2588 FMI 15 - Vehicle Overspeed 1, Event Log, Non Extreme

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Vehicle over-speed level 1: This occurs when vehicle speed is above value in Programmable Parameter (PP) 77232.	Vehicle speed is greater than the value of PP 77232	Key-On Engine-Running (KOER)	

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects vehicle speed exceeds the value set in Programmable Parameter (PP) 77232.

Lamp Reaction

9 - Special error class for VETS faults

Associated Faults

SPN 191 (VSS).

Fault Facts

This fault indicates vehicle speed has exceeded the value programmed in PP 77232. Depending on the value, fault may or may not indicate a vehicle problem.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Vehicle speed has exceeded the value set in PP 77232

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 191 (VSS). Is EST DTC list free of SPN 191?	Yes: Yes: Verify PP 77232 is set to appropriate speed value. No: Repair SPN 191. After repairs are complete, retest for SPN 2588 FMI 15.

NOTE: After doing all diagnostic steps, if SPN 2588 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2589 FMI 0 - Vehicle Overspeed 2, Event Log, Extreme

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Vehicle over-speed level 2: This occurs when vehicle speed is above value in Programmable Parameter (PP) 77242.	Vehicle speed is greater than the value of PP 77242	Key-On Engine-Running (KOER)	

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects vehicle speed exceeds the value set in Programmable Parameter (PP) 77242.

Lamp Reaction

9 - Special error class for VETS faults

Associated Faults

SPN 191 (VSS).

Fault Facts

This fault indicates vehicle speed has exceeded the value programmed in PP 77242. Depending on the value, fault may or may not indicate a vehicle problem.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Vehicle speed has exceeded the value set in PP 77242

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 191 (VSS). Is EST DTC list free of SPN 191?	Yes: Verify PP 77242 is set to appropriate speed value. No: Repair SPN 191. After repairs are complete, retest for SPN 2589 FMI 0.

NOTE: After doing all diagnostic steps, if SPN 2589 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2589 FMI 15 - Vehicle Overspeed 2, Event Log, Non Extreme

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Vehicle over-speed level 2: This occurs when vehicle speed is above value in Programmable Parameter (PP) 77242.	Vehicle speed is greater than the value of PP 77242	Key-On Engine-Running (KOER)	

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects vehicle speed exceeds the value set in Programmable Parameter (PP) 77242.

Lamp Reaction

9 - Special error class for VETS faults

Associated Faults

SPN 191 (VSS).

Fault Facts

This fault indicates vehicle speed has exceeded the value programmed in PP 77242. Depending on the value, fault may or may not indicate a vehicle problem.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Vehicle speed has exceeded the value set in PP 77242

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 191 (VSS). Is EST DTC list free of SPN 191?	Yes: Verify PP 77242 is set to appropriate speed value. No: Repair SPN 191. After repairs are complete, retest for SPN 2589 FMI 15.

NOTE: After doing all diagnostic steps, if SPN 2589 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4076 FMI 0 - ECT2 Above Critical (EWPS Programmable Limit)

EWPS Programmable Parameters

- 1 = 3-way Warning
- 2 = 3-way Protection
- 3 = Standard Warning

ECT Warning Temperature – Specifies temperature threshold where the Triangle Warning light and warning buzzer are turned on.

ECT Critical Temperature – Specifies temperature threshold where an engine shutdown is commanded (Exclamation Engine Stop lamp).

EOP Engine Speed Region Boundary 1 (600 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 1) should be detected.

EOP Engine Speed Region Boundary 2 (800 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 2) should be detected.

EOP Engine Speed Region Boundary 3 (1000 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 3) should be detected.

EOP Warning Pressure for Region 1 (10 psi / 69 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Warning pressure for Region 2 (16 psi / 110 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1 but less than EOP Engine Speed Region Boundary 2. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Warning Pressure for Region 3 (20 psi / 138 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 2, but less than EOP Engine Speed Region Boundary 3. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Critical Pressure for Region 1 (7.5 psi / 52 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1. Failure to meet set point commands an engine shut down.

EOP Critical Pressure for Region 2 (12 psi / 83 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1, but less than EOP Engine Speed Region Boundary 2. Failure to meet set point commands an engine shutdown.

EOP Critical Pressure for Region 3. (15 psi / 103 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 2 but less than EOP Engine Speed Region Boundary 3. Failure to meet set point commands an engine shutdown.

SPN 4076 FMI 15 - ECT2 Above Warning (EWPS rogrammable Limit)

EWPS Programmable Parameters

- 1 = 3-way Warning
- 2 = 3-way Protection
- 3 = Standard Warning

ECT Warning Temperature – Specifies temperature threshold where the Triangle Warning light and warning buzzer are turned on.

ECT Critical Temperature – Specifies temperature threshold where an engine shutdown is commanded (Exclamation Engine Stop lamp).

EOP Engine Speed Region Boundary 1 (600 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 1) should be detected.

EOP Engine Speed Region Boundary 2 (800 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 2) should be detected.

EOP Engine Speed Region Boundary 3 (1000 RPM) – Specifies at what RPM a specified oil pressure (EOP Critical Pressure for Region 3) should be detected.

EOP Warning Pressure for Region 1 (10 psi / 69 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Warning pressure for Region 2 (16 psi / 110 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1 but less than EOP Engine Speed Region Boundary 2. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Warning Pressure for Region 3 (20 psi / 138 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 2, but less than EOP Engine Speed Region Boundary 3. Failure to meet set point turns on the OIL / WATER lamp and warning buzzer.

EOP Critical Pressure for Region 1 (7.5 psi / 52 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1. Failure to meet set point commands an engine shut down.

EOP Critical Pressure for Region 2 (12 psi / 83 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 1, but less than EOP Engine Speed Region Boundary 2. Failure to meet set point commands an engine shutdown.

EOP Critical Pressure for Region 3. (15 psi / 103 kPa) – Specifies the minimum oil pressure with engine speed greater than EOP Engine Speed Region Boundary 2 but less than EOP Engine Speed Region Boundary 3. Failure to meet set point commands an engine shutdown.

SPN 5395 FMI 0 - Engine Unable to Achieve Desired Idle Torque (Too High)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine idle fuel quantity too high, engine unable to achieve desired idle torque.	Engine speed and fuel quantity greater than expected.	Vehicle speed <0.62 mph Key ON Engine coolant temperature < 239°F (115°C) Engine coolant temperature > 16°F (–9°C) Engine speed > 560 rpm	10 Seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects fuel quantity is and engine speed is greater than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 188 FMI 1 (EWPS).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed fuel injector
- Aftermarket PTO system not installed correctly
- Aftermarket PTO system not programmed correctly

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 188 FMI 1 (EWPS). Is EST DTC list free of SPN 188 FMI 1?	Yes: Go to step 2. No: Repair SPN 188 FMI 1. After repairs are complete, retest for SPN 5395 FMI 0.

Step	Action	Decision
2	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 5395 FMI 0. No: Go to step 3

Step	Action	Decision
3	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 4. No: Go to step 5.

Step	Action	Decision
4	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 5395 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 5395 FMI 0.

Step	Action	Decision
5	Inspect for installation of aftermarket PTO system. Was an aftermarket PTO system installed and programmed correctly?	Yes: Do Harness Resistance Check (page 1330). After repairs are complete, retest for SPN 5395 FMI 0. No: After inspection is complete, notify supervisor with results for further action.

NOTE: After doing all diagnostic steps, if SPN 5395 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5395 FMI 1 - Engine Unable to Achieve Desired Idle Torque (Too Low)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Engine idle fuel quantity too low, engine unable to achieve desired idle torque.	engine speed and fuel quantity less than expected.	Vehicle speed <0.62 mph Key ON Engine coolant temperature < 239°F (115°C) Engine coolant temperature > 16°F (–9°C) Engine speed > 560 rpm	10 Seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects an un-commanded load being placed on the engine at idle or detects fuel quantity is less than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 188 FMI 0 (EWPS).

Drive Cycle to Determine Fault Status

Drive Cycle 22 in 2013 HD-OBD Diagnostic Reference Manual.

- Engine mechanical failure
- Failed cylinder
- External fuel source
- Lube oil leak to intake
- Fuel leak to intake
- Contaminated fuel

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 188 FMI 0 (EWPS). Is EST DTC list free of SPN 188 FMI 0?	Yes: Go to step 2. No: Repair SPN 188 FMI 0. After repairs are complete, retest for SPN 5395 FMI 1.

Step	Action	Decision
2	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 5395 FMI 1.
		No: Go to step 3

Step	Action	Decision
3	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 4.
		No: Go to step 5.

Step	Action	Decision
4	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 5395 FMI 1.
		No: Repair failed valve train components. After repairs are complete retest for SPN 5395 FMI 1.

Step	Action	Decision
5	Inspect for airborne combustibles (ex. propane saturated air, ether, etc.) near engine. Inspect air filter and intake system for stains, concentrations of contaminants, odors / smells from external fuel sources, and modifications. Is the engine intake system intact and free from any external fuel sources?	Yes: Go to step 6.
		No: Repair source of combustibles. After repairs are complete, retest for SPN 5395 FMI 1.

Step	Action	Decision
6	Inspect for a lube oil leak to intake. Perform Lube Oil to Intake leak test . Is lube oil leaking to intake?	Yes: Go to step 7.
		No: Repair lube oil leak to intake. After repairs are complete, retest for SPN 5395 FMI 1.

Step	Action	Decision
7	Inspect for a fuel leak to intake. Perform Fuel to Intake leak test . Is fuel leaking to intake?	Yes: Go to step 8.
		No: Repair fuel leak to intake. After repairs are complete, retest for SPN 5395 FMI 1.

Step	Action	Decision
8	Inspect for contaminated fuel (alternate fuels other than Diesel fuel). Perform Fuel Quality Check . Is diesel fuel in good condition and Not contaminated?	Yes: Retest for SPN 5395 FMI 1.
		No: Drain fuel tank, and fill with clean and / or known good diesel fuel. After repairs are complete, retest for SPN 5395 FMI 1.

NOTE: After doing all diagnostic steps, if SPN 5395 FMI 1 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

FDP (Fuel Delivery Pressure) Sensor

Overview of FDP Sensor Group

SPN	FMI	Description
94	0	Fuel pressure above maximum (page 965)
94	3	FDP signal Out of Range HIGH (page 968)
94	4	FDP signal Out of Range LOW (page 972)

Overview

The Fuel Delivery Pressure (FDP) sensor measures the fuel delivery pressure exiting the secondary (engine) fuel filter assembly. This data is sent to the ECM to monitor the low pressure fuel pumps performance and condition.

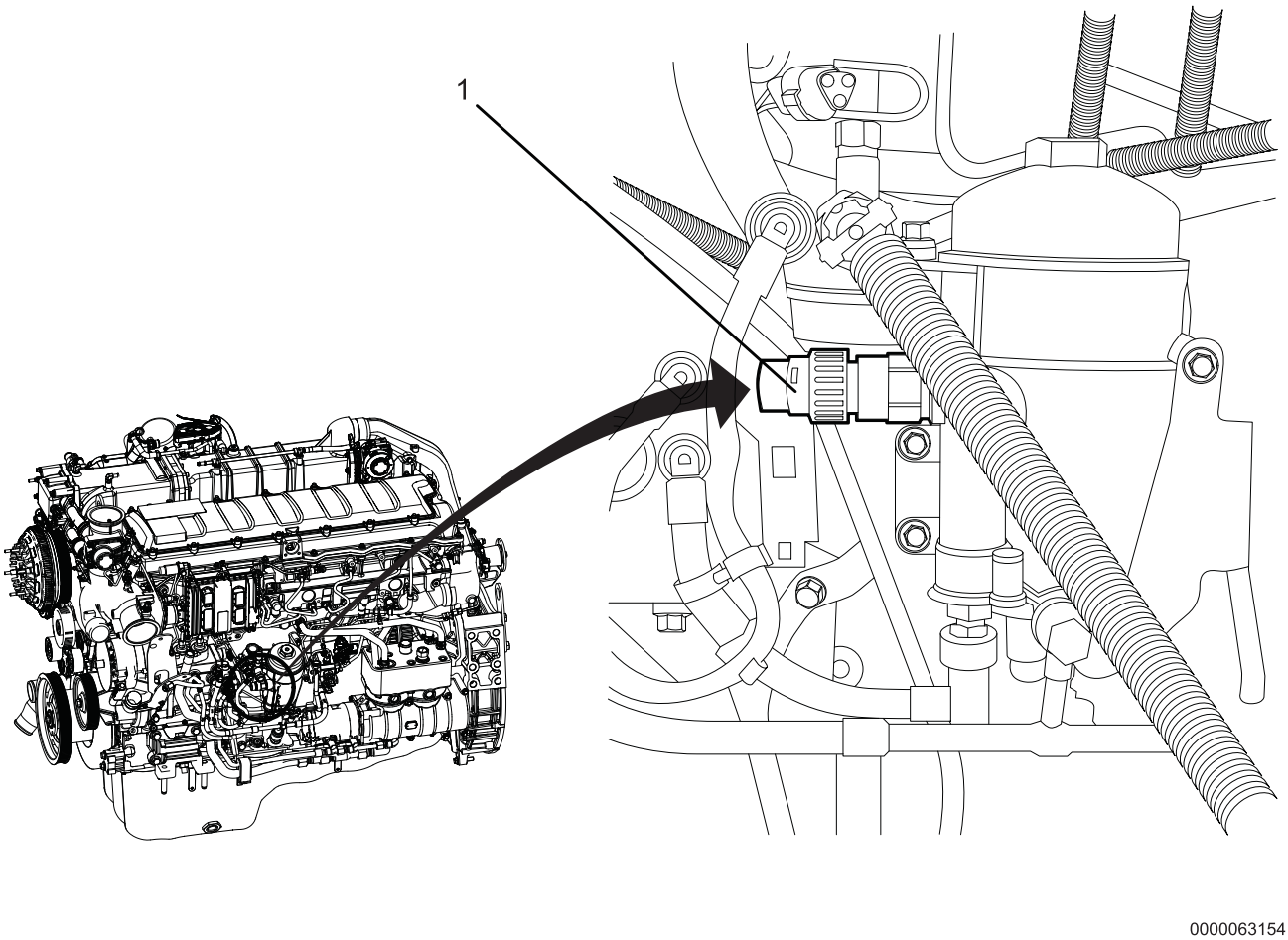

Figure 365 FDP Sensor Location

1. Fuel Delivery Pressure (FDP) sensor

SPN 94 FMI 0 - Fuel Delivery Pressure Above Critical

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Signal from Fuel Delivery Pressure (FDP) sensor above expected (in-range, but not rational).	Fuel delivery pressure > 145 psi (1000 kPa) or (130 psi [900 kPa] at idle)	Key-On Engine-Running (KOER)	2 seconds

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects that Fuel Delivery Pressure (FDP) is over 130 psi (900 kPa) at idle, or over 145 psi (1000 kPa) when engine speed is above idle.

Lamp Reaction

When fault is active, MIL will not illuminate.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- VREF5 circuit Open or high resistance
- SIG GND circuit Open or high resistance
- FDP circuit Open or high resistance
- Restricted secondary (engine) fuel filter
- Restriction in return line to fuel tank
- Failed Fuel Delivery Pressure (FDP) sensor

Step	Action	Decision
1	Inspect connections at Fuel Delivery Pressure (FDP) sensor. Key OFF, disconnect FDP sensor. Check FDP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the FDP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 94 FMI 0.

Step	Action	Decision
2	Check for a failed FDP sensor. Connect Fuel Inlet Restriction / Aeration Tool ZTSE4886 between low side pressure line and the inlet to the secondary (engine) mounted fuel filter. Connect Fuel Pressure Gauge ZTSE4681 to Fuel Inlet Restriction / Aeration Tool ZTSE4886. Run engine at idle and high idle, compare gauge with the ServiceMaxx value. (Note: ServiceMaxx reads 15 psi below gauge pressure). Do idle and high idle fuel pressure values stay within 2 psi each other?	Yes: Go to step 3. No: Go to step 5.

Step	Action	Decision
3	Check for a restricted secondary (engine) fuel filter. Perform the High-pressure Pump Inlet Pressure Test . Is fuel pressure constantly between 85 to 120 psi at low and high idle?	Yes: Go to step 4. No: Replace secondary fuel filter. After repairs are complete, retest for SPN 94 FMI 0.

Step	Action	Decision
4	Check for restriction in return line to fuel tank. Perform the HP Pump Fuel Return Pressure Test . Is fuel pressure < 13 psi?	Yes: Replace the FDP sensor. After repairs are complete, retest for SPN 94 FMI 0. No: Repair restriction in return line to fuel tank. After repairs are complete, retest for SPN 94 FMI 0.

Step	Action	Decision
5	Check for Open or high resistance in VREF5 circuit. Connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness and leave Engine Control Module (ECM) disconnected. Connect Breakout Harness ZTSE4881 to vehicle harness and leave FDP sensor disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness pin-1 to 180-pin Breakout Box pin E1-81. Is resistance less than 5 ohms?	Yes: Go to step 6. No: Repair Open or high resistance between FDP connector pin-1 and ECM pin E1-81. After repairs are complete, retest for SPN 94 FMI 0.

Step	Action	Decision
6	Check for Open or high resistance in SIG GND circuit. Connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness and leave ECM disconnected. Connect Breakout Harness ZTSE4881 to vehicle harness and leave FDP sensor disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness ZTSE4881 pin-2 to 180-pin Breakout Box pin E1-22. Is resistance less than 5 ohms?	Yes: Go to step 7. No: Repair Open or high resistance between FDP connector pin-2 and ECM pin E1-22. After repairs are complete, retest for SPN 94 FMI 0.

Step	Action	Decision
7	Check for Open or high resistance in FDP circuit. Connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness and leave ECM disconnected. Connect Breakout Harness ZTSE4881 to vehicle harness and leave FDP sensor disconnected. Key OFF, use a DMM to measure resistance from Breakout Harness pin-3 to 180-pin Breakout Box pin E1-35. Is resistance less than 5 ohms?	No: Replace the FDP sensor. After repairs are complete, retest for SPN 94 FMI 0. No: Repair Open or high resistance between FDP connector pin-3 and ECM pin E1-35. After repairs are complete, retest for SPN 94 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 94 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 94 FMI 3 - FDP Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Fuel Delivery Pressure (FDP) value greater than expected.	FDP sensor voltage greater than expected	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Fuel Delivery Pressure (FDP) voltage is greater than expected.

Lamp Reaction

Yellow Lamp will illuminate immediately.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- FDP circuit short to PWR
- SIG GND circuit Open
- Failed FDP sensor

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 94 FMI 3. Is EST DTC list SPN 94 FMI 3 active?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Fuel Delivery Pressure (FDP) sensor.	Decision
A. Key OFF. B. Disconnect FDP connector. C. Check FDP and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are FDP connector, harness, and terminals clean and undamaged?		Yes: Perform Pin Point Test (page 969). No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 94 FMI 3.

Pin-Point Test SPN 94 FMI 3

Figure 366 Fuel Delivery Pressure (FDP) Sensor Circuit Diagram

See the latest version of Navistar®N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4850
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF. B. Disconnect FDP sensor. C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). D. Key ON, log into ServiceMaxx™ software.

Test 1	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor FDP voltage.	0 volts ± 0.5 volts
Decision	
Is voltage 0 volts ± 0.5 volts?	Yes: Go to Test 2.
	No: Repair short to PWR between FDP pin-3 and Engine Control Module (ECM) pin E1-35. After repairs are complete, retest for SPN 94 FMI 3.

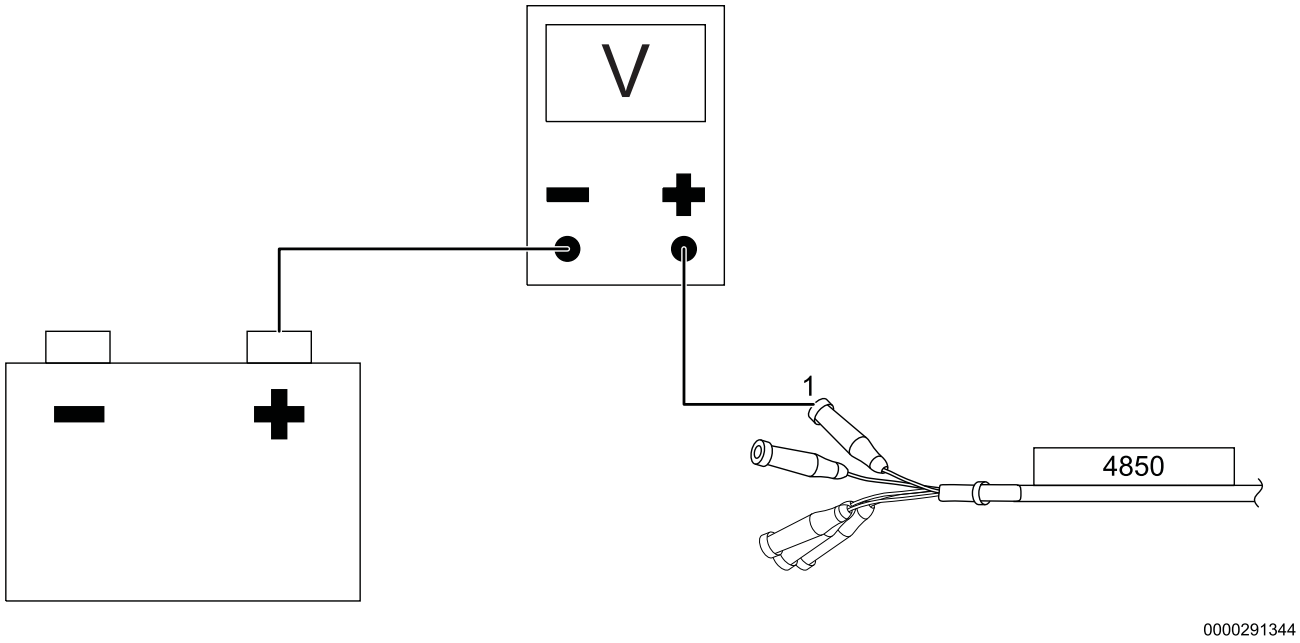

Figure 367 SIG GND Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave FDP sensor disconnected. C. Key ON.

Test 2	Specification
Using a Digital Multimeter (DMM), measure voltage between Breakout Harness ZTSE4850 pin-1 and PWR	B+ ± 0.5 volts
Decision	
Is voltage B+ ± 0.5 volts?	Yes: Replace FDP sensor. After repairs are complete, retest for SPN 94 FMI 3.
	No: Repair Open between FDP pin-1 and ECM pin E1-22. After repairs are complete, retest for SPN 94 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 94 FMI 3 fault code diagnostics.

SPN 94 FMI 4 - FDP Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Fuel Delivery Pressure (FDP) value less than expected.	FDP sensor voltage less than expected	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Fuel Delivery Pressure (FDP) sensor voltage is less than expected.

Lamp Reaction

Yellow Lamp will illuminate immediately.

Associated Faults

SPN 3513 FMI 14 (VREF 5)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- VREF 5 circuit Open or short to GND
- FDP circuit Open
- FDP circuit short to GND
- Failed FDP sensor

Step 1	Check for associated fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3513 FMI 14 (VREF 5). Is EST DTC list free of SPN 3513 FMI 14?		Yes: Go to Step 2. No: Repair SPN 3513 FMI 14. After repairs are complete, retest for SPN 94 FMI 4.

Step 2	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 94 FMI 4. Is EST DTC list SPN 94 FMI 4 active?		Yes: Go to Step 3. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 3	Inspect connections at Fuel Delivery Pressure (FDP) sensor.	Decision
A. Key OFF. B. Disconnect FDP connector. C. Check FDP and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are FDP connector, harness, and terminals clean and undamaged?		Yes: Perform Pin Point Test . No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 94 FMI 4.

Pin-Point Test SPN 94 FMI 4

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4850
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

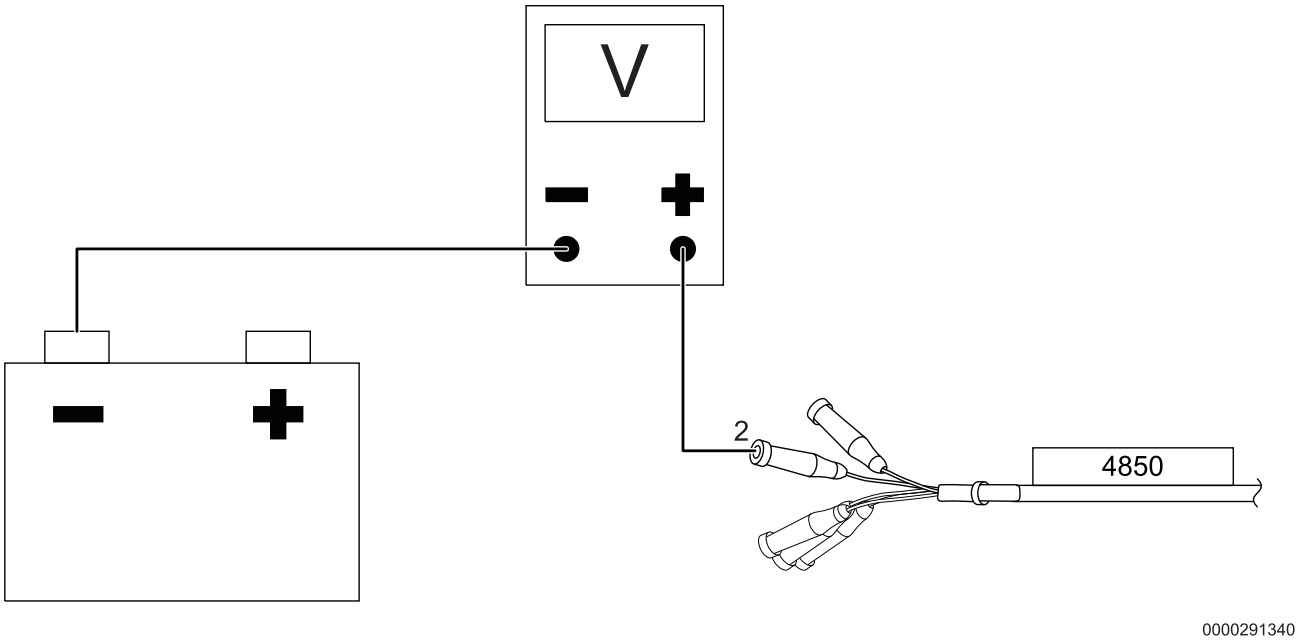

Figure 368 VREF 5 Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave FDP sensor disconnected. C. Key ON.

Test 1	Specification
Using a Digital Multimeter (DMM), measure voltage between Breakout Harness ZTSE4850 pin-2 and a known good GND	5 volts ± 0.5 volts
Decision	
Is voltage 5 volts ± 0.5 volts?	Yes: Go to Test 2.
	No: Repair Open or short to GND between FDP pin-2 and ECM pin E1-81. After repairs are complete, retest for SPN 94 FMI 4.

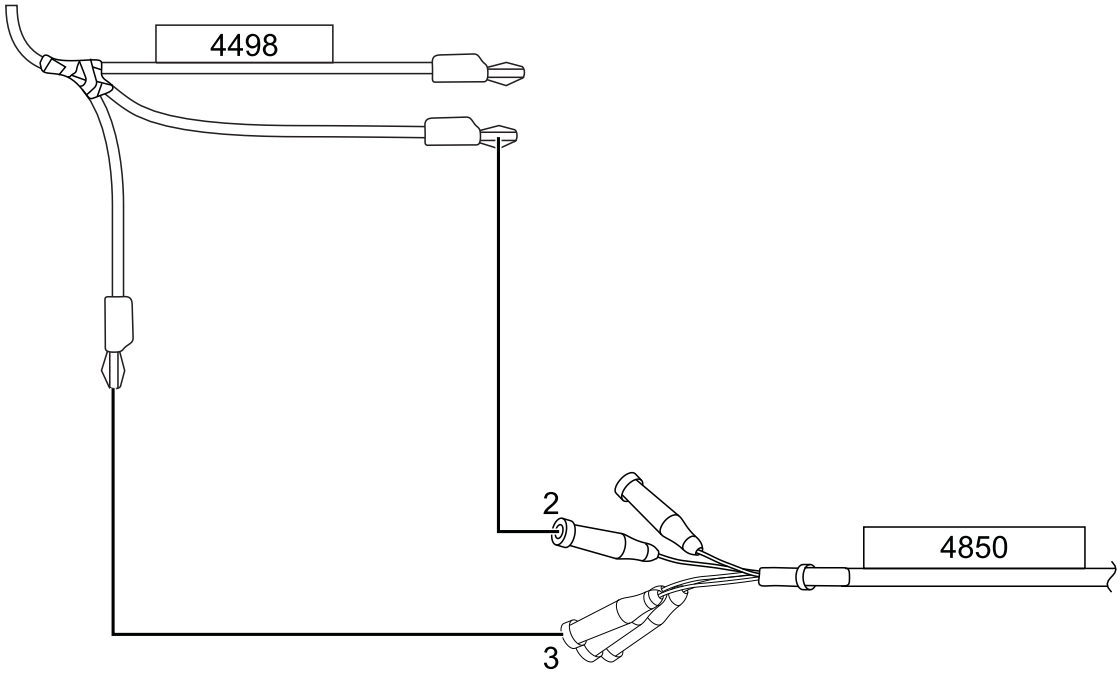

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Figure 369 FDP Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave FDP sensor disconnected. C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4850 pin-2 to pin-3. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON, log into ServiceMaxx™ software.

Test 2	Specification
Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor FDP voltage.	5 volts ± 0.5 volts
Decision	
Is voltage 5 volts ± 0.5 volts?	Yes: Replace FDP sensor. After repairs are complete, retest for SPN 94 FMI 4.
	No: Go to Test 3.

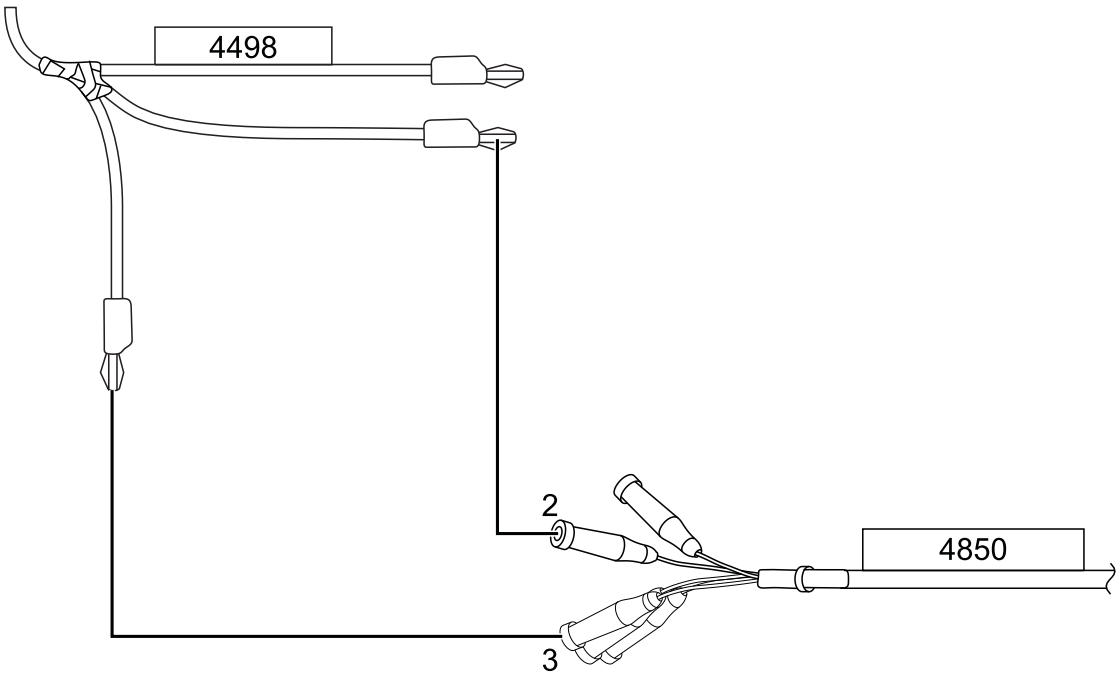

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Figure 370 FDP Circuit Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave FDP sensor disconnected. C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4850 pin-2 to pin-3. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON, log into ServiceMaxx™ software.

Test 3	Specification
Using EST with ServiceMaxx™ software, clear DTC list A. Key ON, clear codes. B. Key OFF, wait for EST screens to clear. C. Key ON, check DTC list for SPN 3513 FMI 14. Is EST DTC list SPN 3513 FMI 14 active?	SPN 94 FMI 3 sets in DTC list.
Decision	
Does SPN 3513 FMI 14 set in DTC list?	Yes: Repair short to GND between FDP pin-3 and ECM pin E1-35. After repairs are complete, retest for SPN 94 FMI 4.

	No: Repair Open between FDP pin-3 and ECM pin E1-35. After repairs are complete, retest for SPN 94 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 94 FMI 4 fault code diagnostics.

FPCV (Fuel Pressure Control Valve) Sensor

Overview of FPCV Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
633	3	FPCV short to PWR	• FPCV circuit short to PWR • Failed FPCV valve	Pin-Point Diagnostics (page 981)
633	4	FPCV short to GND	• FPCV circuit short to GND • Failed FPCV valve	Pin-Point Diagnostics (page 981)
633	5	FPCV open load/circuit	• FPCV circuit OPEN • Failed FPCV	Pin-Point Diagnostics (page 981)

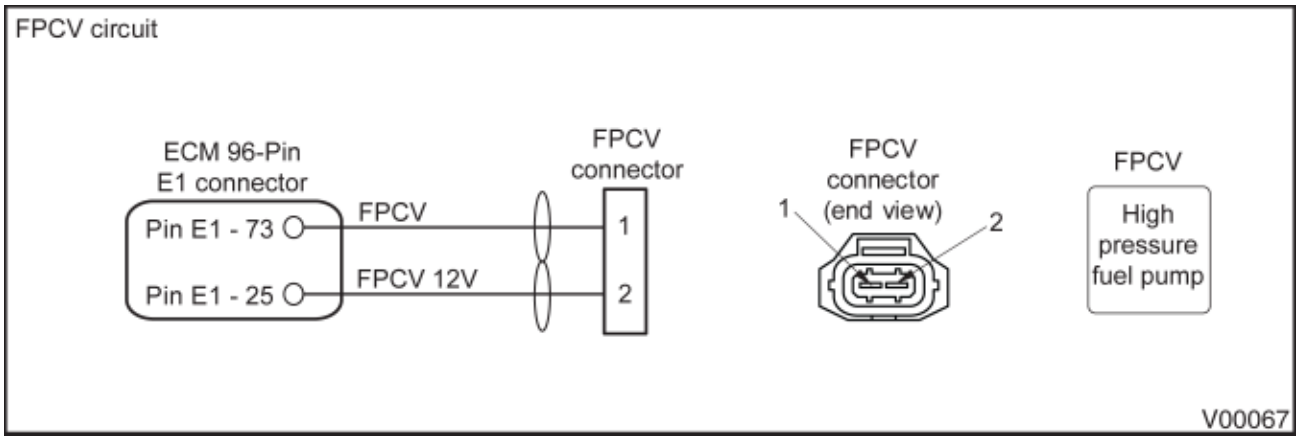

Figure 371 FPCV circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4828 (FPCV)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 633 FMI 3 - FPCV Short to PWR

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, select Tests > KOER Tests > High Pressure Pump Test.
2. Run High Pressure Pump Test.
   - If High Pressure Pump Test fails, check FPCV valve for mechanical problem.
   - If FPCV valve does not move, continue with pinpoint diagnostics.

Connector Voltage Check – FPCV Disconnected

Connect Breakout Harness ZTSE4828 to FPCV engine harness, and leave FPCV sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	B+	If < B+, OPEN circuit. Do Harness Resistance Check
1 to GND	0.8 V	If >1.3 V, Check for OPEN circuit. Do Harness Resistance Checks
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4828 between FPCV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Fuel Pressure Control Valve from the drop-down menu.
3. Command FPCV to 5%.
4. Use DMM to measure voltage.
5. Command FPCV to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5% = 8.5 V ± 1.0 V	If < 7.5 V, check for OPEN circuit. Do Harness Resistance Check.
1 to GND	95% = 1.5 V ± 0.5 V	If > 2.0 V, check for OPEN circuit or failed actuator.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4828 to FPCV engine harness, and leave FPCV sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
1 to E1-73	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for OPEN circuit.
2 to E1-25	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, the FPCV is working correctly. See High Pressure Fuel System in “HARD START AND NO START DIAGNOSTICS."

SPN 633 FMI 4 - FPCV Short to GND

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, select Tests > KOER Tests > High Pressure Pump Test.
2. Run High Pressure Pump Test.
   - If High Pressure Pump Test fails, check FPCV valve for mechanical problem.
   - If FPCV valve does not move, continue with pinpoint diagnostics.

Connector Voltage Check – FPCV Disconnected

Connect Breakout Harness ZTSE4828 to FPCV engine harness, and leave FPCV sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	B+	If < B+, OPEN circuit. Do Harness Resistance Check
1 to GND	0.8 V	If >1.3 V, Check for OPEN circuit. Do Harness Resistance Checks

If measurements are within specifications, do Operational Voltage Check.

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4828 between FPCV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Fuel Pressure Control Valve from the drop-down menu.
3. Command FPCV to 5%.
4. Use DMM to measure voltage.
5. Command FPCV to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5% = 8.5 V ± 1.0 V	If < 7.5 V, check for OPEN circuit. Do Harness Resistance Check.
1 to GND	95% = 1.5 V ± 0.5 V	If > 2.0 V, check for OPEN circuit or failed actuator.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4828 to FPCV engine harness, and leave FPCV sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
1 to E1-73	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for OPEN circuit.
2 to E1-25	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, the FPCV is working correctly. See High Pressure Fuel System in “HARD START AND NO START DIAGNOSTICS."		

SPN 633 FMI 5 - FPCV Open Load / Circuit

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, select Tests > KOER Tests > High Pressure Pump Test.
2. Run High Pressure Pump Test.
   - If High Pressure Pump Test fails, check FPCV valve for mechanical problem.
   - If FPCV valve does not move, continue with pinpoint diagnostics.

Connector Voltage Check – FPCV Disconnected

Connect Breakout Harness ZTSE4828 to FPCV engine harness, and leave FPCV sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	B+	If < B+, OPEN circuit. Do Harness Resistance Check
1 to GND	0.8 V	If >1.3 V, Check for OPEN circuit. Do Harness Resistance Checks
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4828 between FPCV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Fuel Pressure Control Valve from the drop-down menu.
3. Command FPCV to 5%.
4. Use DMM to measure voltage.
5. Command FPCV to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5% = 8.5 V ± 1.0 V	If < 7.5 V, check for OPEN circuit. Do Harness Resistance Check.
1 to GND	95% = 1.5 V ± 0.5 V	If > 2.0 V, check for OPEN circuit or failed actuator.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4828 to FPCV engine harness, and leave FPCV sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
1 to E1-73	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for OPEN circuit.
2 to E1-25	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, the FPCV is working correctly. See High Pressure Fuel System in “HARD START AND NO START DIAGNOSTICS."		

FRP (Fuel Rail Pressure) Sensor

Overview of FRP Sensor Group

SPN	FMI	Description
157	3	FRP signal Out of Range HIGH (page 984)
157	4	FRP signal Out of Range LOW (page 991)
157	20	FRP signal Drifted HIGH (page 994)
157	21	FRP signal Drifted LOW (page 996)

Overview

The Fuel Rail Pressure (FRP) sensor is a variable-capacitance sensor that measures fuel rail pressure at the high-pressure common fuel rail. As pressure increases, sensor capacitance changes causing the voltage sent to Engine Control Module (ECM) to change. The ECM adjusts the Fuel Pressure Control Valve (FPCV) duty cycle to match engine requirements for starting, engine load, speed, and temperature.

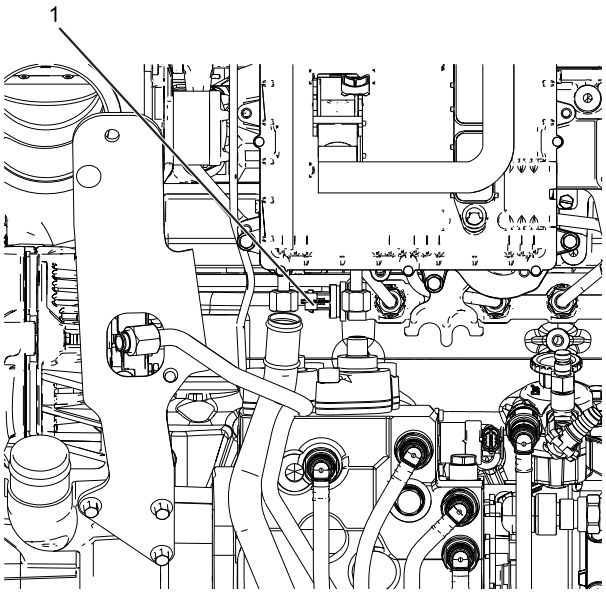

Figure 372 FRP Sensor Location

1. Fuel Rail Pressure (FRP) sensor

SPN 157 FMI 3 - FRP Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Fuel Rail Pressure (FRP) value greater than expected.	FRP sensor voltage > 4.81 volts	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Fuel Rail Pressure (FRP) voltage is greater than 4.81 volts.

Lamp Reaction

Amber Warning Lamp (AWL) will illuminate immediately.

Associated Faults

SPN 3514 FMI 14 (VREF 6)

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- FRP circuit short to PWR
- FRP circuit Open
- SIG GND circuit Open
- VREF6 circuit short GND
- VREF6 circuit Open
- Failed FRP sensor

Step 1	Check for associated fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3514 FMI 14 (VREF 6). Is EST DTC list free of SPN 3514 FMI 14?		Yes: Go to Step 2. No: Repair SPN 3514 FMI 14. After repairs are complete, retest for SPN 157 FMI 3.

Step 2	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 157 FMI 3. Is EST DTC list SPN 157 FMI 3 active?		Yes: Go to Step 3. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 3	Inspect connections at Fuel Rail Pressure (FRP) sensor.	Decision
A. Key OFF. B. Disconnect FRP connector. C. Check FRP and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are FRP connector, harness, and terminals clean and undamaged?		Yes: Perform Pin Point Test . No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 157 FMI 3.

Step 4	Check for short to PWR on FRP signal circuit.	Decision
Perform Test 1 (page 987). Use Digital Multimeter (DMM) to measure voltage between Breakout Harness ZTSE4829 pin-2 and a known good ground. Is voltage greater than 4.85 volts?		Yes: Go to Step 5. No: Repair short to PWR between FRP pin-2 and ECM pin E1-34. After repairs are complete, retest for SPN 157 FMI 3.

Step 6	Check for Open or short to GND in FRP signal circuit.	Decision
Perform Test 2 (page 988). Use DMM to measure voltage between Breakout Harness ZTSE4829 pin-3 and a known good ground. Is voltage 5 volts ± 0.5 volts?		Yes: Go to Step 6. No: Repair Open or short to GND between FRP pin-3 and ECM pin E1-88. After repairs are complete, retest for SPN 157 FMI 3.

Step 7	Perform Continuous Monitor Test.	Decision
Perform Test 3 (page 989). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor FRP voltage. Is voltage 0 ± 0.5 volts?		Yes: Replace FRP sensor. After repairs are complete, retest for SPN 157 FMI 3.
		No: Go to Step 8.

Step 8	Perform Continuous Monitor Test.	Decision
Perform Test 4 (page 990). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor FRP voltage. Is voltage 0 ± 0.5 volts?		Yes: Repair Open between FRP pin-1 and ECM pin E1–21. After repairs are complete, retest for SPN 157 FMI 3.
		No: Repair Open between FRP pin-2 and ECM pin E1–34. After repairs are complete, retest for SPN 157 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 157 FMI 3 fault code diagnostics.

Pin-Point Test SPN 157 FMI 3

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4829
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

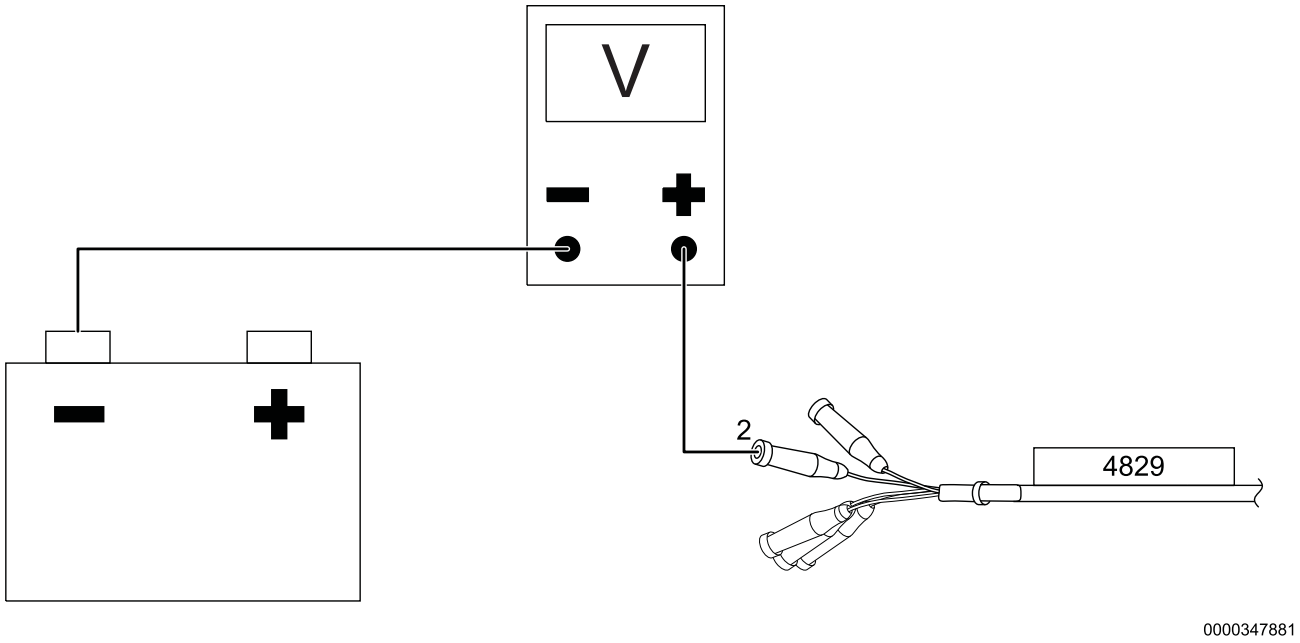

Figure 373 FRP Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4829 to vehicle harness and leave Fuel Rail Pressure (FRP) sensor disconnected. C. Key ON.

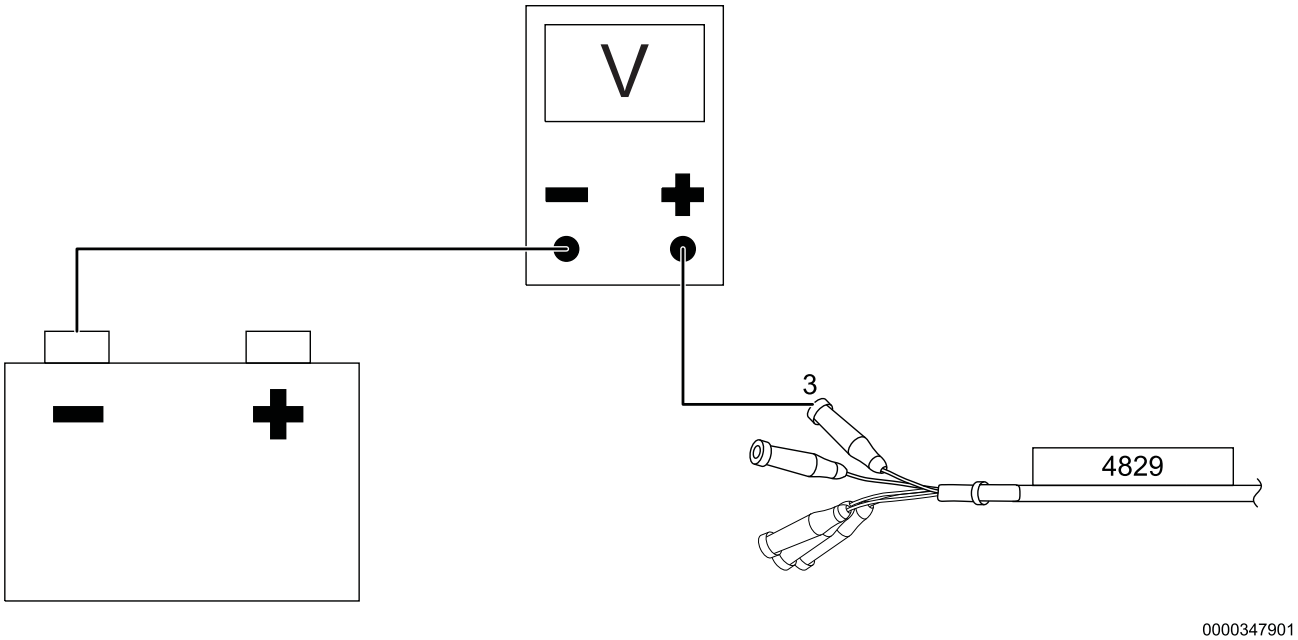

Figure 374 VREF 6 Circuit Check

Test 2 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4829 to vehicle harness and leave FRP sensor disconnected.
C. Key ON.

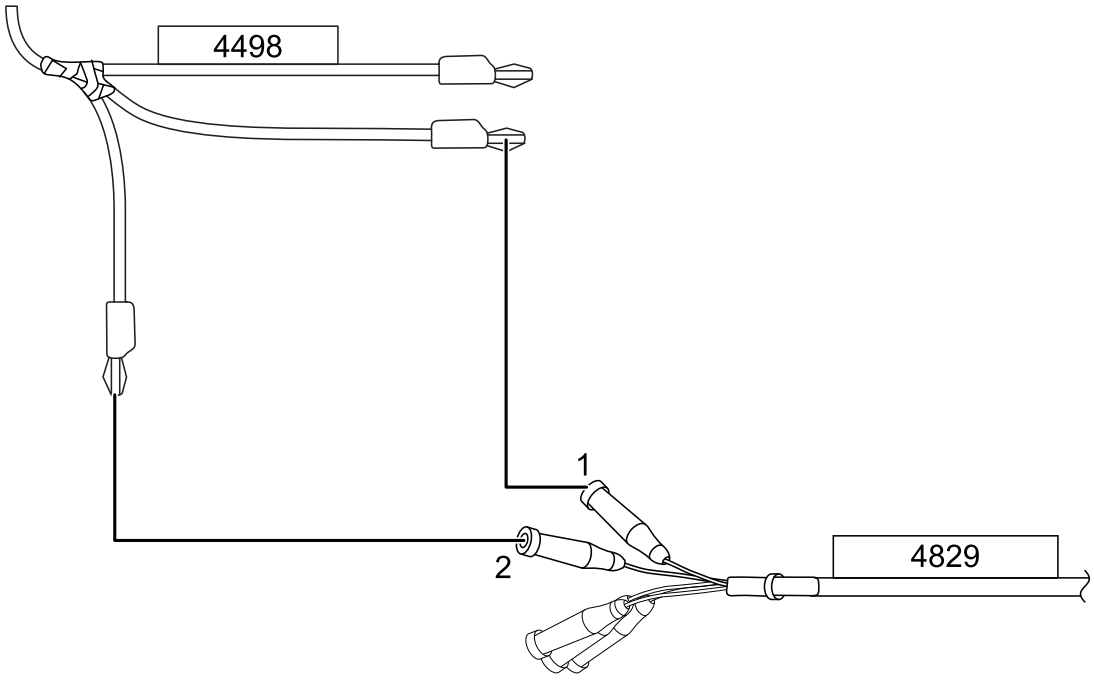

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Figure 375 FRP Circuit Check

Test 3 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4829 to vehicle harness and leave FRP sensor disconnected.
C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4829 pin-1 to pin-2
D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
E. Key ON, log into ServiceMaxx™ software.

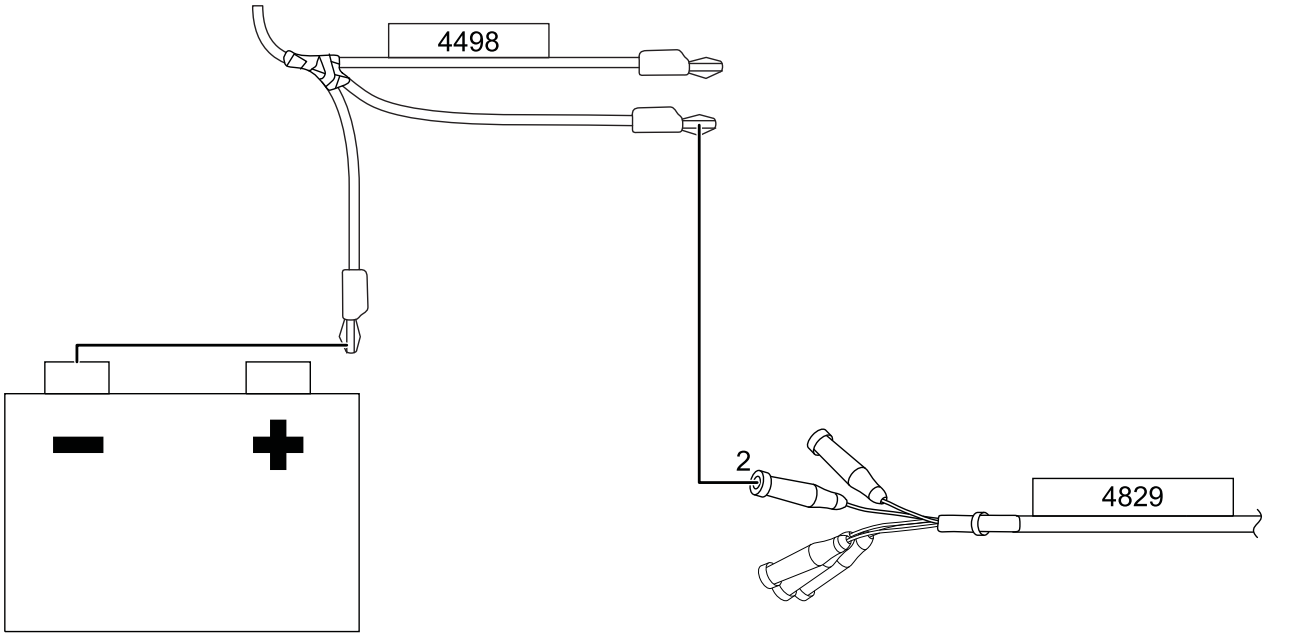

Figure 376 FRP Circuit Check

Test 4 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4829 to vehicle harness and leave FRP sensor disconnected. C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4829 pin-2 to a known good GND. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON, log into ServiceMaxx™ software.

SPN 157 FMI 4 - FRP Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Fuel Rail Pressure (FRP) value lower than expected.	FRP sensor voltage < 0.19 volts	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects Fuel Rail Pressure (FRP) voltage is lower than 0.19 volts.

Lamp Reaction

Yellow Lamp will illuminate immediately.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- FRP circuit short to GND
- Failed FRP sensor

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 157 FMI 3. Is EST DTC list SPN 157 FMI 4 active?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Fuel Rail Pressure (FRP) sensor.	Decision
A. Key OFF. B. Disconnect FRP connector. C. Check FRP and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are FRP connector, harness, and terminals clean and undamaged?		Yes: Go to Step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 157 FMI 4.

Step 3	Check for short to GND.	Decision
Perform Test 1 (page 993). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor FRP voltage. Is voltage 5 ± 0.5 volts?		Yes: Replace FRP sensor. After repairs are complete, retest for SPN 157 FMI 4. No: Repair short to GND between FRP pin-2 and ECM pin E1–34. After repairs are complete, retest for SPN 157 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 157 FMI 4 fault code diagnostics.

Pin-Point Test SPN 157 FMI 4

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF. B. Disconnect Fuel Rail Pressure (FRP) sensor. C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). D. Key ON, log into ServiceMaxx™ software.

SPN 157 FMI 20 - FRP Rationality Offset High

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure rationality offset high (during after run)	Fuel Rail Pressure (FRP) signal greater than 0.609 volts	Engine coolant temp. > 138°F (60°C) Key ON ECM in After Run (“house keeping”) Injector blank shot cycle complete	3 Events

Fault Overview

After shutdown, with enable conditions met, the Engine Control Module (ECM) operates after run cycle (for 30 to 45 seconds) to do needed "house keeping" operations. The after run cycle is the process the ECM goes through to save memory and shutdown.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

If SPN 3514 FMI 14 is active, correct and then retest for SPN 157 FMI 20.

Drive Cycle

See 2013 HD-OBD Diagnostic Reference Manual.

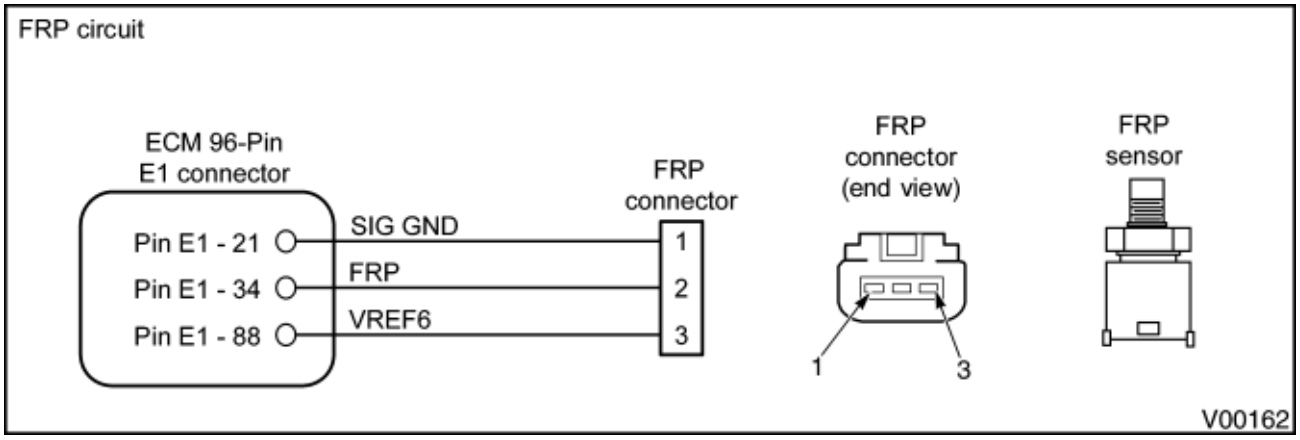

Figure 377 FRP sensor circuit diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 157 FMI 20 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 157 FMI 20.

Step	Action	Decision
2	Inspect connections at FRP sensor. Key OFF, disconnect FRP sensor. Check FRP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the FRP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 157 FMI 20.

Step	Action	Decision
3	Check FRP circuit for short to power. Using EST with ServiceMaxx™, run Continuous Monitor session. Key-On Engine-Off, FRP sensor connected. Does ServiceMaxx™ software show FRP sensor voltage less than 5.0 volts?	Yes: Go to step 4. No: Repair short to power from FRP sensor connector pin 2 to ECM 96–pin connector E1-34. After repairs are complete, retest for SPN 157 FMI 20.

Step	Action	Decision
4	Check SIG GND circuit for high resistance. With FRP sensor disconnected, connect Breakout Harness 4829. Measure resistance between FRP sensor connector pin 1 and a known good ground. Is resistance less than 5 ohms?	Yes: Replace FRP sensor. See Engine Service Manual. No: Repair high resistance between FRP sensor connector pin 1 and ECM 96–pin connector E1-21. After repairs are complete, retest for SPN 157 FMI 20.

NOTE: After doing all diagnostic steps, if SPN 157 FMI 20 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 157 FMI 21 - FRP Rationality Offset Low

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure rationality offset low (during after run)	Fuel Rail Pressure (FRP) signal less than 0.424 volts	Engine coolant temp. > 138°F (60°C) Key ON ECM in After Run (“house keeping”) Injector blank shot cycle complete	3 Events

Fault Overview

After shutdown, with enable conditions met, the Engine Control Module (ECM) operates after run cycle (for 30 to 45 seconds) to do needed "house keeping" operations. The after run cycle is the process the ECM goes through to save memory and shutdown.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

If SPN 3514 FMI 14 is active, correct and then retest for SPN 157 FMI 21.

Drive Cycle

See 2013 HD-OBD Diagnostic Reference Manual.

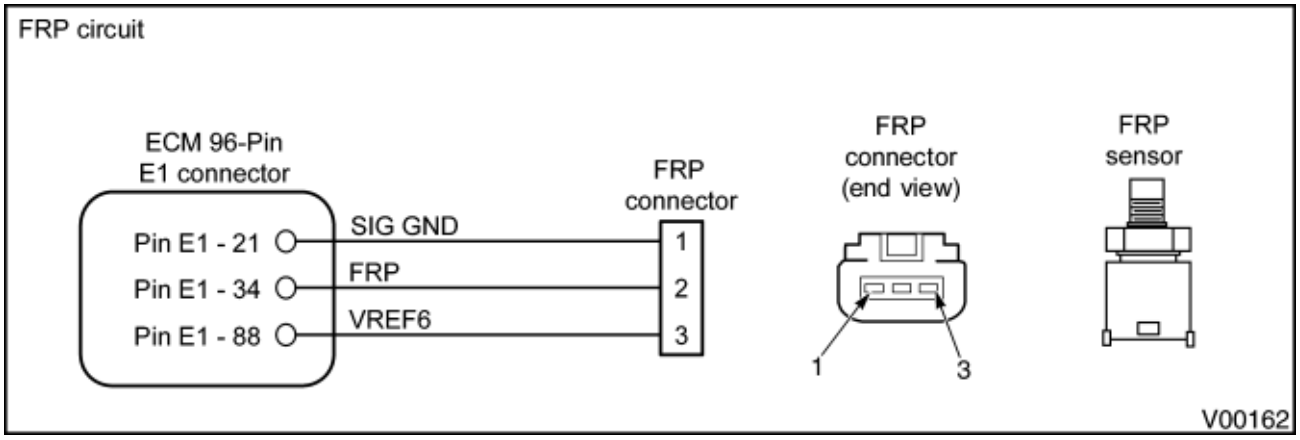

Figure 378 FRP sensor circuit diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 157 FMI 21 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 157 FMI 21.

Step	Action	Decision
2	Inspect connections at FRP sensor. Key OFF, disconnect FRP sensor. Check FRP sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the FRP sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 157 FMI 21.

Step	Action	Decision
3	Check FRP circuit for short to ground. Connect Breakout Harness 4829 to FRP sensor connector and leave FRP sensor disconnected. Use a DMM to measure resistance between Breakout harness 4829 test point 2 and a known, good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short to ground between FRP connector pin 2 and ECM 96–pin connector E1-34. After repairs are complete, retest for SPN 157 FMI 21.

Step	Action	Decision
4	Check VREF6 circuit for Open or high resistance. Key-On Engine-Off (KOEO), with Breakout Harness 4829 connected to FRP sensor connector, use a DMM to measure voltage between FRP sensor connector pin 3 and a known good ground. Is voltage 4.5 volts or greater?	Yes: Go to step 5. No: Repair high resistance between FRP sensor connector pin 3 and ECM 96–pin connector E1-88. After repairs are complete, retest for SPN 157 FMI 21.

Step	Action	Decision
5	Check FRP circuit for high resistance or Open. Using EST with ServiceMaxx™ software, run Continuous Monitor session. KOEO, with Breakout Harness 4829 connected, short FRP sensor connector pin 3 to pin 2. Does ServiceMaxx™ software show FRP sensor voltage 4.5 volts or more?	Yes: Replace FRP sensor. See Engine Service Manual. No: Repair high resistance between FRP sensor connector pin 2 and ECM 96–pin connector E1-34. After repairs are complete, retest for SPN 157 FMI 21.

NOTE: After doing all diagnostic steps, if SPN 157 FMI 21 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

FRP (Fuel Rail Pressure) System

Overview of FRP Group

SPN	FMI	Actions
157	0	FRP relief valve opening fault(page 1000)
157	14	FRP relief valve failure(page 1003)
157	31	Pressure Linearization Monitor(page 1006)
3055	0	FRP exceeded maximum (page 1007)
3055	1	Low Fuel Pressure at start (page 1009)
3055	15	FRP below minimum with maximum command (page 1013)
3055	17	FRP above maximum with minimum command (page 1017)

Overview

The Fuel Rail Pressure (FRP) sensor is a variable-capacitance sensor that measures pressure at the high-pressure common fuel rail. As pressure increases, sensor capacitance changes causing voltage to Engine Control Module (ECM) to change. The ECM adjusts the Fuel Pressure Control Valve (FPCV) duty cycle to control fuel pressure for starting and for changing engine load, speed, and temperature.

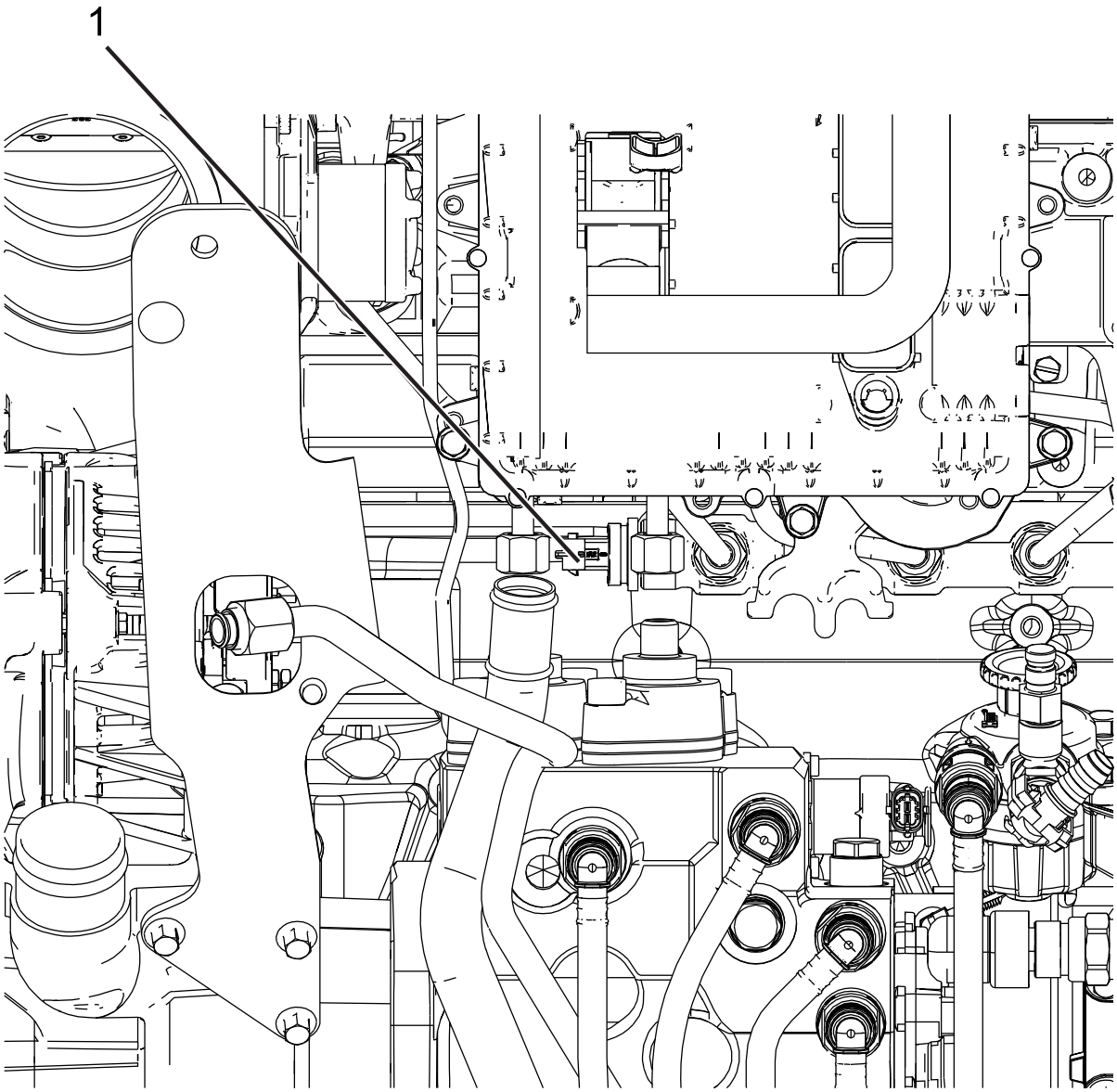

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Figure 379 FRP Sensor Location

1. Fuel Rail Pressure (FRP) sensor

SPN 157 FMI 0 - FRP relief valve opening fault

Condition / Description	Setting Criteria	Enable Conditions / Values
Fuel Rail Pressure (FRP) is less than expected. Fuel Pressure Relief Valve (FPRV) is opening.	FRP is less than expected.	Key ON > 5 seconds Engine Speed > 400 rpm

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Fuel Rail Pressure is less than expected because Fuel Pressure Relief Valve (FPRV) is opening. FPRV is a mechanical pressure relief valve that opens when rail pressure greater than about 37,700 psi (2600 bar). Opening of valve drops pressure to about 11,600 psi (800 bar) and vehicle will continue to operate at 11,600 psi (800 bar) until a key cycle occurs.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

• SPN 94 FMI 0 (FDP)	• SPN 157 FMI 3, 4, 20, and 21 (FRP)	• SPN 633 FMI 3, 4, and 5 (FPCV)	• SPN 3055 FMI 0 and 17 (FRP System)

Fault Facts

None

Drive Cycle to Determine Fault Status

Road Test

Possible Causes

- Restricted high pressure fuel pump return line
- Restricted low pressure fuel return lines
- Failed fuel supply line to low-pressure fuel pump
- Failed fuel primer pump
- Failed secondary fuel filter housing
- Failed Fuel Pressure Control Valve (FPCV)
- Failed FPRV

Step 1	Check for associated faults	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 1000). Is EST DTC list free of Associated Faults?		Yes: Go to step 2. No: Repair Associated Faults. After Repairs are completed, retest for SPN 157 FMI 0.

Step 2	Check fuel system for damage.	Decision
Perform Fuel System Inspection (page 1774). Are fuel lines and fuel filters clean and undamaged?		Yes: Go to step 3. No: Repair damaged fuel filters or fuel lines. After Repairs are completed, prime fuel system and retest for SPN 157 FMI 0.

Step 3	Check for restricted fuel return line.	Decision
Perform HP Pump Fuel Return Pressure Test (page 1700). Is return fuel pressure less than 13 psi?		Yes: Go to step 4. No: Repair restriction in fuel return line between engine and fuel tank. After Repairs are completed, retest for SPN 157 FMI 0.

Step 4	Check for high Fuel Delivery Pressure (FDP).	Decision
Perform HP Pump Inlet Pressure Test (page 1700). Is FDP greater than 120 psi?		Yes: Repair Secondary fuel filter housing or return fuel lines for restriction. After repairs are complete, retest for SPN 157 FMI 0. No: Go to step 5.

Step 5	Check for aerated fuel.	Decision
Perform Fuel Aeration Test (page 1684). Is fuel aerated?		Yes: Repair fuel aeration. After repairs are complete, retest for SPN 157 FMI 0. No: Go to step 6.

Step 6	Check for failed Fuel Pressure Control Valve (FPCV)	Decision
Using EST with ServiceMaxx™ software, record a snap shot in performance session with vehicle idling for 5 minutes. View Graphs of Recorded Data (page 1558), graph FRP and desired FRP. Does difference between FRP and desired FRP remain less than 1160 psi (80 bar) throughout snapshot?		Yes: Go to step 7. No: Replace Fuel Pressure Control Valve. After repairs are complete, retest for SPN 157 FMI 0.

Step 7	Check for failed Fuel Pressure Relief Valve (FPRV)	Decision
Perform HP Pump Return Flow Test Part 2 (page 1703). Does fuel flow from fuel rail during the test?		Yes: Replace fuel rail. Perform FRP Relief Valve Reset Procedure . After repairs are complete, retest for SPN 157 FMI 0.
		No: Retest for SPN 157 FMI 0.

End Diagnostic Tests
After performing all tests, if no problem is found, verify each step was completed correctly and the proper decision was made. Return to SPN 157 FMI 0 fault code diagnostics.

SPN 157 FMI 14 - FRP Relief Valve failure

Condition / Description	Setting Criteria	Enable Conditions / Values
Fuel Pressure Relief Valve (FPRV) has opened more than 50 times or has been open for more than 5 hours.	FPRV opening has been detected more than 50 times or has been open for more than 5 hours.	Key ON > 5 seconds Engine Speed > 400 rpm

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Fuel Pressure Relief Valve (FPRV) has opened more than 50 times or has been open for more than 5 hours. FPRV is a mechanical pressure relief valve that opens when rail pressure greater than about 37,700 psi (2600 bar). Opening of valve drops pressure to about 11,600 psi (800 bar) and vehicle will continue to operate at 11,600 psi (800 bar) until a key cycle occurs.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

• SPN 94 FMI 0 (FDP)	• SPN 157 FMI 3, 4, 20, and 21 (FRP)	• SPN 633 FMI 3, 4, and 5 (FPCV)	• SPN 3055 FMI 0 and 17 (FRP System)

Fault Facts

After diagnosis of this fault is complete, reset PP 95222 and 95212 values to 0.

Drive Cycle to Determine Fault Status

Road Test

Possible Causes

- Restricted high pressure fuel pump return line
- Restricted low pressure fuel return lines
- Failed fuel supply line to low-pressure fuel pump
- Failed fuel primer pump
- Failed secondary fuel filter housing
- Failed Fuel Pressure Control Valve (FPCV)
- Failed FPRV

Step 1	Check for associated faults	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 1003) Is EST DTC list free of Associated Faults?		Yes: Go to step 2. No: Repair Associated Faults. After Repairs are completed, retest for SPN 157 FMI 14.

Step 2	Check fuel system for damage.	Decision
Perform Fuel System Inspection (page 1774). Are fuel lines and fuel filters clean and undamaged?		Yes: Go to step 3. No: Repair damaged fuel filters or fuel lines. Perform FRP Relief Valve Reset(page 1619) procedure. After Repairs are completed, retest for SPN 157 FMI 14.

Step 3	Check for restricted fuel return line.	Decision
Perform HP Pump Fuel Return Pressure Test (page 1700). Is return fuel pressure less than 13 psi?		Yes: Go to step 4. No: Repair restriction in fuel return line between engine and fuel tank. Perform FRP Relief Valve Reset(page 1619) procedure. After Repairs are completed, retest for SPN 157 FMI 14.

Step 4	Check for high Fuel Delivery Pressure (FDP).	Decision
Perform HP Pump Inlet Pressure Test (page 1700). Is FDP greater than 120 psi?		Yes: Repair Secondary fuel filter housing or return fuel lines for restriction. Perform FRP Relief Valve Reset(page 1619) procedure. After repairs are complete, retest for SPN 157 FMI 14. No: Go to step 5.

Step 5	Check for aerated fuel.	Decision
Perform Fuel Aeration Test (page 1684). Is fuel aerated?		Yes: Repair fuel aeration. Perform FRP Relief Valve Reset(page 1619) procedure. After repairs are complete, retest for SPN 157 FMI 14. No: Go to step 6.

Step 6	Check for failed Fuel Pressure Control Valve (FPCV)	Decision
Using EST with ServiceMaxx™ software, record a snap shot of performance session with vehicle idling for 5 minutes. View Graphs of Recorded Data (page 1558), graph FRP and desired FRP. Does difference between FRP and desired FRP remain less than 1160 psi (80 bar) throughout snapshot?		Yes: Go to step 7. No: Replace Fuel Pressure Control Valve. Perform FRP Relief Valve Reset(page 1619) procedure. After repairs are complete, retest for SPN 157 FMI 14.

Step 7	Check for failed Fuel Pressure Relief Valve (FPRV)	Decision
Perform HP Pump Return Flow Test Part 2 (page 1703). Does fuel flow from fuel rail during the test?		Yes: Replace fuel rail. Perform FRP Relief Valve Reset(page 1619) procedure. After repairs are complete, retest for SPN 157 FMI 14. No: Perform FRP Relief Valve Reset(page 1619) procedure. After repairs are complete, retest for SPN 157 FMI 14.

End Diagnostic Tests
After performing all tests, if no problem is found, verify each step was completed correctly and the proper decision was made. Return to SPN 157 FMI 14 fault code diagnostics.

SPN 157 FMI 31 - Pressure Linearization Monitor

Condition / Description	Setting Criteria	Enable Conditions / Values
TBD	TBD	Key ON

Fault Overview

Lamp Reaction

Associated Faults

Fault Facts

Drive Cycle to Determine Fault Status

Possible Causes

•

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 3055 FMI 0 - FRP Exceeded Maximum

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure (FRP) above maximum pressure.	FRP greater than 34,000 psi (235,000 kpa)	Key ON Closed loop FRP control	0.25 seconds

Fault Overview

Fault code sets when signal from the Fuel Rail Pressure (FRP) sensor indicates FRP exceeds 34,000 psi (235,000 kPa).

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20, and 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Restricted high-pressure pump fuel return line
- Failed Fuel Pressure Control Valve (FPCV) (sticking)

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20, and 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV). Is the EST DTC list free of SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21 and SPN 633 FMI 3, 4, and 5?	Yes: Go to step 2. No: Repair SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21; and SPN 633 FMI 3, 4, and 5. After repairs are complete, retest for SPN 3055 FMI 0.

Step	Action	Decision
2	Check for restricted fuel return line. Perform HP Pump Fuel Return Pressure Test . Is pressure < 13 psi?	Yes: Go to step 3. No: Repair restriction in fuel return line between high-pressure fuel pump and fuel tank. After repairs are complete, retest for SPN 3055 FMI 0.

Step	Action	Decision
3	Check for a failed Fuel Pressure Control Valve (FPCV). Key OFF, connect Breakout Harness ZTSE4828 to FPCV and leave vehicle harness disconnected. Using a DMM, measure resistance between ZTSE4828 pin-1 and pin-2. Is resistance between 2.6 and 3.2 ohms?	Yes: Go to step 4. No: Replace FPCV. After repairs are complete, retest for SPN 3055 FMI 0.

Step	Action	Decision
4	Check for a sticking FPCV. Run engine at idle. Using EST, monitor the difference between the desired and actual fuel rail pressure for 5 minutes. Does pressure difference remain < 1160 psi (80 Bar) throughout the test?	Yes: Retest for SPN 3055 FMI 0. No: Replace FPCV. After repairs are complete, retest for SPN 3055 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 3055 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3055 FMI 1 - Low Fuel Pressure at Start

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure (FRP) below minimum pressure.	FRP less than 1,450 psi (10,000 kpa)	Engine Speed > 70 rpm Ambient Pressure > 12 psi (83 kPa) Ambient Temp > 19°F (-7°C) Battery Voltage (before crank) > 11 Volts	0.5 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects Fuel Rail Pressure (FRP) does not build within a predetermined time while the engine is cranking.

Lamp Reaction

MIL may illuminate when this fault is detected during one drive cycle.

Associated Faults

SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20, and 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV)

Fault Facts

The KUEV valve is a flow control valve that allows return fuel to lubricate the internal components of the high-pressure fuel pump when the engine is running. The KUEV valve can be serviced separately from the high-pressure fuel pump.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Fuel Rail Pressure (FRP) sensor or circuit fault
- Low fuel level
- Low-pressure fuel system leaks
- Restricted engine mounted secondary fuel filter
- Aerated fuel delivery
- Restricted low pressure fuel system
- Internal leak in high-pressure fuel system
- Leaking fuel pressure relief valve
- Leaking KUEV valve
- Stuck or sticking FPCV
- Failed low-pressure fuel pump

- Failed high-pressure fuel pump

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20, and 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV). Is EST DTC list free of SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21; and SPN 633 FMI 3, 4, and 5?	Yes: Go to step 2. No: Repair SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21; and SPN 633 FMI 3, 4, and 5. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
2	Check fuel level. Read fuel level using the vehicle instrument panel gauge and perform a visual inspection of fluid level in the fuel tank. Is fuel tank fluid level above 1/2 tank?	Yes: Go to step 3. No: Add fuel and prime engine. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
3	Check fuel tank, fuel lines, and fuel filter assembles for: cracks and pitting; and loose, leaking, or damaged connections. Are the fuel tank, fuel lines, and fuel filter assembles in good condition and Not leaking?	Yes: Go to step 4. No: Add fuel or repair leaks, and prime engine. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
4	Check that the engine cranks at a minimum of 130 rpm. Crank engine for maximum of 20 seconds. Does engine crank at a minimum of 130 rpm?	Yes: Go to step 5. No: Repair low cranking speed. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
5	Verify the engine starts. Crank engine for maximum of 20 seconds. If engine does not start, wait 2 minutes and try again. Does engine start and maintain idle?	Yes: Go to SPN 3055 FMI 15 (page 1013). No: Go to step 6.

Step	Action	Decision
6	Check for a failed FRP sensor or circuit. Disconnect the FRP sensor electrical connector and attempt to start engine. Crank engine for maximum of 20 seconds. Does the engine start?	Yes: Diagnose FRP Sensor (page 983). After repairs are complete, retest for SPN 3055 FMI 1. No: Reconnect sensor and go to step 7.

Step	Action	Decision
7	Check for low FDP. Perform Fuel Delivery Pressure (FDP) Test . Does FDP measure > 30 psi (15 psi in ServiceMaxx™)?	Yes: Go to step 11. No: Go to step 8.

Step	Action	Decision
8	Check for leaks or restrictions in the fuel supply to the low-pressure fuel pump. Perform Fuel Dead head Test . Is fuel dead head pressure greater than 65 psi?	Yes: Go to step 11. No: Go to step 9.

Step	Action	Decision
9	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test . Is low-pressure fuel system free from aeration?	Yes: Go to step 10. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
10	Check for restriction in low-pressure fuel system. Perform Fuel Restriction Test . Is low-pressure fuel system free of restrictions?	Yes: Replace low-pressure fuel pump. After repairs are complete, retest for SPN 3055 FMI 1. No: Repair restriction in low-pressure fuel system. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
11	Check for a restricted engine mounted secondary fuel filter. Perform High-pressure Pump Inlet Pressure Test . Does the fuel pressure gauge read > 30 psi?	Yes: Go to step 12. No: Replace engine mounted secondary fuel filter. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
12	Check for excessive fuel return. Perform Fuel Rail Pressure (FRP) Return Flow Test Part 1 . Is the fuel volume returned between 20-22 ml?	Yes: Go to step 15. No: Go to step 13.

Step	Action	Decision
13	Check for a failed fuel pressure relief valve. Perform Fuel Rail Pressure (FRP) Return Flow Test Part 2 . Is the line free of return fuel from fuel rail?	Yes: Go to step 14.
		No: Replace fuel pressure relief valve. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
14	Check for an internal leak in the high-pressure fuel system. Perform Fuel Rail Pressure (FRP) Leak Isolation . Is fuel leaking out of High Pressure Return Line Tester ZTSE4887?	Yes: Retest for SPN 3055 FMI 1. If fault is still present notify supervisor for further action.
		No: Replace the last capped injector, injector tube, and all HP lines removed during this test. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
15	Check for a failed KUEV valve. Perform the HP Pump Return Flow Test . Is High Pressure Return Line Tester ZTSE4887 free of fuel from the high-pressure pump return port?	Yes: Replace the high-pressure fuel pump. After repairs are complete, go to step 16.
		No: Replace KUEV valve. After repairs are complete, retest for SPN 3055 FMI 1.

Step	Action	Decision
16	Verify the fuel return line is free from restriction. Run HP Pump Fuel Return Pressure Test . Is pressure < 13 psi?	Yes: Retest for SPN 3055 FMI 1. If fault is still present notify supervisor for further action.
		No: Repair restriction in fuel return line between high-pressure fuel pump and fuel tank. After repairs are complete, retest for SPN 3055 FMI 1.

NOTE: After performing all diagnostic steps, if SPN 3055 FMI 1 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3055 FMI 15 - FRP Below Minimum with Maximum Command

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure (FRP) governor deviation above maximum limit	Rail pressure governor error > 725 psi at 600-750 rpm	Key ON Metering unit flow > function engine speed (41,500-55,000 mm^3/s) Engine mode normal Engine speed > 0 rpm OR FRP > 13,050 psi (90,000 kpa) for more than 20 engine revolutions Metering unit flow < 327,670 mm^3/sec	10 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects Fuel Rail Pressure (FRP) is below minimum when the maximum is commanded.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 157 FMI 3, 4, 20, 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Low fuel level
- Fuel pressure fuel system leaks
- Restricted engine mounted secondary fuel filter
- Aerated fuel delivery
- Restricted fuel supply
- Internal leak in high-pressure fuel system
- Leaking fuel pressure relief valve
- Leaking KUEV valve
- Stuck or sticking FPCV
- Failed low-pressure fuel pump
- Failed high-pressure fuel pump

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 157 FMI 3, 4, 20, and 21 (FRP) or SPN 633 FMI 3, 4, and 5 (FPCV). Is the EST DTC list free of SPN 157 FMI 3, 4, 20, and 21, and SPN 633 FMI 3, 4, and 5?	Yes: Go to step 2. No: Repair SPN 157 FMI 3, 4, 20, and 21, and SPN 633 FMI 3, 4, and 5. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
2	Check fuel level. Read fuel level using the vehicle instrument panel gauge and perform a visual inspection of fluid level in the fuel tank. Is fuel tank fluid level above 1/2 tank?	Yes: Go to step 3. No: Add fuel and prime engine. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
3	Check fuel tank, fuel lines, and fuel filter assembles for: cracks and pitting; and loose, leaking, or damaged connections. Are the fuel tank, fuel lines, and fuel filter assembles in good condition and Not leaking?	Yes: Go to step 4. No: Add fuel or repair leaks, and prime engine. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
4	Check that the engine cranks at a minimum of 130 rpm. Crank engine for maximum of 20 seconds. Does engine crank at a minimum of 130 rpm?	Yes: Go to step 5. No: Repair low cranking speed. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
5	Verify the engine starts. Crank engine for maximum of 20 seconds. If engine does not start, wait 2 minutes and try again. Does engine start and maintain idle?	Yes: Go to step 6. No: Go to SPN 3055 FMI 1 (page 1009).

Step	Action	Decision
6	Check for low FDP. Perform Fuel Delivery Pressure (FDP) Test (page 1680). Does FDP measure between 85 - 120 psi?	Yes: Go to step 10. No: Go to step 7.

Step	Action	Decision
7	Check for leaks or restrictions in the fuel supply to the low-pressure fuel pump. Perform Fuel Dead head Test . Is fuel dead head pressure greater than 65 psi?	Yes: Go to step 10. No: Go to step 8.

Step	Action	Decision
8	Check for aeration in low-pressure fuel system. Perform Fuel Aeration Test . Is low-pressure fuel system free from aeration?	Yes: Go to step 9. No: Repair aeration in low-pressure fuel system. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
9	Check for restriction in low-pressure fuel system. Perform Fuel Restriction Test . Is low-pressure fuel system free of restrictions?	Yes: Retest for SPN 3055 FMI 15. If fault is still present notify supervisor for further action. No: Repair restriction in low-pressure fuel system. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
10	Check for a restricted engine mounted secondary fuel filter. Perform High-pressure Pump Inlet Pressure Test . Does the fuel pressure gauge read > 30 psi?	Yes: Go to step 11. No: Replace engine mounted secondary fuel filter. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
11	Check for excessive fuel return. Perform Fuel Rail Pressure (FRP) Return Flow Test Part 1 . Is the fuel volume returned between 20-22 ml?	Yes: Go to step 14. No: Go to step 12.

Step	Action	Decision
12	Check for a failed fuel pressure relief valve. Perform Fuel Rail Pressure (FRP) Return Flow Test Part 2 (page 1703). Is the line free of return fuel from fuel rail?	Yes: Go to step 13. No: Replace fuel pressure relief valve. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
13	Check for an internal leak in the high-pressure fuel system. Perform Fuel Rail Pressure (FRP) Leak Isolation . Is fuel leaking out of High Pressure Return Line Tester ZTSE4887?	Yes: Retest for SPN 3055 FMI 15. If fault is still present notify supervisor for further action.
		No: Replace the last capped injector, injector tube and all HP lines removed during this test. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
14	Check for a failed KUEV valve. Perform the HP Pump Return Flow Test . Is High Pressure Return Line Tester ZTSE4887 free of fuel from the high-pressure pump return port while cranking?	Yes: Replace the high-pressure fuel pump. After repairs are complete, go to step 15.
		No: Replace KUEV valve. After repairs are complete, retest for SPN 3055 FMI 15.

Step	Action	Decision
15	Verify the fuel return line is free from restriction. Run HP Pump Fuel Return Pressure Test . Is pressure < 13 psi?	Yes: Retest for SPN 3055 FMI 15. If fault is still present notify supervisor for further action.
		No: Repair restriction in fuel return line between high-pressure fuel pump and fuel tank. After repairs are complete, retest for SPN 3055 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 3055 FMI 15 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3055 FMI 17 - FRP Above Maximum with Minimum Command

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Fuel Rail Pressure (FRP) governor deviation below minimum limit	FRP governor error less than 725 psi at 600-750 rpm	Key ON ECM Not in limp-home mode Metering unit flow < 327,670 mm^3/sec Engine speed > 0 rpm OR FRP > 13,053 psi (90,000 kpa) for more than 20 engine revolutions Fuel injector quantity command > 5 mg/stroke ECT1 > -40°F (-40°C) Engine Not overrunning	10 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects Fuel Rail Pressure (FRP) exceeds 13,053 psi (90,000 kPa) when the Fuel Pressure Control Valve (FPCV) is commanded to minimum pressure.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20, 21 (FRP); and SPN 633 FMI 3, 4, and 5 (FPCV)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Restricted high-pressure pump fuel return line
- FRP sensor or circuit fault
- Fuel Pressure Control Valve (FPCV) or circuit fault

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 FMI 0 (FDP); SPN 157 FMI 3, 4, 20; and 21 (FRP) or SPN 633 FMI 3, 4, and 5 (FPCV). Is the EST DTC list free of SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21; and SPN 633 FMI 3, 4, and 5?	Yes: Go to step 2. No: Repair SPN 94 FMI 0; SPN 157 FMI 3, 4, 20, and 21; and SPN 633 FMI 3, 4, and 5. After repairs are complete, retest for SPN 3055 FMI 17.

Step	Action	Decision
2	Check for restricted fuel return line. Perform HP Pump Fuel Return Pressure Test . Is pressure < 13 psi?	Yes: Go to step 3. No: Repair restriction in fuel return line between high-pressure fuel pump and fuel tank. After repairs are complete, retest for SPN 3055 FMI 17.

Step	Action	Decision
3	Check for a failed FRP sensor or circuit. Disconnect the FRP sensor electrical connector and attempt to start engine. Crank engine for maximum of 20 seconds. Does the engine start and maintain idle?	Yes: Diagnose FRP Sensor (page 983). After repairs are complete, retest for SPN 3055 FMI 17. No: Reconnect sensor and go to step 4.

Step	Action	Decision
4	Check for a failed Fuel Pressure Control Valve (FPCV). Key OFF, connect Breakout Harness ZTSE4828 to FPCV and leave vehicle harness disconnected. Using a DMM, measure resistance between ZTSE4828 pin-1 and pin-2. Is resistance between 2.6 and 3.2 ohms?	Yes: Go to step 5. No: Replace FPCV. After repairs are complete, retest for SPN 3055 FMI 17.

Step	Action	Decision
5	Check for a sticking FPCV. Run engine at idle. Using EST, monitor the difference between the desired and actual fuel rail pressure for 5 minutes. Does the pressure difference maintain < 1160 psi (80 bar) throughout the test?	Yes: Retest for SPN 3055 FMI 17. No: Replace FPCV. After repairs are complete, retest for SPN 3055 FMI 17.

NOTE: After performing all diagnostic steps, if SPN 3055 FMI 17 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

FRPRV Sensor

Overview of FRPRV Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
157	0	FRP relief valve opening fault	• Outdated ECM calibration	Calibration out-of-date

SPN 157 FMI 0 - FRP Relief Valve Opening

Fuel Level Sensor

Overview of Fuel Level Sensor Group

SPN	FMI	Description
96	3	Fuel Level signal Out of Range HIGH (page 1021)
96	4	Fuel Level signal Out of Range LOW (page 1023)
96	19	Fuel Level not detected on J1939 (page 1025)

Overview

The fuel level is broadcast on the J1939 public Controller Area Network (CAN) bus. This signal is sent from the Body Controller (BC) which is where the fuel level signal is received. If the BC is not located on J1939 many other CAN networks may be affected.

SPN 96 FMI 3 - Fuel Level signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Fuel level sensor is shorted to PWR or Open in fuel level sensor circuit.	Body Controller detects that fuel level sensor voltage is too high	Key ON

Fault Overview

Fault code sets when the Body Controller detects high signal voltage on fuel level sensor circuit.

Lamp Reaction

None

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Fuel Level Sensor circuit fault

Step 1	Check for active or pending fault codes.	Decision
Verify that Body Controller (BC) is communicating. Using EST, check that the BC is listed in the Sniffer section. Is the Body Controller listed?		Yes: Diagnose fuel level circuit fault. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 96 FMI 3.
		No: Repair Body Controller fault. After repairs are complete, retest for SPN 96 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 96 FMI 3 fault code diagnostics.

SPN 96 FMI 4 - Fuel Level signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Fuel level sensor is shorted to GND	Body Controller detects low signal voltage on fuel level sensor circuit	Key ON

Fault Overview

Fault code sets when the Body Controller detects low signal voltage on fuel level sensor circuit.

Lamp Reaction

None

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Fuel Level Sensor circuit fault

Step 1	Check for active or pending fault codes.	Decision
Verify that Body Controller (BC) is communicating. Using EST, check that the BC is listed in the Sniffer section. Is the Body Controller listed?		Yes: Diagnose fuel level circuit fault. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 96 FMI 4.
		No: Repair Body Controller fault. After repairs are complete, retest for SPN 96 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 96 FMI 4 fault code diagnostics.

SPN 96 FMI 19 - Fuel Level Not Detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Fuel level signal message not present on J1939 bus.	Fuel level signal message not present	Key ON

Fault Overview

Fault code sets when the Body Controller detects no fuel level signal message.

Lamp Reaction

None

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- Fuel Level Sensor circuit fault

Step 1	Check for active or pending fault codes.	Decision
Verify that Body Controller (BC) is communicating. Using EST, check that the BC is listed in the Sniffer section. Is the Body Controller listed?		Yes: Diagnose fuel level circuit fault. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 96 FMI 19.
		No: Repair Body Controller fault. After repairs are complete, retest for SPN 96 FMI 19.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 96 FMI 19 fault code diagnostics.

IAH (Intake Air Heater Control) Sensor

Overview of IAH Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
626	18	Inlet Air Heater fault: Lack of heat in the Intake Manifold	• Biased IMT sensor or circuit • Inlet Air Heater system failure • Failed Inlet Air Heater Fuel Solenoid (IAHFS) • Failed IAH • Failed Inlet Air Heater Relay (IAHR) • Inlet Air Heater circuit faults • Aftermarket engine block heater • Low Fuel Delivery Pressure (FDP)	Pin-Point Diagnostics (page 1029)
3061	31	Inlet Air Heater system warm-up fault during CSER	• Aftermarket engine block heater installed • Low Fuel Delivery Pressure (FDP) • Leaking or damaged fuel line to the Inlet Air Heater Fuel Ignitor (IAH) • Failed Inlet Air Heater Fuel Solenoid (IAHFS) • Failed IAH	Step-Based Diagnostics (page 1033)
5548	3	IAH short to PWR	• IAH circuit short to PWR • Failed IAH	Circuit Checks (page 1045)

5548	4	IAH short to GND	• OUT1 short to GND • OUT2 short to GND • IAHRE short to GND • IAHRD / IAHRE shorted together • Failed IAH	Step-Based Diagnostics (page 1039)
5548	5	IAH open load/circuit	• IAH circuit OPEN • Failed IAH	Circuit Checks (page 1045)
5548	7	Inlet Air Heater Relay return (relay, or igniter, or circuit failure)	• IAHR circuit fault • Failed IAHR	Circuit Checks (page 1045)

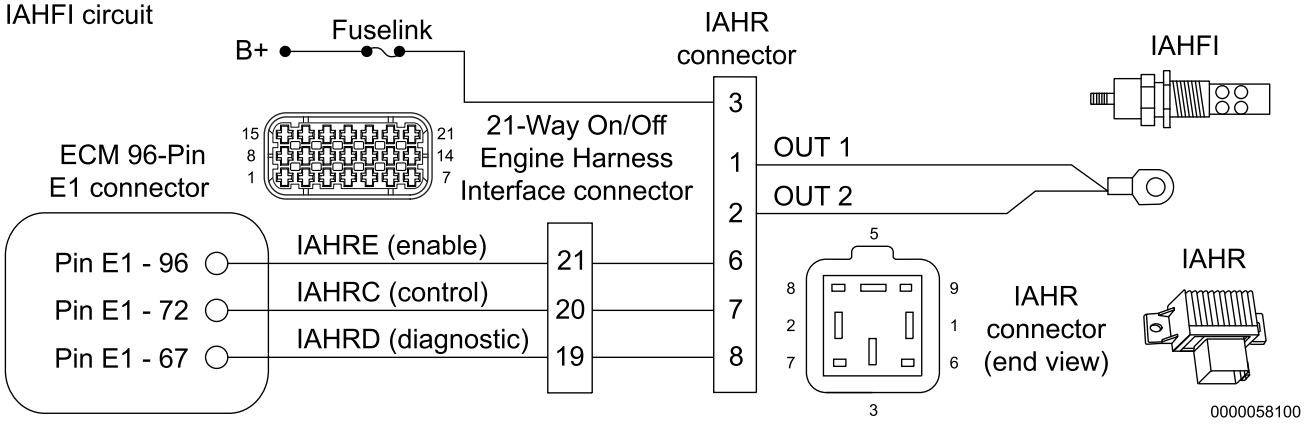


Figure 382 IAH circuit diagram

NOTE: See latest version of N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Inlet Air Heater (IAH) system warms the incoming air to aid emissions reduction. When inlet air heating is needed, the Engine Control Module (ECM) sends a signal to the IAH relay (IAHR). The IAHR then supplies B+ to the IAH fuel ignitor (IAH). The IAH is grounded through the intake manifold.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- Breakout Harness ZTSE4885
- Digital Multimeter (DMM)
- Amp clamp ZTSE4575
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 626 FMI 18 - Cold Start Assist fault: Lack of Heat in the Intake Manifold

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

SPN 626 FMI 18 – Inlet Air Heater fault: Lack of heat in the Intake Manifold

During cold start DTC sets when Intake Manifold Temperature (IMT) signal does not raise 50°F (10°C).

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Inspect for aftermarket engine block heater. Is engine free of an aftermarket engine block heater?
   - Yes: Go to step 2.
   - No: Disconnect aftermarket engine block heater and retest for SPN 626 FMI 18.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, Key-On Engine Off, load the Default session. Compare IMT and Ambient Air Temperature (AAT).

   Are IMT and Ambient Air Temperature (AAT) sensor temperatures within 10°F (5°C) of each other.
   - Yes: IMT circuit is in specification, see Inlet Air Heater System Test in “HARD START AND NO START DIAGNOSTICS."
   - No: Go to IMT sensor Circuit Checks .

Voltage Check on IAH - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
2. Command Inlet Air Heater Fuel Igniter to 95%.
3. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
IAH to GND	B+	If > 0 V to B+, do Amperage Draw Check - Actuator Test.
		If 0 V, do Voltage Checks on Relay Connector (page 1045).

Amperage Draw Check - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Amp Clamp ZTSE4575 to DMM. Set the DMM to DCmV and Zero the Amp clamp.
2. Connect Amp Clamp ZTSE4575 around the IAH wires.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
4. Command Inlet Air Heater Fuel Igniter to 95%.
5. Use DMM to measure voltage from the Amp Clamp, representing amperage through the IAH.

Test Point	Specifications	Comment
DMM - Measure amperage to IAH		

Amperage Draw Check - Actuator Test (cont.)

IAH	30 Amps (within 2 seconds)	If within specification, IAHR and IAH are working correctly. If not within specification, do Voltage Checks on Relay - Actuator Test (page 1047).
If Amps are within specification, do Harness Resistance Check (page 1048) for IAHRD circuit.		

Voltage Checks on Relay Connector

Connect Breakout Harness ZTSE4885 to IAHR engine harness, and leave IAHR disconnected. Turn ignition ON. Use DMM to measure voltage after 60 seconds.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	0 V	If > 0 V, check for short to PWR.
2 to GND	0 V	If > 0 V, check for short to PWR.
3 to GND	B+	If < B+, check for OPEN or short to GND.
6 to GND	1.5 V ± 0.5 V	If < 8 V, check for OPEN or short to GND.
7 to GND	0.5 V ± 0.5 V	If < 3 V, check for OPEN or short to GND. If > 5.5 V, check for short to PWR.
8 to GND	6 V ± 1 V	If < 4 V, check for OPEN or short to GND. If > 6 V, check for short to PWR.
If voltages are within specification, do Voltage Checks on Relay - Actuator Test (page 1047).		

Voltage Checks on Relay - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4885 between IAHR and engine harness.
2. Use DMM to measure voltage.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
4. Command Inlet Air Heater Fuel Igniter to 5%.
5. Use DMM to measure voltage.
6. Command Inlet Air Heater Fuel Igniter to 95%.
7. Use DMM to measure voltage.

Connect Breakout Harness ZTSE4885 between IAHR and engine harness. Turn the ignition switch to ON. Use DMM to measure voltage. Batteries must be fully charged before performing this test.

Test Point	Specifications	Comment – < Less than, > Greater than
6 to GND, Run Actuator Test		
Normal state	> 1 V	If < 1 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	> 10 V	If < 10 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	> 10 V	If < 10 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
7 to GND, Run Actuator Test.		
Normal state	< 1 V	If > 1 V, check IAHRC circuit for short to PWR. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	> 8 V	If < 8 V, check IAHRC circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	<1 V	If > 1 V, check IAHRD circuit for short to PWR. Do Harness Resistance Check (page 1048).
8 to GND, Run Actuator Test.		
Normal state	6 V ± 1.5 V	If < 4.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	6 V ± 1.5 V	If < 4.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	1 V ± 0.5 V	If < 0.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
1 to GND, Run Actuator Test.		

Voltage Checks on Relay - Actuator Test (cont.)

Normal state	0 V	If > 0 V, replace IAHR.
Actuator state LOW	0 V	If > 0 V, replace IAHR.
Actuator state HIGH	B+	If < B+, replace IAHR.
2 to GND, Run Actuator Test.		
Normal state	0 V	If > 0 V, replace IAHR.
Actuator state LOW	0 V	If > 0 V, replace IAHR.
Actuator state HIGH	B+	If < B+, replace IAHR.
If measurements are not within specifications, do Harness Resistance Check (page 1048).		

IAH Resistance Check

Turn ignition switch to OFF. Use DMM to measure resistance between IAH and engine GND.

Test Point	Specifications	Comment – < Less than, > Greater than
IAH to GND	< 5 Ω	If > 5 Ω, replace failed IAH.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4885 to IAHR engine harness, and leave IAHR disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to IAH	< 5 Ω	If > 5 Ω, check for OPEN circuit.
1 to GND	< 5 Ω	If > 5 Ω, check for OPEN IAH.
2 to IAH	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	< 5 Ω	If > 5 Ω, check for OPEN IAH.
3 to B+	< 5 Ω	If > 5 Ω, check for OPEN circuit.
6 to E1-96	< 5 Ω	If > 5 Ω, check for OPEN circuit.
6 to GND	> 1k Ω	If < 1k Ω check for short to GND.
7 to E1-72	< 5 Ω	If > 5 Ω, check for OPEN circuit.
7 to GND	> 1k Ω	If < 1k Ω check for short to GND.
8 to E1-67	< 5 Ω	If > 5 Ω, check for OPEN circuit.
8 to GND	> 1k Ω	If < 1k Ω check for short to GND.
If all checks are within specification, but DTCs are still active, replace the IAHR.		

SPN 3061 FMI 31 - Cold Start System Warm-Up Fault During CSER

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Intake Manifold failed to warm-up during Cold Start Emissions Reduction (CSER) period.	Time CSER system in Warm-up mode > 800 seconds Intake Manifold Temperature (IMT) does not rise as expected after CSER.	Key-On Engine-Running (KOER) CSER Warm-up: Active Limp home mode: Active	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the intake manifold failed to warm-up during Cold Start Emissions Reduction (CSER) monitoring period. CSER helps reduce emissions during engine warm-up by injecting and igniting fuel in the engine intake.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 94 FMI 0, 3, 4 (FDP); SPN 105 FMI 2, 3, 4, 18 (IMT); SPN 171 FMI 2, 3, 4 (AAT); SPN 626 FMI 3, 4, 5 (IAHFS); SPN 626 FMI 18 (IAH); SPN 5548 FMI 3, 4, 5, 7 (IAH)

Drive Cycle to Determine Fault Status

Drive Cycle 19 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Aftermarket engine block heater installed
- Low Fuel Delivery Pressure (FDP)
- Leaking or damaged fuel line to the Inlet Air Heater Fuel Ignitor (IAH)
- Failed Inlet Air Heater Fuel Solenoid (IAHFS)
- Failed IAH

NOTE: Ambient Air Temperature (AAT) reading is used as reference in determining pass / fail for this fault. Moving vehicle from cold to warm ambient temperature may set this fault.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 94 FMI 0, 3, 4 (FDP); SPN 105 FMI 2, 3, 4, 18 (IMT); SPN 171 FMI 2, 3, 4 (AAT); SPN 626 FMI 3, 4, 5 (IAHFS); SPN 626 FMI 18 (IAH); SPN 5548 FMI 3, 4, 5, 7 (IAH). Is EST DTC list free of SPN 94 FMI 0, 3, 4; SPN 105 FMI 2, 3, 4, 18; SPN 171 FMI 2, 3, 4; SPN 626 FMI 3, 4, 5; SPN 626 FMI 18; SPN 5548 FMI 3, 4, 5, 7?	Yes: Go to step 2. No: Repair SPN 94 FMI 0, 3, 4; SPN 105 FMI 2, 3, 4, 18 (IMT); SPN 171 FMI 2, 3, 4; SPN 626 FMI 3 4 5; SPN 626 FMI 18; SPN 5548 FMI 3 4 5 7. After repairs are complete, retest for SPN 3061 FMI 31.

Step	Action	Decision
2	Inspect the engine for an aftermarket block or coolant heater. Is an aftermarket block or coolant heater installed?	Yes: Disconnect block or coolant heater, run drive cycle 10. Retest for SPN 3061 FMI 31.
		No: Go to step 3.

Step	Action	Decision
3	Check current (amperage) going to Inlet Air Heater Fuel Igniter (IAH). With a Digital Multi Meter (DMM) and amperage clamp ZTSE4575 check the current at the IAH. Using EST with ServiceMaxx™ software, go to Key-On Engine-Off (KOEO) Test > Actuator Test > Actuate IAH. Is the amperage greater than 30 amps within 2 seconds.	Yes: Go to step 4
		No: Replace IAH. After repairs are complete, retest for SPN 3061 FMI 31.

Step	Action	Decision
4	Check Fuel Delivery Pressure (FDP). Using EST with ServiceMaxx™ software, Key-On Engine-Running (KOER), monitor FDP. Is FDP 85 - 120 psi?	Yes: Go to step 4.
		No: Repair Low-Pressure Fuel System . After repairs are complete, retest for SPN 3061 FMI 31.

Step	Action	Decision
5	Check fuel lines and connections going to IAH and IAH Fuel Solenoid (IAHFS) for: leaks, damage, and restrictions. Shop air can be used to check for restricted fuel lines. Are fuel lines and connections going to IAH and IAHFS in good condition and Not leaking, damaged, or restricted?	Yes: Go to step 6.
		No: Replace leaking, damaged, or restricted line or connection. After repairs are complete, retest for SPN 3061 FMI 31.

Step	Action	Decision
6	Check for fuel flow to the IAH. Using EST with ServiceMaxx™ software, go to Key-On Engine-Off (KOEO) Test > Cold Start Assist Test. Does Intake Manifold Temperature (IMT) raise at least 10°F after engine has started.	Yes: Retest for SPN 3061 FMI 31.
		No: Replace IAHFS. After repairs are complete, retest for SPN 3061 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 3061 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5548 FMI 3 - CSFI Short to PWR

Voltage Check on IAH - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
2. Command Inlet Air Heater Fuel Igniter to 95%.
3. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
IAH to GND	B+	If > 0 V to B+, do Amperage Draw Check - Actuator Test. If 0 V, do Voltage Checks on Relay Connector (page 1045).

Amperage Draw Check - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Amp Clamp ZTSE4575 to DMM. Set the DMM to DCmV and Zero the Amp clamp.
2. Connect Amp Clamp ZTSE4575 around the IAH wires.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
4. Command Inlet Air Heater Fuel Igniter to 95%.
5. Use DMM to measure voltage from the Amp Clamp, representing amperage through the IAH.

Test Point	Specifications	Comment
DMM - Measure amperage to IAH		
IAH	30 Amps (within 2 seconds)	If within specification, IAHR and IAH are working correctly. If not within specification, do Voltage Checks on Relay - Actuator Test (page 1047).
If Amps are within specification, do Harness Resistance Check (page 1048) for IAHRD circuit.		

Voltage Checks on Relay Connector

Connect Breakout Harness ZTSE4885 to IAHR engine harness, and leave IAHR disconnected. Turn ignition ON. Use DMM to measure voltage after 60 seconds.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	0 V	If > 0 V, check for short to PWR.
2 to GND	0 V	If > 0 V, check for short to PWR.
3 to GND	B+	If < B+, check for OPEN or short to GND.
6 to GND	1.5 V ± 0.5 V	If < 8 V, check for OPEN or short to GND.
7 to GND	0.5 V ± 0.5 V	If < 3 V, check for OPEN or short to GND. If > 5.5 V, check for short to PWR.

Voltage Checks on Relay Connector (cont.)

8 to GND	6 V ± 1 V	If < 4 V, check for OPEN or short to GND. If > 6 V, check for short to PWR.

If voltages are within specification, do Voltage Checks on Relay - Actuator Test (page 1047).

Voltage Checks on Relay - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4885 between IAHR and engine harness.
2. Use DMM to measure voltage.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
4. Command Inlet Air Heater Fuel Igniter to 5%.
5. Use DMM to measure voltage.
6. Command Inlet Air Heater Fuel Igniter to 95%.
7. Use DMM to measure voltage.

Connect Breakout Harness ZTSE4885 between IAHR and engine harness. Turn the ignition switch to ON. Use DMM to measure voltage. Batteries must be fully charged before performing this test.

Test Point	Specifications	Comment – < Less than, > Greater than
6 to GND, Run Actuator Test		
Normal state	> 1 V	If < 1 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	> 10 V	If < 10 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	> 10 V	If < 10 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
7 to GND, Run Actuator Test.		
Normal state	< 1 V	If > 1 V, check IAHRC circuit for short to PWR. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	> 8 V	If < 8 V, check IAHRC circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	<1 V	If > 1 V, check IAHRD circuit for short to PWR. Do Harness Resistance Check (page 1048).
8 to GND, Run Actuator Test.		
Normal state	6 V ± 1.5 V	If < 4.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	6 V ± 1.5 V	If < 4.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	1 V ± 0.5 V	If < 0.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
1 to GND, Run Actuator Test.		

Voltage Checks on Relay - Actuator Test (cont.)

Normal state	0 V	If > 0 V, replace IAHR.
Actuator state LOW	0 V	If > 0 V, replace IAHR.
Actuator state HIGH	B+	If < B+, replace IAHR.
2 to GND, Run Actuator Test.		
Normal state	0 V	If > 0 V, replace IAHR.
Actuator state LOW	0 V	If > 0 V, replace IAHR.
Actuator state HIGH	B+	If < B+, replace IAHR.
If measurements are not within specifications, do Harness Resistance Check (page 1048).		

IAH Resistance Check

Turn ignition switch to OFF. Use DMM to measure resistance between IAH and engine GND.

Test Point	Specifications	Comment – < Less than, > Greater than
IAH to GND	< 5 Ω	If > 5 Ω, replace failed IAH.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4885 to IAHR engine harness, and leave IAHR disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to IAH	< 5 Ω	If > 5 Ω, check for OPEN circuit.
1 to GND	< 5 Ω	If > 5 Ω, check for OPEN IAH.
2 to IAH	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	< 5 Ω	If > 5 Ω, check for OPEN IAH.
3 to B+	< 5 Ω	If > 5 Ω, check for OPEN circuit.
6 to E1-96	< 5 Ω	If > 5 Ω, check for OPEN circuit.
6 to GND	> 1k Ω	If < 1k Ω check for short to GND.
7 to E1-72	< 5 Ω	If > 5 Ω, check for OPEN circuit.
7 to GND	> 1k Ω	If < 1k Ω check for short to GND.
8 to E1-67	< 5 Ω	If > 5 Ω, check for OPEN circuit.
8 to GND	> 1k Ω	If < 1k Ω check for short to GND.
If all checks are within specification, but DTCs are still active, replace the IAHR.		

SPN 5548 FMI 4 - CSFI Short to GND

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
IAH circuit short to GND	The resistance between the IAHRE or OUT1 / OUT2 circuits and ground < 0.2 Ohms	Key ON Inlet Air Heater commanded ON	1 second

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects a short to GND in the Inlet Air Heater (IAH) circuits.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

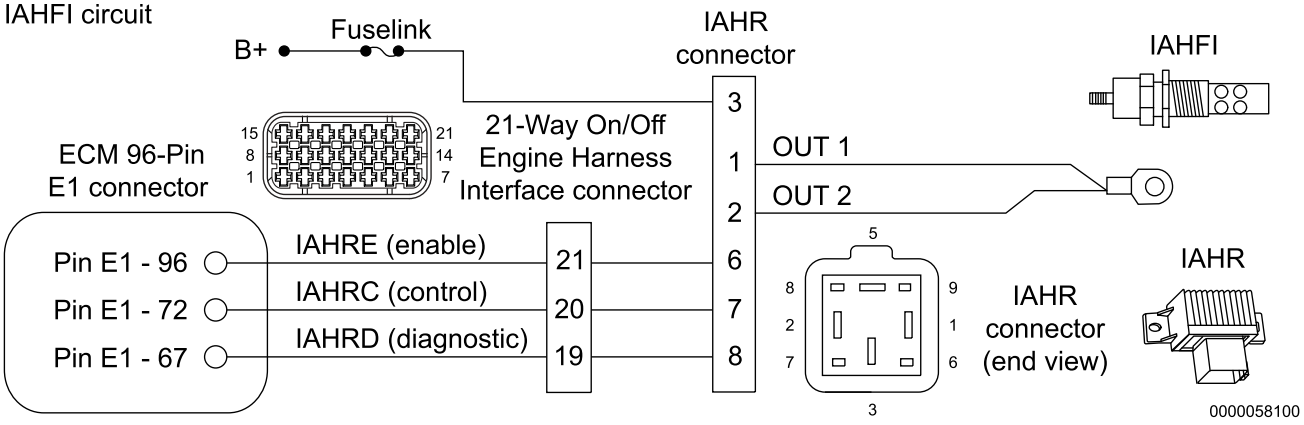


Figure 383 IAH circuit diagram

Possible Causes

- OUT1 short to GND
- OUT2 short to GND
- IAHRE short to GND
- IAHRD / IAHRE shorted together
- Failed IAH

Step	Action	Decision
1	Inspect connections at Inlet Air Heater Fuel Igniter (IAH). Check IAH connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the IAH harness and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5548 FMI 4.

Step	Action	Decision
2	Inspect connections at Inlet Air Heater Relay (IAHR). Key-Off, disconnect IAHR connector. Check IAHR connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the IAHR connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5548 FMI 4.

Step	Action	Decision
3	Check IAHRE circuit for short to GND. Connect Breakout Harness ZTSE4885 to vehicle harness and leave IAHR disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness ZTSE4885 pin-6 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 4. No: Repair short to GND in IAHRE circuit between IAHR pin-6 and ECM pin E1-96. After repairs are complete, retest for SPN 5548 FMI 4.

Step	Action	Decision
4	Check IAHRE circuit for short to IAHRD. Key OFF with Breakout Harness ZTSE4885 connected to vehicle harness and IAHR disconnected. Use a DMM to measure resistance between Breakout Harness pin-6 and pin-8. Is resistance greater than 1000 ohms?	Yes: Go to step 5. No: Repair short between IAHR pin-6 and IAHR pin-8. After repairs are complete, retest for SPN 5548 FMI 4.

Step	Action	Decision
5	Check OUT1 circuit for short to GND. With Breakout Harness ZTSE4885 connected to vehicle harness and IAHR disconnected. Disconnect IAH and leave terminals disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 6. No: Repair short to GND in OUT1 circuit between IAH relay pin-1 and IAH terminal. After repairs are complete, retest for SPN 5548 FMI 4.

Step	Action	Decision
6	Check OUT2 circuit for short to GND. With Breakout Harness ZTSE4885 connected to vehicle harness and IAHR disconnected. Key OFF with IAH disconnected, use a DMM to measure resistance between Breakout Harness pin-2 and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace IAH. After repairs are complete, retest for SPN 5548 FMI 4.
		No: Repair short to GND in OUT2 circuit between IAH relay pin-2 and IAH terminal. After repairs are complete, retest for SPN 5548 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 5548 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5548 FMI 5 - CSFI Open / Load Circuit

Voltage Check on IAH - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
2. Command Inlet Air Heater Fuel Igniter to 95%.
3. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
IAH to GND	B+	If > 0 V to B+, do Amperage Draw Check - Actuator Test. If 0 V, do Voltage Checks on Relay Connector (page 1045).

Amperage Draw Check - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Amp Clamp ZTSE4575 to DMM. Set the DMM to DCmV and Zero the Amp clamp.
2. Connect Amp Clamp ZTSE4575 around the IAH wires.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
4. Command Inlet Air Heater Fuel Igniter to 95%.
5. Use DMM to measure voltage from the Amp Clamp, representing amperage through the IAH.

Test Point	Specifications	Comment
DMM - Measure amperage to IAH		
IAH	30 Amps (within 2 seconds)	If within specification, IAHR and IAH are working correctly. If not within specification, do Voltage Checks on Relay - Actuator Test (page 1047).
If Amps are within specification, do Harness Resistance Check (page 1048) for IAHRD circuit.		

Voltage Checks on Relay Connector

Connect Breakout Harness ZTSE4885 to IAHR engine harness, and leave IAHR disconnected. Turn ignition ON. Use DMM to measure voltage after 60 seconds.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	0 V	If > 0 V, check for short to PWR.
2 to GND	0 V	If > 0 V, check for short to PWR.
3 to GND	B+	If < B+, check for OPEN or short to GND.
6 to GND	1.5 V ± 0.5 V	If < 8 V, check for OPEN or short to GND.
7 to GND	0.5 V ± 0.5 V	If < 3 V, check for OPEN or short to GND.
		If > 5.5 V, check for short to PWR.
8 to GND	6 V ± 1 V	If < 4 V, check for OPEN or short to GND.
		If > 6 V, check for short to PWR.

If voltages are within specification, do Voltage Checks on Relay - Actuator Test (page 1047).

Voltage Checks on Relay - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4885 between IAHR and engine harness.
2. Use DMM to measure voltage.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
4. Command Inlet Air Heater Fuel Igniter to 5%.
5. Use DMM to measure voltage.
6. Command Inlet Air Heater Fuel Igniter to 95%.
7. Use DMM to measure voltage.

Connect Breakout Harness ZTSE4885 between IAHR and engine harness. Turn the ignition switch to ON. Use DMM to measure voltage. Batteries must be fully charged before performing this test.

Test Point	Specifications	Comment – < Less than, > Greater than
6 to GND, Run Actuator Test		
Normal state	> 1 V	If < 1 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	> 10 V	If < 10 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	> 10 V	If < 10 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
7 to GND, Run Actuator Test.		
Normal state	< 1 V	If > 1 V, check IAHRC circuit for short to PWR. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	> 8 V	If < 8 V, check IAHRC circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	<1 V	If > 1 V, check IAHRD circuit for short to PWR. Do Harness Resistance Check (page 1048).
8 to GND, Run Actuator Test.		
Normal state	6 V ± 1.5 V	If < 4.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	6 V ± 1.5 V	If < 4.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	1 V ± 0.5 V	If < 0.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
1 to GND, Run Actuator Test.		

Voltage Checks on Relay - Actuator Test (cont.)

Normal state	0 V	If > 0 V, replace IAHR.
Actuator state LOW	0 V	If > 0 V, replace IAHR.
Actuator state HIGH	B+	If < B+, replace IAHR.
2 to GND, Run Actuator Test.		
Normal state	0 V	If > 0 V, replace IAHR.
Actuator state LOW	0 V	If > 0 V, replace IAHR.
Actuator state HIGH	B+	If < B+, replace IAHR.
If measurements are not within specifications, do Harness Resistance Check (page 1048).		

IAH Resistance Check

Turn ignition switch to OFF. Use DMM to measure resistance between IAH and engine GND.

Test Point	Specifications	Comment – < Less than, > Greater than
IAH to GND	< 5 Ω	If > 5 Ω, replace failed IAH.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4885 to IAHR engine harness, and leave IAHR disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to IAH	< 5 Ω	If > 5 Ω, check for OPEN circuit.
1 to GND	< 5 Ω	If > 5 Ω, check for OPEN IAH.
2 to IAH	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	< 5 Ω	If > 5 Ω, check for OPEN IAH.
3 to B+	< 5 Ω	If > 5 Ω, check for OPEN circuit.
6 to E1-96	< 5 Ω	If > 5 Ω, check for OPEN circuit.
6 to GND	> 1k Ω	If < 1k Ω check for short to GND.
7 to E1-72	< 5 Ω	If > 5 Ω, check for OPEN circuit.
7 to GND	> 1k Ω	If < 1k Ω check for short to GND.
8 to E1-67	< 5 Ω	If > 5 Ω, check for OPEN circuit.
8 to GND	> 1k Ω	If < 1k Ω check for short to GND.
If all checks are within specification, but DTCs are still active, replace the IAHR.		

SPN 5548 FMI 7 - Cold Start Relay Return (Relay, or Igniter, or Circuit Failure)

Voltage Check on IAH - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
2. Command Inlet Air Heater Fuel Igniter to 95%.
3. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
IAH to GND	B+	If > 0 V to B+, do Amperage Draw Check - Actuator Test. If 0 V, do Voltage Checks on Relay Connector (page 1045).

Amperage Draw Check - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Amp Clamp ZTSE4575 to DMM. Set the DMM to DCmV and Zero the Amp clamp.
2. Connect Amp Clamp ZTSE4575 around the IAH wires.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
4. Command Inlet Air Heater Fuel Igniter to 95%.
5. Use DMM to measure voltage from the Amp Clamp, representing amperage through the IAH.

Test Point	Specifications	Comment
DMM - Measure amperage to IAH		
IAH	30 Amps (within 2 seconds)	If within specification, IAHR and IAH are working correctly. If not within specification, do Voltage Checks on Relay - Actuator Test (page 1047).
If Amps are within specification, do Harness Resistance Check (page 1048) for IAHRD circuit.		

Voltage Checks on Relay Connector

Connect Breakout Harness ZTSE4885 to IAHR engine harness, and leave IAHR disconnected. Turn ignition ON. Use DMM to measure voltage after 60 seconds.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to GND	0 V	If > 0 V, check for short to PWR.
2 to GND	0 V	If > 0 V, check for short to PWR.
3 to GND	B+	If < B+, check for OPEN or short to GND.
6 to GND	1.5 V ± 0.5 V	If < 8 V, check for OPEN or short to GND.
7 to GND	0.5 V ± 0.5 V	If < 3 V, check for OPEN or short to GND. If > 5.5 V, check for short to PWR.

Voltage Checks on Relay Connector (cont.)

8 to GND	6 V ± 1 V	If < 4 V, check for OPEN or short to GND. If > 6 V, check for short to PWR.

If voltages are within specification, do Voltage Checks on Relay - Actuator Test (page 1047).

Voltage Checks on Relay - Actuator Test

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4885 between IAHR and engine harness.
2. Use DMM to measure voltage.
3. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Igniter from the drop-down menu.
4. Command Inlet Air Heater Fuel Igniter to 5%.
5. Use DMM to measure voltage.
6. Command Inlet Air Heater Fuel Igniter to 95%.
7. Use DMM to measure voltage.

Connect Breakout Harness ZTSE4885 between IAHR and engine harness. Turn the ignition switch to ON. Use DMM to measure voltage. Batteries must be fully charged before performing this test.

Test Point	Specifications	Comment – < Less than, > Greater than
6 to GND, Run Actuator Test		
Normal state	> 1 V	If < 1 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	> 10 V	If < 10 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	> 10 V	If < 10 V, check IAHRE circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
7 to GND, Run Actuator Test.		
Normal state	< 1 V	If > 1 V, check IAHRC circuit for short to PWR. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	> 8 V	If < 8 V, check IAHRC circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	<1 V	If > 1 V, check IAHRD circuit for short to PWR. Do Harness Resistance Check (page 1048).
8 to GND, Run Actuator Test.		
Normal state	6 V ± 1.5 V	If < 4.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state LOW (5%)	6 V ± 1.5 V	If < 4.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
Actuator state HIGH (95%)	1 V ± 0.5 V	If < 0.5 V, check IAHRD circuit for OPEN or short to GND. Do Harness Resistance Check (page 1048).
1 to GND, Run Actuator Test.		

Voltage Checks on Relay - Actuator Test (cont.)

Normal state	0 V	If > 0 V, replace IAHR.
Actuator state LOW	0 V	If > 0 V, replace IAHR.
Actuator state HIGH	B+	If < B+, replace IAHR.
2 to GND, Run Actuator Test.		
Normal state	0 V	If > 0 V, replace IAHR.
Actuator state LOW	0 V	If > 0 V, replace IAHR.
Actuator state HIGH	B+	If < B+, replace IAHR.
If measurements are not within specifications, do Harness Resistance Check (page 1048).		

IAH Resistance Check

Turn ignition switch to OFF. Use DMM to measure resistance between IAH and engine GND.

Test Point	Specifications	Comment – < Less than, > Greater than
IAH to GND	< 5 Ω	If > 5 Ω, replace failed IAH.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4885 to IAHR engine harness, and leave IAHR disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to IAH	< 5 Ω	If > 5 Ω, check for OPEN circuit.
1 to GND	< 5 Ω	If > 5 Ω, check for OPEN IAH.
2 to IAH	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	< 5 Ω	If > 5 Ω, check for OPEN IAH.
3 to B+	< 5 Ω	If > 5 Ω, check for OPEN circuit.
6 to E1-96	< 5 Ω	If > 5 Ω, check for OPEN circuit.
6 to GND	> 1k Ω	If < 1k Ω check for short to GND.
7 to E1-72	< 5 Ω	If > 5 Ω, check for OPEN circuit.
7 to GND	> 1k Ω	If < 1k Ω check for short to GND.
8 to E1-67	< 5 Ω	If > 5 Ω, check for OPEN circuit.
8 to GND	> 1k Ω	If < 1k Ω check for short to GND.
If all checks are within specification, but DTCs are still active, replace the IAHR.		

IAHFS Sensor

Overview of IAHFS Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
626	3	IAHFS short to PWR	• IAHFS circuit short to PWR	Circuit Checks (page 1052)
626	4	IAHFS short to GND	• IAHFS circuit short to GND	Circuit Checks (page 1052)
626	5	IAHFS open load/circuit	• IAHFS circuit OPEN • IAHFS failure	Circuit Checks (page 1052)

IAHFS circuit

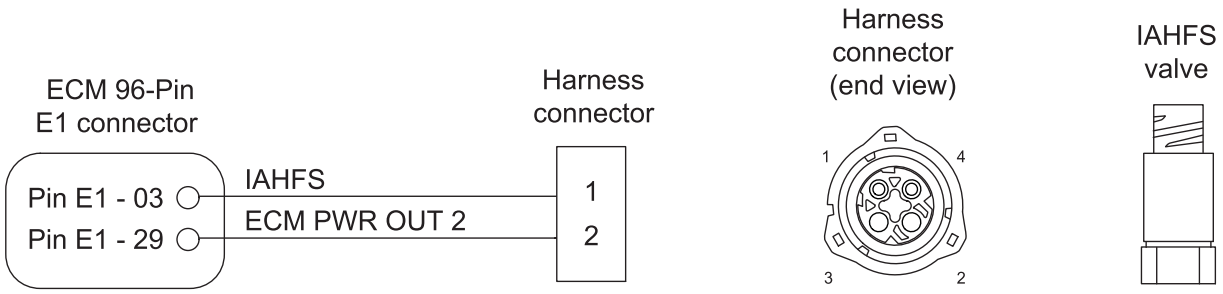


Figure 384 IAHFS circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4827 (IAHFS)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

SPN 626 FMI 3 - CSFS Short to PWR

Connector Voltage Check – IAHFS Disconnected

Connect Breakout Harness ZTSE4827 to engine harness. Leave IAHFS disconnected. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
2 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check (page 1053).
1 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN circuit. Do Harness Resistance Check (page 1053).
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4827 between IAHFS and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Solenoid from the drop-down menu.
3. Command Inlet Air Heater Fuel Solenoid to 5%.
4. Use DMM to measure voltage.
5. Command Inlet Air Heater Fuel Solenoid to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5% = 0.5 V ± 0.5 V	If > 1 V, check for OPEN circuit or failed IAHFS.
1 to GND	95% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE4827 to IAHFS and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to 2	8 Ω	If not within specification, replace IAHFS.
If measurements are within specifications, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to IAHFS engine harness, and leave IAHFS disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-03	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-29	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, replace IAHFS.		

SPN 626 FMI 4 - CSFS Short to GND

Connector Voltage Check – IAHFS Disconnected

Connect Breakout Harness ZTSE4827 to engine harness. Leave IAHFS disconnected. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
2 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check (page 1053).
1 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN circuit. Do Harness Resistance Check (page 1053).
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4827 between IAHFS and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Solenoid from the drop-down menu.
3. Command Inlet Air Heater Fuel Solenoid to 5%.
4. Use DMM to measure voltage.
5. Command Inlet Air Heater Fuel Solenoid to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5% = 0.5 V ± 0.5 V	If > 1 V, check for OPEN circuit or failed IAHFS.
1 to GND	95% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE4827 to IAHFS and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to 2	8 Ω	If not within specification, replace IAHFS.

If measurements are within specifications, do Harness Resistance Check.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to IAHFS engine harness, and leave IAHFS disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-03	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-29	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, replace IAHFS.

SPN 626 FMI 5 - CSFS Open Load / Circuit

Connector Voltage Check – IAHFS Disconnected

Connect Breakout Harness ZTSE4827 to engine harness. Leave IAHFS disconnected. Use DMM to measure voltage.

Test Point	Specifications	Comment – < Less than, > Greater than
2 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check (page 1053).
1 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN circuit. Do Harness Resistance Check (page 1053).

If measurements are within specifications, do Operational Voltage Check.

Operational Voltage Check

NOTE: Ensure battery voltage is at or above 12 V, before running this procedure.

1. Connect Breakout Harness ZTSE4827 between IAHFS and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Inlet Air Heater Fuel Solenoid from the drop-down menu.
3. Command Inlet Air Heater Fuel Solenoid to 5%.
4. Use DMM to measure voltage.
5. Command Inlet Air Heater Fuel Solenoid to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	5% = 0.5 V ± 0.5 V	If > 1 V, check for OPEN circuit or failed IAHFS.
1 to GND	95% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE4827 to IAHFS and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment – < Less than, > Greater than
1 to 2	8 Ω	If not within specification, replace IAHFS.

If measurements are within specifications, do Harness Resistance Check.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4827 to IAHFS engine harness, and leave IAHFS disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-03	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-29	< 5 Ω	If > 5 Ω, check for OPEN circuit.

If voltage and resistance checks are within specifications, replace IAHFS.

IMP (Intake Manifold Pressure) Sensor

Overview of IMP Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
102	2	IMP signal does not agree with BARO	• Biased IMP sensor or circuit	Circuit Checks (page 1060)
102	3	IMP signal Out of Range HIGH	• IMP signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed IMP sensor	Circuit Checks (page 1060)
102	4	IMP signal Out of Range LOW	• IMP signal circuit short to GND • VREF2 circuit OPEN • Failed IMP sensor	Circuit Checks (page 1060)

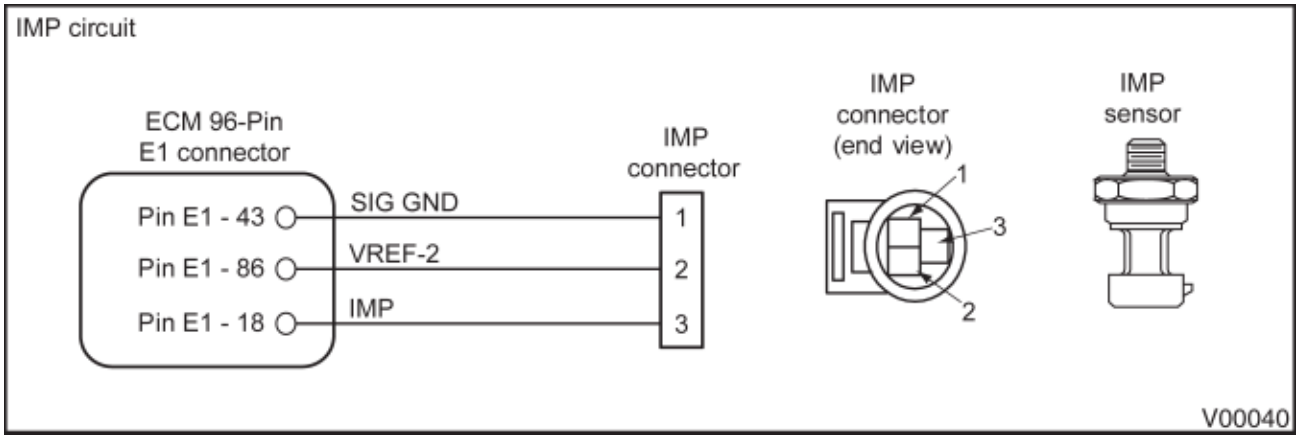


Figure 385 IMP Sensor Circuit Diagram

Overview

The IMP sensor is a variable-capacitance sensor that measures charge-air pressure entering the air intake throttle duct. As pressure increases, ceramic material moves closer to a thin metal disc (internal sensor), causing a change in capacitance that changes the voltage sent to, and interpreted by, the Engine Control Module (ECM). IMP is monitored by the ECM for Exhaust Gas Recirculation (EGR) and turbocharger wastegate control.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE4850 (IMP)

- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

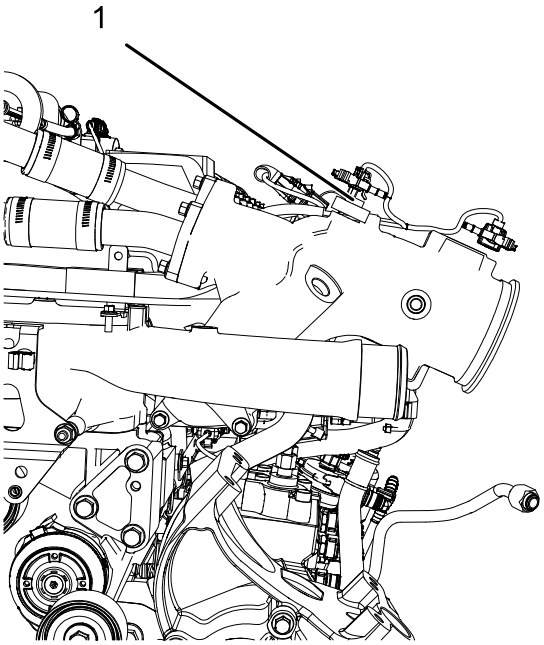


Figure 386 IMP Sensor Location

1. Intake Manifold Pressure (IMP) sensor

SPN 102 FMI 2 - IMP Signal Erratic, Intermittent, or Incorrect

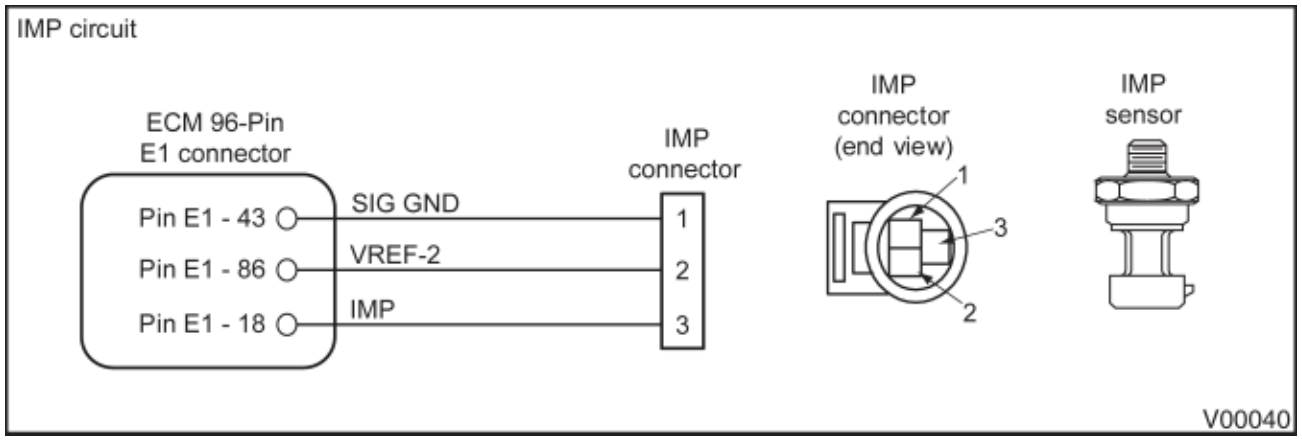


Figure 387 IMP Sensor Circuit Diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Biased Sensor or Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Biased Sensor or Circuit Check

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Continuous Monitor session.
3. Verify S_IMP volts are within specification. See “APPENDIX A: PERFORMANCE SPECIFICATIONS."
   - If voltage is not within specification, go to Circuit Checks (page 1060). If circuits are within specification, replace IMP sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor IMPv	5.0 V ± 0.5 V	If < 4.5 V, check IMP signal circuit for short to GND. Do Harness Resistance Check (page 1061).
DMM – Measure volts 2 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF2 circuit for short to PWR. If < 4.5 V, check VREF2 circuit for OPEN or short to GND. Do Harness Resistance Check (page 1061).
DMM – Measure voltage 1 to 2	5.0 V ± 0.5 V	If < 4.5 V, check SIG GND for OPEN. Do Harness Resistance Check (page 1061).
EST – Monitor IMPv Short across Breakout Harness ZTSE4850 pins 1 and 3	0 V	If > 0.5 V, check IMP signal circuit for OPEN or short to PWR. Do Harness Resistance Check (page 1061).
If checks are within specifications, connect sensor and clear DTCs. If active DTC remains, replace IMP sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to B+	B+	If < B+, check SIG GND circuit for OPEN or short to PWR.
2 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF2 for short to PWR. If < 4.5 V, check VREF2 for OPEN or short to GND. Do Harness Resistance Check (page 1061).
3 to GND	5.0 V ± 0.5 V	If < 4.5 V, check IMP signal circuit for short to GND. Do Harness Resistance Check (page 1061).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-43	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-86	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-18	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 102 FMI 3 - IMP Signal Out of Range HIGH

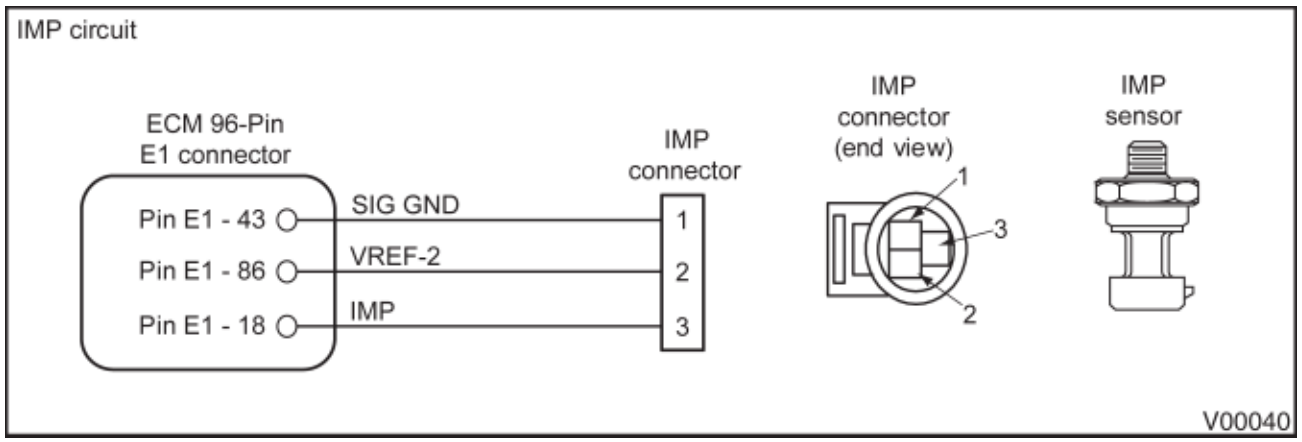


Figure 388 IMP Sensor Circuit Diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.

2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Biased Sensor or Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Biased Sensor or Circuit Check

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Continuous Monitor session.
3. Verify S_IMP volts are within specification. See “APPENDIX A: PERFORMANCE SPECIFICATIONS."
   - If voltage is not within specification, go to Circuit Checks (page 1060). If circuits are within specification, replace IMP sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor IMPv	5.0 V ± 0.5 V	If < 4.5 V, check IMP signal circuit for short to GND. Do Harness Resistance Check (page 1061).
DMM – Measure volts 2 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF2 circuit for short to PWR. If < 4.5 V, check VREF2 circuit for OPEN or short to GND. Do Harness Resistance Check (page 1061).
DMM – Measure voltage 1 to 2	5.0 V ± 0.5 V	If < 4.5 V, check SIG GND for OPEN. Do Harness Resistance Check (page 1061).
EST – Monitor IMPv Short across Breakout Harness ZTSE4850 pins 1 and 3	0 V	If > 0.5 V, check IMP signal circuit for OPEN or short to PWR. Do Harness Resistance Check (page 1061).
If checks are within specifications, connect sensor and clear DTCs. If active DTC remains, replace IMP sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to B+	B+	If < B+, check SIG GND circuit for OPEN or short to PWR.
2 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF2 for short to PWR. If < 4.5 V, check VREF2 for OPEN or short to GND. Do Harness Resistance Check (page 1061).
3 to GND	5.0 V ± 0.5 V	If < 4.5 V, check IMP signal circuit for short to GND. Do Harness Resistance Check (page 1061).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-43	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-86	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-18	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 102 FMI 4 - IMP Signal Out of Range LOW

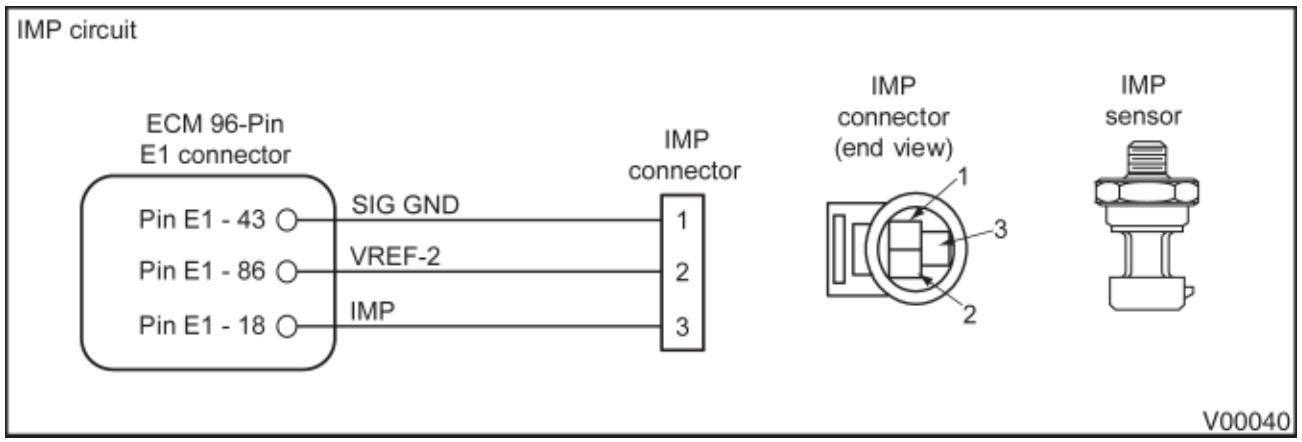


Figure 389 IMP Sensor Circuit Diagram

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.

2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Biased Sensor or Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Biased Sensor or Circuit Check

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Continuous Monitor session.
3. Verify S_IMP volts are within specification. See “APPENDIX A: PERFORMANCE SPECIFICATIONS."
   - If voltage is not within specification, go to Circuit Checks (page 1060). If circuits are within specification, replace IMP sensor.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor IMPv	5.0 V ± 0.5 V	If < 4.5 V, check IMP signal circuit for short to GND. Do Harness Resistance Check (page 1061).
DMM – Measure volts 2 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF2 circuit for short to PWR. If < 4.5 V, check VREF2 circuit for OPEN or short to GND. Do Harness Resistance Check (page 1061).
DMM – Measure voltage 1 to 2	5.0 V ± 0.5 V	If < 4.5 V, check SIG GND for OPEN. Do Harness Resistance Check (page 1061).
EST – Monitor IMPv Short across Breakout Harness ZTSE4850 pins 1 and 3	0 V	If > 0.5 V, check IMP signal circuit for OPEN or short to PWR. Do Harness Resistance Check (page 1061).
If checks are within specifications, connect sensor and clear DTCs. If active DTC remains, replace IMP sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to B+	B+	If < B+, check SIG GND circuit for OPEN or short to PWR.
2 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF2 for short to PWR. If < 4.5 V, check VREF2 for OPEN or short to GND. Do Harness Resistance Check (page 1061).
3 to GND	5.0 V ± 0.5 V	If < 4.5 V, check IMP signal circuit for short to GND. Do Harness Resistance Check (page 1061).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4850 to IMP engine harness, and leave IMP sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-43	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-86	< 5 Ω	If > 5 Ω, check for OPEN circuit.
3 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
3 to E1-18	< 5 Ω	If > 5 Ω, check for OPEN circuit.

IMT (Intake Manifold Temperature) Sensor

Overview of IMT Sensor Group

SPN	FMI	Description
105	2	IMT signal does not agree with other sensors (page 1063)
105	3	IMT signal Out of Range HIGH (page 1068)
105	4	IMT signal Out of Range LOW (page 1074)

Overview

Intake Manifold Temperature (IMT) sensor provides feedback signal to Engine Control Module (ECM) indicating manifold air temperature. ECM controls Exhaust Gas Recirculation (EGR) system based on air temperature in intake manifold. This aids in cold engine starting and warm-ups, and also reduces exhaust emissions.

SPN 105 FMI 2 - IMT Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Intake Manifold Temperature (IMT) does not agree with other sensors.	IMT sensor temperature differs from Ambient Air Temperature (AAT), CAC Outlet Temperature (CACOT) > 27°F (15°C).	Key ON Engine is cold soaked Engine speed > 0 RPM

Fault Overview

Fault code sets when Intake Manifold Temperature (IMT) sensor temperature differs from Ambient Air Temperature (AAT), CAC Outlet Temperature (CACOT) by greater than 27°F (15°C) after a cold soak.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 105 FMI 3 and 4 (IMT)			

Fault Facts

Diagnostic runs at initial Key ON after a minimum of an 8 hour cold soak.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- IMT circuit high resistance
- SIG GND circuit high resistance
- Failed IMT sensor

Step 1	Check for associated fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults(page 1063). Is EST DTC list free of Associated Faults?		Yes: Go to Step 2. No: Repair Associated Faults. After repairs are complete, retest for SPN 105 FMI 2.

Step 2	Check for active or pending fault code.	Decision
Using EST with ServiceMaxx™ software. Key ON, check DTC list for SPN 105 FMI 2. Is EST DTC list SPN 105 FMI 2 active or pending?		Yes: Go to Step 3. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 3	Inspect connections at Intake Manifold Temperature (IMT) connector.	Decision
A. Key OFF. B. Disconnect IMT connector. C. Check IMT and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are IMT connector, harness, and terminals clean and undamaged?		Yes: Go to Step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 105 FMI 2.

Step 4		Decision
Perform Test 1(page 1066). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor IMT voltage. Is voltage less than 0.05 volts?		Yes: Replace IMT sensor. After repairs are complete, retest for SPN 105 FMI 2. No: Go to Step 5.

Step 5		Decision
Perform Test 2(page 1067). Using DMM, measure resistance between Breakout Harness ZTSE4782 pin-1 and a known good GND. Is resistance less than 5 ohms?		Yes: Repair Open between IMT pin-2 and ECM pin E1-37. After repairs are complete, retest for SPN 105 FMI 2. No: Repair Open between IMT pin-1 and ECM pin E1-83. After repairs are complete, retest for SPN 105 FMI 2.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 105 FMI 2 fault code diagnostics.

Pin-Point Test SPN 105 FMI 2

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4782
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

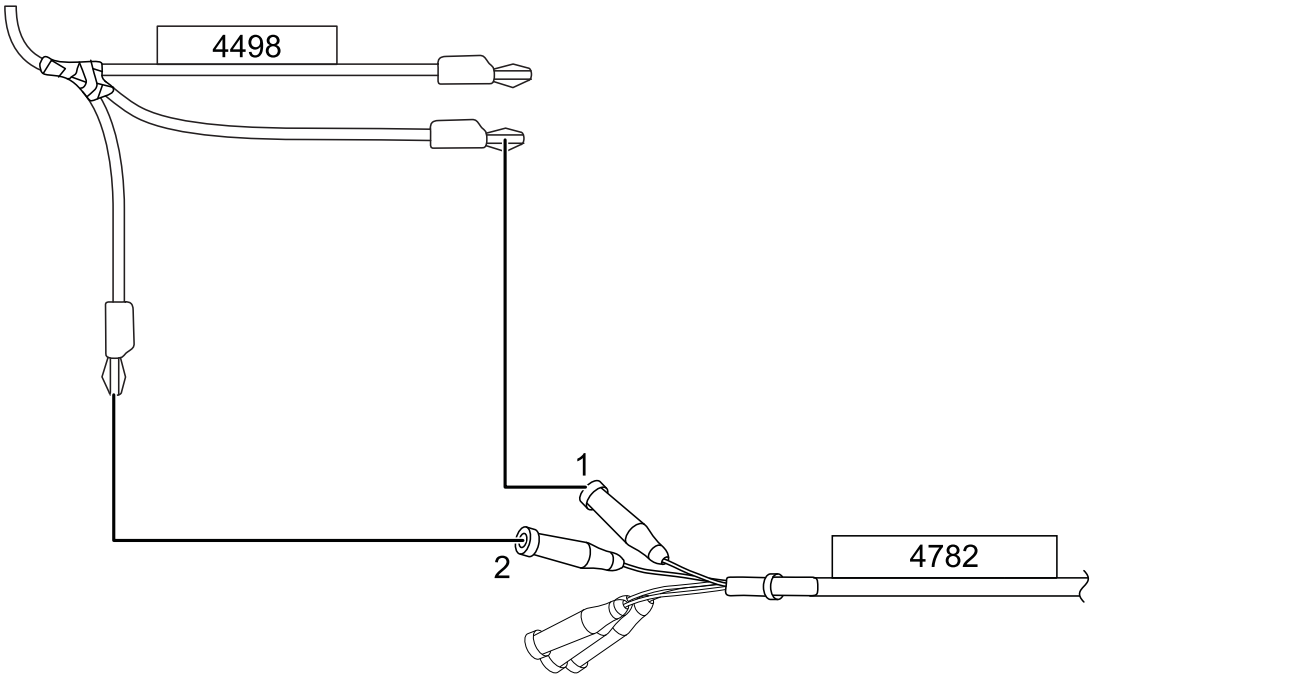


Figure 390 IMT Sensor Circuit Check

Test 1 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4782 to vehicle harness and leave Intake Manifold Temperature (IMT) sensor disconnected.
C. Using Breakout Harness ZTSE4498 short pin-1 and pin-2 of Breakout Harness ZTSE4782 together.
D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
E. Key ON, log into ServiceMaxx™ software.

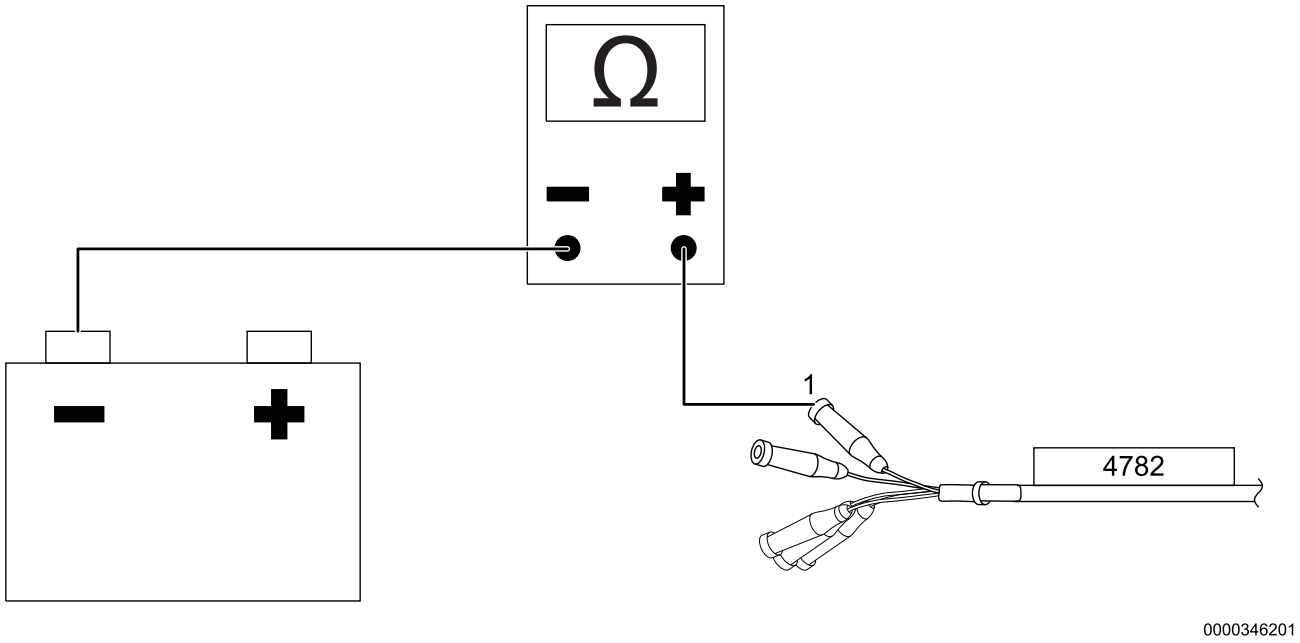


Figure 391 SIG GND Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4782 to vehicle harness and leave Intake Manifold Temperature (IMT) sensor disconnected. C. Key ON.

SPN 105 FMI 3 - IMT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Intake Manifold Temperature (IMT) value greater than expected.	IMT sensor voltage > 4.8 volts.	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Intake Manifold Temperature (IMT) voltage is greater than 4.8 volts.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will immediately illuminate when this fault is detected.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- SIG GND circuit Open or High resistance
- IMT circuit Open or high resistance
- IMT circuit short to PWR
- Failed IMT sensor

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 105 FMI 3. Is EST DTC list SPN 105 FMI 3 active?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Intake Manifold Temperature (IMT) connector.	Decision
A. Key OFF. B. Disconnect IMT connector. C. Check IMT and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are IMT connector, harness, and terminals clean and undamaged?		Yes: Go to Step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 105 FMI 3.

Step 3		Decision
Perform Test 1(page 1071). Use DMM to measure voltage between Breakout Harness ZTSE4782 pin-2 and a known good ground. Is voltage greater than 4.85 volts?		Yes: Repair short to PWR between IMT pin-2 and Engine Control Module (ECM) pin E1-37. After repairs are complete, retest for SPN 105 FMI 3. No: Go to Step 4.

Step 4		Decision
Perform Test 2(page 1072). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor IMT voltage. Is voltage approximately 0 volts?		Yes: Replace IMT sensor. After repairs are complete, retest for SPN 105 FMI 3. No: Go to Step 5.

Step 5		Decision
Perform Test 3(page 1073). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor IMT voltage. Is voltage approximately 0 volts?		Yes: Repair Open between IMT pin-1 and ECM pin E1-83. After repairs are complete, retest for SPN 105 FMI 3. No: Repair Open between IMT pin-2 and ECM pin E1-37. After repairs are complete, retest for SPN 105 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 105 FMI 3 fault code diagnostics.

Pin-Point Test SPN 105 FMI 3

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4782
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

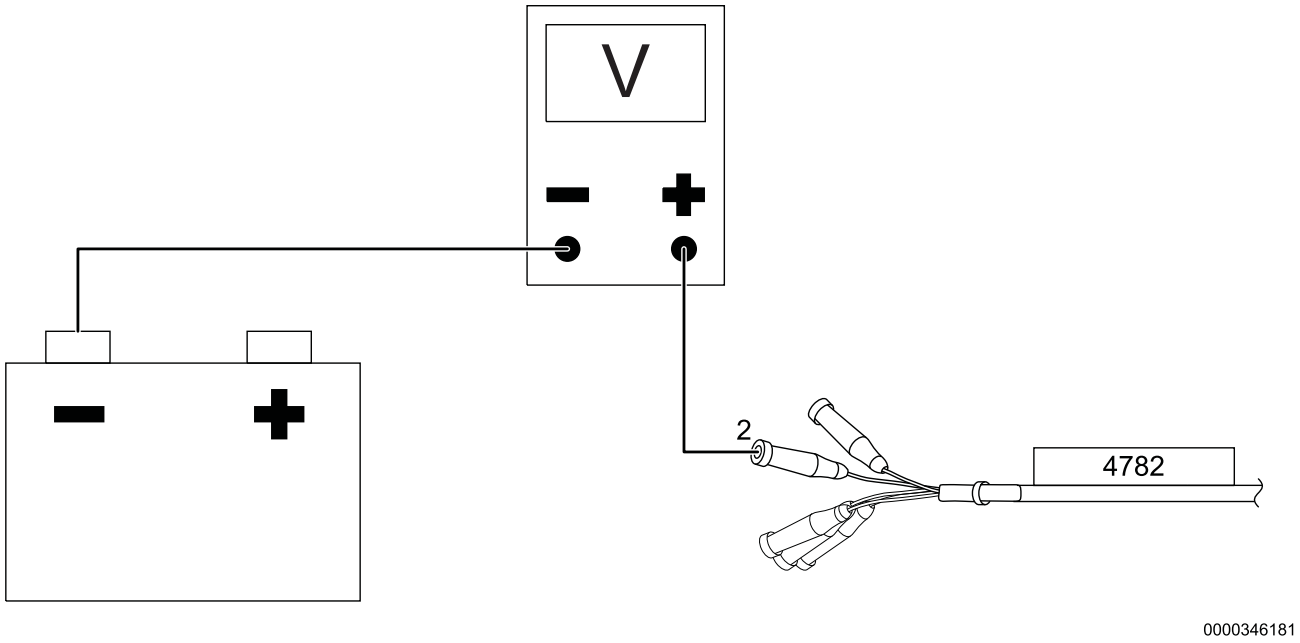
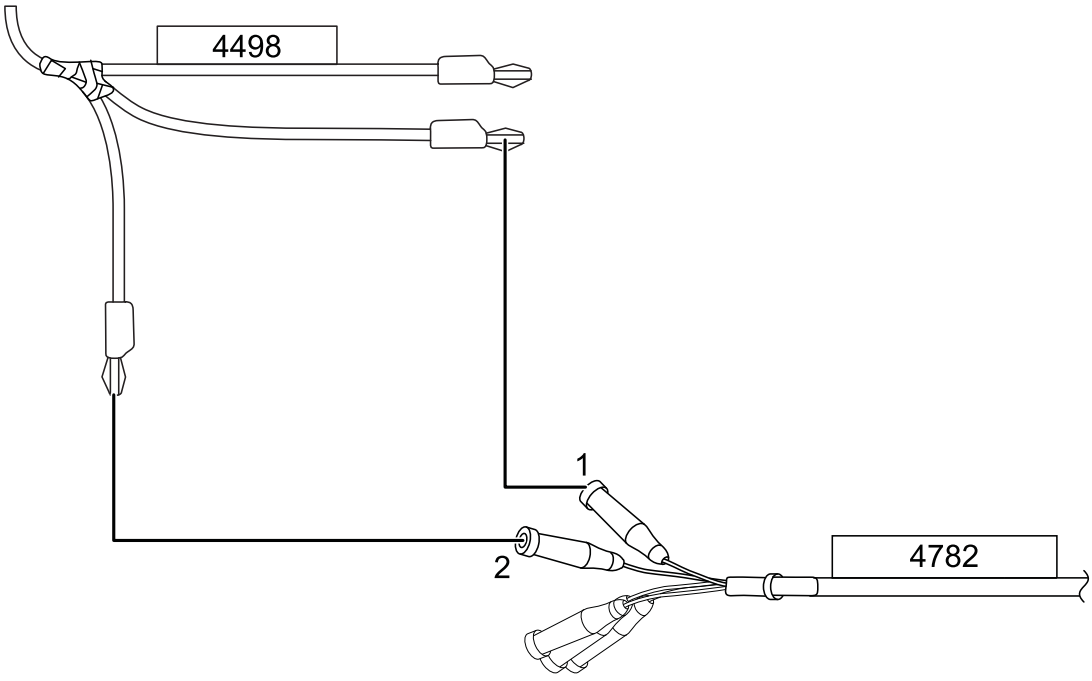


Figure 392 IMT Circuit Voltage Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4782 to vehicle harness and leave Intake Manifold Temperature (IMT) sensor disconnected. C. Key ON.



0000346161

Figure 393 IMT Sensor Circuit Check

Test 2 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4782 to vehicle harness and leave IMT sensor disconnected.
C. Using Breakout Harness ZTSE4498 short pin-1 and pin-2 of Breakout Harness ZTSE4782 together.
D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
E. Key ON, log into ServiceMaxx™ software.

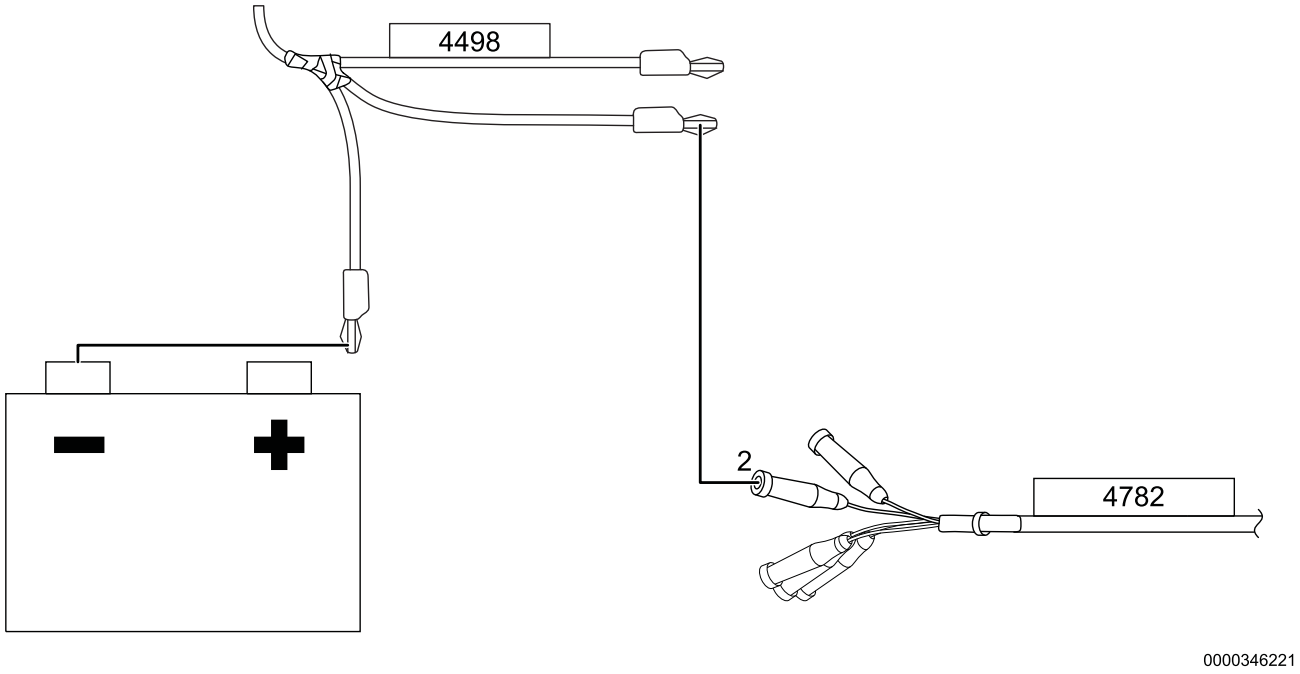


Figure 394 IMT Circuit Check

Test 3 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4782 to vehicle harness and leave IMT sensor disconnected.
C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4782 pin-2 to GND.
D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector.
E. Key ON, log in to ServiceMaxx™ software.

SPN 105 FMI 4 - IMT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
Intake Manifold Temperature (IMT) sensor reading less than expected.	IMT sensor voltage > 0.13 volts.	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects that Intake Manifold Temperature (IMT) signal voltage is less than expected.

Lamp Reaction

MIL will immediately illuminate when this fault is detected.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- IMT circuit short to GND
- SIG GND circuit shorted to IMT circuit
- Failed IMT sensor

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 105 FMI 4. Is EST DTC list SPN 105 FMI 4 active?		Yes: Go to Step 2. No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Intake Manifold Temperature (IMT) connector.	Decision
A. Key OFF. B. Disconnect IMT connector. C. Check IMT and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are IMT connector, harness, and terminals clean and undamaged?		Yes: Go to Step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 105 FMI 4.

Step 3		Decision
Perform Test 1(page 1076). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor IMT voltage. Is voltage 4.85 volts ± 0.05 volts?		Yes: Replace IMT sensor. After repairs are complete, retest for SPN 105 FMI 4. No: Repair short to GND between IMT pin-1 and Engine Control Module pin E1-37. After repairs are complete, retest for SPN 105 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 105 FMI 4 fault code diagnostics.

Pin-Point Test SPN 105 FMI 4

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF.
B. Disconnect Intake Manifold Temperature (IMT) sensor
C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
D. Key ON, log into ServiceMaxx™ software.

INJ (Injector) Circuits

Overview of INJ Circuit Group

SPN	FMI	Actions
651	3	Injector 1 short to PWR
651	4	Injector 1 short circuit (page 1079)
651	5	Injector 1 open load/circuit (page 1089)
652	3	Injector 2 short to PWR
652	4	Injector 2 short circuit (page 1097)
652	5	Injector 2 open load/circuit (page 1108)
653	3	Injector 3 short to PWR
653	4	Injector 3 short circuit (page 1116)
653	5	Injector 3 open load/circuit (page 1127)
654	3	Injector 4 short to PWR
654	4	Injector 4 short circuit (page 1135)
654	5	Injector 4 open load/circuit (page 1146)
655	3	Injector 5 short to PWR
655	4	Injector 5 short circuit (page 1154)
655	5	Injector 5 open load/circuit (page 1165)
656	3	Injector 6 short to PWR
656	4	Injector 6 short circuit (page 1173)
656	5	Injector 6 open load/circuit (page 1184)
2797	11	INJ Control Group 1 short circuit (INJ 1, 3, 5) (page 1191)
2798	11	INJ Control Group 2 short circuit (INJ 2, 4, 6) (page 1201)

Overview

When the Engine Control Module (ECM) determines fueling is required to a cylinder, voltage is supplied to the fuel injector. The fuel injector has a magnetic coil, which lifts a needle inside the injector. The needle moving upward uncovers the spray holes directing fuel into the cylinder. When the ECM determines injection should end, voltage to the magnetic coil is removed.

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

SPN 651 FMI 3 - Injector 1 Short to PWR

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 651 FMI 4 - Injector 1 Short Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Short to GND detected in fuel injector 1 circuit	INJ1 circuit resistance to ground < 0.5 ohms	Engine Control Module (ECM) commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 1 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ1 H circuit shorted to INJ1 L circuit
- INJ1 H circuit short to GND
- INJ1 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector 1

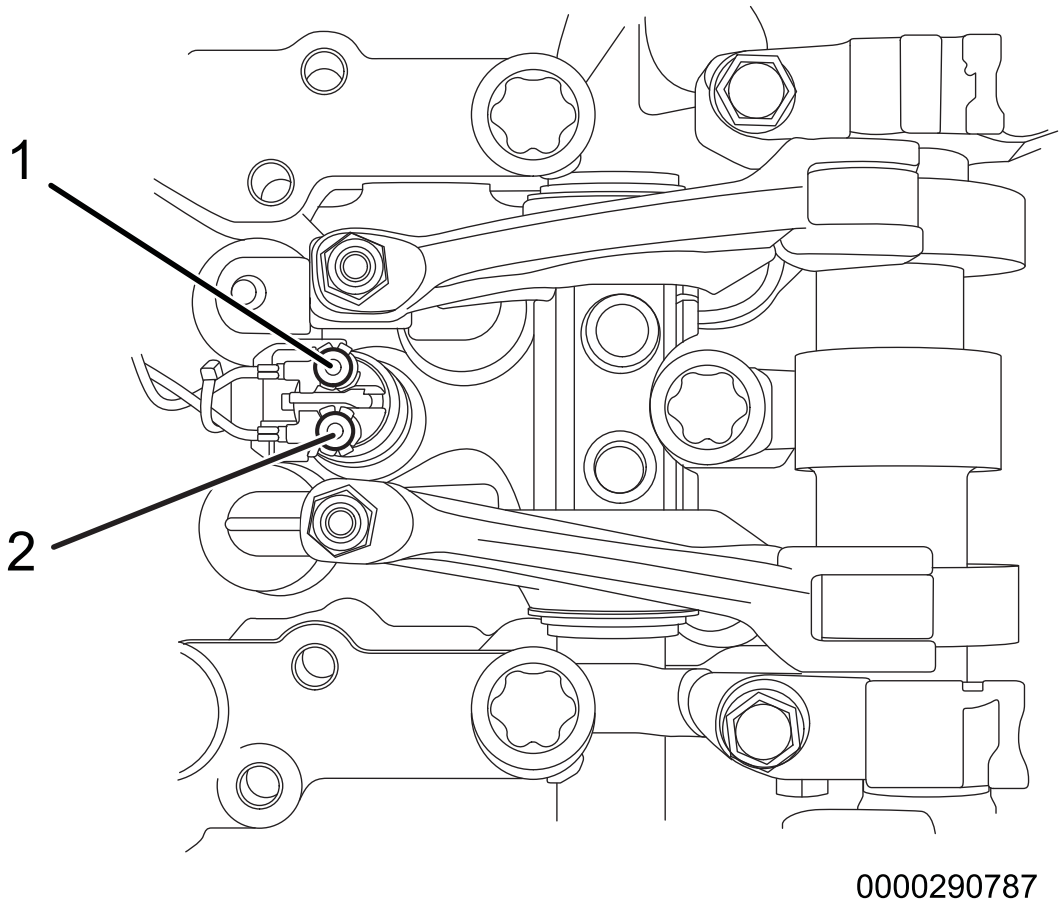


Figure 396 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step 1	Inspect connections at fuel injector 1 connector.	Decision
Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings.		Yes: Go to step 2.
Are fuel injector 1 terminals oriented correctly and Not contacting the engine brake housing?		No: Adjust connections so fuel injector 1 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 651 FMI 4.

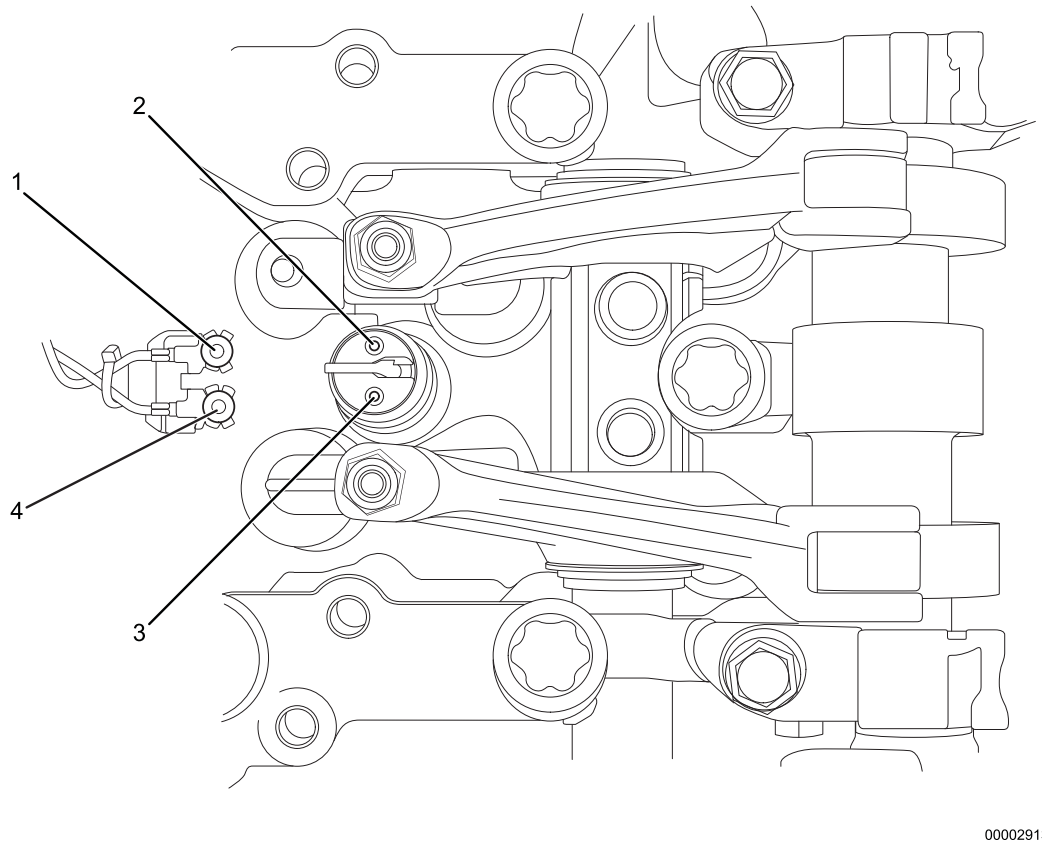


Figure 397 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 1 coil.	Decision
Perform Test 1 (page 1084). Using a Digital Multi-Meter (DMM) measure resistance between fuel injector 1 H and L terminals.		Yes: Go to step 3.
Is resistance between 0.2 to 0.8 Ohms?		No: Replace fuel injector 1. After repairs are complete, retest for SPN 651 FMI 4.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are ECM E2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 651 FMI 4.

Step 4	Check for fuel injector 1 H terminal short to ground.	Decision
Perform Test 2 (page 1085). Using a DMM measure resistance between fuel injector 1 H terminal and a known good GND.		Yes: Go to step 5.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 1. After repairs are complete, retest for SPN 651 FMI 4.

Step 5	Check for fuel injector 1 L terminal short to ground.	Decision
Perform Test 3 (page 1086). Using a DMM measure resistance between fuel injector 1 L terminal and a known good GND.		Yes: Go to step 6.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 1. After repairs are complete, retest for SPN 651 FMI 4.

Step 6	Check for INJ1 H circuit short to INJ1 L circuit.	Decision
Perform Test 4 (page 1087). Using a DMM measure resistance between Breakout Box pins E2-05 and E2-12 (wiggle test may be required).		Yes: Go to step 7.
Is resistance greater than 1000 ohms?		No: Repair short between INJ1 H circuit and INJ1 L circuit. After repairs are complete, retest for SPN 651 FMI 4.

Step 7	Check INJ 1 H circuit for short to GND.	Decision
Perform Test 5 (page 1088). Using a DMM with fuel injector 1 disconnected, measure resistance between Breakout Box pin E2-05 and known good GND (wiggle test may be required).		No: Repair short to GND between E2-12 and fuel injector 1. After repairs are complete, retest for SPN 651 FMI 4.
Is resistance greater than 1000 Ohms?		No: Repair short to GND between E2-05 and fuel injector 1. After repairs are complete, retest for SPN 651 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 651 FMI 4 fault code diagnostics.

Pin-Point Test SPN 651 FMI 4

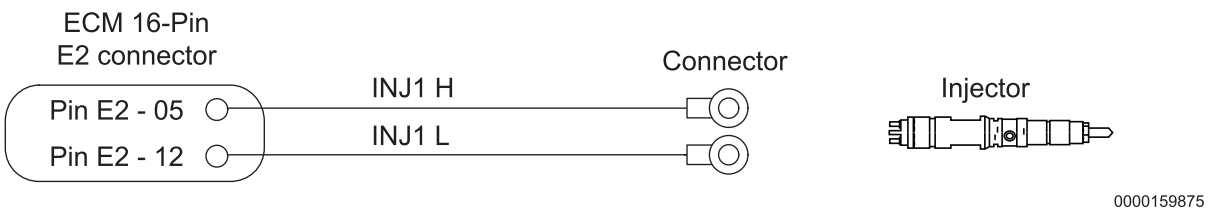


Figure 398 Fuel Injector 1 circuit diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

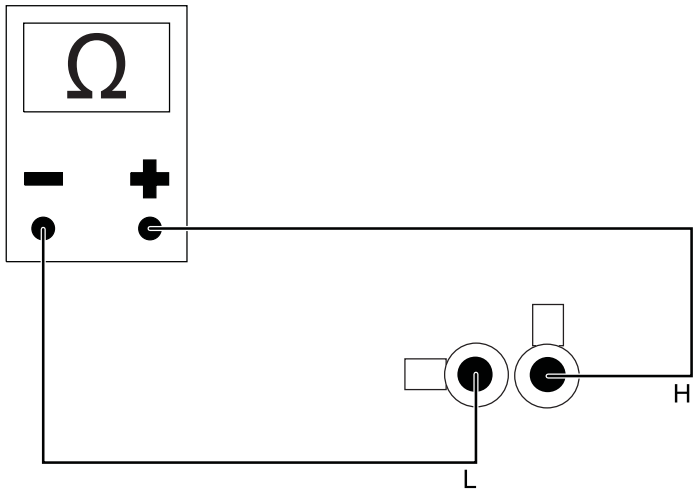


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Figure 399 Fuel Injector 1 Circuit Check

Test 1
A. Key OFF
B. Disconnect fuel injector 1 H and L terminals

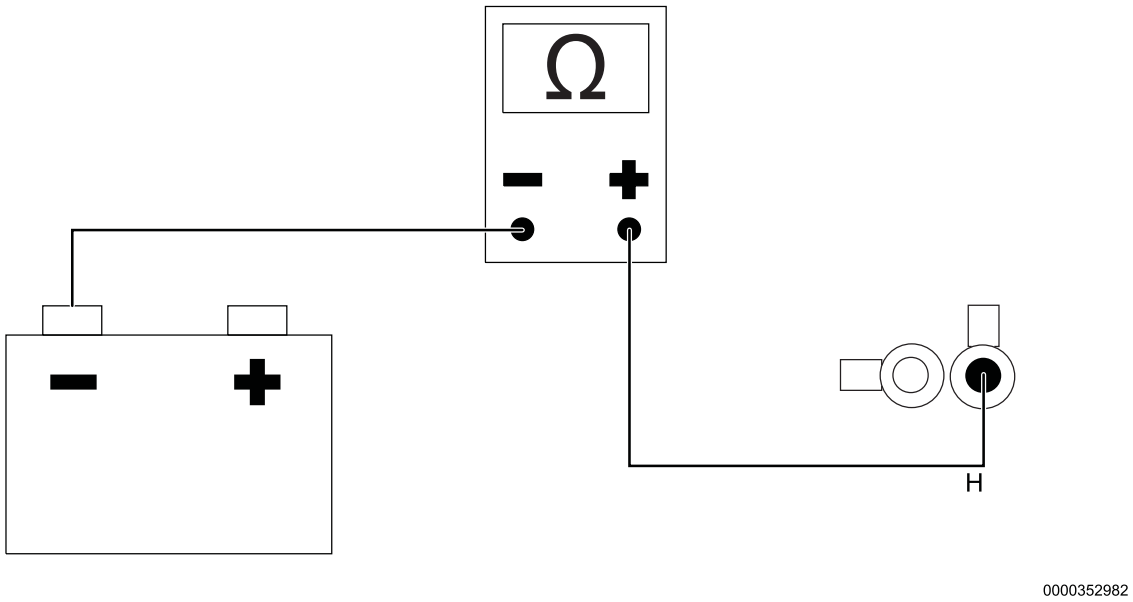

Figure 400 Fuel Injector 1 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect Fuel Injector 1 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.

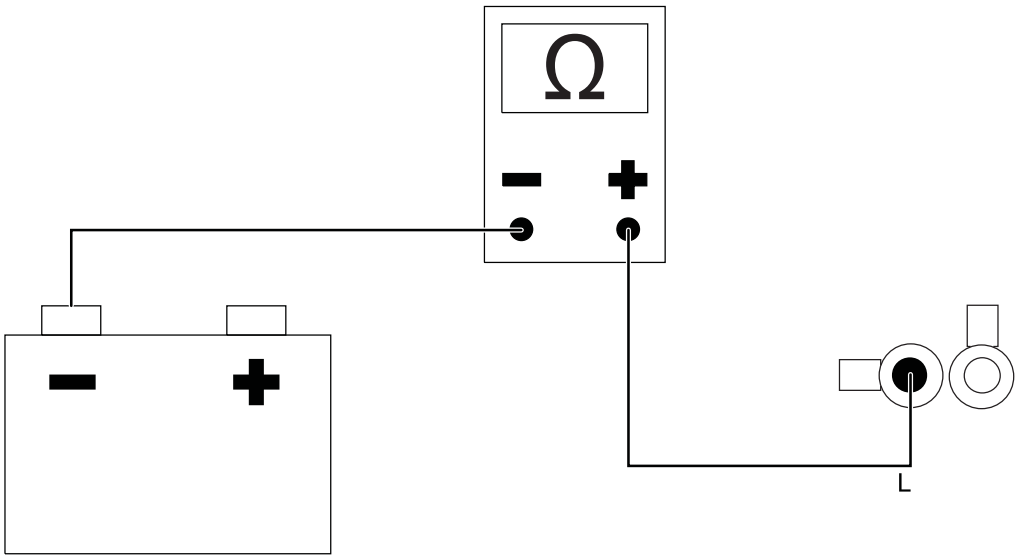

Figure 401 Fuel Injector 1 Low Side Circuit Check

Test 3
A. Key OFF
B. Disconnect Fuel Injector 1 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.

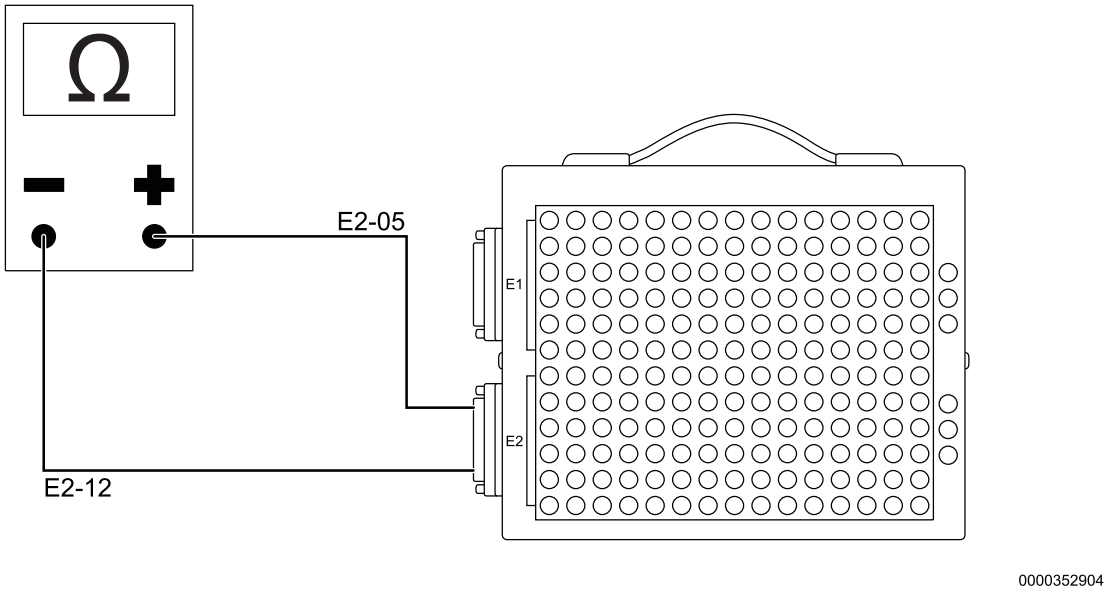

Figure 402 Fuel Injector 1 Circuit Check

Test 4
A. Key OFF. B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00. C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected. D. Disconnect Fuel Injector 1 H and L terminals

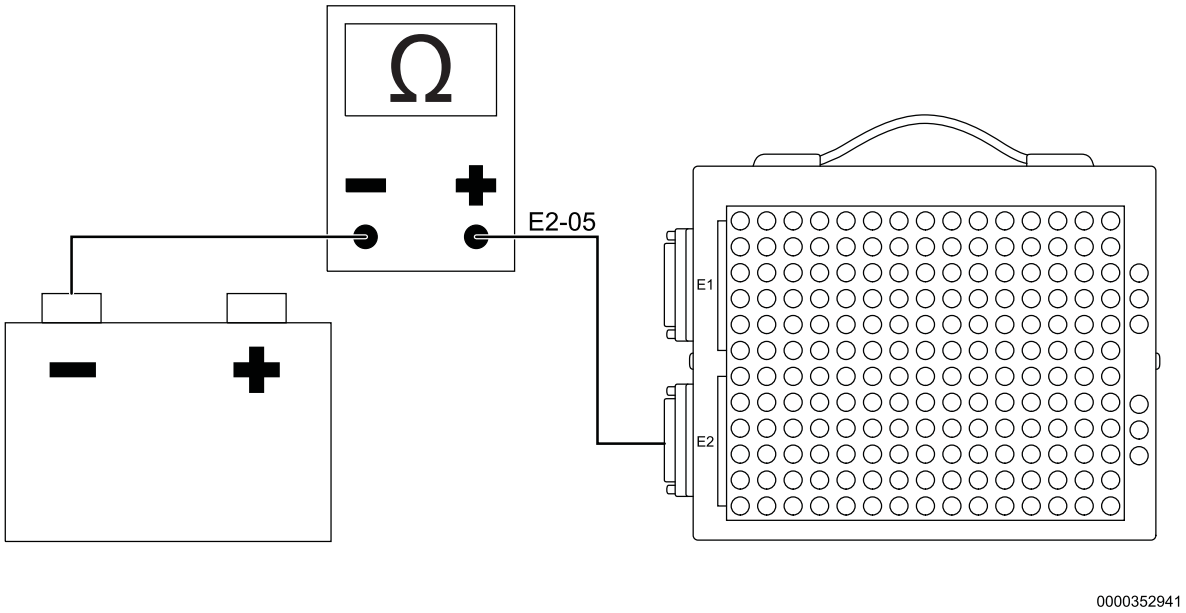

Figure 403 Fuel Injector 1 High Side Circuit Check

Test 5
A. Key OFF. B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00. C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected. D. Disconnect Fuel Injector 1 H and L terminals

SPN 651 FMI 5 - Injector 1 Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Open detected in fuel injector 1 circuit.	INJ1 circuit > 30 ohms	Engine Control Module (ECM) commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 1 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ1 H circuit Open or high resistance
- INJ1 L circuit Open or high resistance
- Failed fuel injector 1

Step 1	Inspect connections at fuel injector 1	Decision
A. Key OFF. B. Remove upper valve cover and engine brake housing (see Engine Service Manual). C. Disconnect fuel injector 1 connector. D. Check fuel injector 1 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 2.
Are fuel injector 1 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 651 FMI 5.

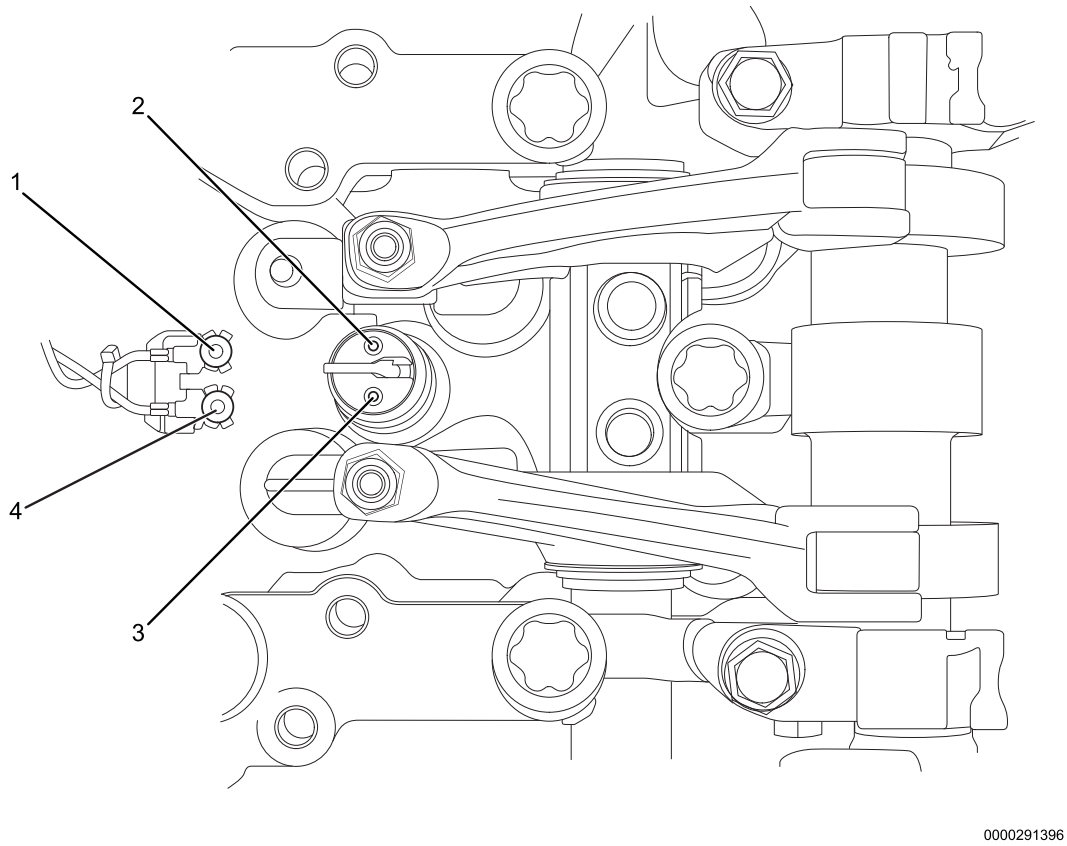

Figure 404 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 1 coil.	Decision
Perform Test 1 (page 1093). Using DMM measure resistance between fuel injector 1 H and L terminals.		Yes: Go to step 3.
Is resistance between 0.2 to 0.8 Ohms?		No: Replace fuel injector 1. After repairs are complete, retest for SPN 651 FMI 5.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are ECM E2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 651 FMI 5.

Step 4	Check INJ1 H circuit for Open or high resistance (voltage drop).	Decision
Perform Test 2 (page 1094). Using DMM measure voltage between fuel injector 1 INJ1 H ring terminal and terminal in ECM pin E2-05.		Yes: Repair Open or high resistance between fuel injector 1 INJ1 L ring terminal and ECM pin E2-12. After repairs are complete, retest for SPN 651 FMI 5.
Is voltage less than 0.3 volts?		No: Repair Open or high resistance between fuel injector 1 INJ1 H ring terminal and ECM pin E2-05. After repairs are complete, retest for SPN 651 FMI 5.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 651 FMI 5 fault code diagnostics.

Pin-Point Test SPN 651 FMI 5

Injector 1 circuit

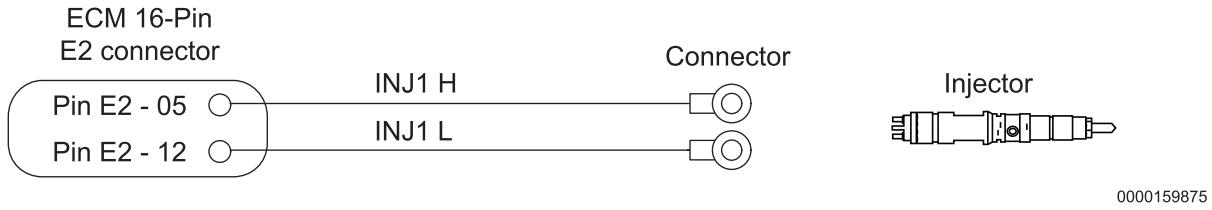

Figure 405 Fuel Injector 1 circuit diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- 500 Ohm Resistor ZTSE4497
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

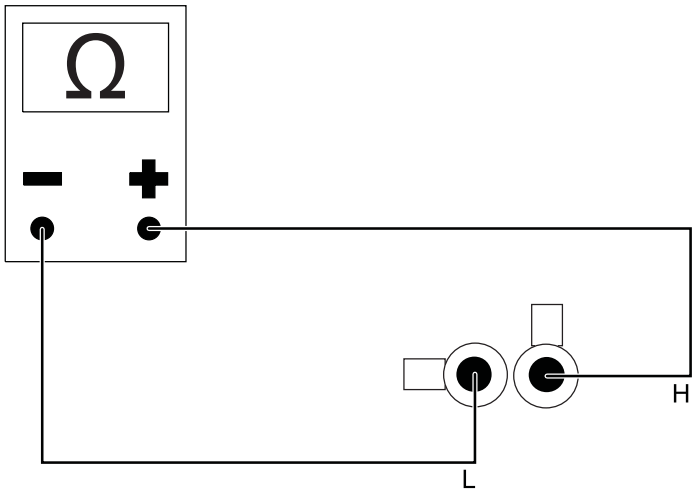

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Figure 406 Fuel Injector 1 Circuit Check

Test 1
A. Key OFF B. Disconnect Fuel Injector 1 H and L terminals

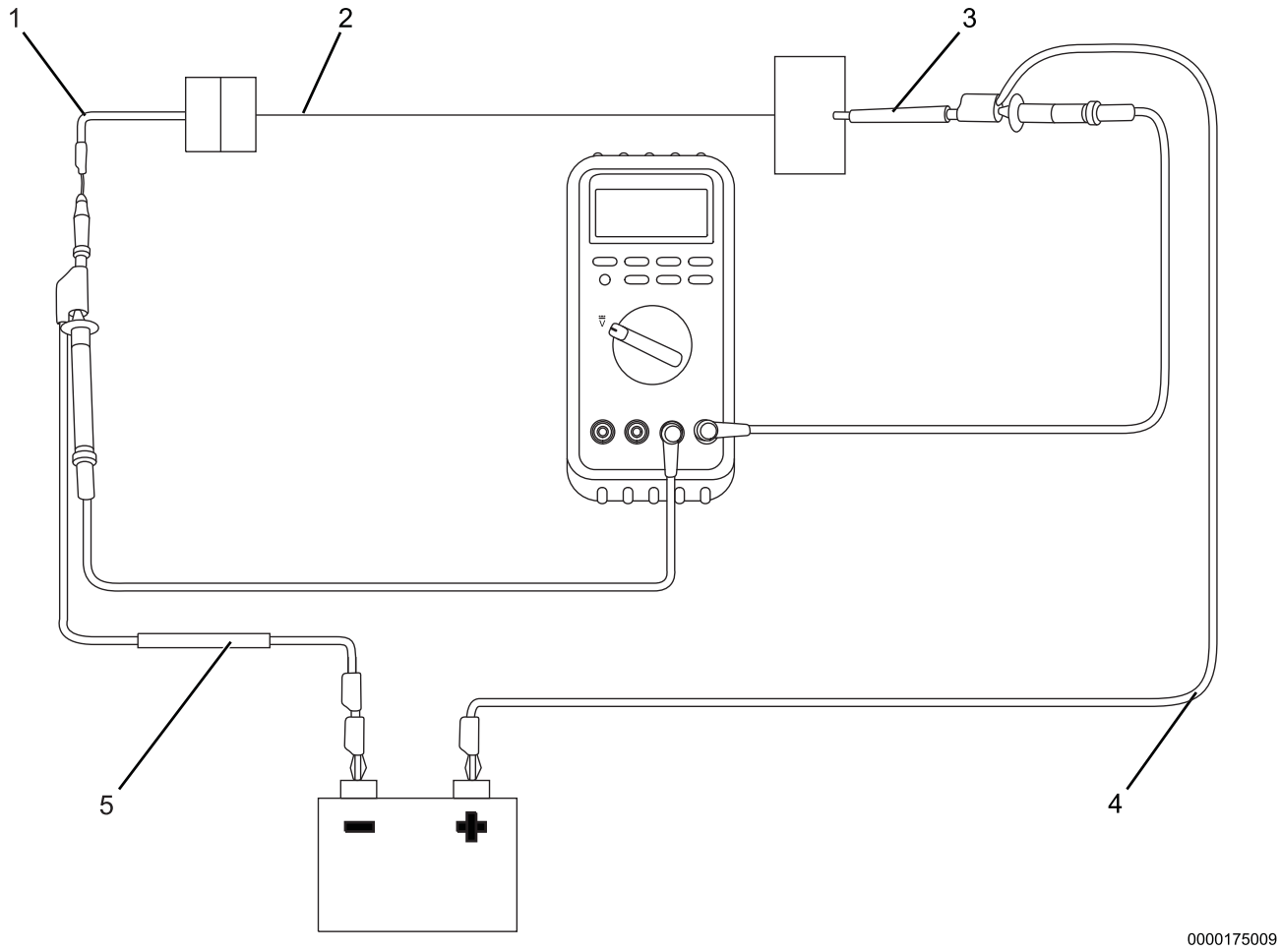


Figure 407 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

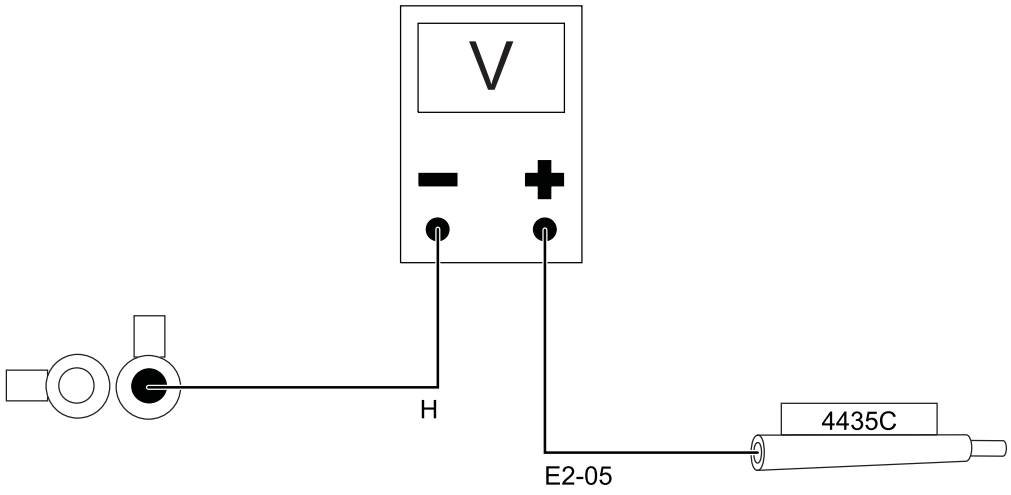


Figure 408 Fuel Injector 1 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect Fuel Injector 1 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.
D. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-05.
E. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-05, and connect the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed).
F. Connect INJ1 H ring terminal to a known good GND (use a jumper wire if needed)

SPN 652 FMI 3 - Injector 2 Short to PWR

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 652 FMI 4 - Injector 2 Short Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Short to GND detected in fuel injector 2 circuit	INJ2 circuit resistance to ground < 0.5 ohms	ECM commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 2 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ2 H circuit shorted to INJ2 L circuit
- INJ2 H circuit short to GND
- INJ2 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector 2

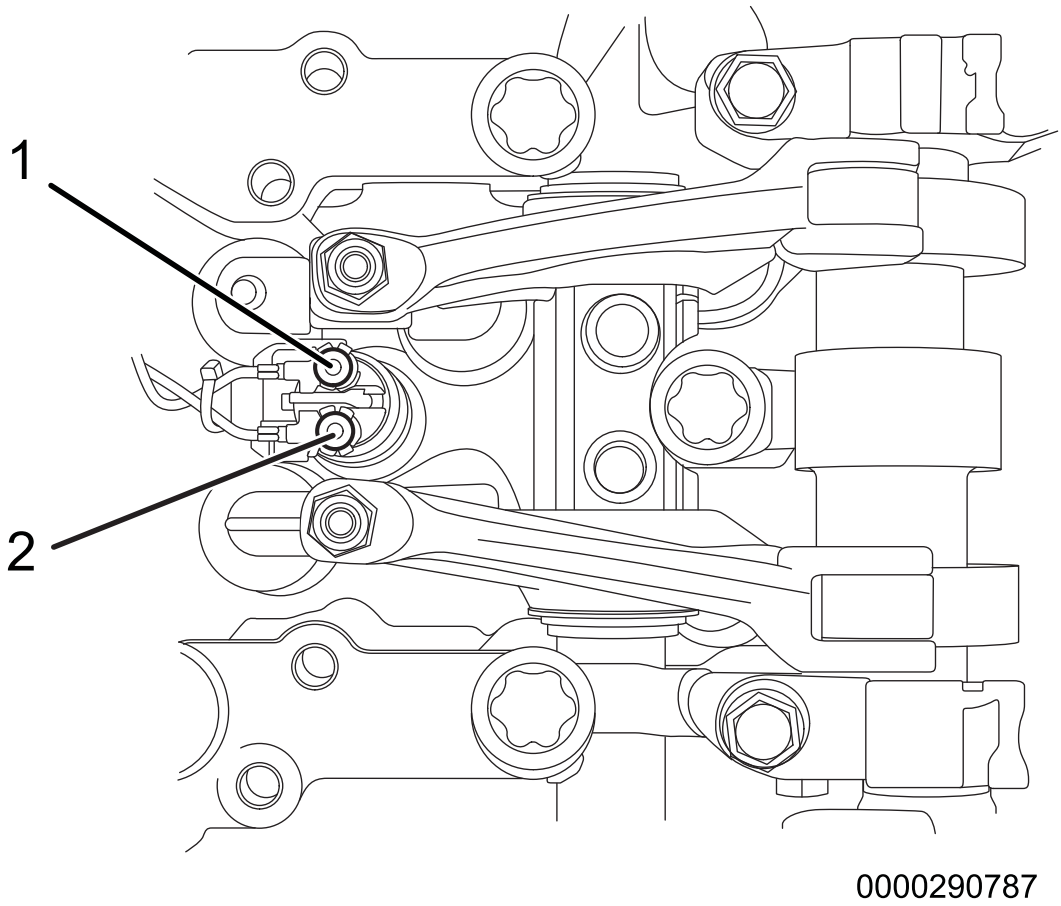


Figure 410 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step 1	Inspect connections at fuel injector 2 connector.	Decision
Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings.		Yes: Go to step 2.
Are fuel injector 2 terminals oriented correctly and Not contacting the engine brake housing?		No: Adjust connections so fuel injector 2 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 652 FMI 4.

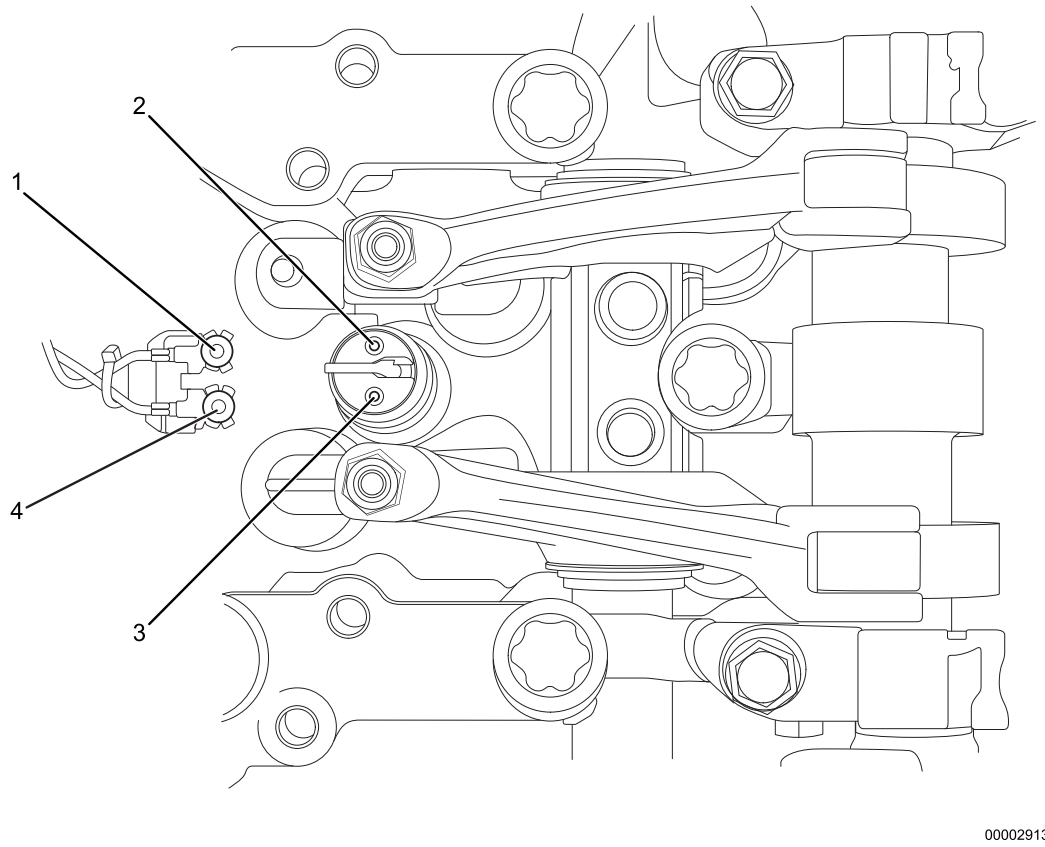


Figure 411 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 2 coil.	Decision
Perform Test 1 (page 1103). Using a Digital Multi-Meter (DMM) measure resistance between fuel injector 2 H and L terminals.		Yes: Go to step 3.
Is resistance between 0.2 to 0.8 Ohms?		No: Replace fuel injector 2. After repairs are complete, retest for SPN 652 FMI 4.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are ECM E2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 652 FMI 4.

Step 4	Check for fuel injector 2 H terminal short to ground.	Decision
Perform Test 2 (page 1104). Using a DMM measure resistance between fuel injector 2 H terminal and a known good GND.		Yes: Go to step 5.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 2. After repairs are complete, retest for SPN 652 FMI 4.

Step 5	Check for fuel injector 2 L terminal short to ground.	Decision
Perform Test 3 (page 1105). Using a DMM measure resistance between fuel injector 2 L terminal and a known good GND.		Yes: Go to step 6.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 2. After repairs are complete, retest for SPN 652 FMI 4.

Step 6	Check for INJ2 H circuit short to INJ2 L circuit.	Decision
Perform Test 4 (page 1106). Using a DMM measure resistance between Breakout Box pins E2-06 and E2-11 (wiggle test may be required).		Yes: Go to step 7.
Is resistance greater than 1000 ohms?		No: Repair short between INJ2 H circuit and INJ2 L circuit. After repairs are complete, retest for SPN 652 FMI 4.

Step 7	Check INJ 2H circuit for short to GND.	Decision
Perform Test 5 (page 1107). Using a DMM measure resistance between Breakout Box pin E2-06 and known good GND (wiggle test may be required).		Yes: Repair short to GND between E2-11 and fuel injector 2. After repairs are complete, retest for SPN 652 FMI 4.
Is resistance greater than 1000 Ohms?		No: Repair short to GND between E2-06 and fuel injector 2. After repairs are complete, retest for SPN 652 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 652 FMI 4 fault code diagnostics.

Pin-Point Test SPN 652 FMI 4

Injector 2 circuit

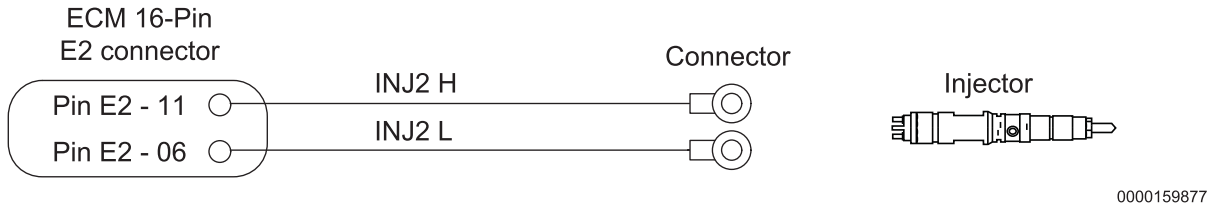
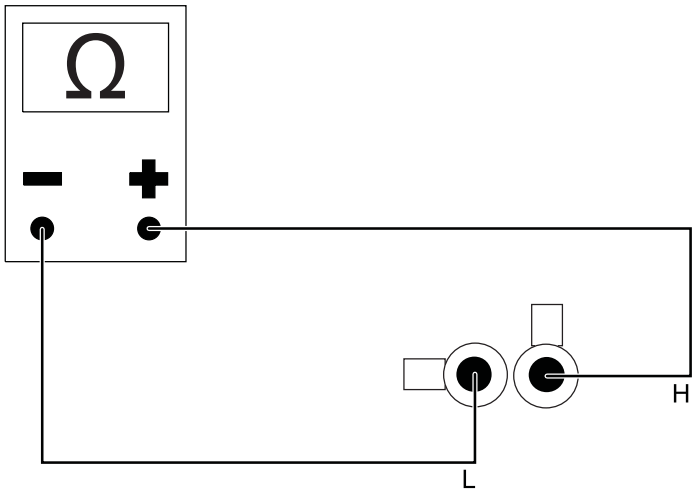


Figure 412 Fuel Injector 2 Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)



0000352981

Figure 413 Fuel Injector 2 Circuit Check

Test 1
A. Key OFF B. Disconnect fuel injector 2 H and L terminals

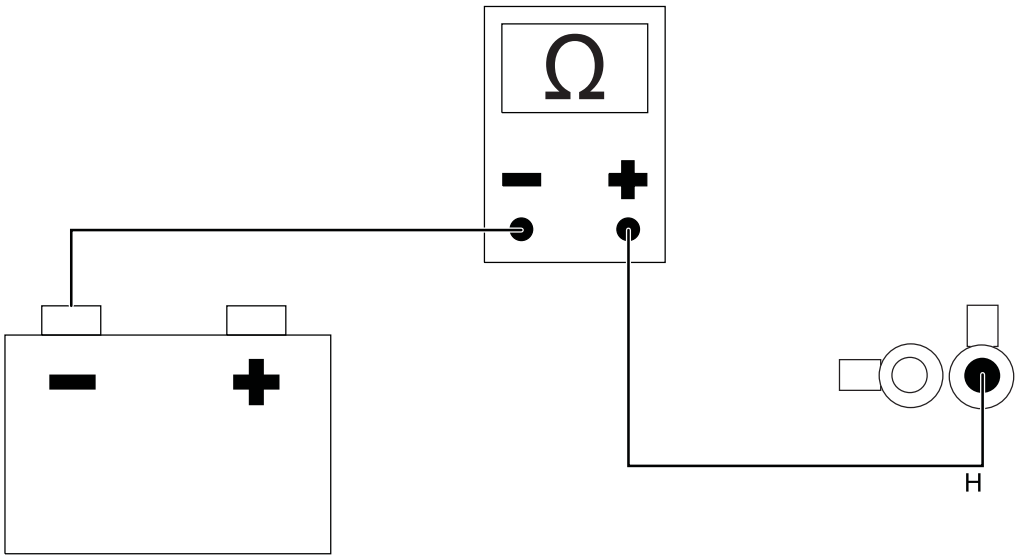


Figure 414 Fuel Injector 2 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect fuel injector 2 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.

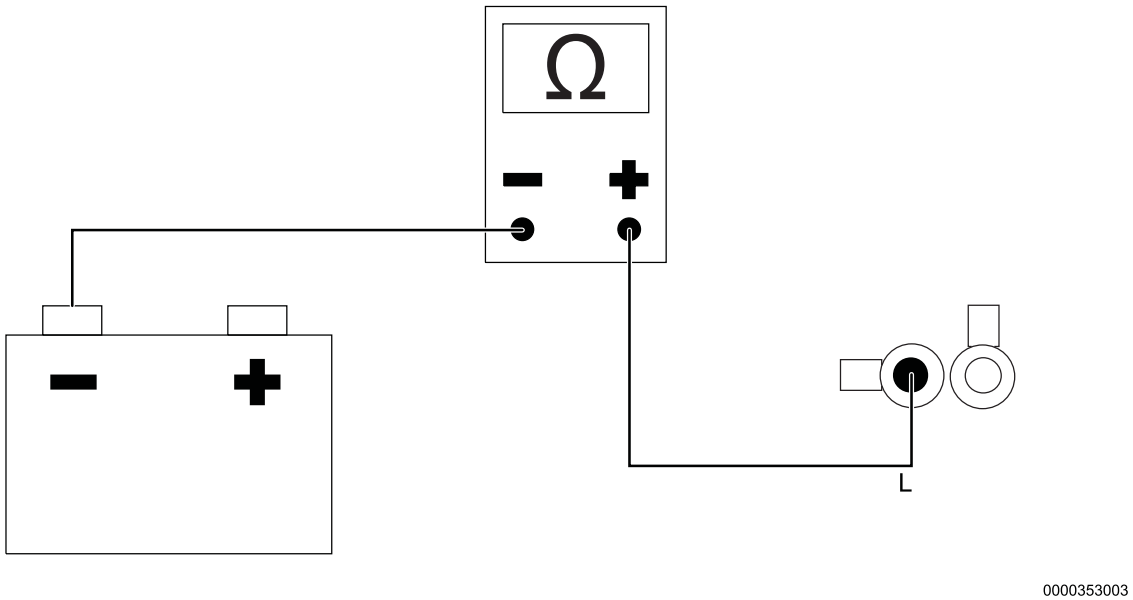


Figure 415 Fuel Injector 2 Low Side Circuit Check

Test 3
A. Key OFF B. Disconnect fuel injector 2 H and L terminals C. Disconnect ECM E2 connector.

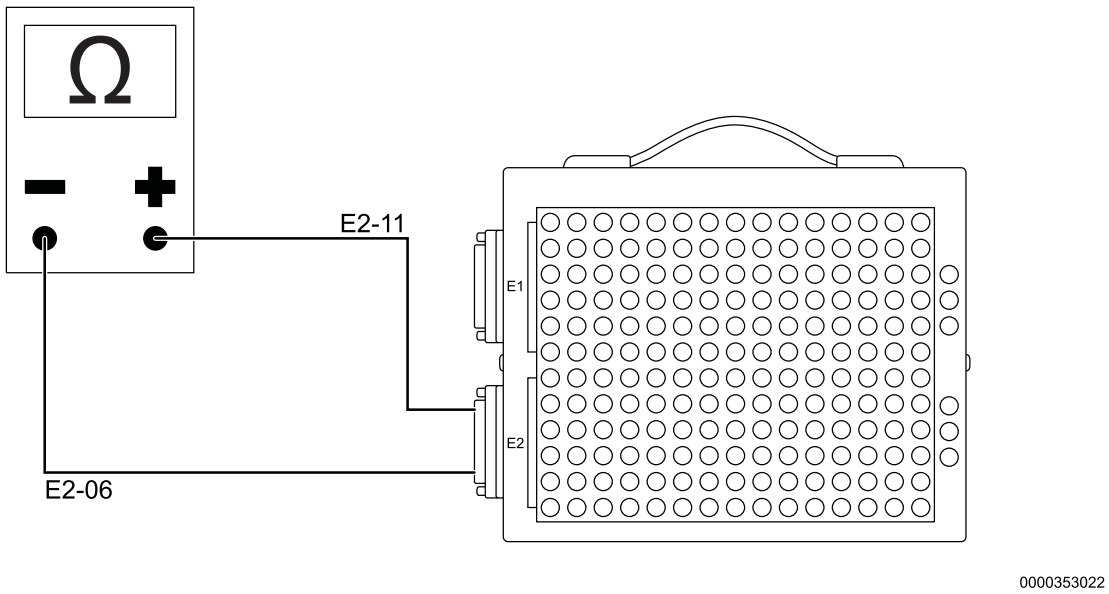


Figure 416 Fuel Injector 2 Circuit Check

Test 4
A. Key OFF.
B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00.
C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected.
D. Disconnect fuel injector 2 H and L terminals

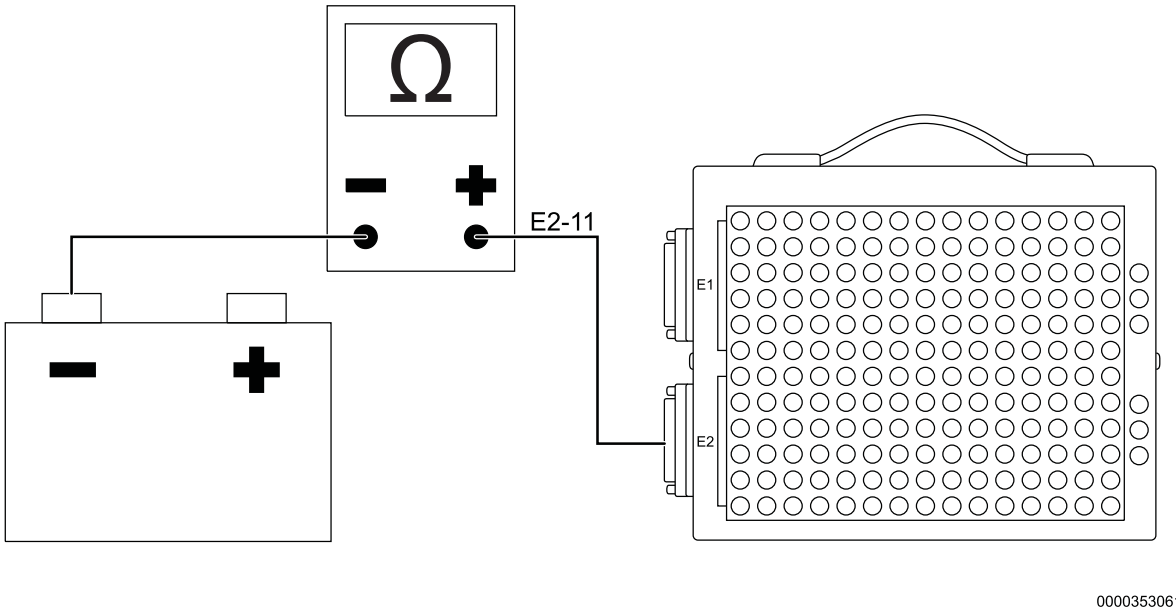


Figure 417 Fuel Injector 2 High Side Circuit Check

Test 5
A. Key OFF. B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00. C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected. D. Disconnect fuel injector 2 H and L terminals

SPN 652 FMI 5 - Injector 2 Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Open detected in fuel injector 2 circuit.	INJ2 circuit > 30 ohms	Engine Control Module (ECM) commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in fuel injector 2 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ2 H circuit Open or high resistance
- INJ2 L circuit Open or high resistance
- Failed fuel injector 2

Step 1	Inspect connections at fuel injector 2	Decision
A. Key OFF. B. Remove upper valve cover and engine brake housing (see Engine Service Manual). C. Disconnect fuel injector 2 connector. D. Check fuel injector 2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 2.
Are fuel injector 2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 652 FMI 5.

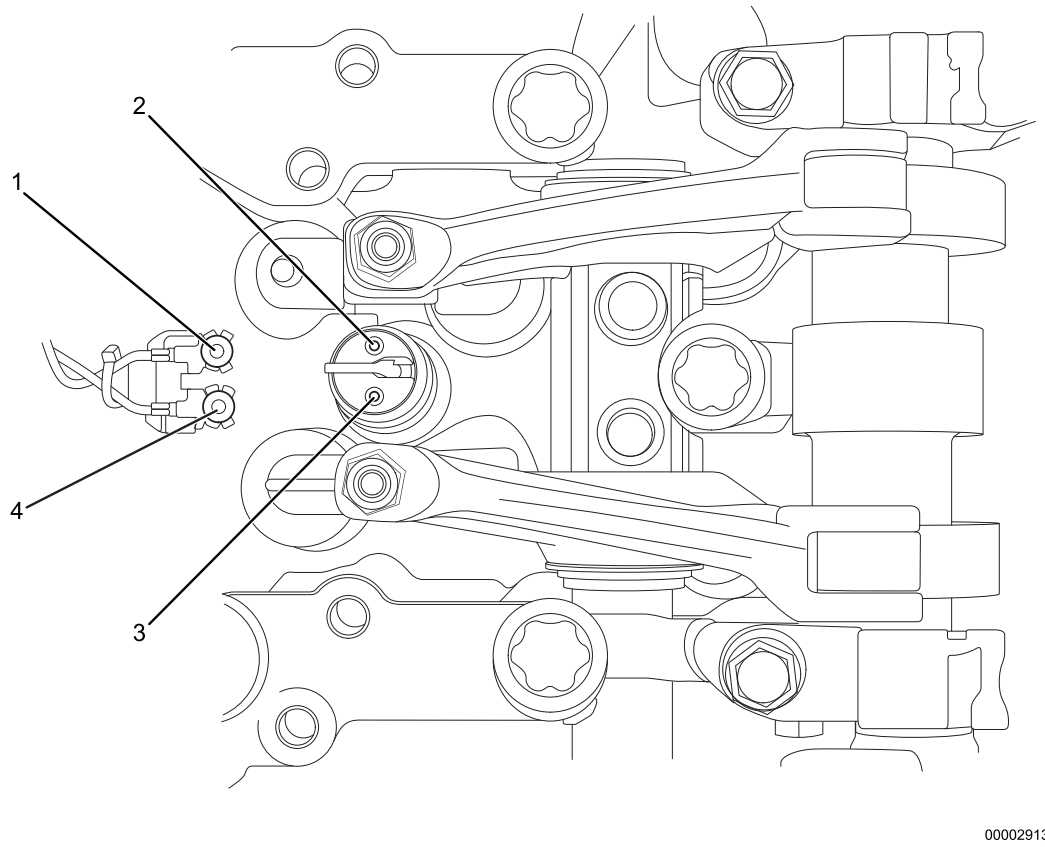


Figure 418 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 2 coil.	Decision
Perform Test 1 (page 1112). Using DMM measure resistance between fuel injector 2 H and L terminals.		Yes: Go to step 3.
Is resistance between 0.2 to 0.8 Ohms?		No: Replace fuel injector 2. After repairs are complete, retest for SPN 652 FMI 5.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are ECM E2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 652 FMI 5.

Step 4	Check INJ2 H circuit for Open or high resistance (voltage drop).	Decision
Perform Test 2 (page 1113). Using DMM measure voltage between fuel injector 2 INJ2 H ring terminal and terminal in ECM pin E2-11.		Yes: Repair Open or high resistance between fuel injector 2 INJ2 L ring terminal and ECM pin E2-06. After repairs are complete, retest for SPN 652 FMI 5.
Is voltage less than 0.3 volts?		No: Repair Open or high resistance between fuel injector 2 INJ2 H ring terminal and ECM pin E2-11. After repairs are complete, retest for SPN 652 FMI 5.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 652 FMI 5 fault code diagnostics.

Pin-Point Test SPN 652 FMI 5

Injector 2 circuit

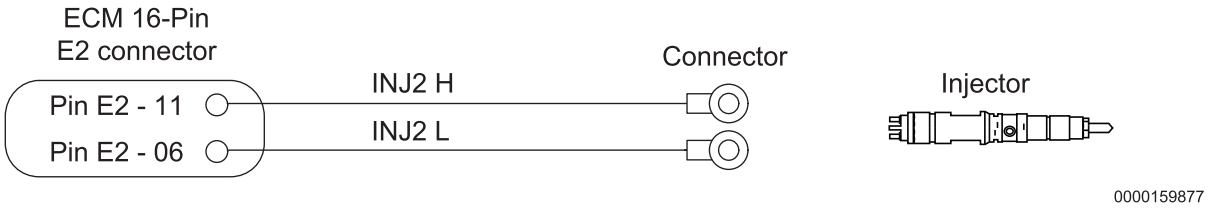
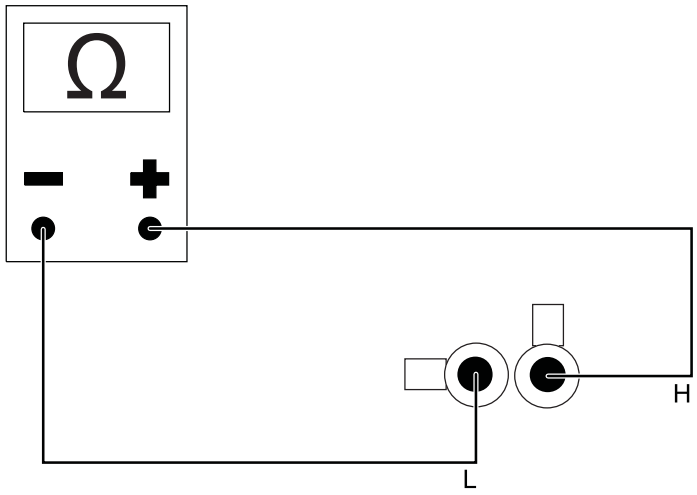


Figure 419 Fuel Injector 2 Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- 500 Ohm Resistor ZTSE4497
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)



0000352981

Figure 420 Fuel Injector 2 Circuit Check

Test 1
A. Key OFF
B. Disconnect Fuel Injector 2 H and L terminals

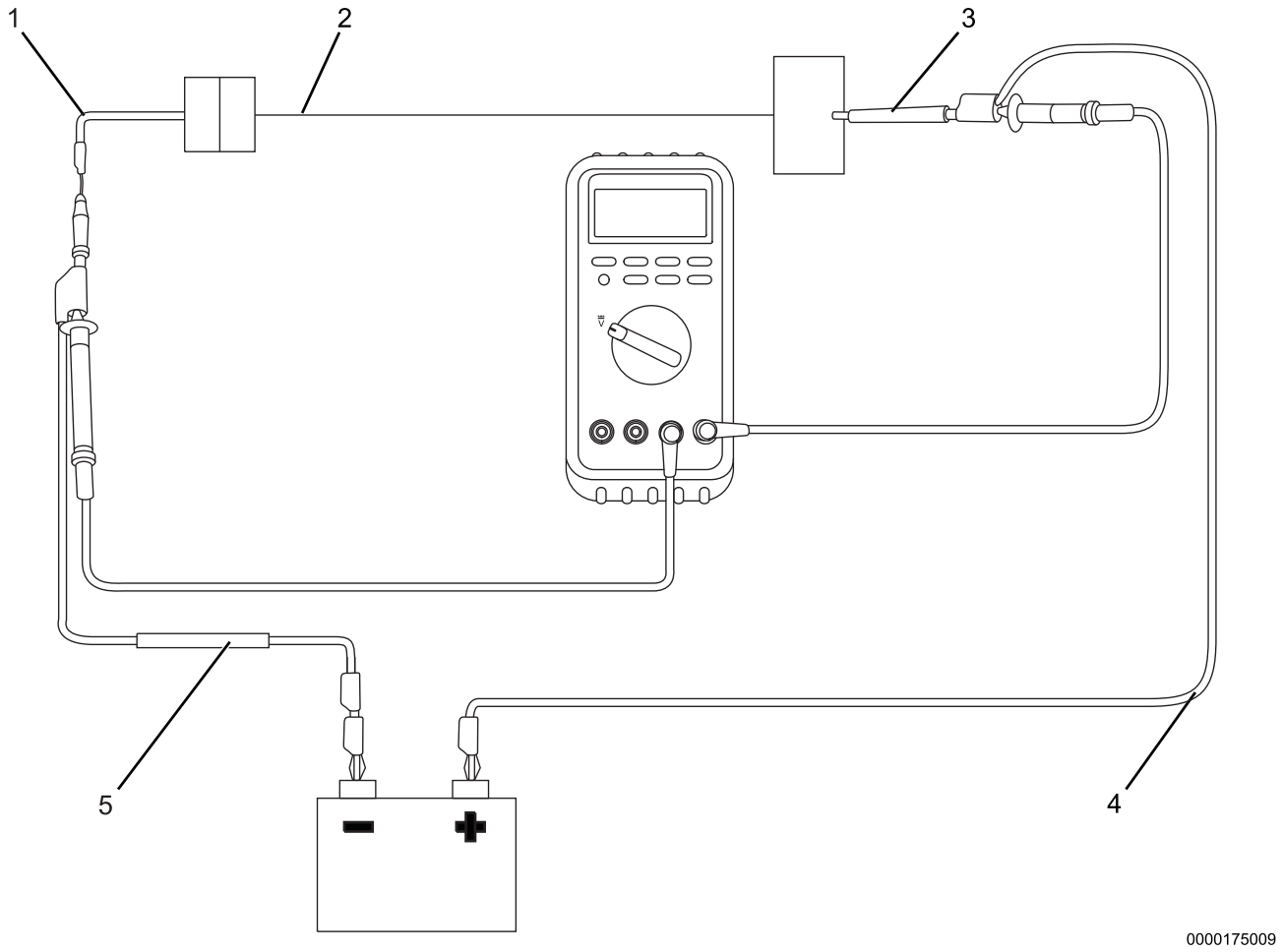


Figure 421 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

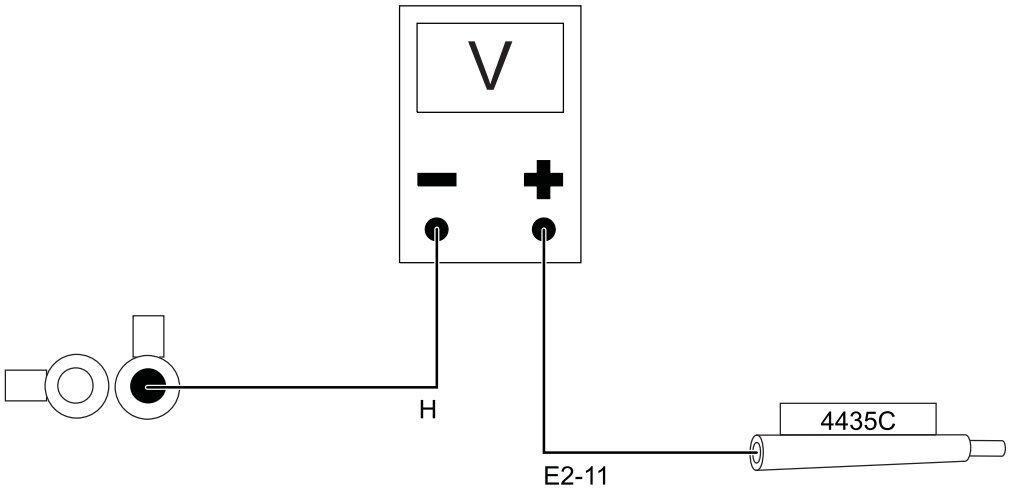


Figure 422 Fuel Injector 2 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect Fuel Injector 2 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.
D. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-11.
E. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-11, and connect the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed).
F. Connect INJ2 H ring terminal to a known good GND (use a jumper wire if needed)

SPN 653 FMI 3 - Injector 3 Short to PWR

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 653 FMI 4 - Injector 3 Short Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Short to GND detected in fuel injector 3 circuit	INJ3 circuit resistance to ground < 0.5 ohms	ECM commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 3 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ3 H circuit shorted to INJ3 L circuit
- INJ3 H circuit short to GND
- INJ3 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector 3

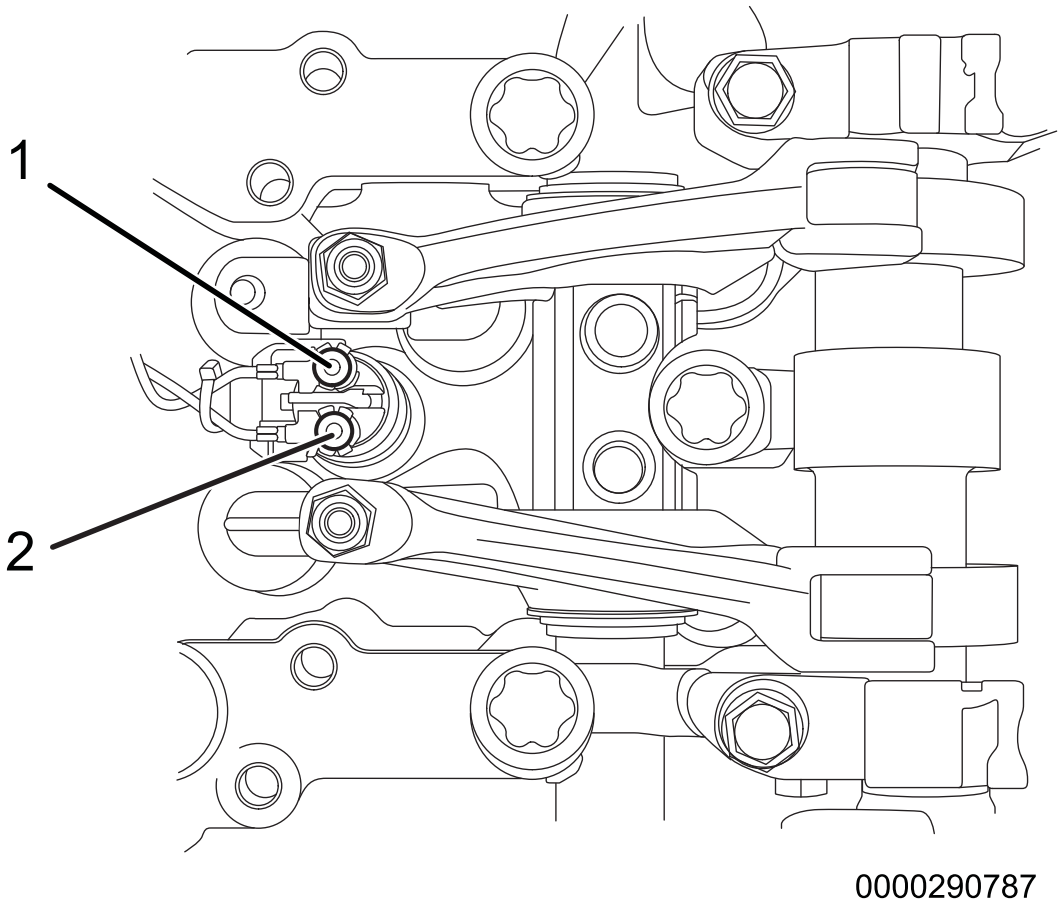


Figure 424 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step 1	Inspect connections at fuel injector 3 connector.	Decision
Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings.		Yes: Go to step 2.
Are fuel injector 3 terminals oriented correctly and Not contacting the engine brake housing?		No: Adjust connections so fuel injector 3 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 653 FMI 4.

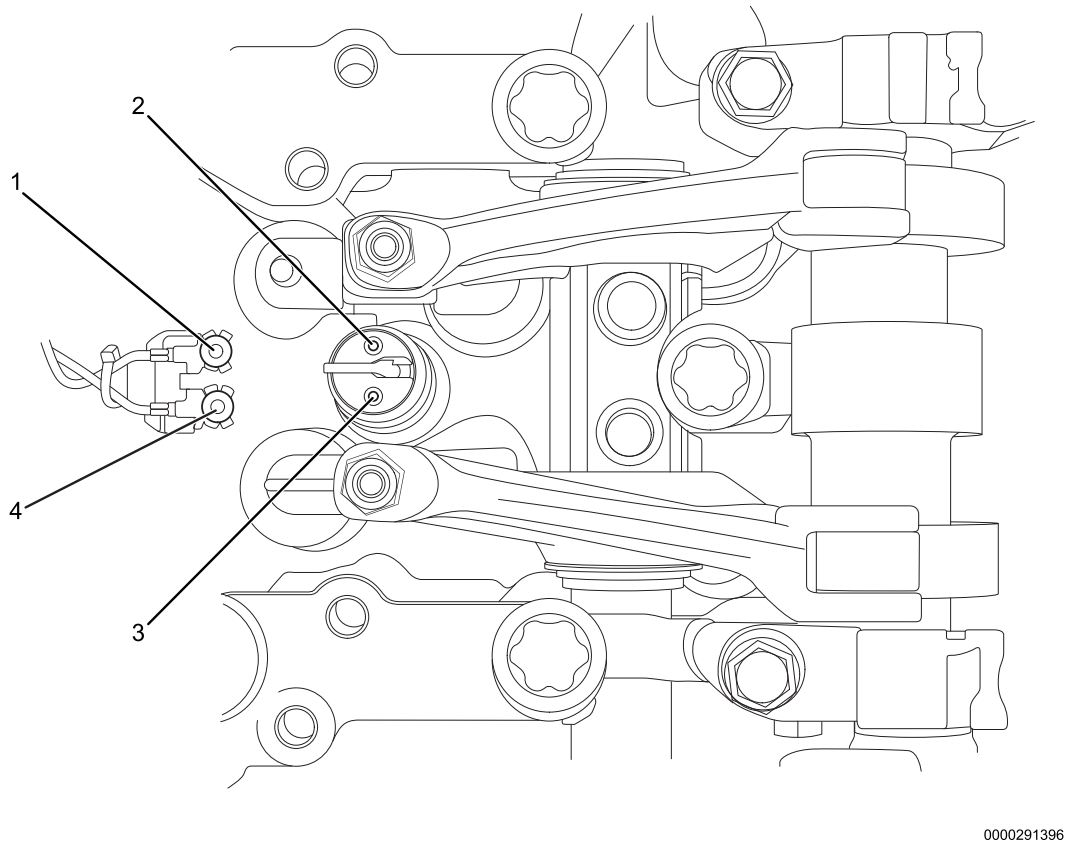


Figure 425 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 3 coil.	Decision
Perform Test 1 (page 1122). Using a Digital Multi-Meter (DMM) measure resistance between fuel injector 3 H and L terminals.		Yes: Go to step 3.
Is resistance between 0.2 to 0.8 Ohms?		No: Replace fuel injector 3. After repairs are complete, retest for SPN 653 FMI 4.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are ECM E2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 653 FMI 4.

Step 4	Check for fuel injector 1 H terminal short to ground.	Decision
Perform Test 2 (page 1123). Using a DMM measure resistance between fuel injector 1 H terminal and a known good GND.		Yes: Go to step 5.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 3. After repairs are complete, retest for SPN 653 FMI 4.

Step 5	Check for fuel injector 1 L terminal short to ground.	Decision
Perform Test 3 (page 1124). Using a DMM measure resistance between fuel injector 3 L terminal and a known good GND.		Yes: Go to step 6.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 3. After repairs are complete, retest for SPN 653 FMI 4.

Step 6	Check for INJ1 H circuit short to INJ1 L circuit.	Decision
Perform Test 4 (page 1125). Using a DMM measure resistance between Breakout Box 00-00956-08 pins E2-04 and E2-13 (wiggle test may be required).		Yes: Go to step 7.
Is resistance greater than 1000 ohms?		No: Repair short between INJ3 H circuit and INJ3 L circuit. After repairs are complete, retest for SPN 653 FMI 4.

Step 7	Check INJ 1 H circuit for short to GND.	Decision
Perform Test 5 (page 1126). Using a DMM with fuel injector 3 disconnected, measure resistance between Breakout Box 00-00956-08 pin E2-04 and known good GND (wiggle test may be required).		No: Repair short to GND between E2-13 and fuel injector 3. After repairs are complete, retest for SPN 653 FMI 4.
Is resistance greater than 1000 Ohms?		No: Repair short to GND between E2-04 and fuel injector 3. After repairs are complete, retest for SPN 653 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 653 FMI 4 fault code diagnostics.

Pin-Point Test SPN 653 FMI 4

Injector 3 circuit

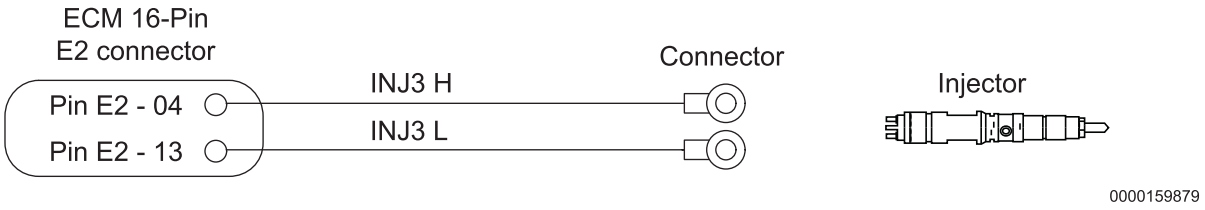
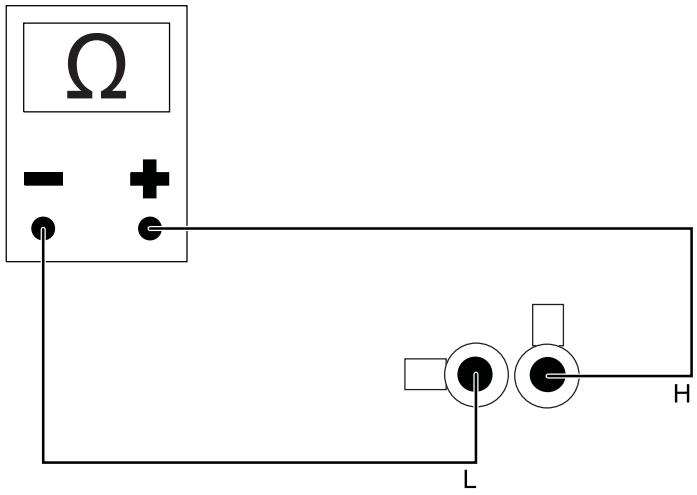


Figure 426 Fuel Injector 3 Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)



0000352981

Figure 427 Fuel Injector 3 Circuit Check

Test 1
A. Key OFF
B. Disconnect fuel injector 3 H and L terminals

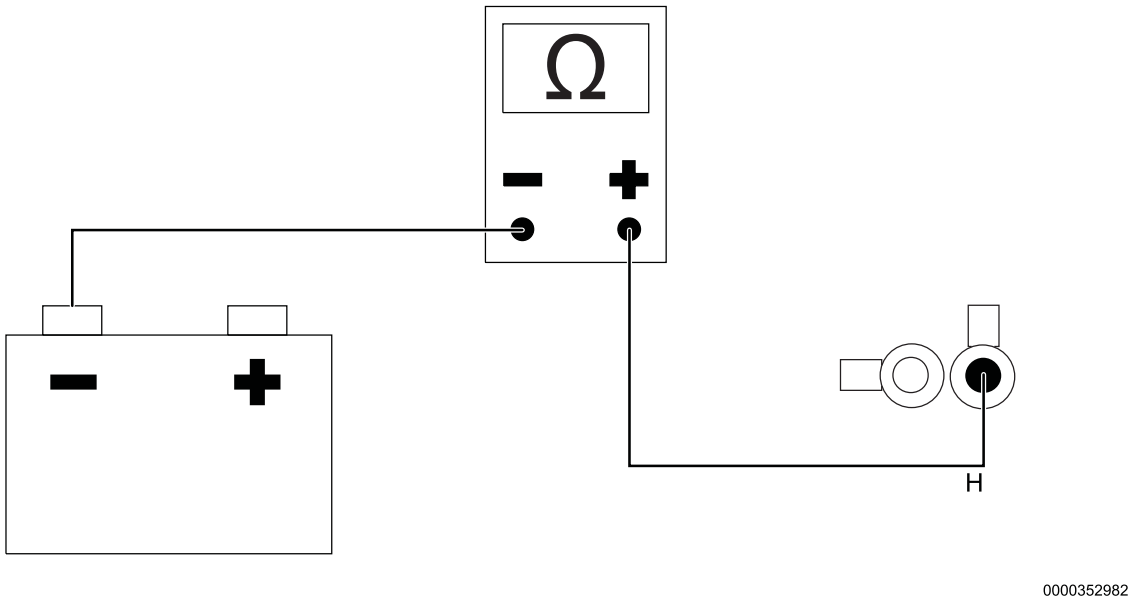


Figure 428 Fuel Injector 3 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect Fuel Injector 3 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.

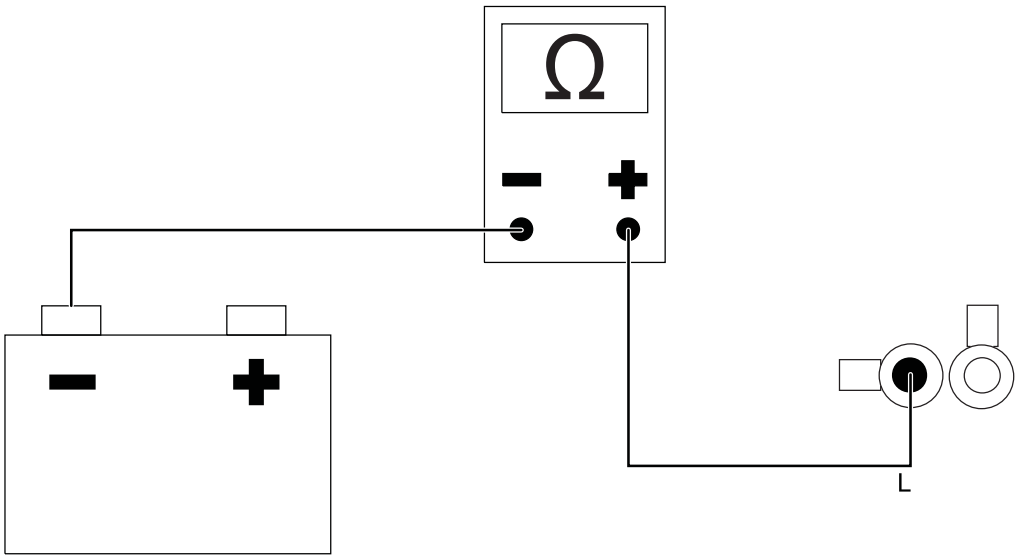


Figure 429 Fuel Injector 3 Low Side Circuit Check

Test 3
A. Key OFF
B. Disconnect Fuel Injector 3 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.

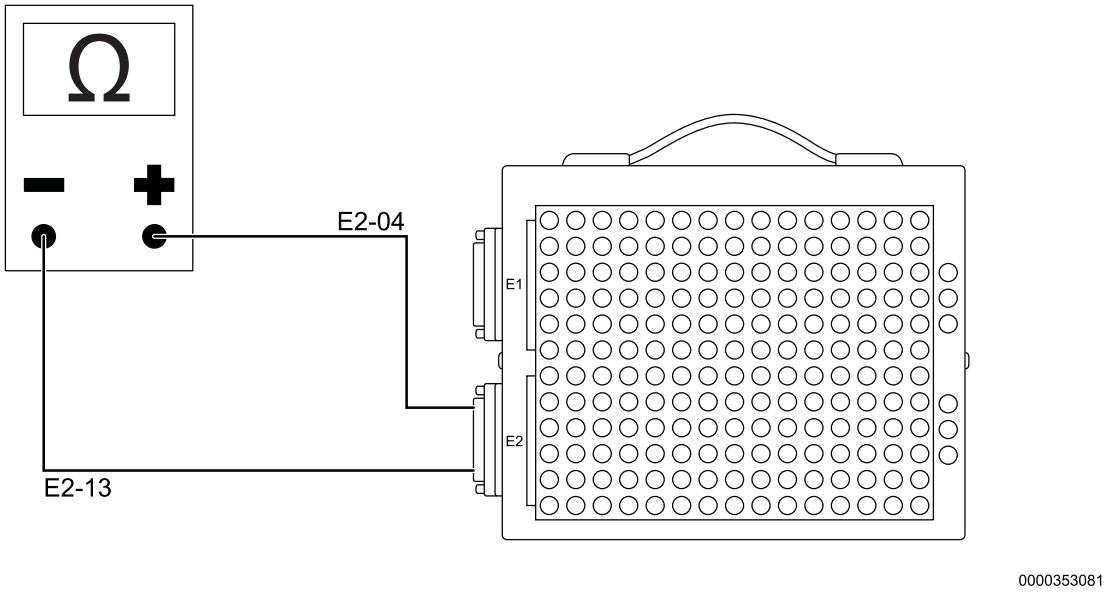


Figure 430 Fuel Injector 3 Circuit Check

Test 4
A. Key OFF.
B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00.
C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected.
D. Disconnect Fuel Injector 3 H and L terminals

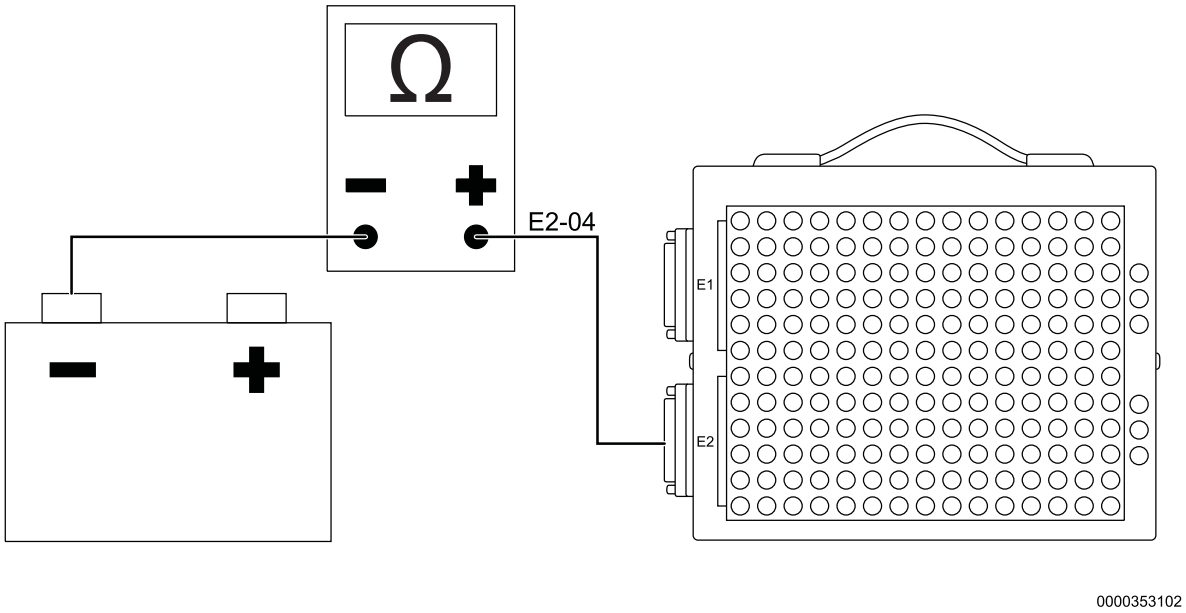


Figure 431 Fuel Injector 3 High Side Circuit Check

Test 5
A. Key OFF. B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00. C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected. D. Disconnect Fuel Injector 3 H and L terminals

SPN 653 FMI 5 - Injector 3 Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Open detected in fuel injector 3 circuit.	INJ3 circuit > 30 ohms	Engine Control Module (ECM) commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 3 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ3 H circuit Open or high resistance
- INJ3 L circuit Open or high resistance
- Failed fuel injector 3

Step 1	Inspect connections at fuel injector 3	Decision
A. Key OFF. B. Remove upper valve cover and engine brake housing (see Engine Service Manual). C. Disconnect fuel injector 3 connector. D. Check fuel injector 3 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 2.
Are fuel injector 3 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 653 FMI 5.

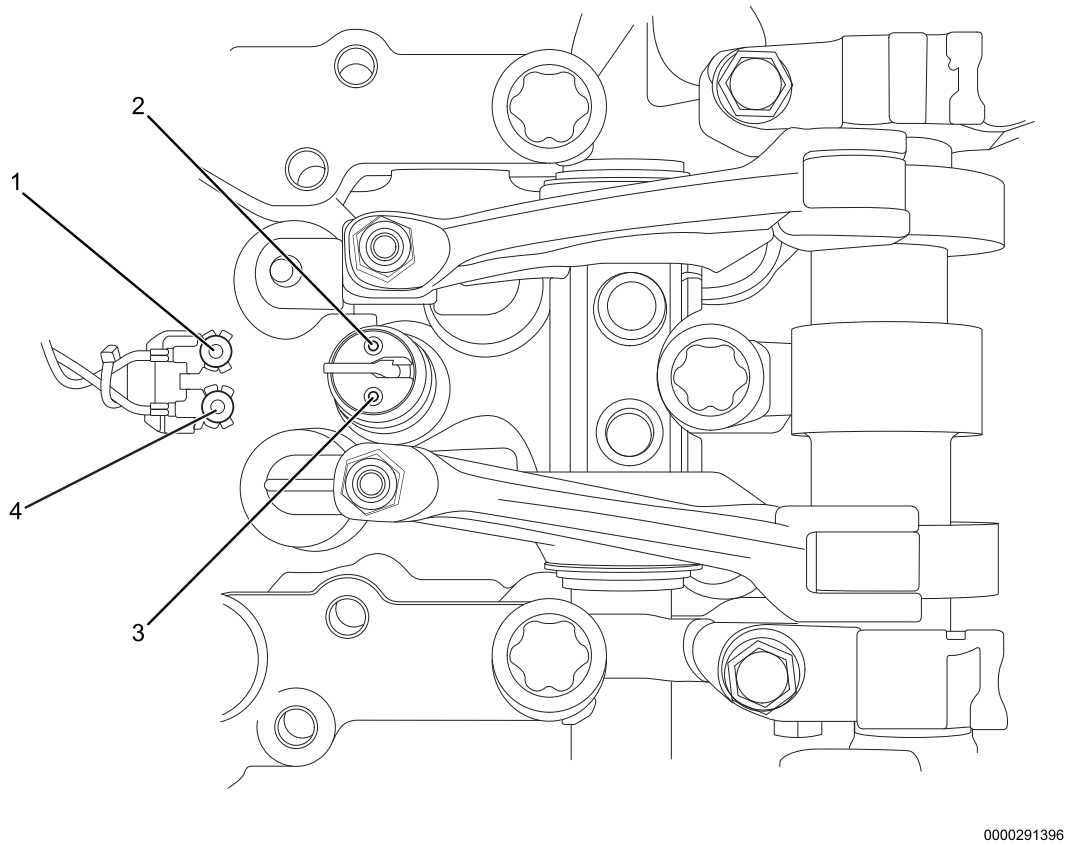


Figure 432 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 3 coil.	Decision
Perform Test 1 (page 1131). Using DMM measure resistance between fuel injector 3 H and L terminals.		Yes: Go to step 3.
Is resistance between 0.2 to 0.8 Ohms?		No: Replace fuel injector 3. After repairs are complete, retest for SPN 653 FMI 5.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are ECM E2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 653 FMI 5.

Step 4	Check INJ3 H circuit for Open or high resistance (voltage drop).	Decision
Perform Test 2 (page 1132). Using DMM measure voltage between fuel injector 3 INJ3 H ring terminal and terminal in ECM pin E2-04.		Yes: Repair Open or high resistance between fuel injector 3 INJ3 L ring terminal and ECM pin E2-13. After repairs are complete, retest for SPN 653 FMI 5.
Is voltage less than 0.3 volts?		No: Repair Open or high resistance between fuel injector 3 INJ3 H ring terminal and ECM pin E2-04. After repairs are complete, retest for SPN 653 FMI 5.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 653 FMI 5 fault code diagnostics.

Pin-Point Test SPN 653 FMI 5

Injector 3 circuit

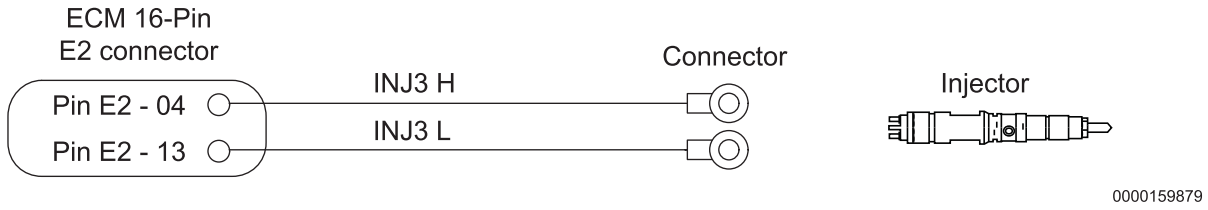
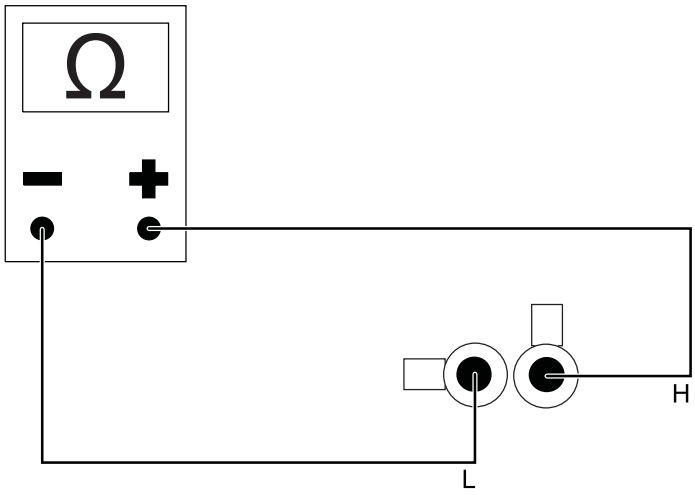


Figure 433 Fuel Injector 3 Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- 500 Ohm Resistor ZTSE4497
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)



0000352981

Figure 434 Fuel Injector 3 Circuit Check

Test 1
A. Key OFF B. Disconnect Fuel Injector 3 H and L terminals

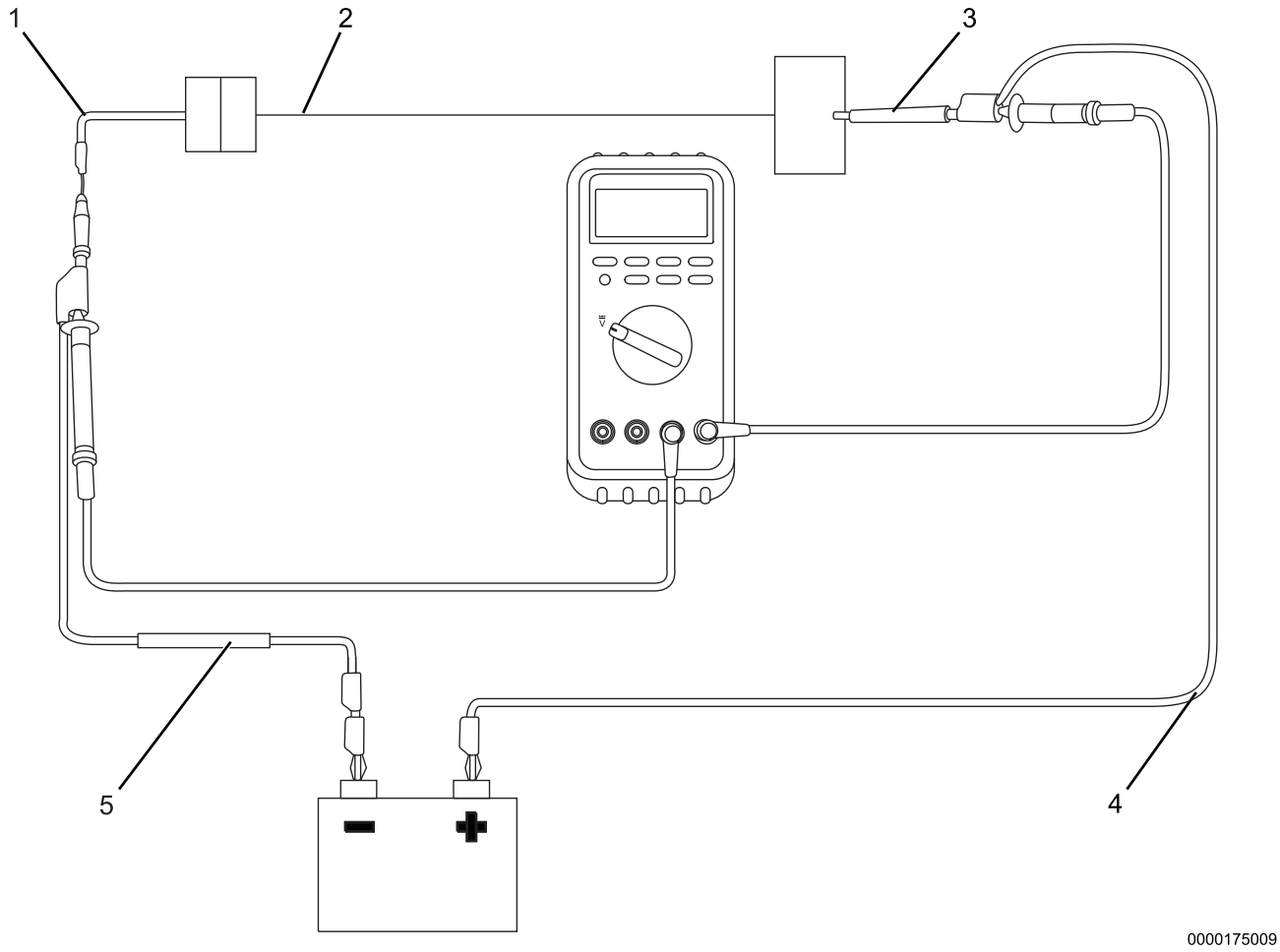


Figure 435 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

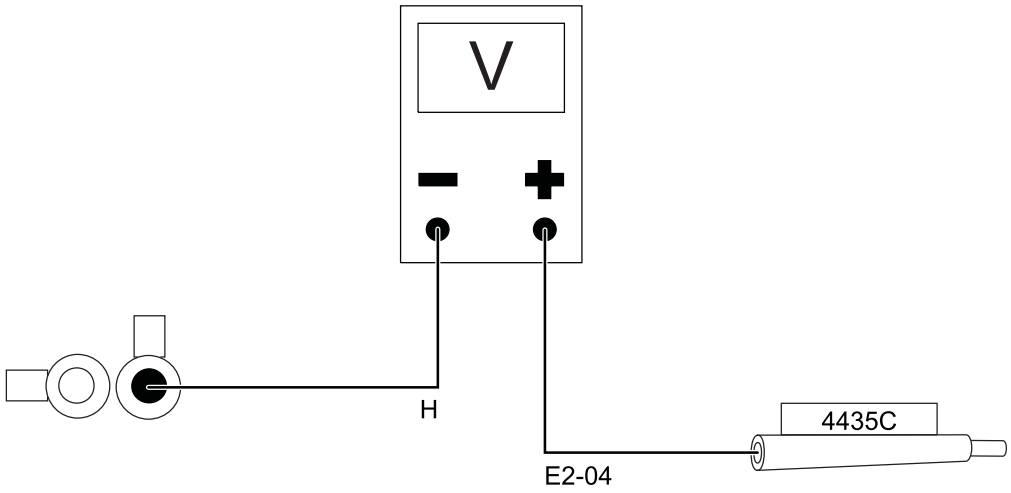


Figure 436 Fuel Injector 3 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect Fuel Injector 3 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.
D. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-04.
E. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-04, and connect the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed).
F. Connect INJ3 H ring terminal to a known good GND (use a jumper wire if needed)

SPN 654 FMI 3 - Injector 4 Short to PWR

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 654 FMI 4 - Injector 4 Short Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Short to GND detected in fuel injector 4 circuit	INJ4 circuit resistance to ground < 0.5 ohms	ECM commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 4 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ4 H circuit shorted to INJ4 L circuit
- INJ4 H circuit short to GND
- INJ4 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector 4

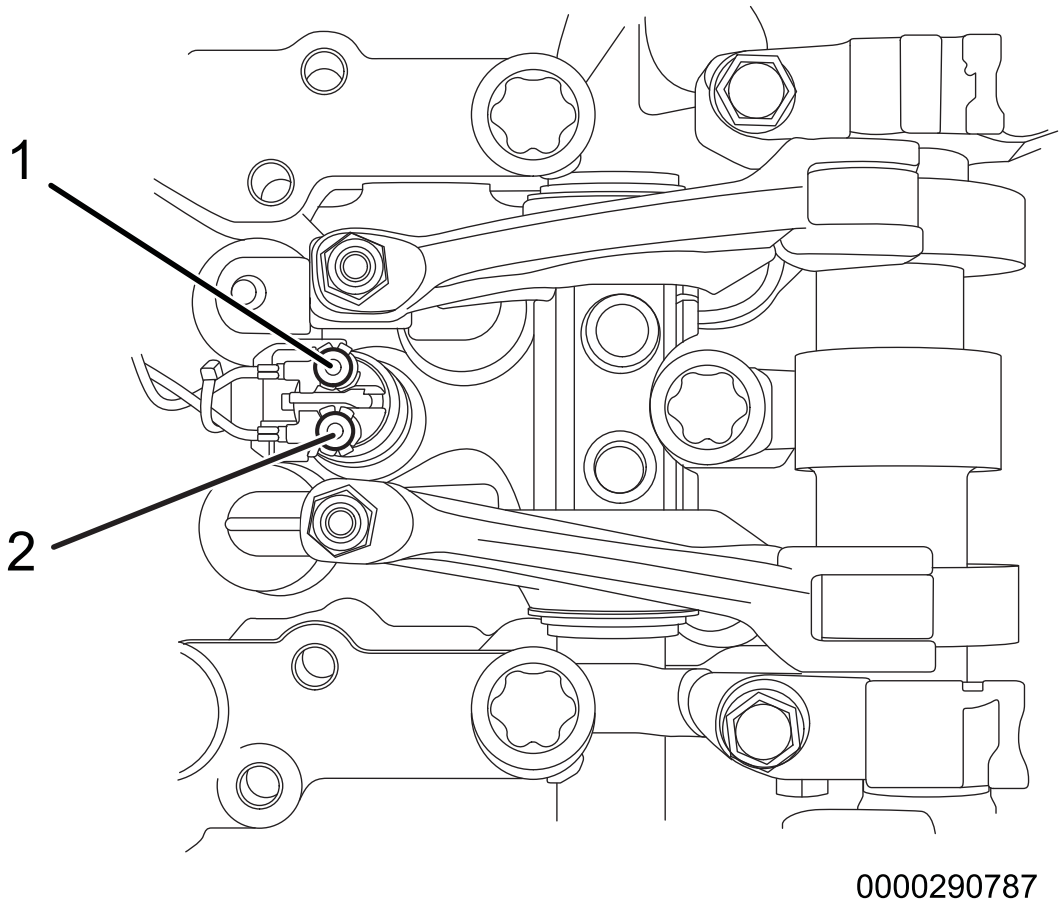


Figure 438 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step 1	Inspect connections at fuel injector 4 connector.	Decision
Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings.		Yes: Go to step 2.
Are fuel injector 4 terminals oriented correctly and Not contacting the engine brake housing?		No: Adjust connections so fuel injector 4 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 654 FMI 4.

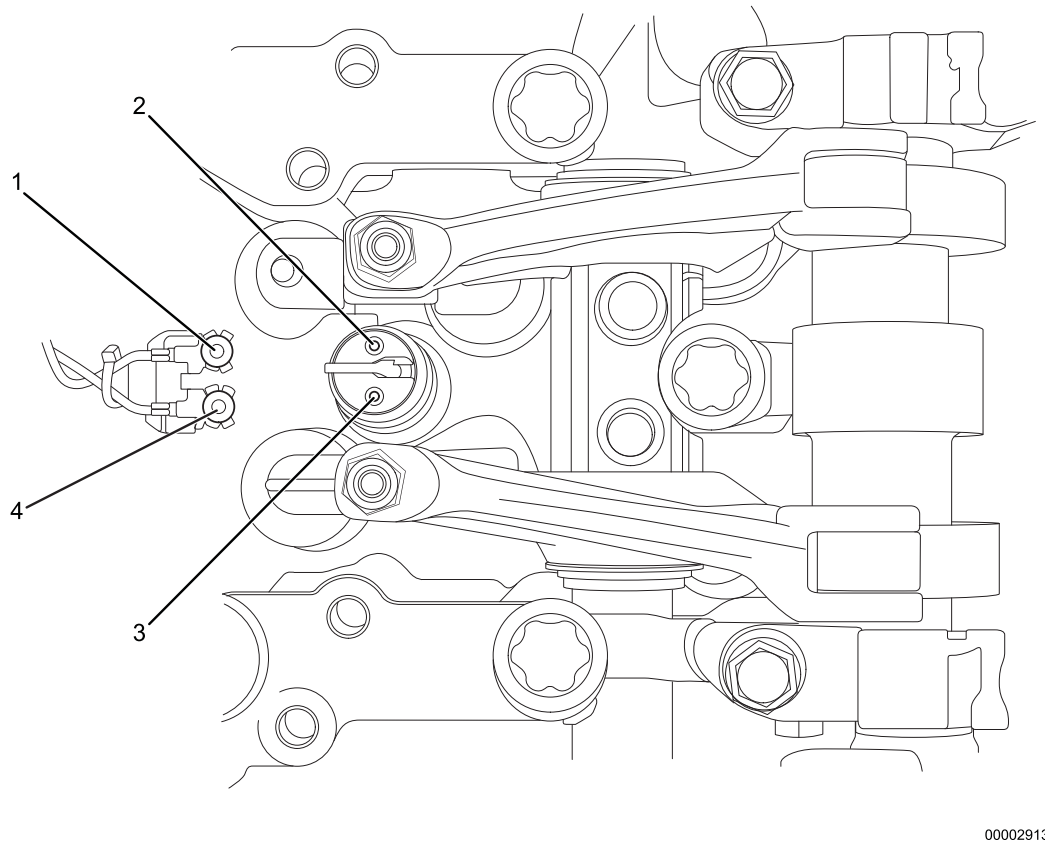


Figure 439 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 4 coil.	Decision
Perform Test 1 (page 1141). Using a Digital Multi-Meter (DMM) measure resistance between fuel injector 4 H and L terminals.		Yes: Go to step 3.
Is resistance between 0.2 to 0.8 Ohms?		No: Replace fuel injector 4. After repairs are complete, retest for SPN 654 FMI 4.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are ECM E2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 654 FMI 4.

Step 4	Check for fuel injector 4 H terminal short to ground.	Decision
Perform Test 2 (page 1142). Using a DMM measure resistance between fuel injector 4 H terminal and a known good GND.		Yes: Go to step 5.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 4. After repairs are complete, retest for SPN 654 FMI 4.

Step 5	Check for fuel injector 4 L terminal short to ground.	Decision
Perform Test 3 (page 1143). Using a DMM measure resistance between fuel injector 4 L terminal and a known good GND.		Yes: Go to step 6.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 4. After repairs are complete, retest for SPN 654 FMI 4.

Step 6	Check for INJ4 H circuit short to INJ4 L circuit.	Decision
Perform Test 4 (page 1144). Using a DMM measure resistance between Breakout Box 00-00956-08 pins E2-03 and E2-14 (wiggle test may be required).		Yes: Go to step 7.
Is resistance greater than 1000 ohms?		No: Repair short between INJ4 H circuit and INJ4 L circuit. After repairs are complete, retest for SPN 652 FMI 4.

Step 7	Check INJ 4H circuit for short to GND.	Decision
Perform Test 5 (page 1145). Using a DMM measure resistance between Breakout Box 00-00956-08 pin E2-03 and known good GND (wiggle test may be required).		Yes: Repair short to GND between E2-14 and fuel injector 4. After repairs are complete, retest for SPN 652 FMI 4.
Is resistance greater than 1000 Ohms?		No: Repair short to GND between E2-03 and fuel injector 4. After repairs are complete, retest for SPN 652 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 654 FMI 4 fault code diagnostics.

Pin-Point Test SPN 654 FMI 4

Injector 4 circuit

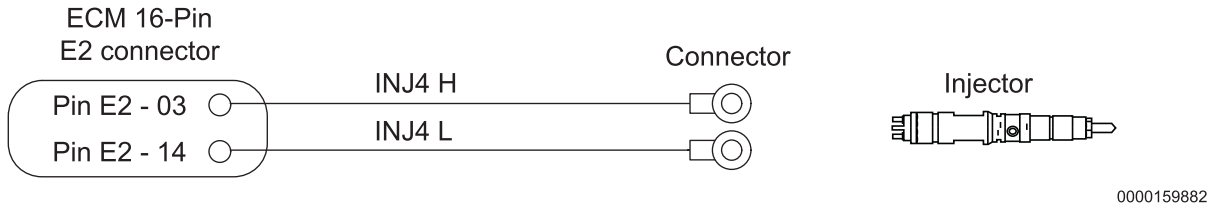


Figure 440 Fuel Injector 4 Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

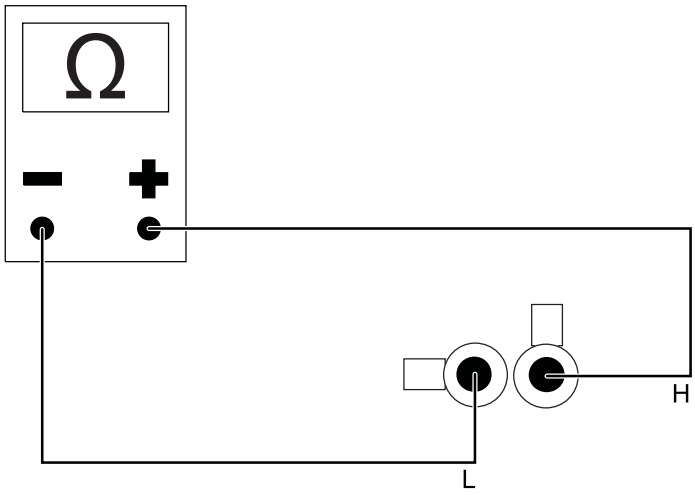


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Figure 441 Fuel Injector 4 Circuit Check

Test 1
A. Key OFF B. Disconnect fuel injector 4 H and L terminals

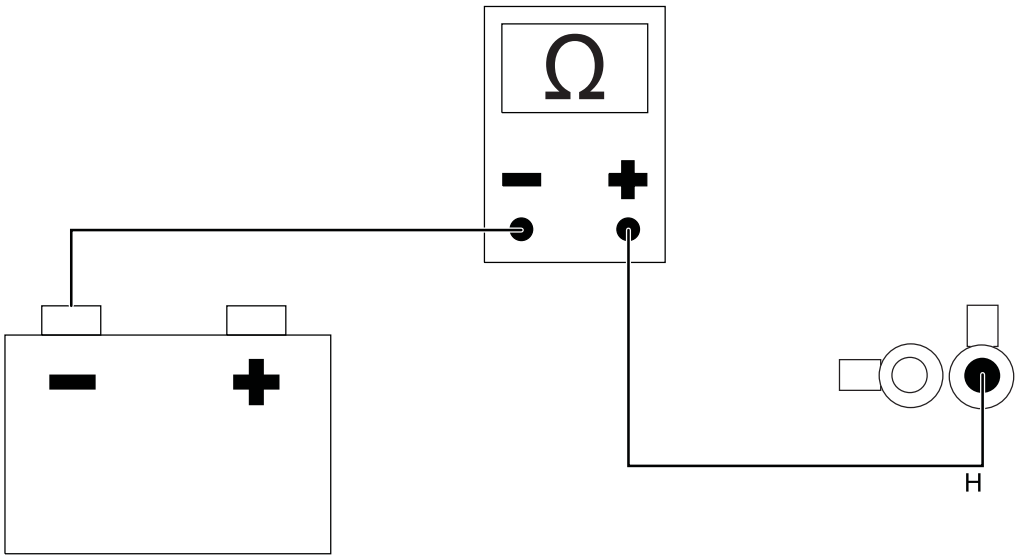


Figure 442 Fuel Injector 4 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect fuel injector 4 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.

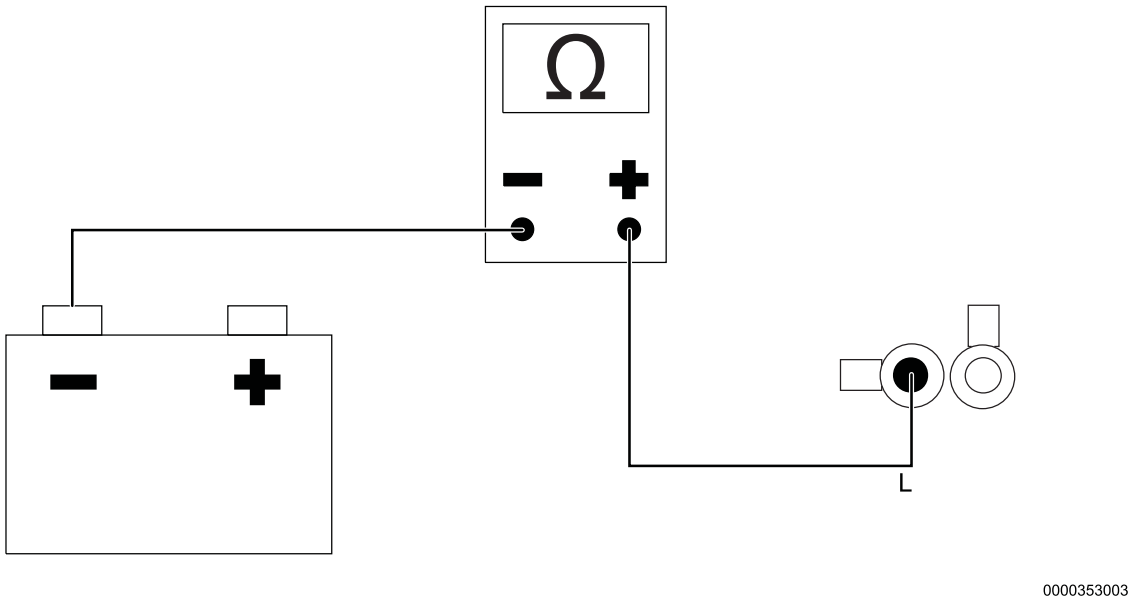


Figure 443 Fuel Injector 4 Low Side Circuit Check

Test 3
A. Key OFF
B. Disconnect fuel injector 4 H and L terminals
C. Disconnect ECM E2 connector.

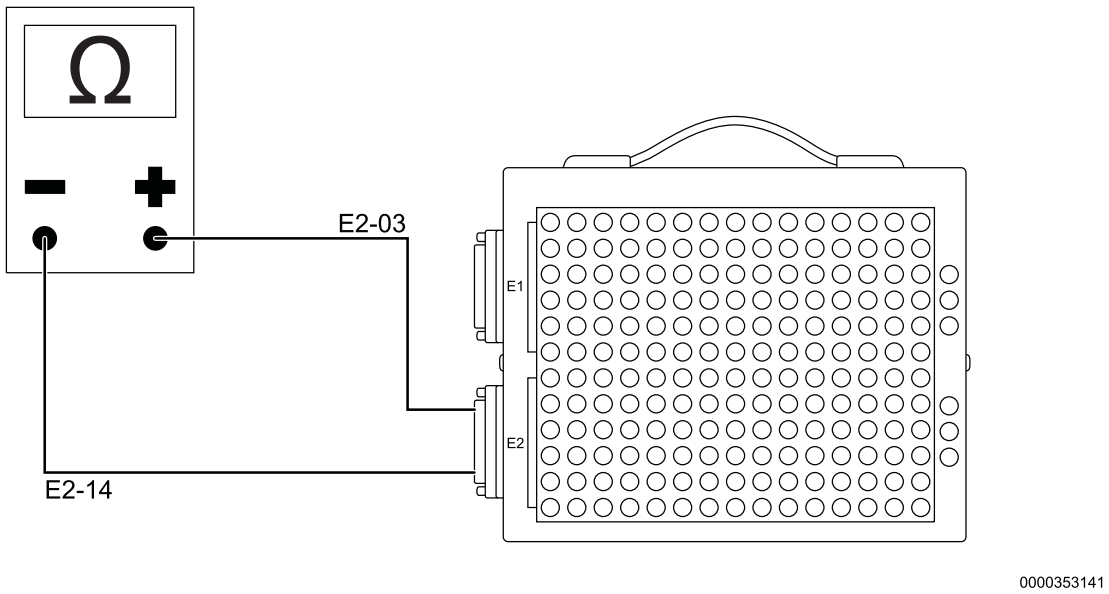


Figure 444 Fuel Injector 4 Circuit Check

Test 4
A. Key OFF.
B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00.
C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected.
D. Disconnect fuel injector 4 H and L terminals

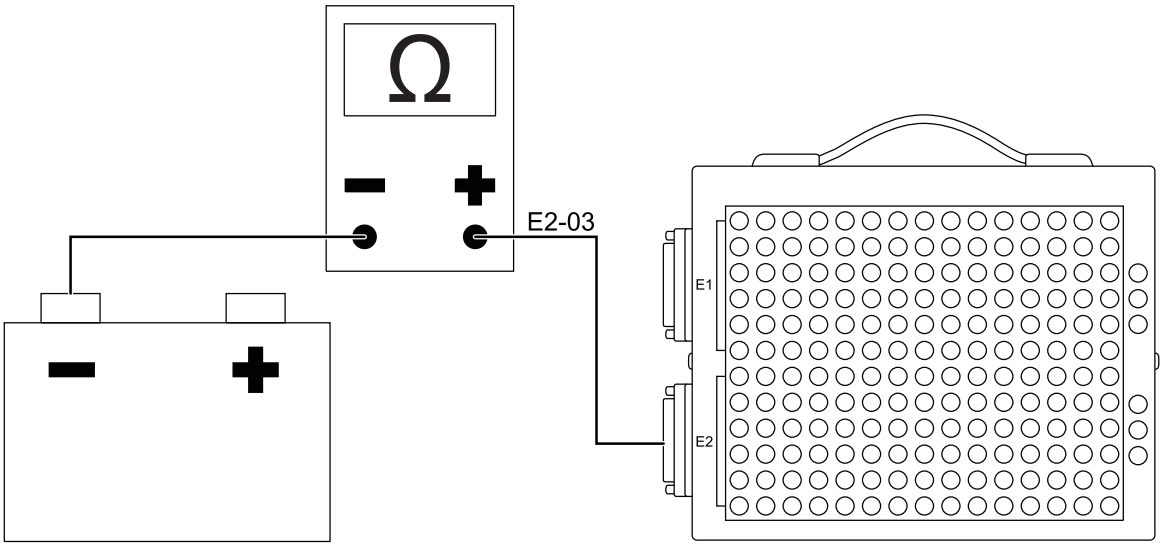


Figure 445 Fuel Injector 4 High Side Circuit Check

Test 5
A. Key OFF. B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00. C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected. D. Disconnect fuel injector 4 H and L terminals

SPN 654 FMI 5 - Injector 4 Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Open detected in fuel injector 4 circuit.	INJ4 circuit > 30 ohms	Engine Control Module (ECM) commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 4 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ4 H circuit Open or high resistance
- INJ4 L circuit Open or high resistance
- Failed fuel injector 4

Step 1	Inspect connections at fuel injector 4	Decision
A. Key OFF. B. Remove upper valve cover and engine brake housing (see Engine Service Manual). C. Disconnect fuel injector 4 connector. D. Check fuel injector 4 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 2.
Are fuel injector 4 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 654 FMI 5.

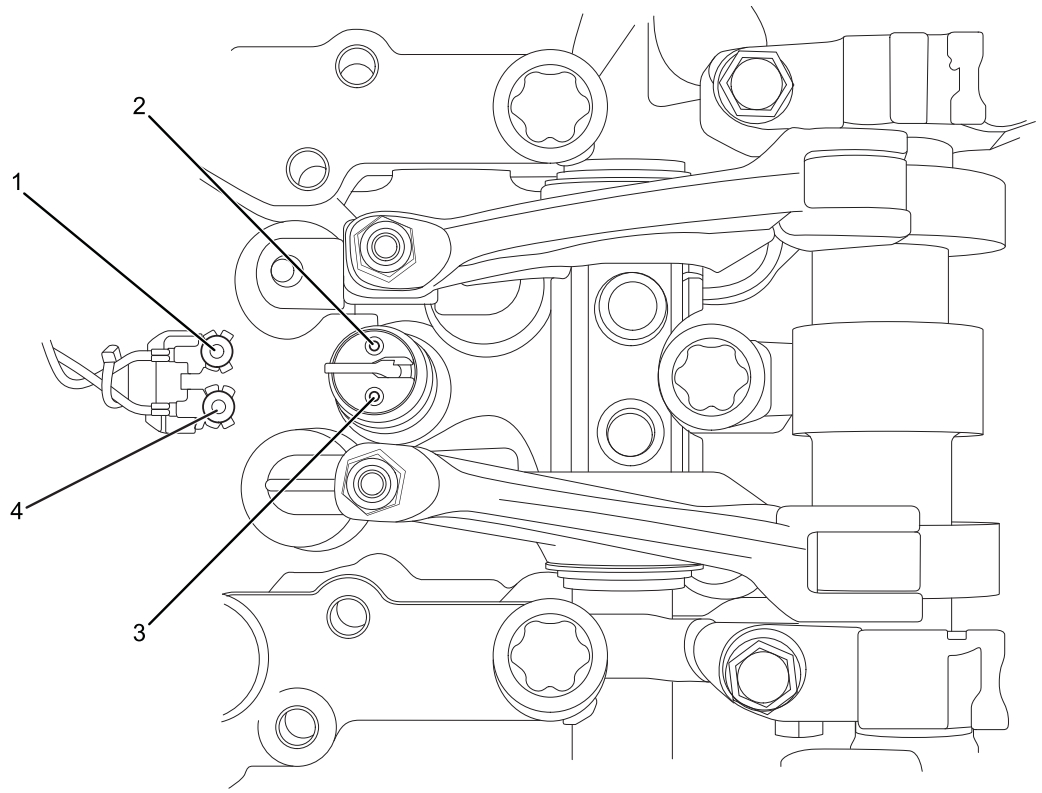


Figure 446 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 4 coil.	Decision
Perform Test 1 (page 1150). Using DMM measure resistance between fuel injector 4 H and L terminals. Is resistance between 0.2 to 0.8 Ohms?		Yes: Go to step 3. No: Replace fuel injector 4. After repairs are complete, retest for SPN 654 FMI 5.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are ECM E2 connector, harness, and terminals clean and undamaged?		Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 654 FMI 5.

Step 4	Check INJ4 H circuit for Open or high resistance (voltage drop).	Decision
Perform Test 2 (page 1151). Using DMM measure voltage between fuel injector 4 INJ4 H ring terminal and terminal in ECM pin E2-03.		Yes: Repair Open or high resistance between fuel injector 4 INJ4 L ring terminal and ECM pin E2-14. After repairs are complete, retest for SPN 654 FMI 5.
Is voltage less than 0.3 volts?		No: Repair Open or high resistance between fuel injector 4 INJ4 H ring terminal and ECM pin E2-03. After repairs are complete, retest for SPN 654 FMI 5.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 654 FMI 5 fault code diagnostics.

Pin-Point Test SPN 654 FMI 5

Injector 4 circuit

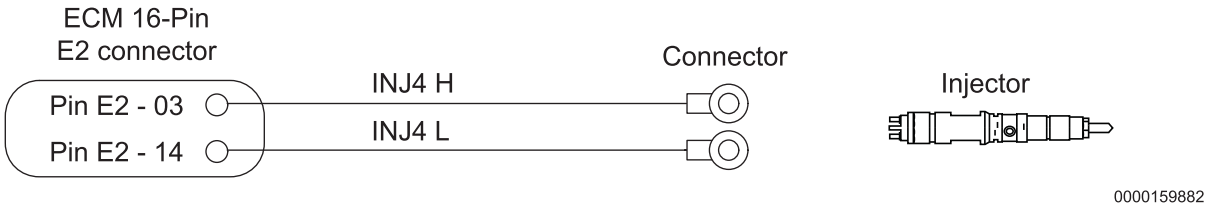
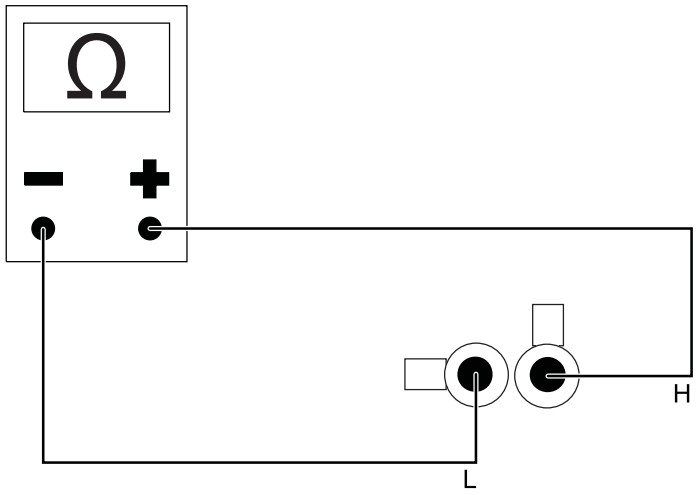


Figure 447 Fuel Injector 4 Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- 500 Ohm Resistor ZTSE4497
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)



0000352981

Figure 448 Fuel Injector 4 Circuit Check

Test 1
A. Key OFF
B. Disconnect Fuel Injector 4 H and L terminals

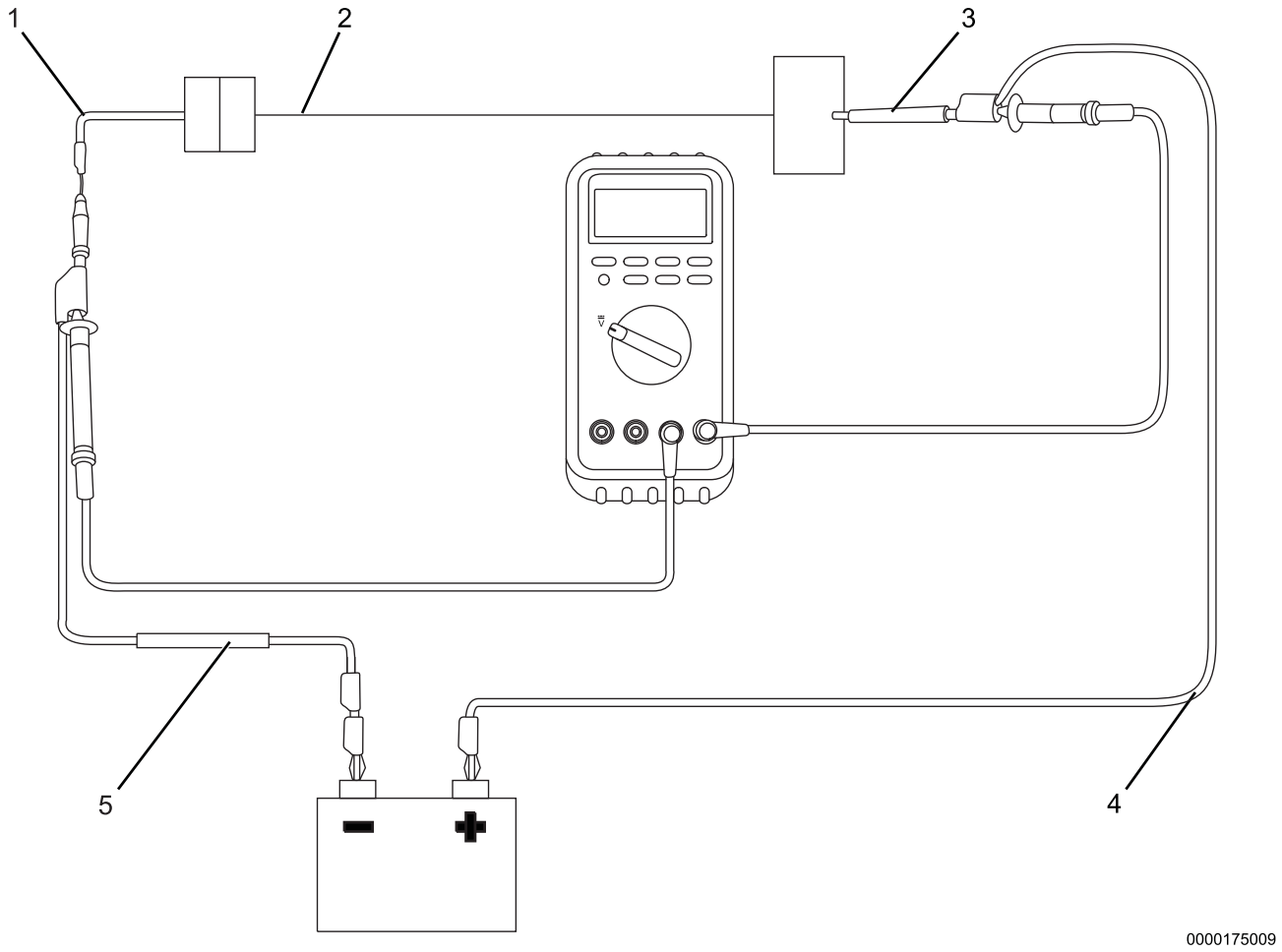


Figure 449 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

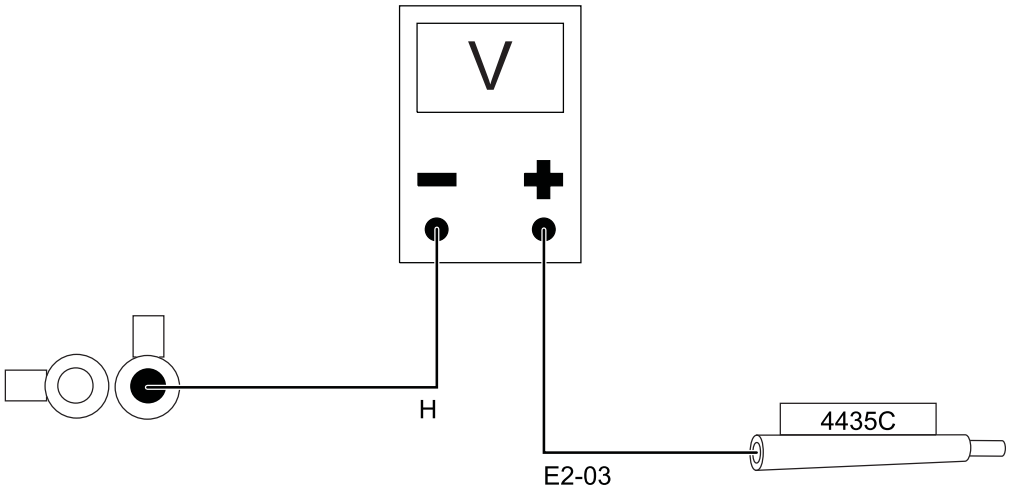


Figure 450 Fuel Injector 4 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect Fuel Injector 4 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.
D. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-03.
E. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-03, and connect the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed).
F. Connect INJ4 H ring terminal to a known good GND (use a jumper wire if needed)

SPN 655 FMI 3 - Injector 5 Short to PWR

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 655 FMI 4 - Injector 5 Short Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Short to GND detected in fuel injector 5 circuit	INJ5 circuit resistance to ground < 0.5 ohms	ECM commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 5 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ5 H circuit shorted to INJ5 L circuit
- INJ5 H circuit short to GND
- INJ5 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector 5

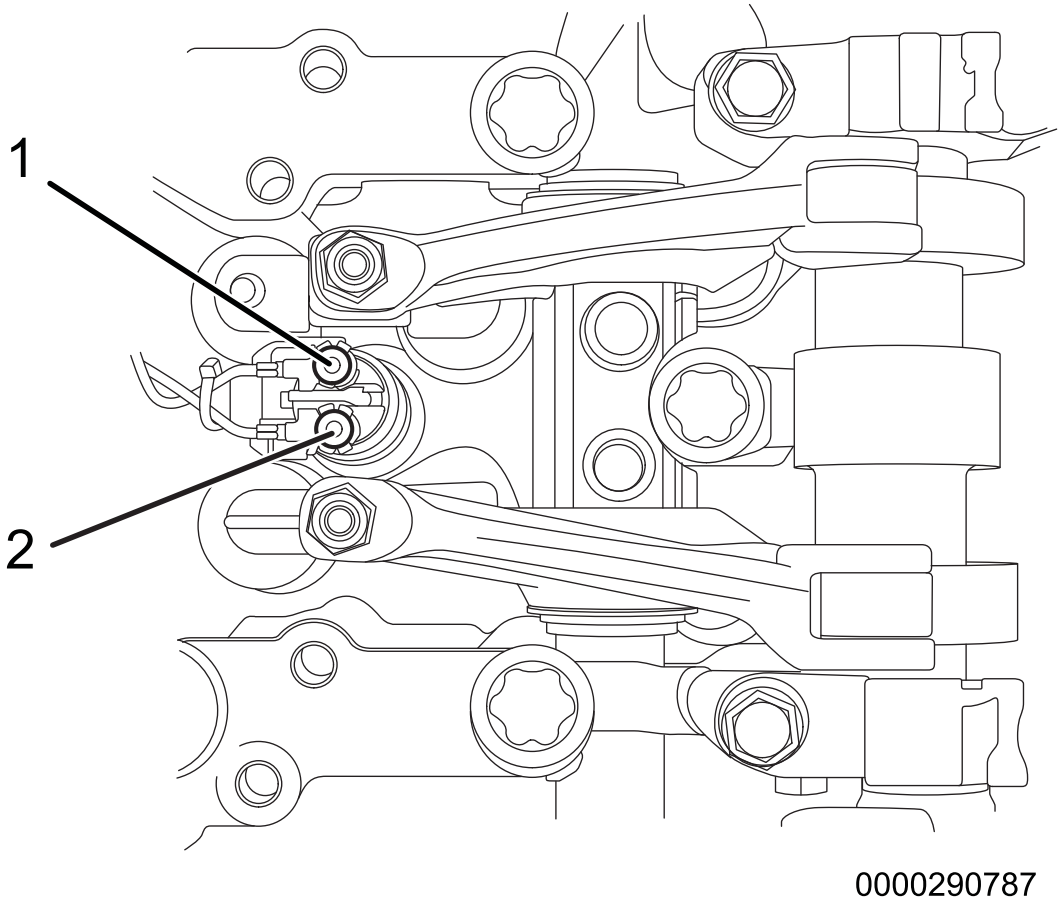


Figure 452 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step 1	Inspect connections at fuel injector 5 connector.	Decision
Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings.		Yes: Go to step 2.
Are fuel injector 5 terminals oriented correctly and Not contacting the engine brake housing?		No: Adjust connections so fuel injector 5 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 655 FMI 4.

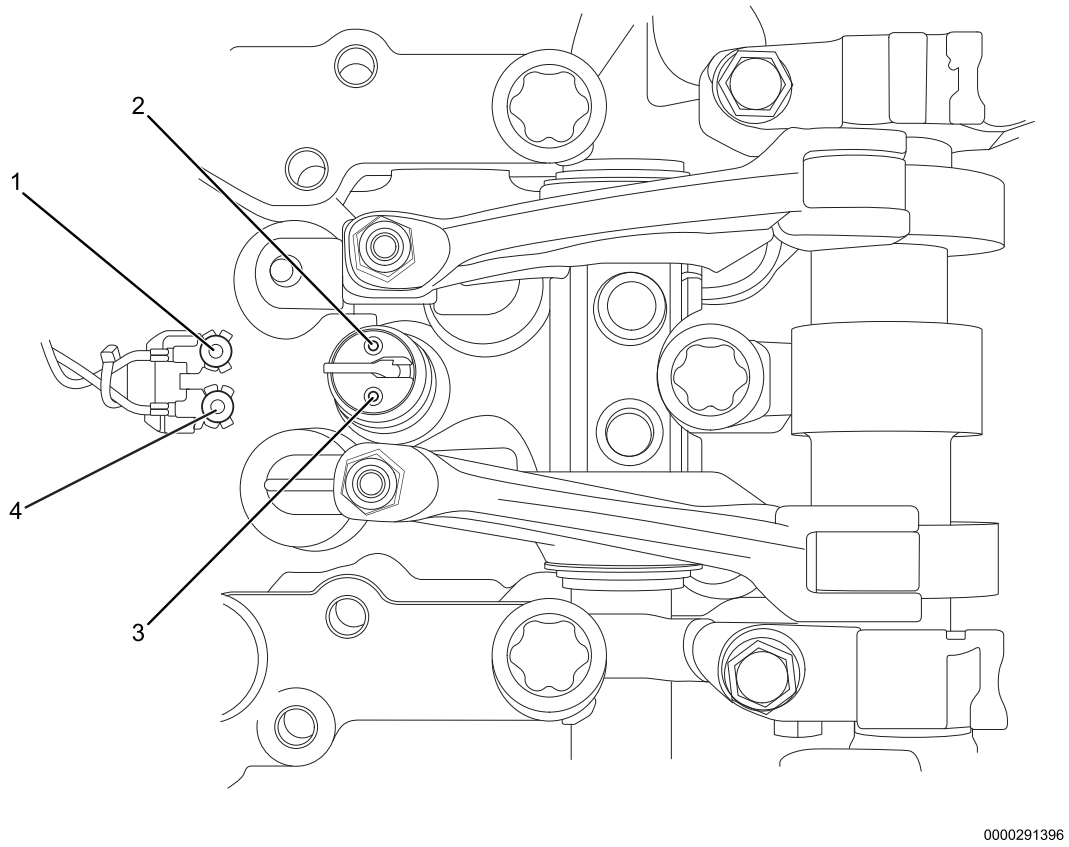


Figure 453 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 5 coil.	Decision
Perform Test 1 (page 1160). Using a Digital Multi-Meter (DMM) measure resistance between fuel injector 5 H and L terminals. Is resistance between 0.2 to 0.8 Ohms?		Yes: Go to step 3. No: Replace fuel injector 5. After repairs are complete, retest for SPN 655 FMI 4.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are ECM E2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 655 FMI 4.

Step 4	Check for fuel injector 5 H terminal short to ground.	Decision
Perform Test 2 (page 1161). Using a DMM measure resistance between fuel injector 5 H terminal and a known good GND.		Yes: Go to step 5.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 5. After repairs are complete, retest for SPN 655 FMI 4.

Step 5	Check for fuel injector 5 L terminal short to ground.	Decision
Perform Test 3 (page 1162). Using a DMM measure resistance between fuel injector 5 L terminal and a known good GND.		Yes: Go to step 6.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 5. After repairs are complete, retest for SPN 655 FMI 4.

Step 6	Check for INJ5 H circuit short to INJ5 L circuit.	Decision
Perform Test 4 (page 1163). Using a DMM measure resistance between Breakout Box 00-00956-08 pins E2-02 and E2-15 (wiggle test may be required).		Yes: Go to step 7.
Is resistance greater than 1000 ohms?		No: Repair short between INJ5 H circuit and INJ5 L circuit. After repairs are complete, retest for SPN 655 FMI 4.

Step 7	Check INJ 5H circuit for short to GND.	Decision
Perform Test 5 (page 1164). Using a DMM measure resistance between Breakout Box 00-00956-08 pin E2-02 and known good GND (wiggle test may be required).		Yes: Repair short to GND between E2-15 and fuel injector 5. After repairs are complete, retest for SPN 655 FMI 4.
Is resistance greater than 1000 Ohms?		No: Repair short to GND between E2-02 and fuel injector 5. After repairs are complete, retest for SPN 655 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 655 FMI 4 fault code diagnostics.

Pin-Point Test SPN 655 FMI 4

Injector 5 circuit

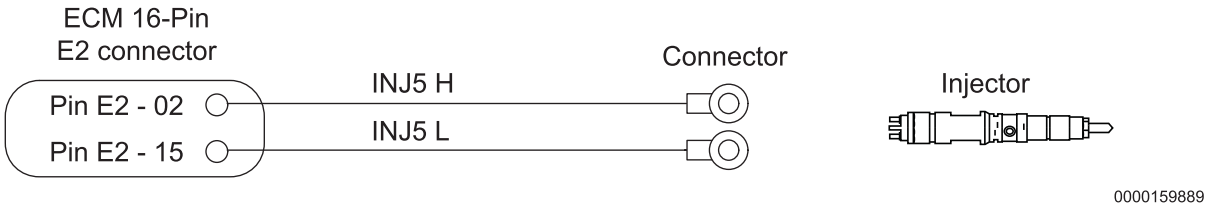


Figure 454 Fuel Injector 5 Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

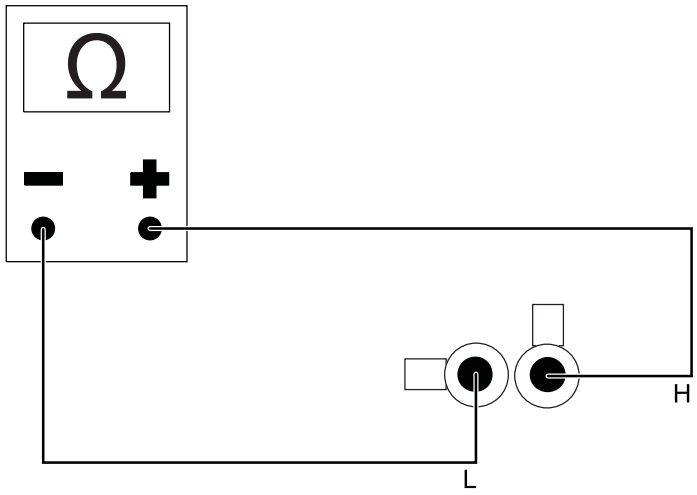


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Figure 455 Fuel Injector 5 Circuit Check

Test 1
A. Key OFF
B. Disconnect fuel injector 5 H and L terminals

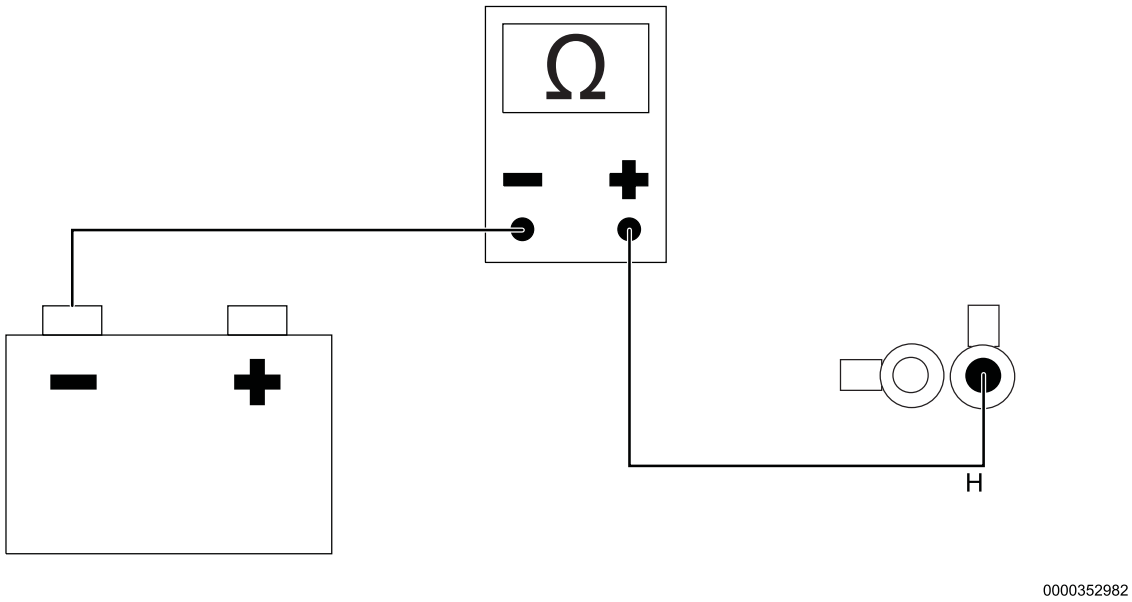


Figure 456 Fuel Injector 5 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect fuel injector 5 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.

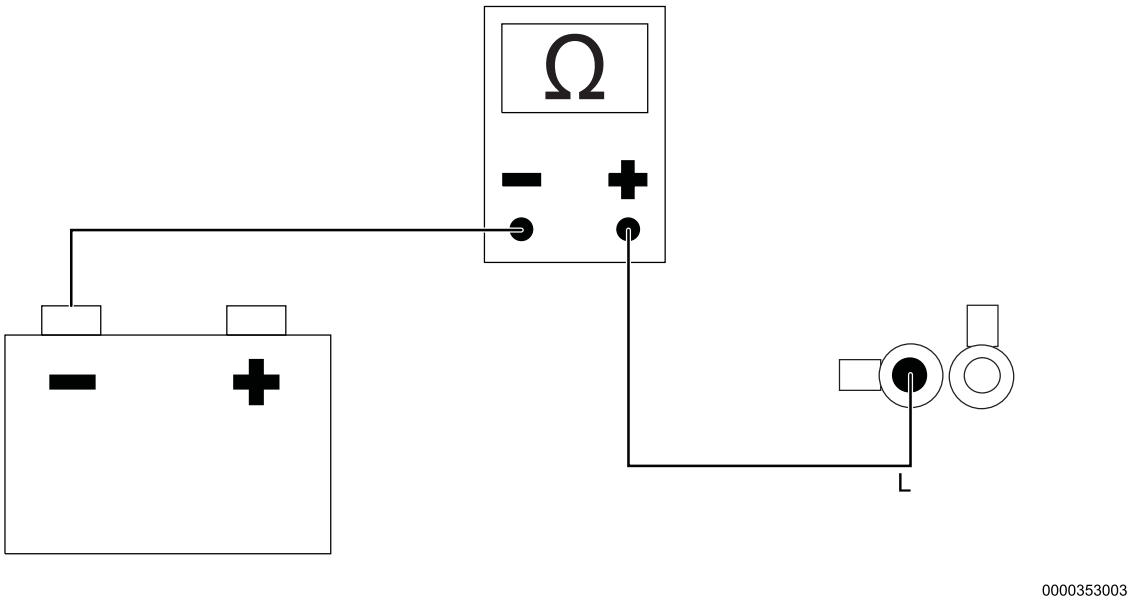


Figure 457 Fuel Injector 5 Low Side Circuit Check

Test 3
A. Key OFF
B. Disconnect fuel injector 5 H and L terminals
C. Disconnect ECM E2 connector.

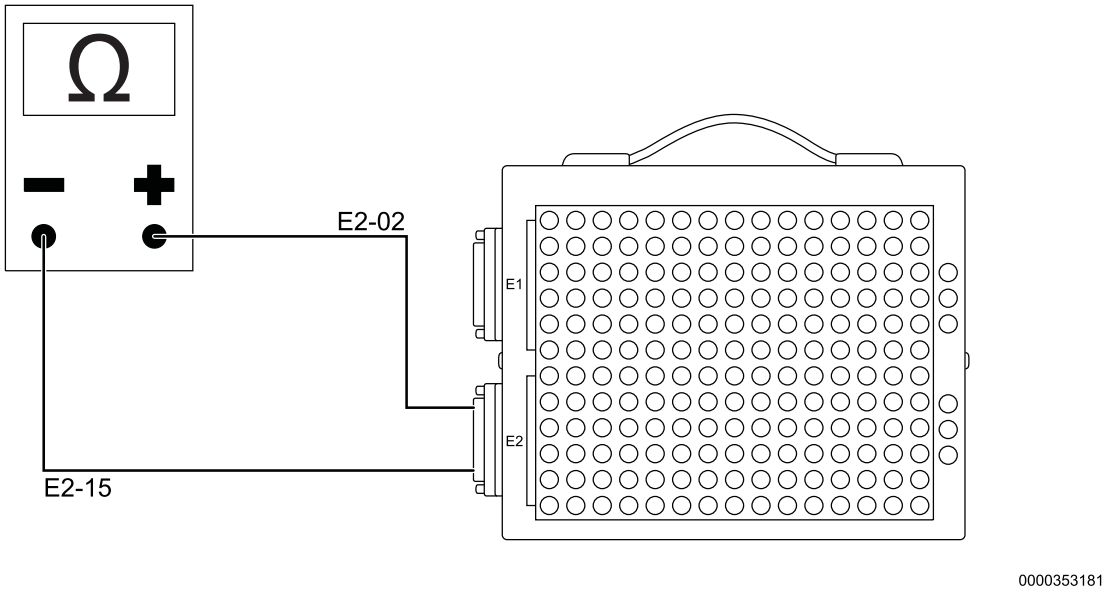


Figure 458 Fuel Injector 5 Circuit Check

Test 4
A. Key OFF. B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00. C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected. D. Disconnect fuel injector 5 H and L terminals

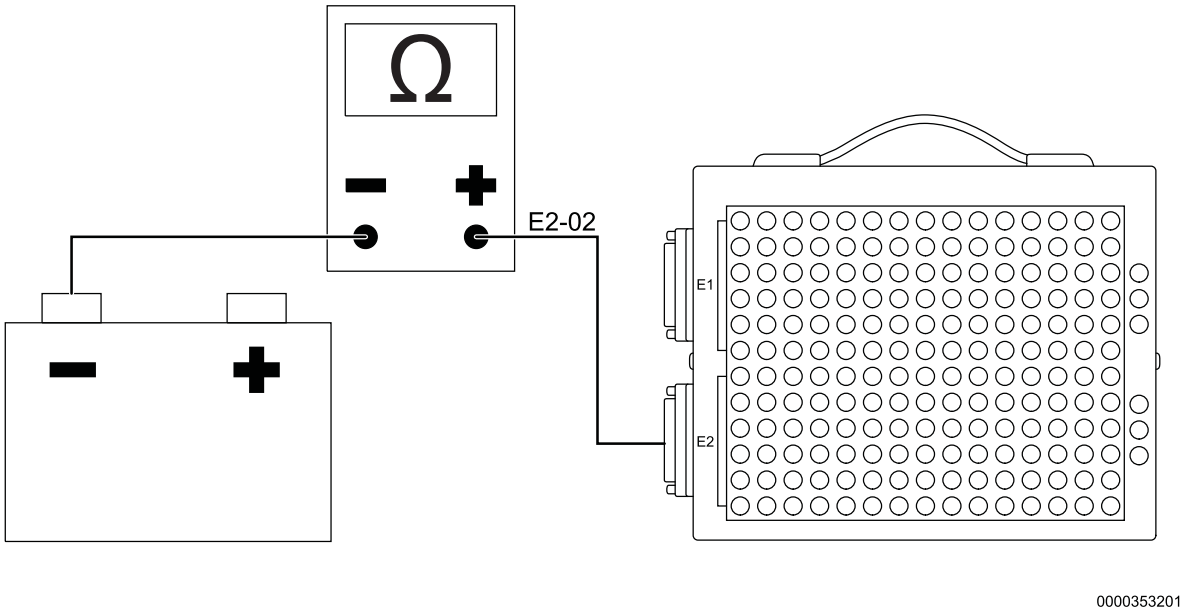


Figure 459 Fuel Injector 5 High Side Circuit Check

Test 5
A. Key OFF. B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00. C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected. D. Disconnect fuel injector 5 H and L terminals

SPN 655 FMI 5 - Injector 5 Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Open detected in fuel injector 5 circuit.	INJ5 circuit > 30 ohms	ECM commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 5 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ5 H circuit Open or high resistance
- INJ5 L circuit Open or high resistance
- Failed fuel injector 5

Step 1	Inspect connections at fuel injector 5	Decision
A. Key OFF. B. Remove upper valve cover and engine brake housing (see Engine Service Manual). C. Disconnect fuel injector 5 connector. D. Check fuel injector 5 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 2.
Are fuel injector 5 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 655 FMI 5.

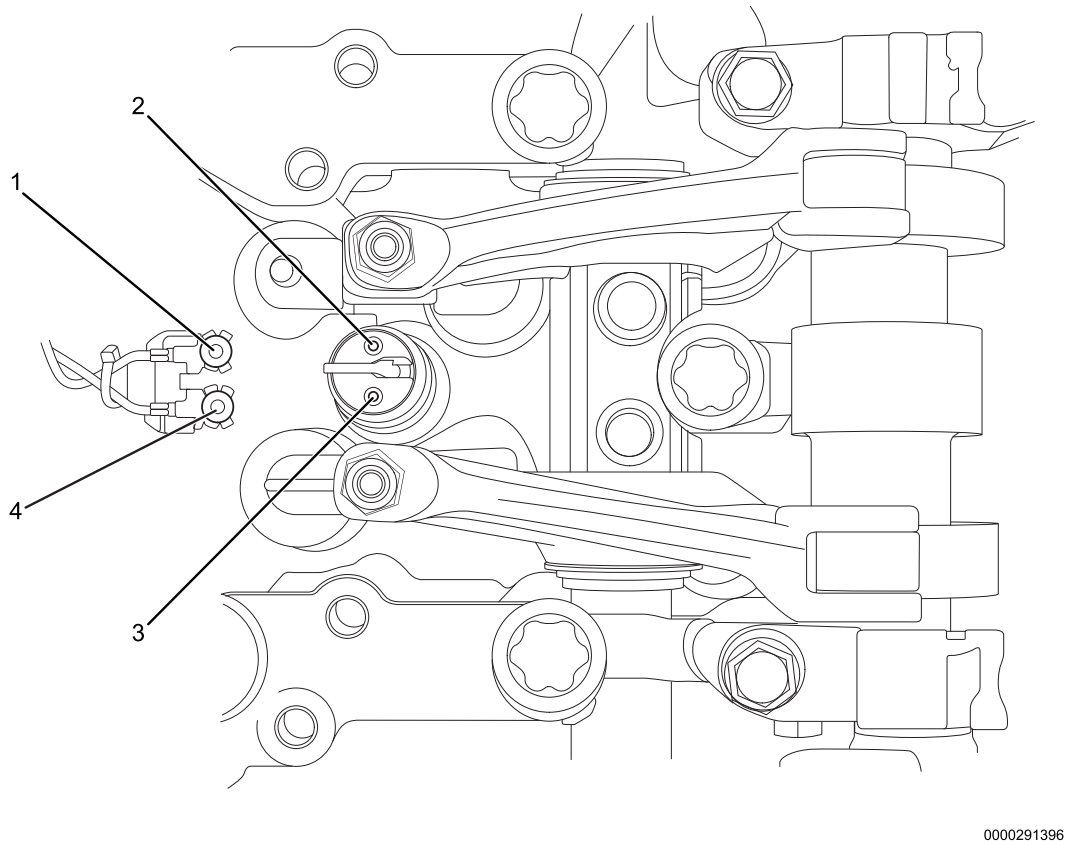


Figure 460 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 5 coil.	Decision
Perform Test 1 (page 1169). Using DMM measure resistance between fuel injector 5 H and L terminals.		Yes: Go to step 3.
Is resistance between 0.2 to 0.8 Ohms?		No: Replace fuel injector 5. After repairs are complete, retest for SPN 655 FMI 5.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are ECM E2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 655 FMI 5.

Step 4	Check INJ5 H circuit for Open or high resistance (voltage drop).	Decision
Perform Test 2 (page 1170). Using DMM measure voltage between fuel injector 5 INJ5 H ring terminal and terminal in ECM pin E2-02.		Yes: Repair Open or high resistance between fuel injector 5 INJ5 L ring terminal and ECM pin E2-15. After repairs are complete, retest for SPN 655 FMI 5.
Is voltage less than 0.3 volts?		No: Repair Open or high resistance between fuel injector 5 INJ5 H ring terminal and ECM pin E2-02. After repairs are complete, retest for SPN 655 FMI 5.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 655 FMI 5 fault code diagnostics.

Pin-Point Test SPN 655 FMI 5

Injector 5 circuit

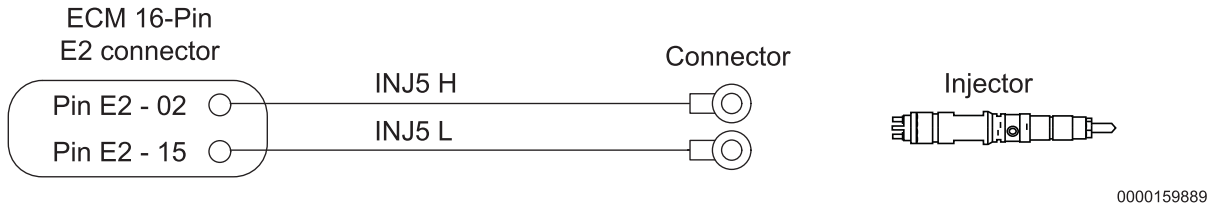
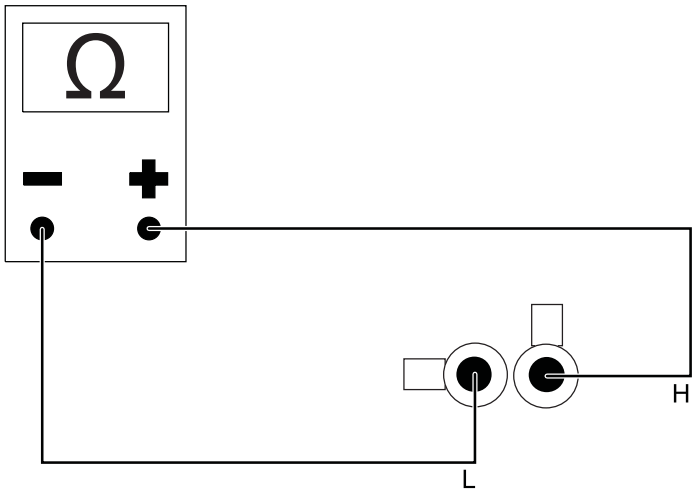


Figure 461 Fuel Injector 5 Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- 500 Ohm Resistor ZTSE4497
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)



0000352981

Figure 462 Fuel Injector 5 Circuit Check

Test 1
A. Key OFF B. Disconnect Fuel Injector 5 H and L terminals

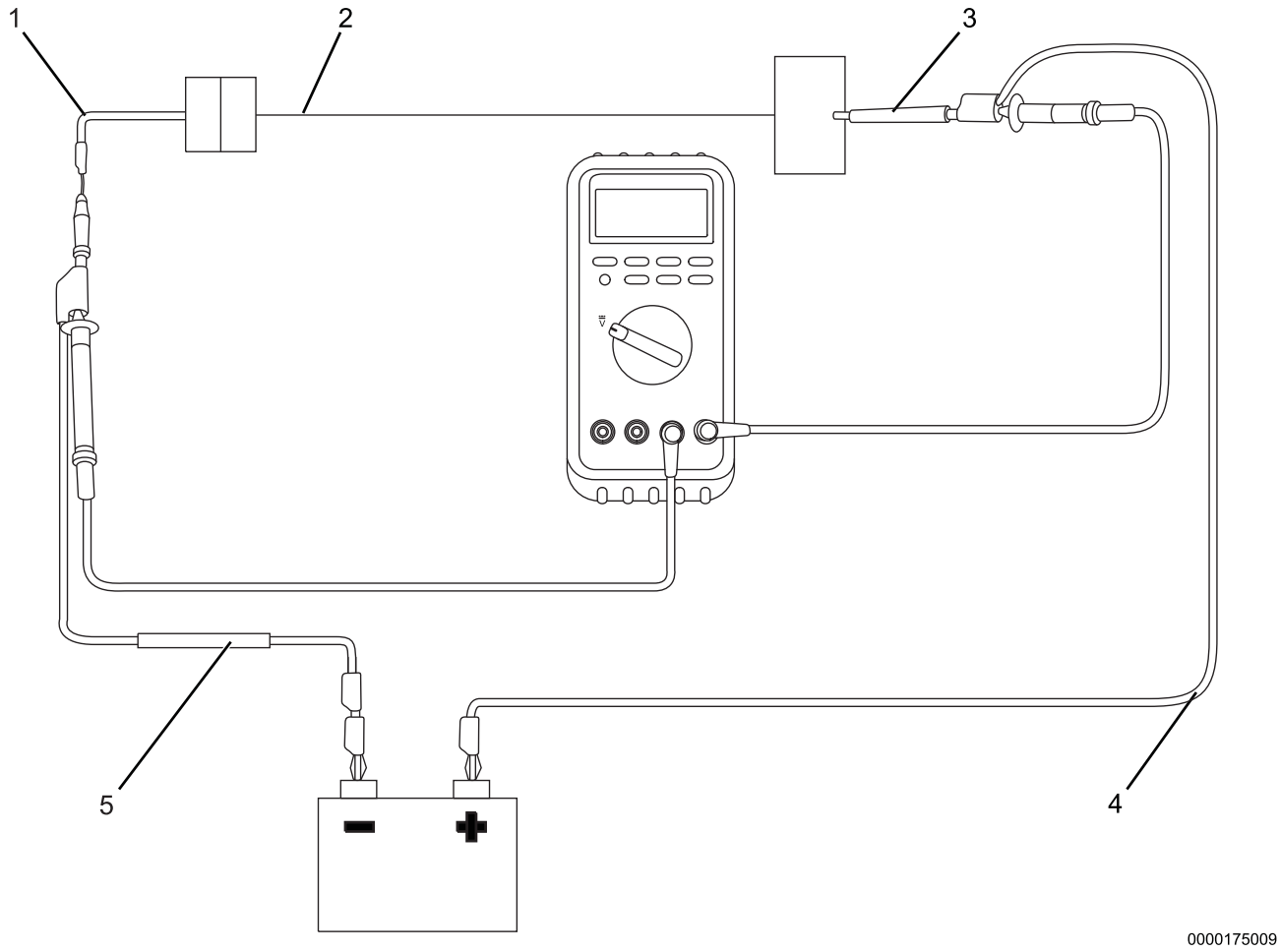


Figure 463 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

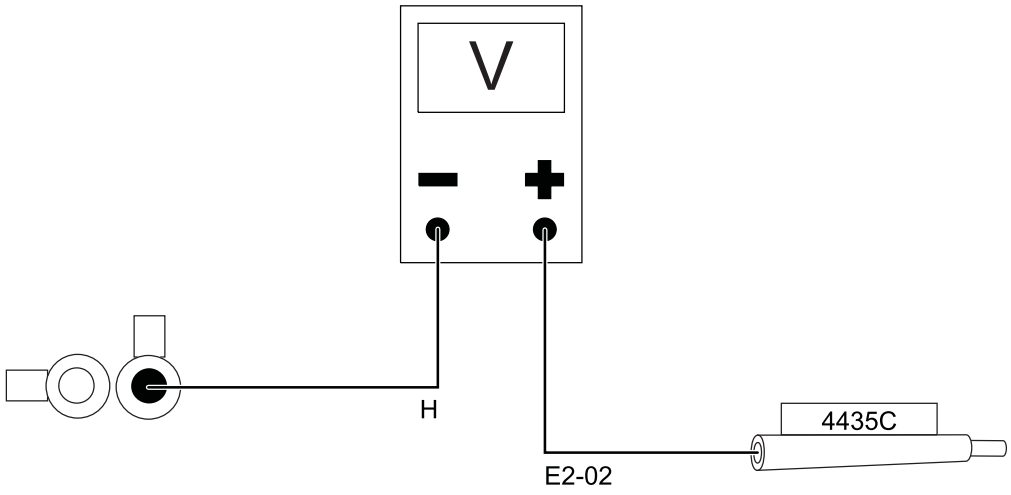


Figure 464 Fuel Injector 5 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect Fuel Injector 5 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.
D. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-02.
E. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-02, and connect the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed).
F. Connect INJ5 H ring terminal to a known good GND (use a jumper wire if needed)

SPN 656 FMI 3 - Injector 6 Short to PWR

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 656 FMI 4 - Injector 6 Short Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Short to GND detected in fuel injector 6 circuit	INJ6 circuit resistance to ground < 0.5 ohms	ECM commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 6 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ6 H circuit shorted to INJ6 L circuit
- INJ6 H circuit short to GND
- INJ6 L circuit short to GND
- Fuel injector shorted to engine brake housing
- Failed fuel injector 6

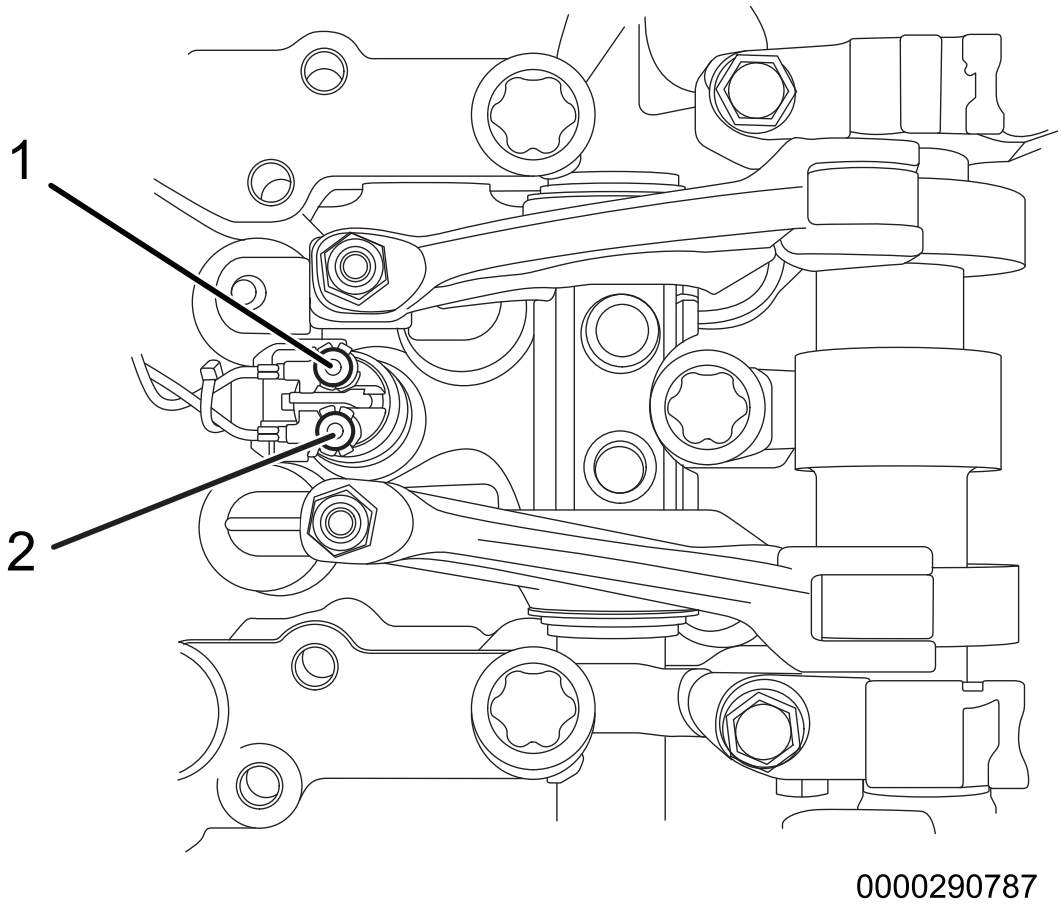


Figure 466 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step 1	Inspect connections at fuel injector 6 connector.	Decision
Verify proper fuel injector and terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel to avoid a short to ground on the engine brake housings.		Yes: Go to step 2.
Are fuel injector 6 terminals oriented correctly and Not contacting the engine brake housing?		No: Adjust connections so fuel injector 6 and injector terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 656 FMI 4.

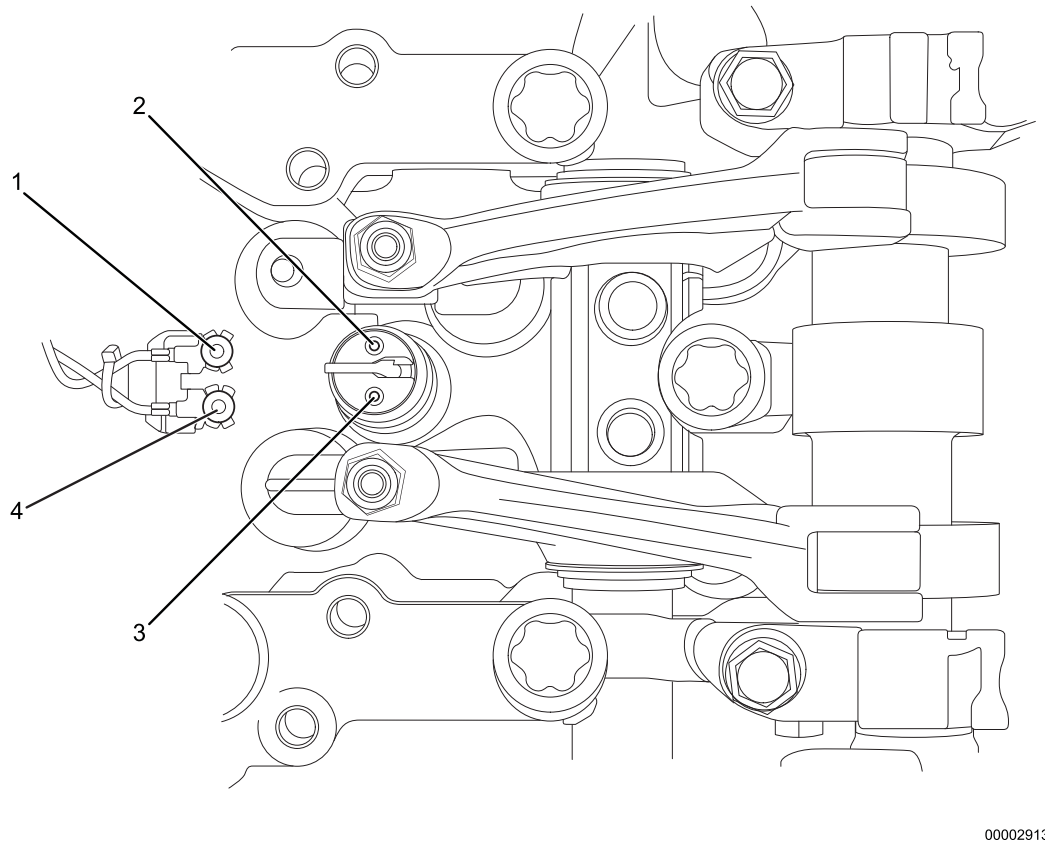


Figure 467 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 6 coil.	Decision
Perform Test 1 (page 1179). Using a Digital Multi-Meter (DMM) measure resistance between fuel injector 6 H and L terminals.		Yes: Go to step 3.
Is resistance between 0.2 to 0.8 Ohms?		No: Replace fuel injector 6. After repairs are complete, retest for SPN 656 FMI 4.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are ECM E2 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 656 FMI 4.

Step 4	Check for fuel injector 6 H terminal short to ground.	Decision
Perform Test 2 (page 1180). Using a DMM measure resistance between fuel injector 6 H terminal and a known good GND.		Yes: Go to step 5.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 6. After repairs are complete, retest for SPN 656 FMI 4.

Step 5	Check for fuel injector 6 L terminal short to ground.	Decision
Perform Test 3 (page 1181). Using a DMM measure resistance between fuel injector 6 L terminal and a known good GND.		Yes: Go to step 6.
Is resistances greater than 1000 ohms?		No: Replace fuel injector 6. After repairs are complete, retest for SPN 656 FMI 4.

Step 6	Check for INJ6 H circuit short to INJ6 L circuit.	Decision
Perform Test 4 (page 1182). Using a DMM measure resistance between Breakout Box 00-00956-08 pins E2-01 and E2-16 (wiggle test may be required).		Yes: Go to step 7.
Is resistance greater than 1000 ohms?		No: Repair short between INJ6 H circuit and INJ6 L circuit. After repairs are complete, retest for SPN 656 FMI 4.

Step 7	Check INJ6 H circuit for short to GND.	Decision
Perform Test 5 (page 1183). Using a DMM measure resistance between Breakout Box 00-00956-08 pin E2-01 and known good GND (wiggle test may be required).		Yes: Repair short to GND between E2-16 and fuel injector 6. After repairs are complete, retest for SPN 656 FMI 4.
Is resistance greater than 1000 Ohms?		No: Repair short to GND between E2-01 and fuel injector 6. After repairs are complete, retest for SPN 656 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 656 FMI 4 fault code diagnostics.

Pin-Point Test SPN 656 FMI 4

Injector 6 circuit

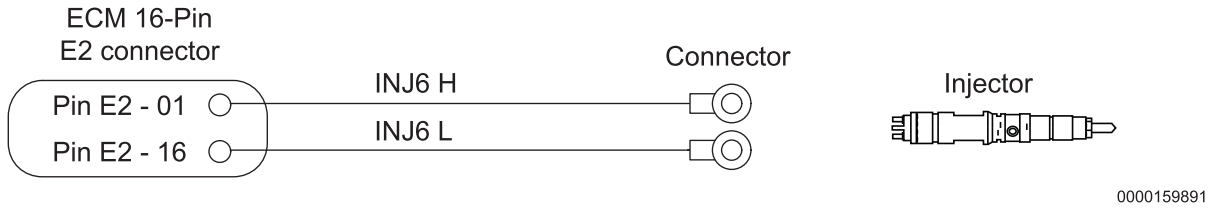
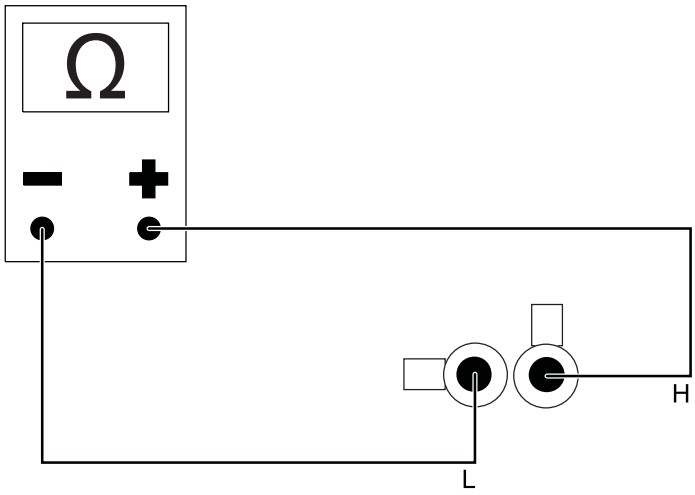


Figure 468 Fuel Injector 6 Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)



0000352981

Figure 469 Fuel Injector 6 Circuit Check

Test 1
A. Key OFF B. Disconnect fuel injector 6 H and L terminals

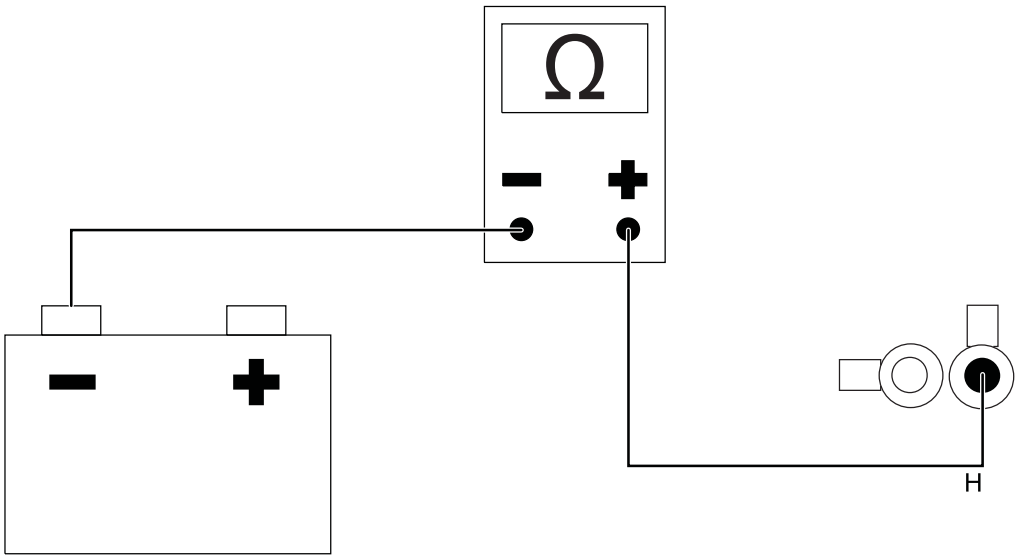


Figure 470 Fuel Injector 6 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect fuel injector 6 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.

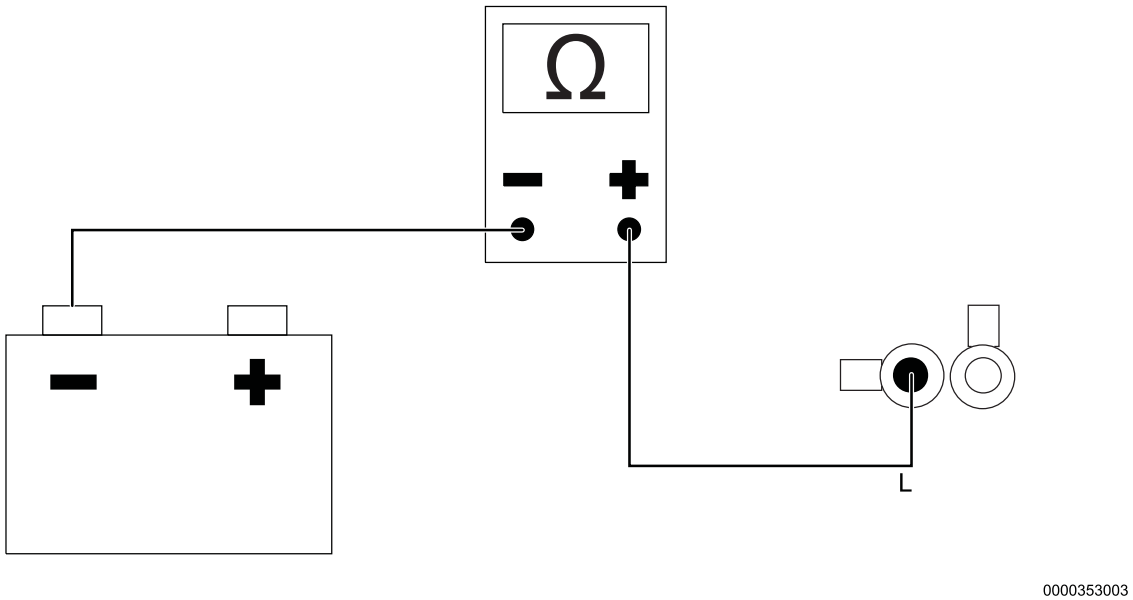


Figure 471 Fuel Injector 6 Low Side Circuit Check

Test 3
A. Key OFF B. Disconnect fuel injector 6 H and L terminals C. Disconnect ECM E2 connector.

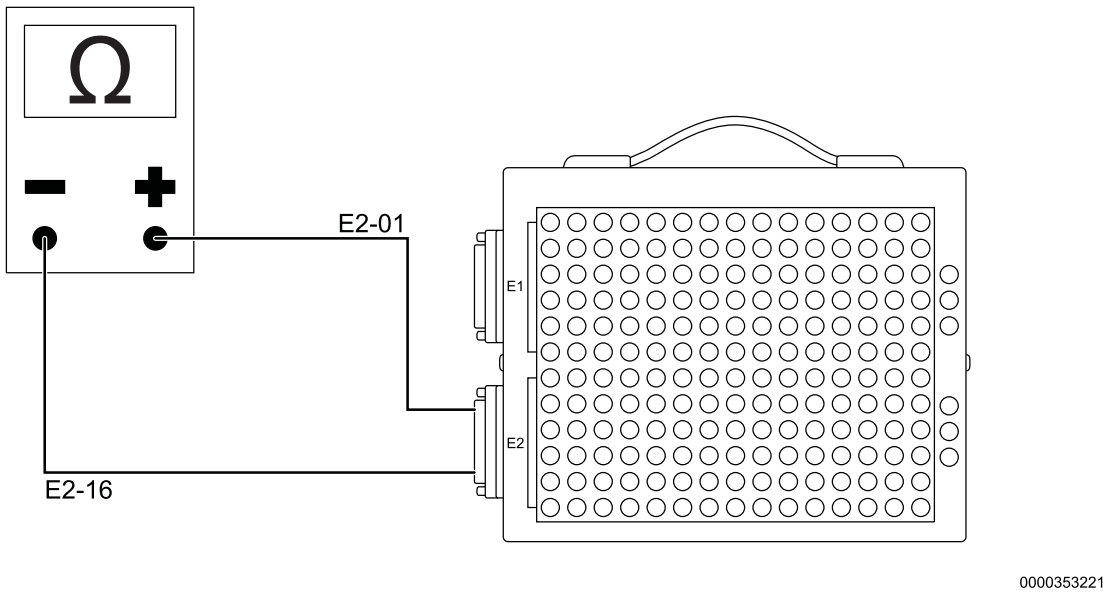


Figure 472 Fuel Injector 6 Circuit Check

Test 4
A. Key OFF.
B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00.
C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected.
D. Disconnect fuel injector 6 H and L terminals

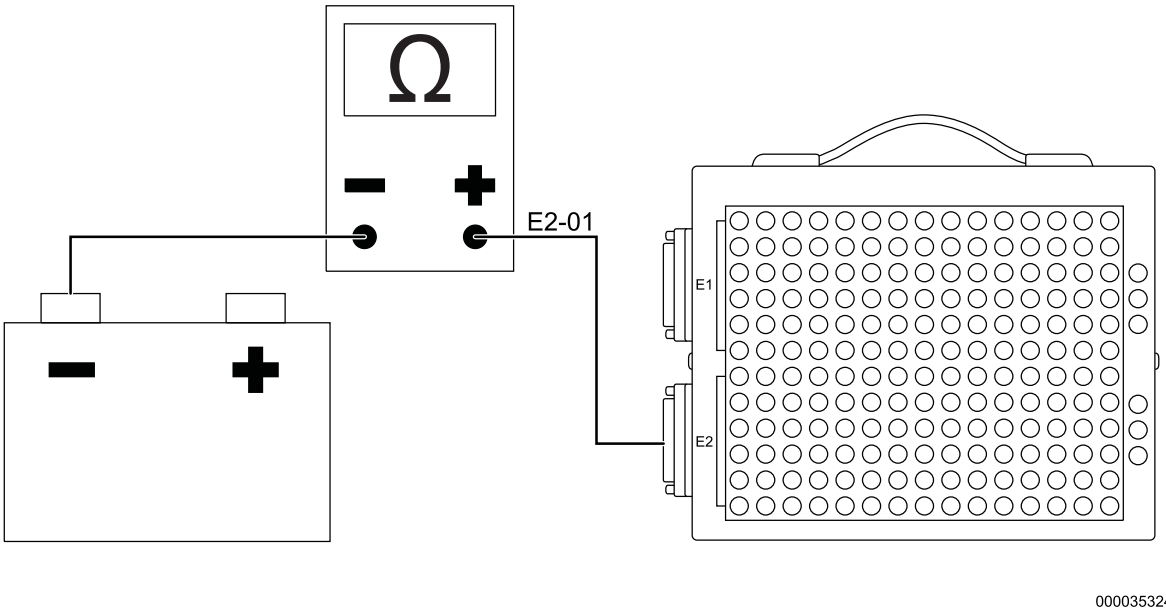


Figure 473 Fuel Injector 6 High Side Circuit Check

Test 5
A. Key OFF. B. Connect Breakout Box 00-00956-08 to Breakout Harness 00-01468-00. C. Connect Breakout Harness 00-01468-00 to vehicle harness and leave ECM E2 connector disconnected. D. Disconnect fuel injector 6 H and L terminals

SPN 656 FMI 5 - Injector 6 Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values
Open detected in fuel injector 6 circuit.	INJ6 circuit > 30 ohms	ECM commands injector firing

Fault Overview

Fault code sets when Engine Control Module (ECM) detects a short to GND in Fuel Injector 6 circuit.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- INJ6 H circuit Open or high resistance
- INJ6 L circuit Open or high resistance
- Failed fuel injector 6

Step 1	Inspect connections at fuel injector 6	Decision
A. Key OFF. B. Remove upper valve cover and engine brake housing (see Engine Service Manual). C. Disconnect fuel injector 6 connector. D. Check fuel injector 6 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 2.
Are fuel injector 6 connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 656 FMI 5.

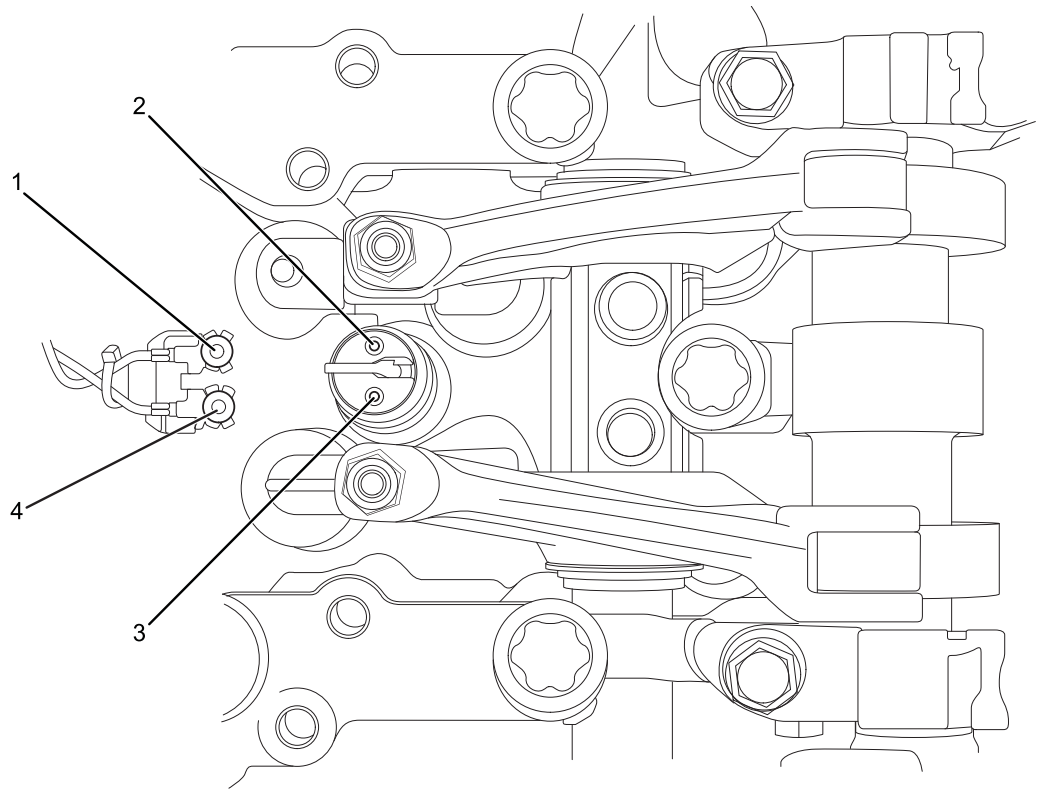


Figure 474 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step 2	Check for a shorted fuel injector 6 coil.	Decision
Perform Test 1 (page 1188). Using DMM measure resistance between fuel injector 6 H and L terminals. Is resistance between 0.2 to 0.8 Ohms?		Yes: Go to step 3. No: Replace fuel injector 6. After repairs are complete, retest for SPN 656 FMI 5.

Step 3	Inspect connections at Electronic Control Module (ECM) E2 connector.	Decision
A. Key OFF. B. Disconnect ECM E2 connector. C. Check ECM E2 and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing. Are ECM E2 connector, harness, and terminals clean and undamaged?		Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 656 FMI 5.

Step 4	Check INJ6 H circuit for Open or high resistance (voltage drop).	Decision
Perform Test 2 (page 1189). Using DMM measure voltage between fuel injector 6 INJ6 H ring terminal and terminal in ECM pin E2-01. Is voltage less than 0.3 volts?		Yes: Repair Open or high resistance between fuel injector 6 INJ6 L ring terminal and ECM pin E2-16. After repairs are complete, retest for SPN 656 FMI 5. No: Repair Open or high resistance between fuel injector 6 INJ6 H ring terminal and ECM pin E2-01. After repairs are complete, retest for SPN 656 FMI 5.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 656 FMI 5 fault code diagnostics.

Pin-Point Test SPN 656 FMI 5

Injector 6 circuit

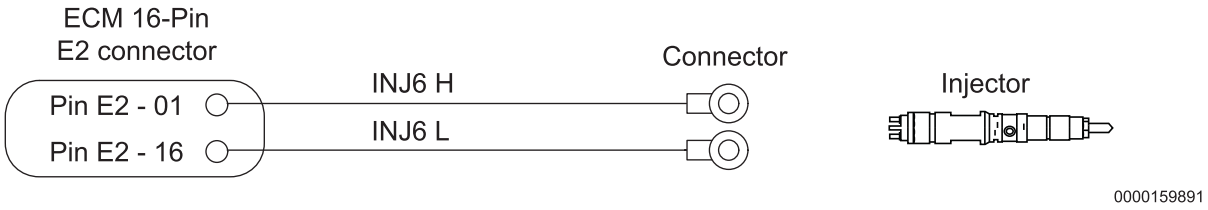


Figure 475 Fuel Injector 6 Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- 180-pin Breakout Box 00-00956-08
- Breakout Harness 00-01468-00
- 500 Ohm Resistor ZTSE4497
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

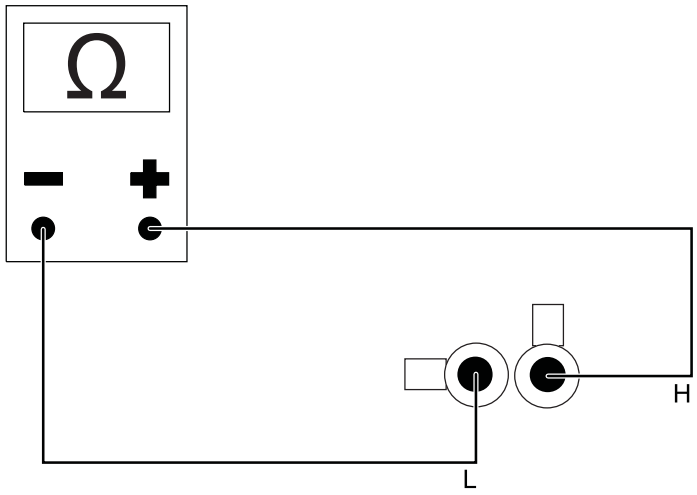


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Figure 476 Fuel Injector 6 Circuit Check

Test 1
A. Key OFF
B. Disconnect Fuel Injector 6 H and L terminals

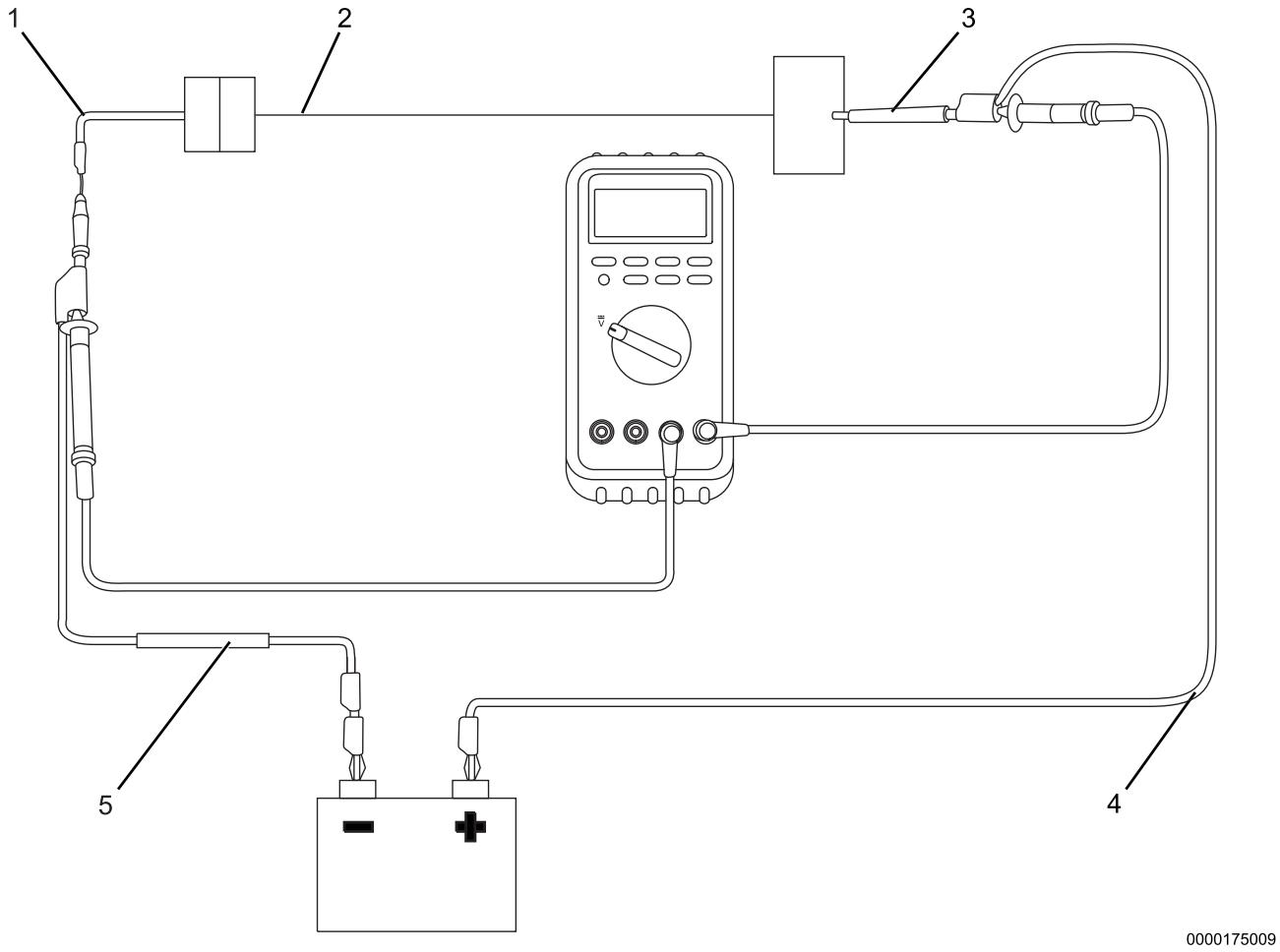

Figure 477 Voltage drop test (typical)

1. Breakout harness
2. Circuit under test
3. Terminal from ZTSE4435C
4. Jumper wire
5. 500 Ohm Resistor Jumper Harness ZTSE4497

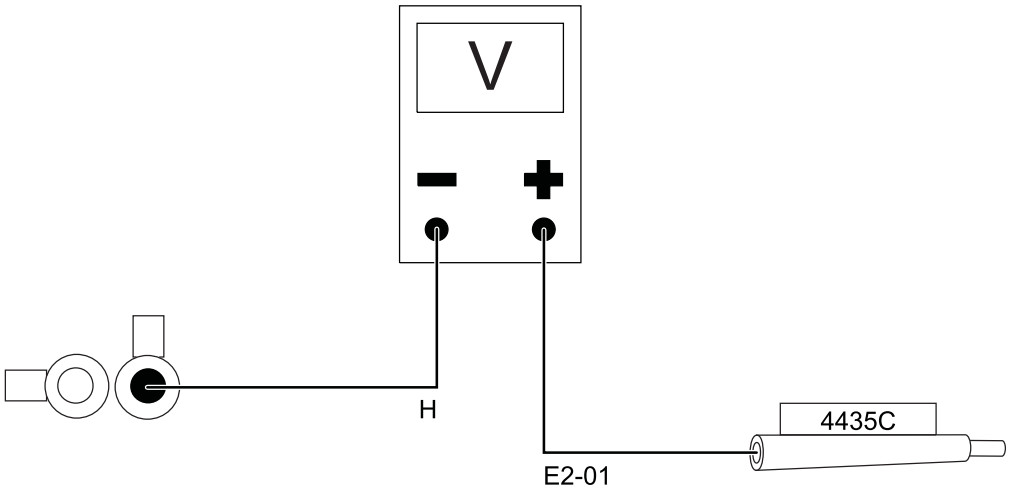

Figure 478 Fuel Injector 6 High Side Circuit Check

Test 2
A. Key OFF
B. Disconnect Fuel Injector 6 H and L terminals
C. Disconnect Engine Control Module (ECM) E2 connector.
D. Using Engine Terminal Test Kit ZTSE4435C, insert proper terminal into ECM pin E2-01.
E. Connect one end of the 500 Ohm Resistor Jumper Harness ZTSE4497 to terminal in E2-01, and connect the other end of 500 Ohm Resistor Jumper Harness to PWR (use a jumper wire if needed).
F. Connect INJ6 H ring terminal to a known good GND (use a jumper wire if needed)

SPN 2797 FMI 11 - Injector Control Group 1 Short Circuit (INJ 1, 3, 5)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Short detected in fuel injector 1, 3, or 5 circuits	High side circuit short to PWR impedance < 0.5 Ohms High side circuit short to GND impedance < 1 Ohms Low side circuit short to PWR impedance < 2 Ohms Low side circuit short to GND impedance < 2 Ohms	Engine Speed > 0 rpm Crankshaft angle between 25 deg BTDC and 23 deg ATDC Battery Voltage > 7 Volts	5 firing events

Fault Overview

Fault codes sets when a short circuit is detected in fuel injector 1, 3, or 5.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 651 FMI 4 and 5 (INJ); SPN 653 FMI 4 and 5 (INJ); SPN 655 FMI 4 and 5 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

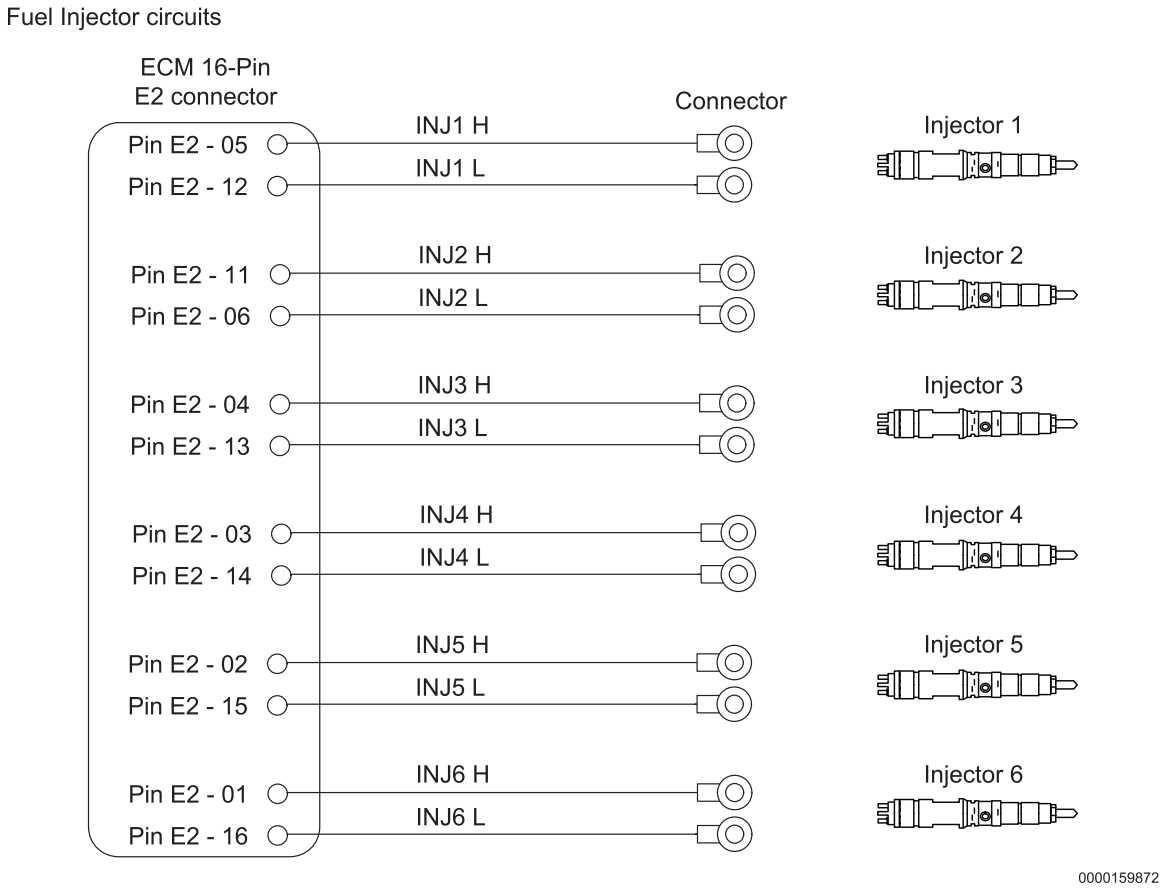

Figure 479 Fuel Injector circuit diagram

Possible Causes

- INJ1 H circuit short to PWR
- INJ1 H circuit short to GND
- INJ1 H short to INJ1 L
- INJ1 L circuit short to PWR
- INJ1 L circuit short to GND
- Fuel injector 1 wiring terminals shorted to engine brake housing
- Failed fuel injector 1
- INJ3 H circuit short to PWR
- INJ3 H circuit short to GND
- INJ3 H short to INJ3 L
- INJ3 L circuit short to PWR
- INJ3 L circuit short to GND
- Fuel injector 3 wiring terminals shorted to engine brake housing

- Failed fuel injector 3
- INJ5 H circuit short to PWR
- INJ5 H circuit short to GND
- INJ5 H short to INJ6 L
- INJ5 L circuit short to PWR
- INJ5 L circuit short to GND
- Fuel injector 5 wiring terminals shorted to engine brake housing
- Failed fuel injector 5

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 651 FMI 4 and 5 (INJ); SPN 653 FMI 4 and 5 (INJ); SPN 655 FMI 4 and 5 (INJ). Is EST DTC list free of SPN 651 FMI 4 and 5; SPN 653 FMI 4 and 5; SPN 655 FMI 4 and 5?	Yes: Go to step 2.
		No: Repair SPN 651 FMI 4 and 5; SPN 653 FMI 4 and 5; SPN 655 FMI 4 and 5. After repairs are complete, retest for SPN 2797 FMI 11.

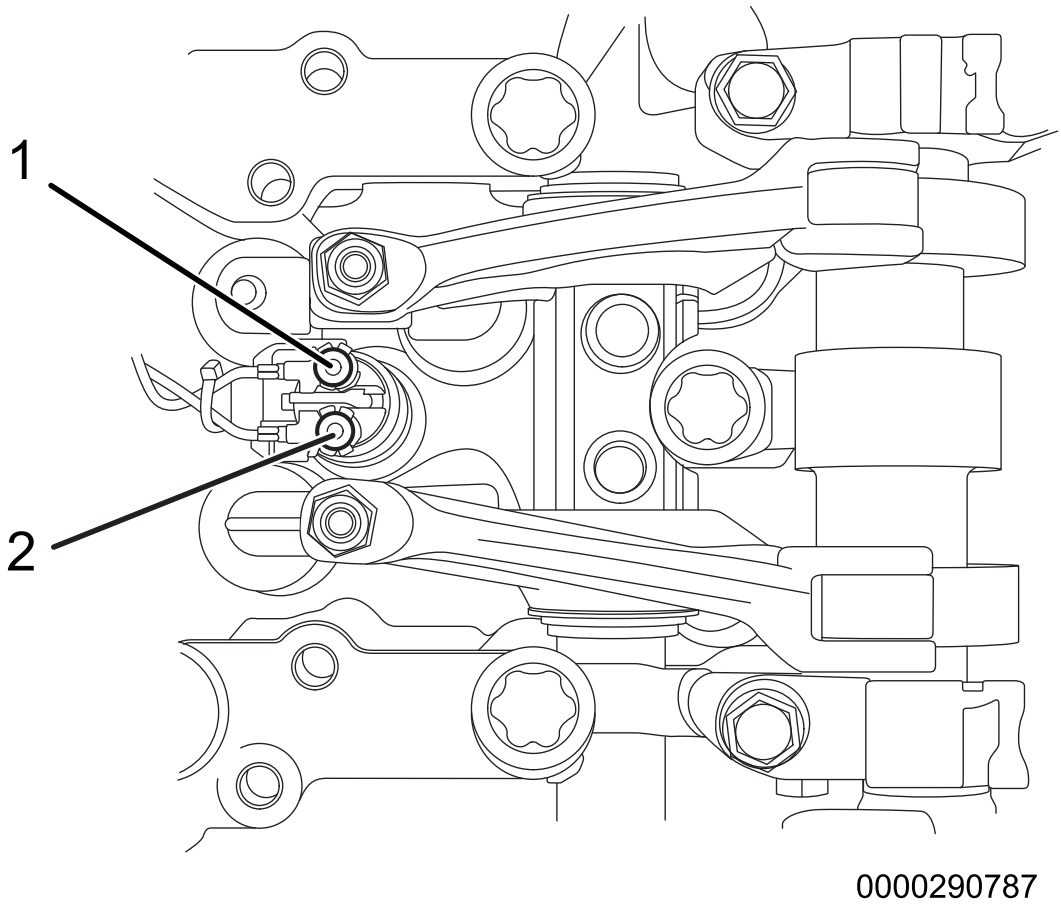

Figure 480 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
2	Verify proper fuel injector wire terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel so they do not short to ground on the engine brake housings or other components. Are fuel injector wire terminals oriented correctly and Not contacting the engine brake housing?	Yes: Go to step 3. No: Adjust connections so fuel injectors wire terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
3	Check for a shorted fuel injector 1 coil. Disconnect wiring terminals from fuel injector 1. Check resistance across fuel injector 1. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 4. No: Replace fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
4	Check for a shorted fuel injector 3 coil. Disconnect wiring terminals from fuel injector 3. Check resistance across fuel injector 3. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 5. No: Replace fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
5	Check for a shorted fuel injector 5 coil. Disconnect wiring terminals from fuel injector 5. Check resistance across fuel injector 5. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 6. No: Replace fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

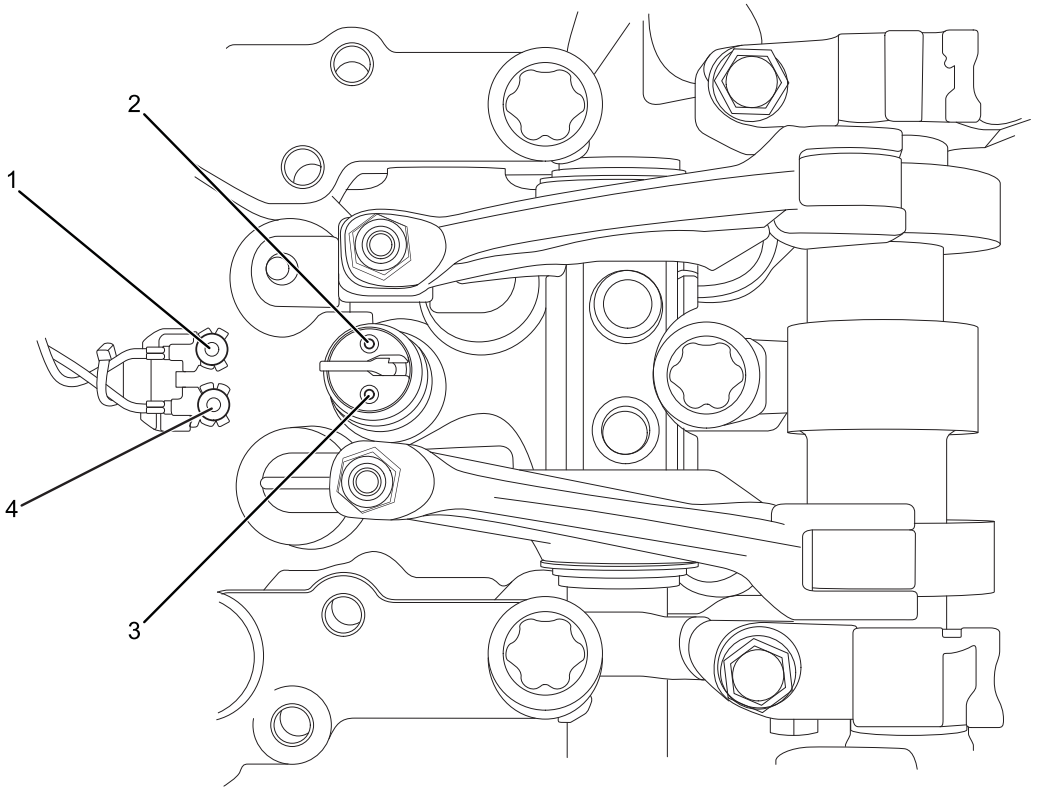

Figure 481 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
6	Check fuel injector 1 H terminal for short to GND. Key OFF with fuel injector 1 disconnected, use a DMM to measure resistance between fuel injector 1 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Replace fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
7	Check fuel injector 1 L terminal for short to GND. Key OFF with fuel injector 1 disconnected, use a DMM to measure resistance between fuel injector 1 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 8. No: Replace fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
8	Check fuel injector 3 H terminal for short to GND. Key OFF with fuel injector 3 disconnected, use a DMM to measure resistance between fuel injector 3 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Replace fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
9	Check fuel injector 3 L terminal for short to GND. Key OFF with fuel injector 3 disconnected, use a DMM to measure resistance between fuel injector 3 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 10. No: Replace fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
10	Check fuel injector 5 H terminal for short to GND. Key OFF with fuel injector 5 disconnected, use a DMM to measure resistance between fuel injector 5 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 11. No: Replace fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
11	Check fuel injector 5 L terminal for short to GND. Key OFF with fuel injector 5 disconnected, use a DMM to measure resistance between fuel injector 5 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 12. No: Replace fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
12	Inspect connections at ECM E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 13. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
13	Check for INJ1 H short to INJ1 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 1 disconnected measure resistance between Breakout Box pins E2-05 and E2-12 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 14. No: Repair INJ1 H short to INJ1 L. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
14	Check for INJ3 H short to INJ3 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 injector harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 3 disconnected measure resistance between Breakout Box pins E2-04 and E2-13 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 15. No: Repair INJ3 H short to INJ3 L. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
15	Check for INJ5 H short to INJ5 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 injector harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 5 disconnected measure resistance between Breakout Box pins E2-02 and E2-15 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 16. No: Repair INJ5 H short to INJ5 L. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
16.	Check INJ1 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 1 disconnected, measure resistance between Breakout Box pin E2-05 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 17. No: Repair short to GND between ECM pin E2-05 and fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
17	Check INJ1 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 1 disconnected, measure resistance between Breakout Box pin E2-12 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 18. No: Repair short to GND between ECM pin E2-12 and fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
18	Check INJ3 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 3 disconnected, measure resistance between Breakout Box pin E2-04 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 19. No: Repair short to GND between ECM pin E2-04 and fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
19	Check INJ3 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 3 disconnected, measure resistance between Breakout Box pin E2-13 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 20. No: Repair short to GND between ECM pin E2-13 and fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
20	Check INJ5 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 5 disconnected, measure resistance between Breakout Box pin E2-02 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 21. No: Repair short to GND between ECM pin E2-02 and fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
21	Check INJ5 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 5 disconnected, measure resistance between Breakout Box pin E2-15 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 22. No: Repair short to GND between ECM pin E2-15 and fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
22	Check INJ1 H circuit for short to PWR. Key-On Engine-Off (KOEO), connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 1 disconnected, measure voltage between Breakout Box pin E2-05 and a known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 23. No: Repair short to PWR between ECM pin E2-05 and fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
23	Check INJ1 L circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 1 disconnected, measure voltage between Breakout Box pin E2-12 and known good GND (wiggle test may be required). Is voltage less than 0.5 Volts?	Yes: Go to step 24. No: Repair short to PWR between ECM pin E2-12 and fuel injector 1. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
24	Check INJ3 H circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 3 disconnected, measure voltage between Breakout Box pin E2-04 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 25. No: Repair short to PWR between ECM pin E2-04 and fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
25	Check INJ3 L circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 3 disconnected, measure voltage between Breakout Box pin E2-13 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 26. No: Repair short to PWR between ECM pin E2-13 and fuel injector 3. After repairs are complete, retest for SPN 2797 FMI 11.

Step	Action	Decision
26	Check INJ5 H circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 5 disconnected, measure voltage between Breakout Box pin E2-02 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Repair short to PWR between ECM pin E2-15 and fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11. No: Repair short to PWR between ECM pin E2-02 and fuel injector 5. After repairs are complete, retest for SPN 2797 FMI 11.

NOTE: After performing all diagnostic steps, if SPN 2797 FMI 11 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 2798 FMI 11 - Injector Control Group 2 Short Circuit (INJ 2, 4, 6)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Short detected in fuel injector 2, 4, or 6 circuits	High side circuit short to PWR impedance < 0.5 Ohms High side circuit short to GND impedance < 1 Ohms Low side circuit short to PWR impedance < 2 Ohms Low side circuit short to GND impedance < 2 Ohms	Engine Speed >0 rpm Crankshaft angle between 25 deg BTDC and 23 deg ATDC Battery Voltage > 7 Volts	5 firing events

Fault Overview

Fault codes sets when a short circuit is detected in fuel injector 2, 4, or 6.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 652 FMI 4 and 5 (INJ); SPN 654 FMI 4 and 5 (INJ); SPN 656 FMI 4 and 5 (INJ)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

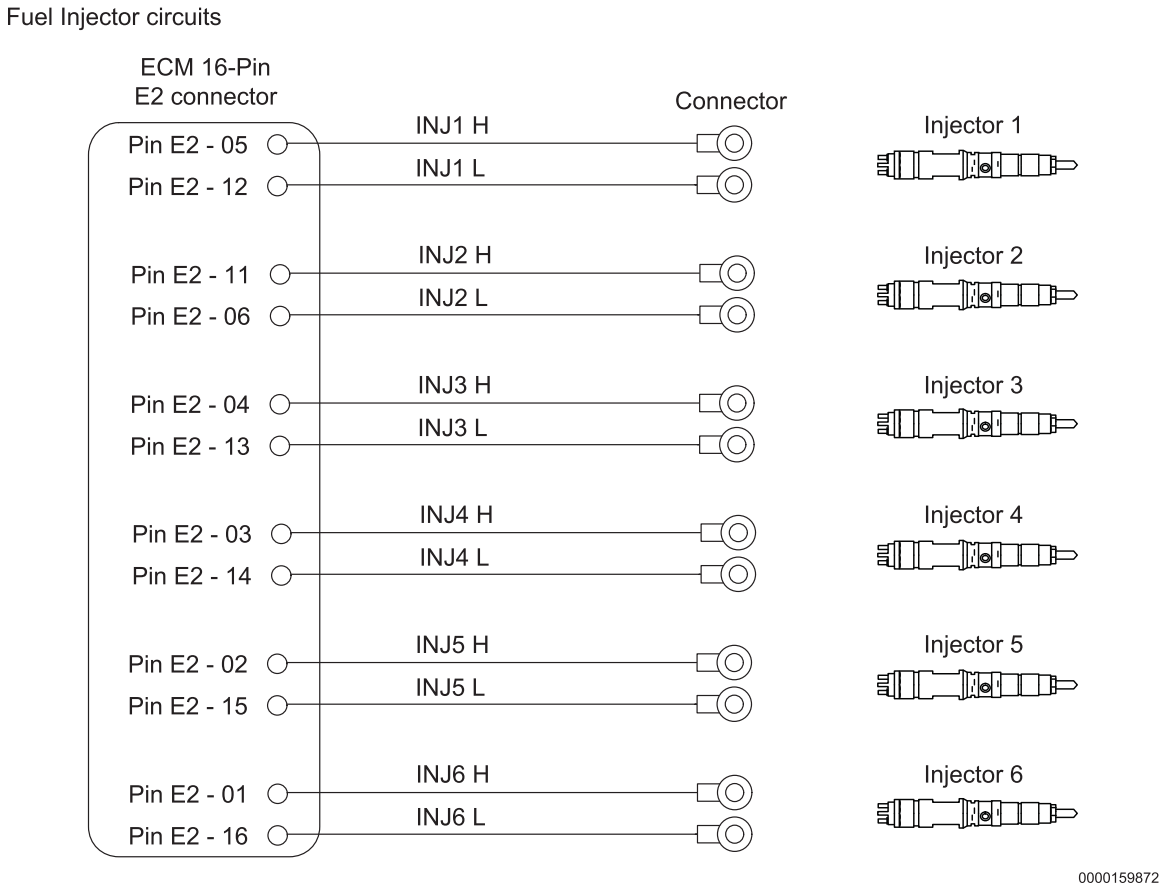

Figure 482 Fuel Injector circuit diagram

Possible Causes

- INJ2 H circuit short to PWR
- INJ2 H circuit short to GND
- INJ2 H short to INJ2 L
- INJ2 L circuit short to PWR
- INJ2 L circuit short to GND
- Fuel injector 2 shorted to engine brake housing
- Failed fuel injector 2
- INJ4 H circuit short to PWR
- INJ4 H circuit short to GND
- INJ4 H short to INJ4 L
- INJ4 L circuit short to PWR
- INJ4 L circuit short to GND
- Fuel injector 4 shorted to engine brake housing

- Failed fuel injector 4
- INJ6 H circuit short to PWR
- INJ6 H circuit short to GND
- INJ6 H short to INJ6 L
- INJ6 L circuit short to PWR
- INJ6 L circuit short to GND
- Fuel injector 6 shorted to engine brake housing
- Failed fuel injector 6

WARNING: To prevent personal injury or death, shut engine down before doing voltage checks for injector solenoids. When the engine is running, injector circuits have high voltage and amperage.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting connectors. Failure to turn ignition switch to OFF will cause a voltage spike and damage to electrical components.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 652 FMI 4 and 5 (INJ); SPN 654 FMI 4 and 5 (INJ); SPN 656 FMI 4 and 5 (INJ). Is EST DTC list free of SPN 652 FMI 4 and 5; SPN 654 FMI 4 and 5; SPN 656 FMI 4 and 5?	Yes: Go to step 2. No: Repair SPN 652 FMI 4 and 5; SPN 654 FMI 4 and 5; SPN 656 FMI 4 and 5. After repairs are complete, retest for SPN 2798 FMI 11.

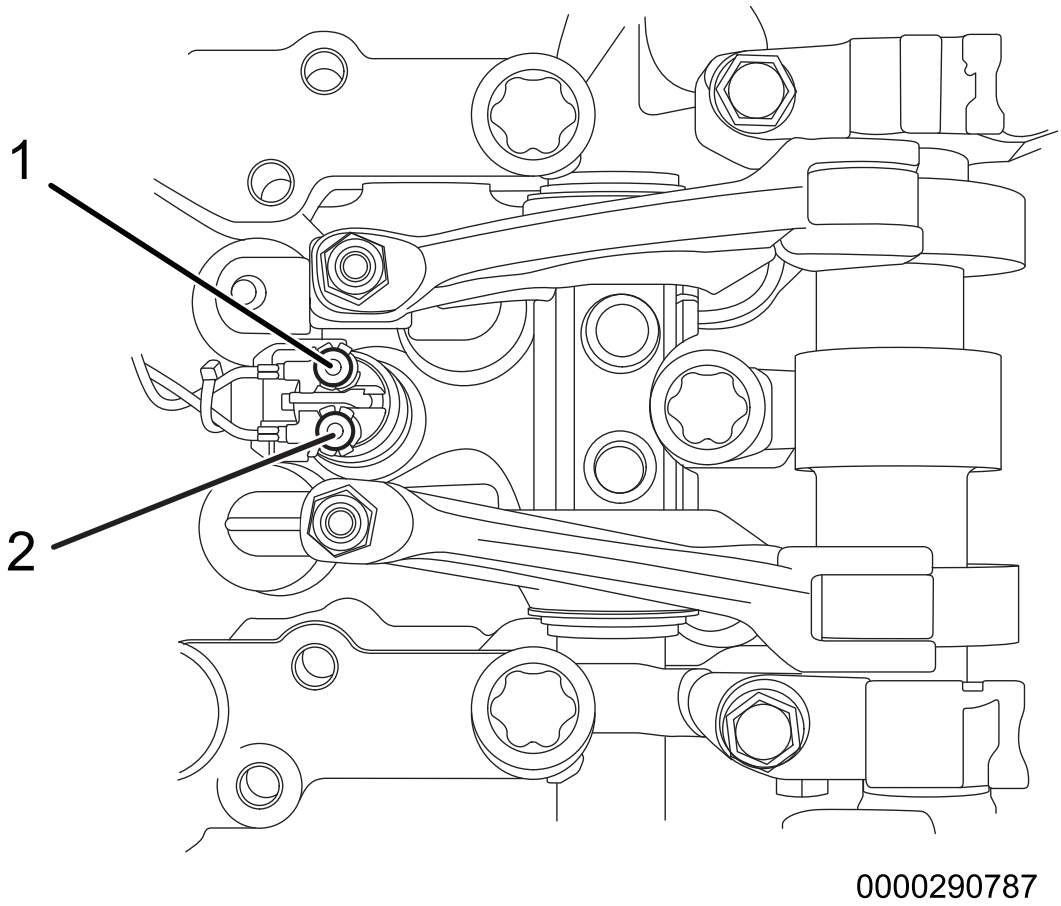

Figure 483 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
2	Verify proper fuel injector wire terminal orientation. Remove upper valve cover and engine brake housing (see Engine Service Manual). Verify fuel injector terminals are installed parallel so they do not short to ground on the engine brake housings or other components. Are fuel injector wire terminals oriented correctly and Not contacting the engine brake housing?	Yes: Go to step 3. No: Adjust connections so fuel injectors wire terminals will not contact the engine brake housing. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
3	Check for a shorted fuel injector 2 coil. Disconnect wiring terminals from fuel injector 2. Check resistance across fuel injector 2. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 4. No: Replace fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
4	Check for a shorted fuel injector 4 coil. Disconnect wiring terminals from fuel injector 3. Check resistance across fuel injector 4. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 5. No: Replace fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
5	Check for a shorted fuel injector 6 coil. Disconnect wiring terminals from fuel injector 5. Check resistance across fuel injector 6. Is resistance between 0.2 to 0.8 Ohms?	Yes: Go to step 6. No: Replace fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

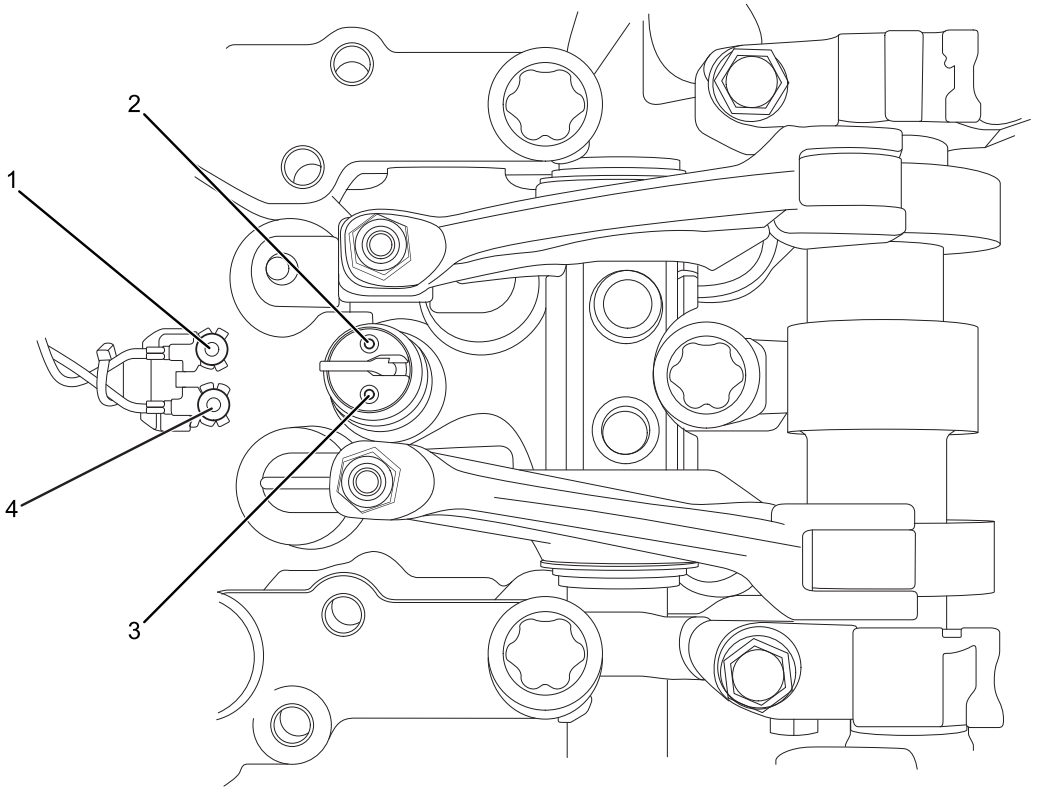

Figure 484 Fuel Injector Wiring Terminal Orientation

1. Fuel injector H wiring terminal
2. Fuel injector H terminal
3. Fuel injector L terminal
4. Fuel injector L wiring terminal (brown wire color [typical])

Step	Action	Decision
6	Check fuel injector 2 H terminal for short to GND. Key OFF with fuel injector 2 disconnected, use a DMM to measure resistance between fuel injector 2 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 7. No: Replace fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
7	Check fuel injector 2 L terminal for short to GND. Key OFF with fuel injector 2 disconnected, use a DMM to measure resistance between fuel injector 2 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 8. No: Replace fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
8	Check fuel injector 4 H terminal for short to GND. Key OFF with fuel injector 4 disconnected, use a DMM to measure resistance between fuel injector 4 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 9. No: Replace fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
9	Check fuel injector 4 L terminal for short to GND. Key OFF with fuel injector 4 disconnected, use a DMM to measure resistance between fuel injector 4 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 10. No: Replace fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
10	Check fuel injector 6 H terminal for short to GND. Key OFF with fuel injector 6 disconnected, use a DMM to measure resistance between fuel injector 6 H terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 11. No: Replace fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
11	Check fuel injector 6 L terminal for short to GND. Key OFF with fuel injector 6 disconnected, use a DMM to measure resistance between fuel injector 6 L terminal and GND. Is resistance greater than 1000 ohms?	Yes: Go to step 12. No: Replace fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
12	Inspect connections at ECM E2 connector. Key OFF, disconnect ECM E2 connector. Check ECM E2 connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E2 connector, harness, and terminals clean and undamaged?	Yes: Go to step 13. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
13	Check for INJ2 H short to INJ2 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 2 disconnected measure resistance between Breakout Box pins E2-11 and E2-06 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 14. No: Repair INJ2 H short to INJ2 L. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
14	Check for INJ4 H short to INJ4 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 injector harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 4 disconnected measure resistance between Breakout Box pins E2-03 and E2-14 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 15. No: Repair INJ4 H short to INJ4 L. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
15	Check for INJ6 H short to INJ6 L. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 injector harness, leave ECM E2 disconnected. Using a DMM, with fuel injector 6 disconnected measure resistance between Breakout Box pins E2-01 and E2-16 (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 16. No: Repair INJ6 H short to INJ6 L. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
16.	Check INJ2 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 2 disconnected, measure resistance between Breakout Box pin E2-11 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 17. No: Repair short to GND between ECM pin E2-11 and fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
17	Check INJ2 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 2 disconnected, measure resistance between Breakout Box pin E2-06 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 18. No: Repair short to GND between ECM pin E2-06 and fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
18	Check INJ4 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 4 disconnected, measure resistance between Breakout Box pin E2-03 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 19. No: Repair short to GND between ECM pin E2-03 and fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
19	Check INJ4 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 4 disconnected, measure resistance between Breakout Box pin E2-14 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 20. No: Repair short to GND between ECM pin E2-14 and fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
20	Check INJ6 H circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 6 disconnected, measure resistance between Breakout Box pin E2-01 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 21. No: Repair short to GND between ECM pin E2-01 and fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
21	Check INJ6 L circuit for short to GND. Key OFF, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 6 disconnected, measure resistance between Breakout Box pin E2-16 and a known good GND (wiggle test may be required). Is resistance greater than 1000 ohms?	Yes: Go to step 22. No: Repair short to GND between ECM pin E2-16 and fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
22	Check INJ2 H circuit for short to PWR. Key-On Engine-Off (KOEO), connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 2 disconnected, measure voltage between Breakout Box pin E2-11 and a known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 23. No: Repair short to PWR between ECM pin E2-11 and fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
23	Check INJ2 L circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 2 disconnected, measure voltage between Breakout Box pin E2-06 and known good GND (wiggle test may be required). Is voltage less than 0.5 Volts?	Yes: Go to step 24. No: Repair short to PWR between ECM pin E2-06 and fuel injector 2. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
24	Check INJ4 H circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 4 disconnected, measure voltage between Breakout Box pin E2-03 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 25. No: Repair short to PWR between ECM pin E2-03 and fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
25	Check INJ4 L circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 4 disconnected, measure voltage between Breakout Box pin E2-14 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Go to step 26. No: Repair short to PWR between ECM pin E2-14 and fuel injector 4. After repairs are complete, retest for SPN 2798 FMI 11.

Step	Action	Decision
26	Check INJ6 H circuit for short to PWR. KOEO, connect 180-pin Breakout Box with Breakout Harness 00-01468-00 to vehicle harness, and leave ECM disconnected. Using a DMM with fuel injector 6 disconnected, measure voltage between Breakout Box pin E2-01 and known good GND (wiggle test may be required). Is voltage less than 0.5 volts?	Yes: Repair short to PWR between ECM pin E2-16 and fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11. No: Repair short to PWR between ECM pin E2-01 and fuel injector 6. After repairs are complete, retest for SPN 2798 FMI 11.

NOTE: After performing all diagnostic steps, if SPN 2798 FMI 11 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

J1939 Data Link Communications

Overview of J1939 Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
560	19	Transmission Driveline Engaged not detected on J1939(page 1213)	• TCM Offline • Transmission driveline engaged switch or circuit fault	See *Electrical System Troubleshooting Guide* for troubleshooting the switch
609	19	ACM not detected on J1939(page 1223)	• CAN-AH circuit Open • CAN-AL circuit Open • CAN-AH circuit short to GND • CAN-AL circuit short to GND • CAN-AH short to CAN-AL • CAN-AH circuit short to power • CAN-AL circuit short to power	Step-Based Diagnostics (page 1223)
639	14	J1939 Data Link Error (ECM unable to transmit)	• J1939 Data link circuit fault • Failed ECM	Circuit Checks (page 1222)
639	19	J1939 Data Link Error (ECM unable to transmit or receive)	• J1939 Data link circuit fault • Failed ECM	Circuit Checks (page 1222)

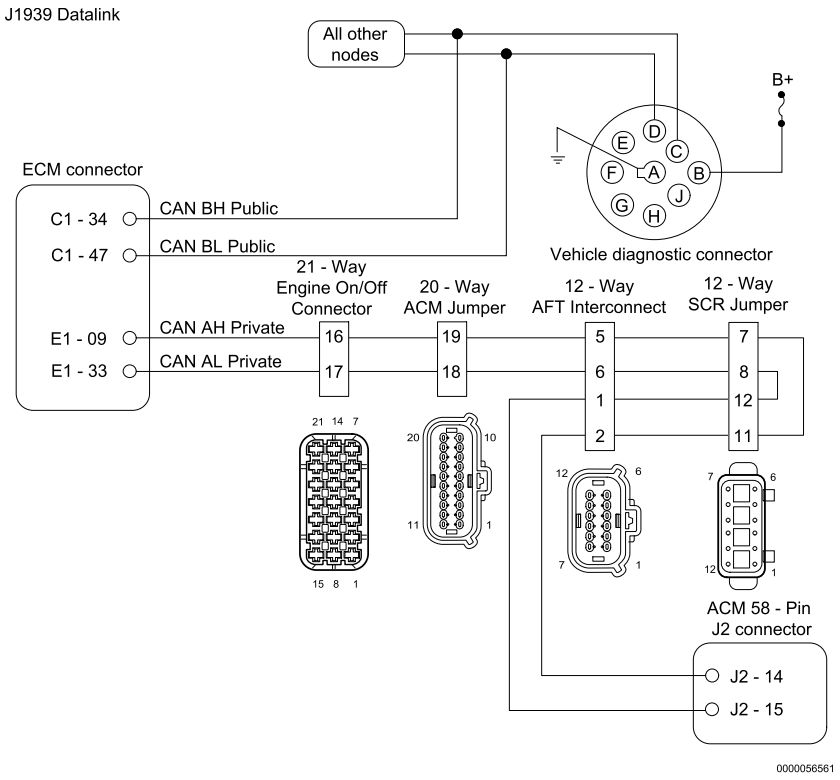

Figure 485 J1939 data link circuit diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Public J1939 circuit provides a communication path between the Engine Control Module (ECM), and other vehicle Controller Area Network (CAN) nodes. The circuit contains two 120 ohm terminating resistors. One resistor will be located inside the cab, and one will be located outside the cab. Wiring for the Public J1939 circuit consists of a shielded twisted pair wire where one wire is CAN-BH, and the other is CAN-BL.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- Big Bore Terminal Test Kit ZTSE4899
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with Diamond Logic Builder™ software
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 560 FMI 19 - Transmission Driveline Engaged Not Detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
TBD	TBD	TBD

See *Electrical System Troubleshooting Guide* for troubleshooting the switch

Fault Overview

Lamp Reaction

Associated Faults

Fault Facts

Drive Cycle to Determine Fault Status

Possible Causes

•

Step 1	Verify Transmission Control Module (TCM) is communicating.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check that TCM is listed in Sniffer Section. Is TCM listed?		Yes: Diagnose Transmission Driveline engaged switch or circuit fault. See appropriate Transmission/Truck Service Manual. After repairs are completed, retest for SPN 560 FMI 19.
		No: Repair Transmission Driveline engaged not detected on J1939 fault. After Repairs are completed, retest for SPN 560 FMI 19.

SPN 609 FMI 19 - Private CAN Bus No Tx or Rx CAN Message Not Received

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
TBD	TBD	TBD

Fault Overview

Fault code sets when the Engine Control Module (ECM) is unable to communicate with Aftertreatment Control Module (ACM).

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

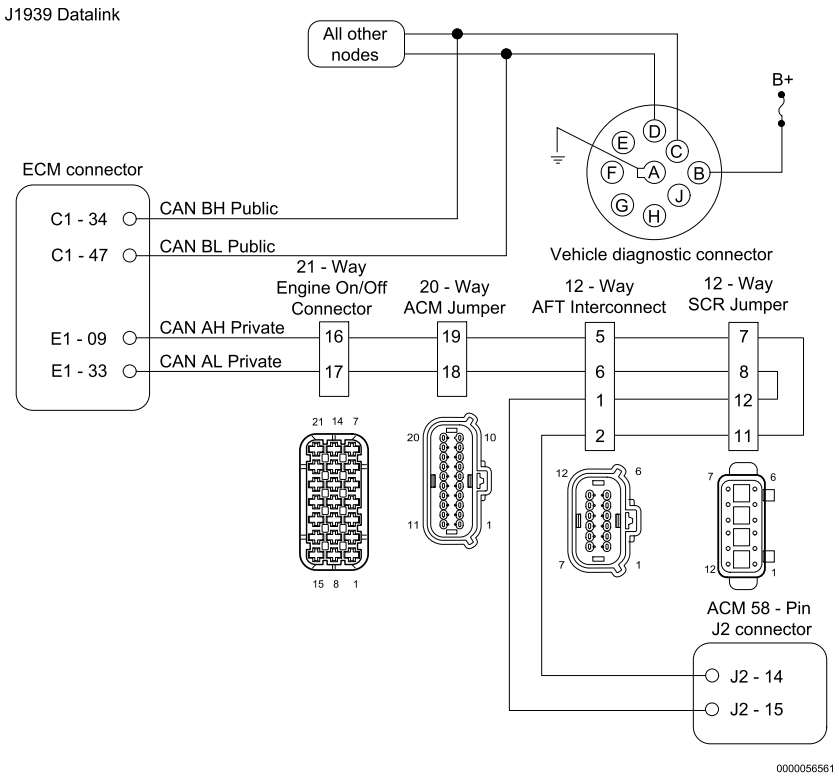

Figure 486 J1939 data link circuit diagram

Possible Causes

- CAN-AH circuit Open
- CAN-AL circuit Open
- CAN-AH circuit short to GND
- CAN-AL circuit short to GND
- CAN-AH short to CAN-AL
- CAN-AH circuit short to power
- CAN-AL circuit short to power

Step	Action	Decision
1	Inspect connections at ACM. Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
2	Check ACM VBATT circuits. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Key ON, using a DMM, measure voltage between ACM pin J2-03 and a known good ground, and pin J2-05 and a known good ground. Is voltage at both pins within 0.5 volts of battery voltage?	Yes: Go to step 3. No: Go to step 11

Step	Action	Decision
3	Check ACM GND circuits. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Key ON, using a DMM, measure voltage between ACM pin J2-04 and B+, and ACM pin J2-06 and B+. Is voltage at both pins within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 17.

Step	Action	Decision
4	Inspect connections at Engine Control Module (ECM). Key OFF, disconnect ECM. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to GND. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Key ON, use a DMM to measure voltage between pin J2-14 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 6. No: short to GND between ACM pin J2-14 and ECM pin E1-09.

Step	Action	Decision
6	Check CAN-AL circuit for short to GND. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Key ON, use a DMM to measure voltage at pin J2-15 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: short to GND between ACM pin J2-15 and ECM pin E1-33.

Step	Action	Decision
7	Check CAN-AH circuit for short to power. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Key ON, use a DMM to measure voltage at pin J2-14. Is voltage less than 4 volts?	Yes: Go to step 8. No: short to power between ACM pin J2-14 and ECM pin E1-09.

Step	Action	Decision
8	Check CAN-AL circuit for short to power. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Kry ON, use a DMM to measure voltage at in J2-15 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 9. No: short to power between ACM pin J2-15 and ECM pin E1-33.

Before performing any resistance checks on the data link circuit, turn ignition switch to the OFF position and disconnect vehicle batteries.

Step	Action	Decision
9	Check CAN-AH circuit for a short to CAN-AL. Leaving breakout box connected to the harnesses, disconnect ACM J2 connector from ACM, and ECM E1 connector from ECM. Key OFF, use a DMM to measure resistance between pin J2-14 and pin J2-15. Is resistance less than 50 ohms?	Yes: Repair short between CAN-AH, and CAN-AL. After repairs are complete, retest for SPN 609 FMI 19. No: Go to step 10.

Step	Action	Decision
10	Check CAN-AH circuit for Open or high resistance. Use a DMM to measure resistance between pin J2-14 and pin J1-07/E1-09. Is resistance less than 5 ohms?	Yes: Open or high resistance between ACM pin J2-15 and ECM pin E1-33. No: Open or high resistance between ACM pin J2-14 and ECM pin E1-09.

Step	Action	Decision
11	Inspect connections at 15-Way Way Underhood PDM connector. Key OFF, disconnect 15-Way Underhood PDM connector. Check 15-Way Underhood PDM connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 15-Way Underhood PDM connector, harness, and terminals clean and undamaged?	Yes: Go to step 12. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
12	Check voltage to the 15-Way Underhood PDM connector. Key OFF, disconnect 15-Way. Using appropriate terminal from Big Bore Terminal Test Kit ZTSE4899, connect DMM to pin-13 of Underhood PDM and leave harness disconnected. Key ON, measure voltage between pin-13 of Underhood PDM and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 13. No: Diagnose loss of power from Underhood PDM. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
13	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way. Check 20-Way terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way connector, harness, and terminals clean and undamaged?	Yes: Go to step 14. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

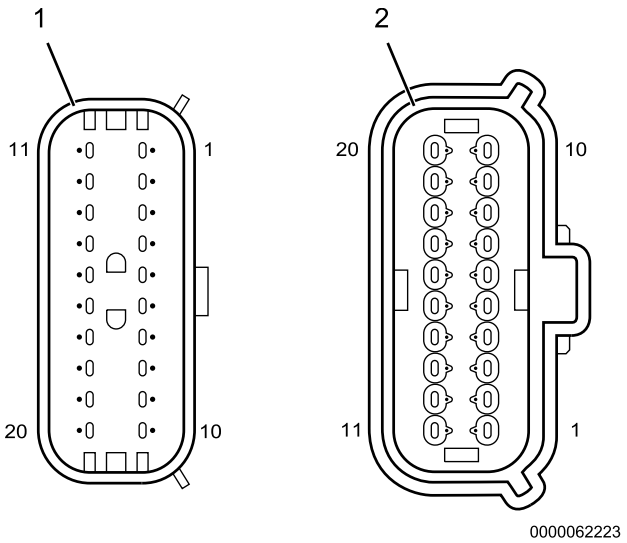

Figure 487 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
14	Check voltage to the 20-Way DEF Harness Interconnect. Key OFF, reconnect 15-Way Underhood PDM connector. Connect 20-Way DEF Harness Interconnect Breakout Harness 18-050-01 to the female side of the 20-Way, and leave male side disconnected. Key ON, using a DMM, measure voltage between pin-12 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 15. No: Repair Open or high resistance in VBATT circuit between 20-Way pin-12 and ACM connector pin J2-03. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
15	Check voltage to the 20-Way DEF Harness Interconnect. Key OFF, connect 20-Way DEF Harness Interconnect Breakout Harness 18-050-01 to the female side of the 20-Way, and leave male side disconnected. Key ON, using a DMM, measure voltage between pin-13 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 16. No: Repair Open or high resistance in VBATT circuit between 20-Way pin-13 and ACM connector pin J2-05. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
16	Check VBATT circuits between 20-Way DEF Harness Interconnect and ACM. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Key ON, using a DMM, measure voltage between ACM pin J2-05 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance in VBATT circuit between 20-Way pin-12 and ACM connector pin J2-03. After repairs are complete, retest for SPN 609 FMI 19.
		No: Repair Open or high resistance in VBATT circuit between 20-Way pin-13 and ACM connector pin J2-05. After repairs are complete, retest for SPN 609 FMI 19.

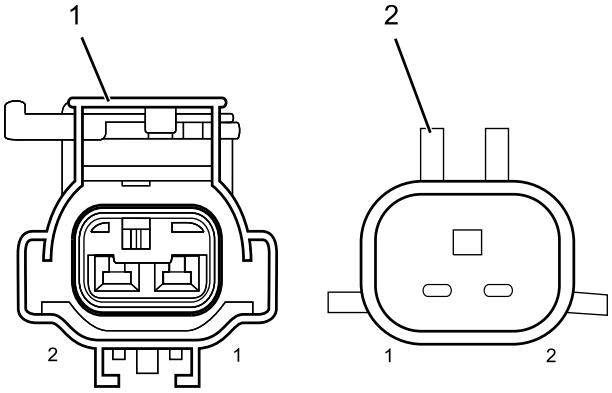

Figure 488 DEF Harness PWR and GND connector view

1. Female connector
2. Male connector

Step	Action	Decision
17	Inspect connections at DEF harness PWR & GND connector. Key OFF, disconnect DEF harness PWR & GND connector. Check DEF harness PWR & GND connector for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF harness PWR & GND connector, harness, and terminals clean and undamaged?	Yes: Go to step 18.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
18	Check ground at the DEF harness PWR & GND connector. Key OFF, connect Breakout Harness ZTSE4760A to the male side of the 20-Way, and leave female side disconnected. Using a DMM, measure voltage between Breakout Harness ZTSE4760A pin-2 and B+. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 19. No: Diagnose loss of ground to DEF harness PWR & GND connector. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
19	Check GND circuits between DEF harness PWR & GND connector and ACM. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Using a DMM, measure voltage between ACM pin J2-04 and B+. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance in GND circuit between DEF harness PWR & GND connector pin-2 and ACM connector pin J2-06. After repairs are complete, retest for SPN 609 FMI 19. No: Repair Open or high resistance in GND circuit between DEF harness PWR & GND connector pin-2 and ACM connector pin J2-04. After repairs are complete, retest for SPN 609 FMI 19.

NOTE: After doing all diagnostic steps, if SPN 609 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 639 FMI 14 - J1939 Data Link Error (ECM Unable to Transmit)

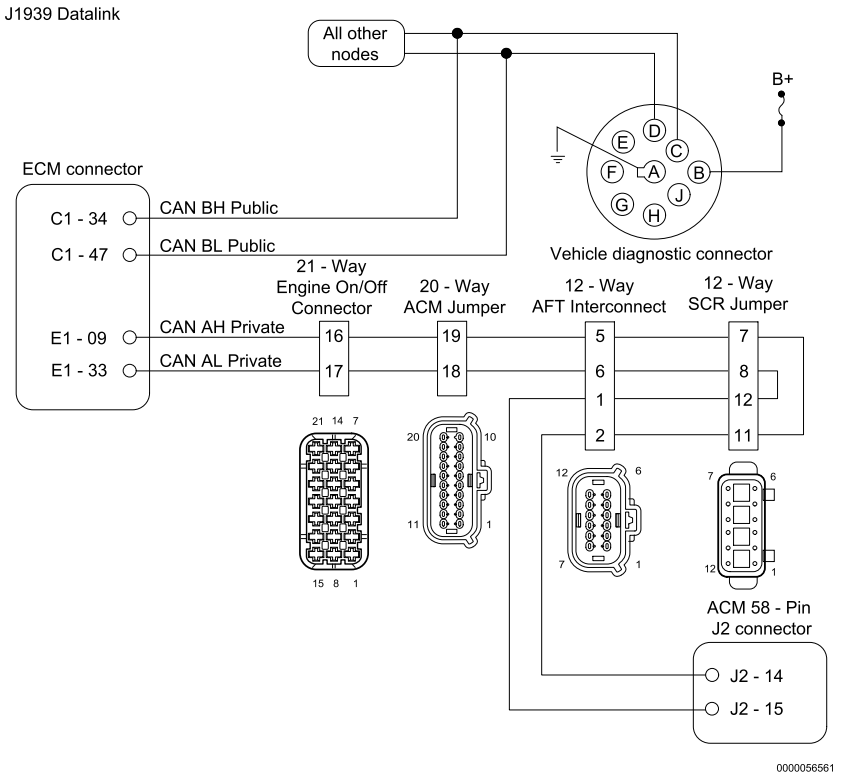

Figure 489 J1939 data link circuit diagram

Vehicle Diagnostic Connector Voltage Check

Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
B to GND	B+	If < B+, check B+ circuit to vehicle diagnostic connector for OPEN or short to GND, or blown fuse.
B to A	B+	If < B+, check GND circuit to vehicle diagnostic connector for OPEN.
C to GND	1 V to 4 V	The sum of C to GND and D to GND should = 4 V to 5 V.
D to GND	1 V to 4 V	The sum of C to GND and D to GND should = 4 V to 5 V.

EST Communication Check

Turn ignition switch to ON. Connect EST to vehicle diagnostic connector. If the EST is unable to communicate with the ECM, disconnect each module connected to the J1939 data link individually, until communication is established.

NOTE:

- If communication to ECM is established, check J1939 circuits to disconnected node for correct wiring. See truck *Electrical System Troubleshooting Guide*.
- If communication to ECM is not established, go to next test point.

Test Point	Comment
Disconnect Transmission Control Module (TCM)	See above note.
Disconnect Body Controller	See above note.
Disconnect instrument cluster	See above note.
Disconnect other nodes	See above note.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C to D	approximately 60 Ω	If not within specification, measure individual CAN terminating resistors.
Terminating Resistor Terminals	approximately 120 Ω	If not within specification, replace faulty terminating resistor(s).
C to C1-34	< 5 Ω	If > 5 Ω, check J1939-H for OPEN in circuit.
C to GND	> 1k Ω	If < 1k Ω, check J1939-H for short to GND.
D to C1-47	< 5 Ω	If > 5 Ω, check J1939-L for OPEN in circuit.
D to GND	> 1k Ω	If < 1k Ω, check J1939-L for short to GND.
A to GND	< 5 Ω	If > 5 Ω, check GND for OPEN in circuit.

Pinpoint Diagnostics With ServiceMaxx™ Software

SPN 639 FMI 19 - J1939 Data Link Error (ECM Unable to Transmit or Receive)

Fault Overview

Fault code sets when the Engine Control Module (ECM) is unable to communicate with Aftertreatment Control Module (ACM).

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

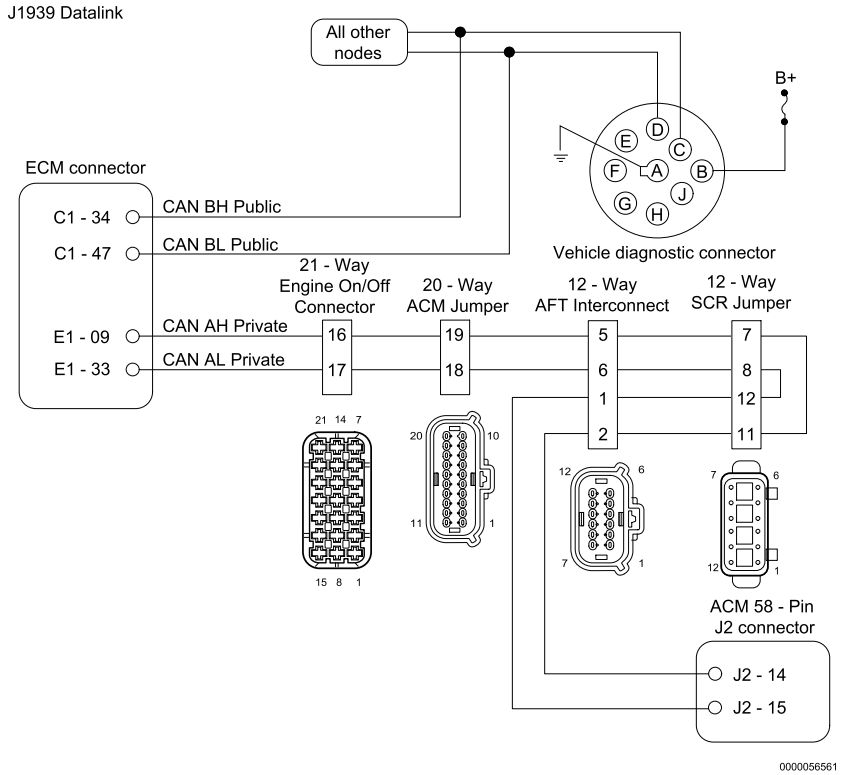

Figure 490 J1939 data link circuit diagram

Possible Causes

- CAN-AH circuit Open
- CAN-AL circuit Open
- CAN-AH circuit short to GND
- CAN-AL circuit short to GND
- CAN-AH short to CAN-AL
- CAN-AH circuit short to power
- CAN-AL circuit short to power

Step	Action	Decision
1	Inspect connections at ACM. Key OFF, disconnect ACM. Check ACM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ACM connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
2	Check ACM VBATT circuits. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Key ON, using a DMM, measure voltage between ACM pin J2-03 and a known good ground, and pin J2-05 and a known good ground. Is voltage at both pins within 0.5 volts of battery voltage?	Yes: Go to step 3. No: Go to step 11

Step	Action	Decision
3	Check ACM GND circuits. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Key ON, using a DMM, measure voltage between ACM pin J2-04 and B+, and ACM pin J2-06 and B+. Is voltage at both pins within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 17.

Step	Action	Decision
4	Inspect connections at Engine Control Module (ECM). Key OFF, disconnect ECM. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM connector, harness, and terminals clean and undamaged?	Yes: Go to step 5. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to GND. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Key ON, use a DMM to measure voltage between pin J2-14 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 6. No: short to GND between ACM pin J2-14 and ECM pin E1-09.

Step	Action	Decision
6	Check CAN-AL circuit for short to GND. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Key ON, use a DMM to measure voltage at pin J2-15 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: short to GND between ACM pin J2-15 and ECM pin E1-33.

Step	Action	Decision
7	Check CAN-AH circuit for short to power. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Key ON, use a DMM to measure voltage at pin J2-14. Is voltage less than 4 volts?	Yes: Go to step 8. No: short to power between ACM pin J2-14 and ECM pin E1-09.

Step	Action	Decision
8	Check CAN-AL circuit for short to power. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Connect Breakout Harness 00-01462-00 E1 connector between ECM and aftertreatment harness. Place ACM overlay on Breakout Box. Connect ACM Breakout harness Z connector and ECM Breakout Harness X connector to Breakout Box. Kry ON, use a DMM to measure voltage at in J2-15 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 9. No: short to power between ACM pin J2-15 and ECM pin E1-33.

NOTE: Before performing any resistance checks on the data link circuit, turn ignition switch to the OFF position and disconnect vehicle batteries.

Step	Action	Decision
9	Check CAN-AH circuit for a short to CAN-AL. Leaving breakout box connected to the harnesses, disconnect ACM J2 connector from ACM, and ECM E1 connector from ECM. Key OFF, use a DMM to measure resistance between pin J2-14 and pin J2-15. Is resistance less than 50 ohms?	Yes: Go to step 10. No: Repair short between CAN-AH, and CAN-AL. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
10	Check CAN-AH circuit for Open or high resistance. Use a DMM to measure resistance between pin J2-14 and pin J1-07/E1-09. Is resistance less than 5 ohms?	Yes: Open or high resistance between ACM pin J2-15 and ECM pin E1-33. No: Open or high resistance between ACM pin J2-14 and ECM pin E1-09.

Step	Action	Decision
11	Inspect connections at 15-Way Way Underhood PDM connector. Key OFF, disconnect 15-Way Underhood PDM connector. Check 15-Way Underhood PDM connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 15-Way Underhood PDM connector, harness, and terminals clean and undamaged?	Yes: Go to step 12. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
12	Check voltage to the 15-Way Underhood PDM connector. Key OFF, disconnect 15-Way. Using appropriate terminal from Big Bore Terminal Test Kit ZTSE4899, connect DMM to pin-13 of Underhood PDM and leave harness disconnected. Key ON, measure voltage between pin-13 of Underhood PDM and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 13. No: Diagnose loss of power from Underhood PDM. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
13	Inspect connections at 20-Way DEF harness interconnect. Key OFF, disconnect 20-Way. Check 20-Way terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the 20-Way connector, harness, and terminals clean and undamaged?	Yes: Go to step 14. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

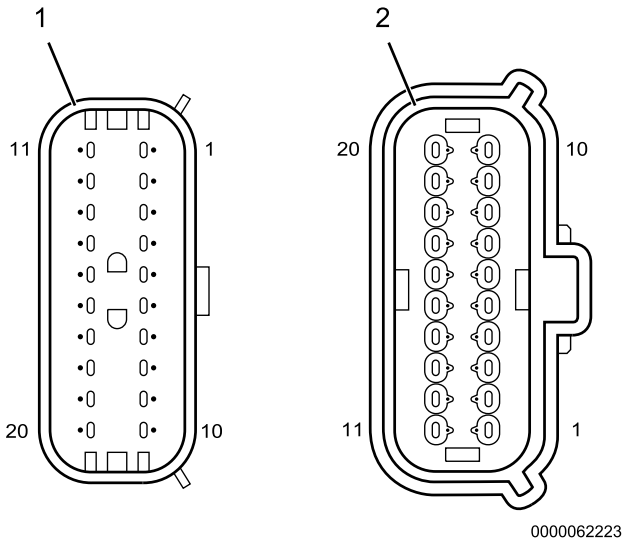

Figure 491 20-Way DEF Harness Connector End View

1. 20-Way DEF harness male side connector
2. 20-Way DEF harness female side connector

Step	Action	Decision
14	Check voltage to the 20-Way DEF Harness Interconnect. Key OFF, reconnect 15-Way Underhood PDM connector. Connect 20-Way DEF Harness Interconnect Breakout Harness 18-050-01 to the female side of the 20-Way, and leave male side disconnected. Key ON, using a DMM, measure voltage between pin-12 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 15. No: Repair Open or high resistance in VBATT circuit between 20-Way pin-12 and ACM connector pin J2-03. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
15	Check voltage to the 20-Way DEF Harness Interconnect. Key OFF, connect 20-Way DEF Harness Interconnect Breakout Harness 18-050-01 to the female side of the 20-Way, and leave male side disconnected. Key ON, using a DMM, measure voltage between pin-13 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 16. No: Repair Open or high resistance in VBATT circuit between 20-Way pin-13 and ACM connector pin J2-05. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
16	Check VBATT circuits between 20-Way DEF Harness Interconnect and ACM. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Key ON, using a DMM, measure voltage between ACM pin J2-05 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance in VBATT circuit between 20-Way pin-12 and ACM connector pin J2-03. After repairs are complete, retest for SPN 609 FMI 19. No: Repair Open or high resistance in VBATT circuit between 20-Way pin-13 and ACM connector pin J2-05. After repairs are complete, retest for SPN 609 FMI 19.

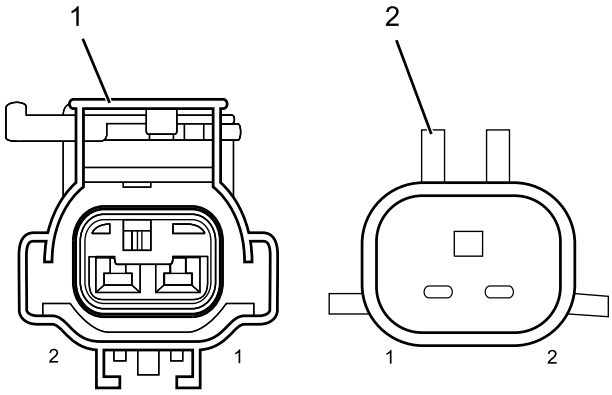

Figure 492 DEF Harness PWR and GND connector view

1. Female connector
2. Male connector

Step	Action	Decision
17	Inspect connections at DEF harness PWR & GND connector. Key OFF, disconnect DEF harness PWR & GND connector. Check DEF harness PWR & GND connector for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF harness PWR & GND connector, harness, and terminals clean and undamaged?	Yes: Go to step 18. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
18	Check ground at the DEF harness PWR & GND connector. Key OFF, connect Breakout Harness ZTSE4760A to the male side of the 20-Way, and leave female side disconnected. Using a DMM, measure voltage between Breakout Harness ZTSE4760A pin-2 and B+. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 19. No: Diagnose loss of ground to DEF harness PWR & GND connector. See appropriate Truck Service Manual. After repairs are complete, retest for SPN 609 FMI 19.

Step	Action	Decision
19	Check GND circuits between DEF harness PWR & GND connector and ACM. Key OFF, connect ACM Breakout Harness 18-537-01 J2 connector between ACM and aftertreatment harness. Using a DMM, measure voltage between ACM pin J2-04 and B+. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance in GND circuit between DEF harness PWR & GND connector pin-2 and ACM connector pin J2-06. After repairs are complete, retest for SPN 609 FMI 19. No: Repair Open or high resistance in GND circuit between DEF harness PWR & GND connector pin-2 and ACM connector pin J2-04. After repairs are complete, retest for SPN 609 FMI 19.

NOTE: After doing all diagnostic steps, if SPN 609 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

LTT (Low Temperature Thermostat) Sensor

Overview of LTT Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
1659	20	Low temperature Thermostat stuck closed	•	

SPN 1659 FMI 20 - Low Temperature Thermostat Stuck Closed

Cold Soak Sensor Compare Check With ServiceMaxx™ Software

NOTE: Temperature values need to be measured after 8 hours of cold soak.

1. Turn ignition switch ON, engine OFF.
2. Using ServiceMaxx™ software, open the Default session.
3. Compare Engine Coolant Temperature 1 (ECT1) to Engine Coolant Temperature 2 (ECT2). Sensor temperatures should be within 10°F (6°C) of each other.
   - If ECT1 is 10°F (6°C) or more above or below ECT2, check for poor circuitry going to the ECT1 sensor.
4. Verify engine fan is not stuck ON. Using EST with ServiceMaxx™ software, run Tests > KOER Test > Engine Fan Test.
5. Remove thermostats using procedure in the *Engine Service Manual*.
   - If the thermostat assemblies are stuck open, damaged, cracked, or not operating properly, replace them.
   - If engine fan or thermostat are not the cause, verify if code was set due to extended idle time in very cold ambient temperatures while running a large cabin heater.

LTR Thermostat

Overview of LTR Thermostat Sensor Group

SPN 7423 SPN 20 - ECT2 above expected: Check Thermostat stuck closed

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 7423 SPN 21 - ECT2 below expected: Check Thermostat stuck open

CONTENT
UNDER
DEVELOPMENT

0000305681

MIL (Malfunction Indicator Lamp) Sensor

Overview of MIL Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
1213	3	MIL circuit short to PWR	• MIL circuit short to PWR	Circuit Checks (page 1236)
1213	4	MIL circuit short to GND	• MIL circuit shorted to GND • Failed MIL	Circuit Checks (page 1236)
1213	5	MIL open load/circuit	• MIL circuit OPEN • Failed MIL	Circuit Checks (page 1236)

Overview

The Malfunction Indicator Lamp (MIL) illuminates when the Heavy-Duty On-Board Diagnostics (HD-OBD) system detects a malfunction related to the emissions control system. The illuminated MIL indicates the vehicle needs to be serviced at the first convenient opportunity. Lamp may remain active after repair until system operation confirms repair.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- Digital Multimeter (DMM)

SPN 1213 FMI 3 - MIL Circuit Short to PWR

MIL Connector Voltage Check Without ServiceMaxx™ Software

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness between ECM C1 and C2 connectors and ECM. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
MIL circuit not activated C1-57 to GND	0.1 V to 0.3 V	If no voltage is present, check for OPEN or short to GND. If > 0.3 V, check for short to PWR.
MIL circuit activated C1-57 to GND	B+	If no voltage is present, check for OPEN or short to GND.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-57 to 1-H	< 5 Ω	If > 5 Ω, check for OPEN circuit.
C1-24 to 2-C	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 1213 FMI 4 - MIL Circuit Short to GND

MIL Connector Voltage Check Without ServiceMaxx™ Software

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness between ECM C1 and C2 connectors and ECM. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
MIL circuit not activated	0.1 V to 0.3 V	If no voltage is present, check for OPEN or short to GND.
C1-57 to GND		If > 0.3 V, check for short to PWR.
MIL circuit activated	B+	If no voltage is present, check for OPEN or short to GND.
C1-57 to GND		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-57 to 1-H	< 5 Ω	If > 5 Ω, check for OPEN circuit.
C1-24 to 2-C	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 1213 FMI 5 - MIL Open Load / Circuit

MIL Connector Voltage Check Without ServiceMaxx™ Software

Turn ignition OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness between ECM C1 and C2 connectors and ECM. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
MIL circuit not activated	0.1 V to 0.3 V	If no voltage is present, check for OPEN or short to GND.
C1-57 to GND		If > 0.3 V, check for short to PWR.
MIL circuit activated	B+	If no voltage is present, check for OPEN or short to GND.
C1-57 to GND		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-57 to 1-H	< 5 Ω	If > 5 Ω, check for OPEN circuit.
C1-24 to 2-C	< 5 Ω	If > 5 Ω, check for OPEN circuit.

NOx (Nitrogen Oxides) IN Sensor Module

Overview of NOx IN Sensor Module Group

SPN	FMI	Condition	Possible Causes	Actions
3216	2	NOx IN signal erratic, intermittent or incorrect	• Failed Nitrogen Oxides (NOx) IN sensor module • SWBAT circuit intermittent short to GND or Open • Power Distribution Module (PDM) loose fuse or relay • Low battery voltage • GND circuit Open or high resistance	Step-Based Diagnostics (page 1242)
3216	4	NOx IN signal Out of Range LOW	• Failed NOx IN sensor module	Step-Based Diagnostics (page 1246)
3216	10	NOx IN signal abnormal rate of change	• Failed NOx IN sensor module	Step-Based Diagnostics (page 1248)
3216	13	NOx IN Out of Calibration	• Incorrect NOx IN sensor module installed	Step-Based Diagnostics (page 1250)
3216	19	NOx IN not detected on J1939	• SWBAT circuit short to GND or Open • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power • CAN-AL circuit short to power • GND circuit Open or high resistance • CAN-AH short to CAN-AL • Failed Nitrogen Oxides (NOx) IN sensor module	Step-Based Diagnostics (page 1252)

3216	20	NOx IN signal drifted HIGH	•	Failed NOx IN sensor module	Step-Based Diagnostics (page 1256)
3216	21	NOx IN signal drifted LOW	•	Failed NOx IN sensor module	Step-Based Diagnostics (page 1258)
3218	2	NOx IN power supply signal erratic, intermittent or incorrect	•	Failed NOx IN sensor module	Step-Based Diagnostics (page 1260)
			•	Low battery voltage	
			•	SWBAT circuit intermittent short to GND or Open	
			•	GND circuit Open or high resistance	
			•	Power Distribution Module (PDM) loose fuse or relay	
			•	Incorrect NOx IN sensor module installed	
5024	10	NOx IN Sensor Heater abnormal rate of change	•	Failed NOx IN sensor module	Step-Based Diagnostics(page 1264)
			•	GND circuit Open or high resistance	
			•	SWBAT circuit Open or high resistance	

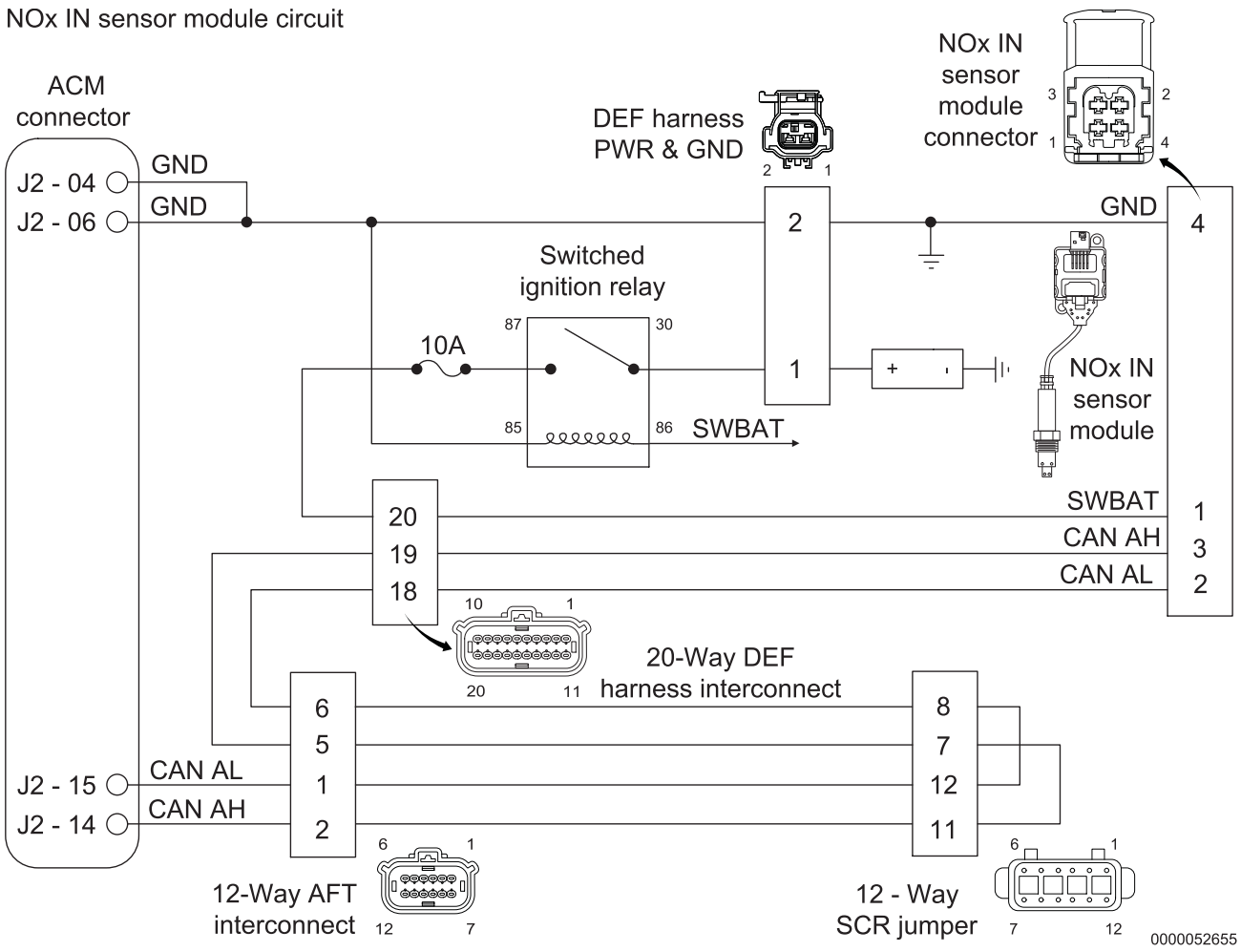

Figure 495 NOx IN Sensor Module Circuit Diagram

NOTE: See latest version of N13 with SCR Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Nitrogen Oxides (NOx) IN sensor module is a smart device used to measure the NOx emissions at the intake of the aftertreatment system. The NOx IN sensor module performs internal diagnostics and reports malfunctions back to the ACM using the J1939 data link. The NOx IN sensor is permanently attached to the NOx control module. They are serviced as a single component and can not be replaced individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01
- Breakout Harness 18-648-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software

- Interface cable (RP1210B compliant supporting J1939 and J1708)

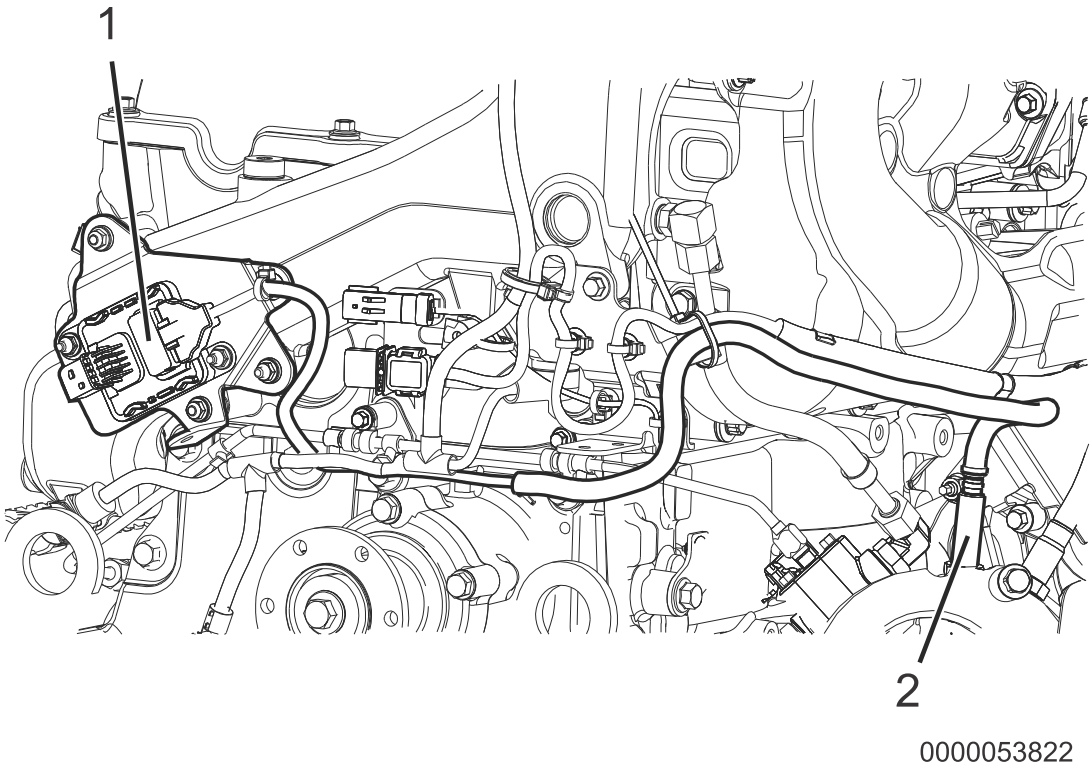

Figure 496 NOx IN Sensor Module Location (Engine Rear View, Typical)

1. Nitrogen Oxides (NOx) IN module
2. NOx IN sensor

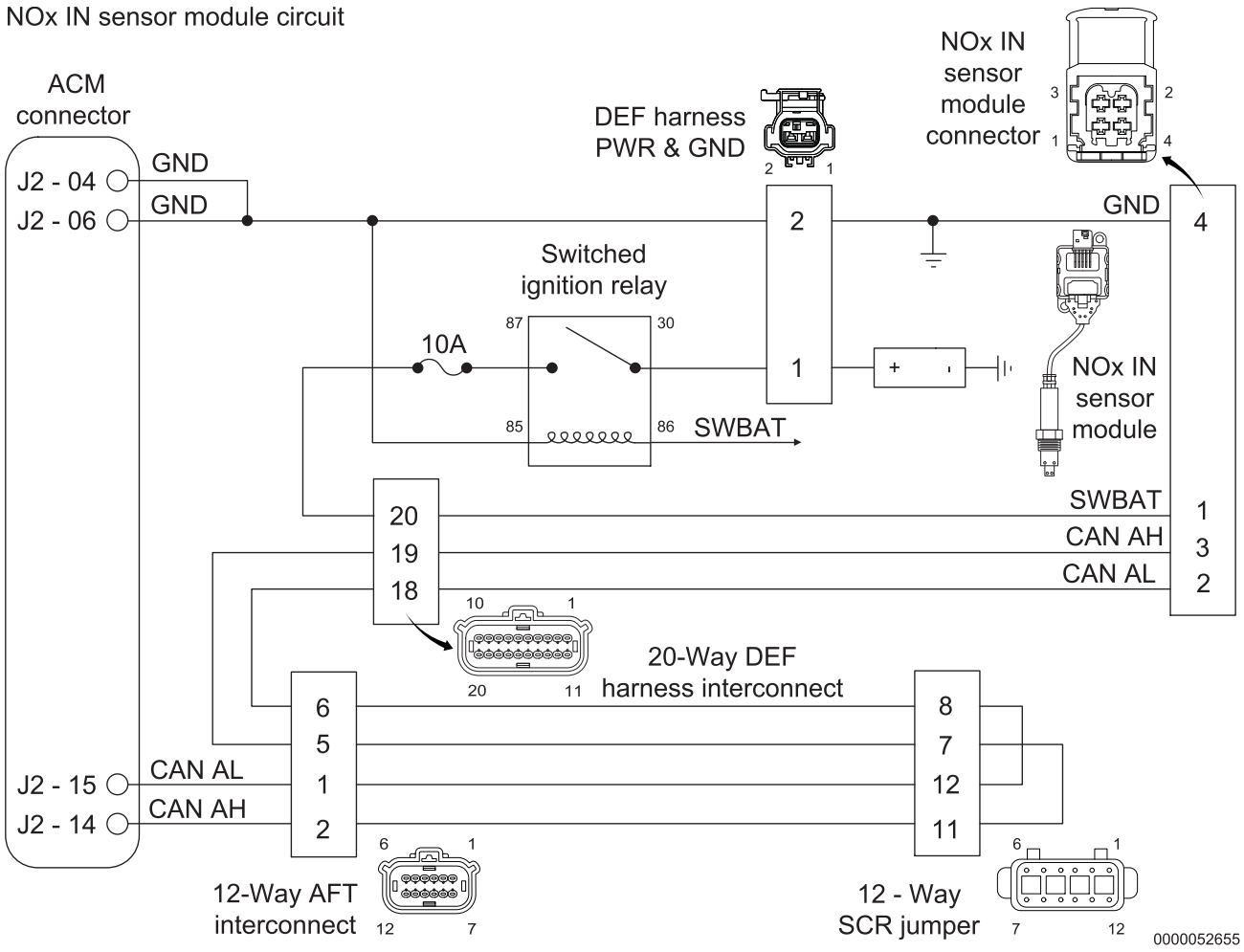

Figure 497 NOx IN Sensor Module Circuit Diagram

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness 18-648-01, leave sensor disconnected. Turn ignition switch to ON. Used DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN or short to GND.
2 to GND	1 V to 4 V	The sum of 2 to GND and 3 to GND should = 4 V to 5 V.
3 to GND	1 V to 4 V	The sum of 2 to GND and 3 to GND should = 4 V to 5 V.
4 to GND	0 V	If > 0 V, check for short to PWR.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect the 180-Pin Breakout Box and SCR (ACM) Breakout Harness 18–100–01 (58–Pin) to ACM. Leave ACM and NOx IN sensor module disconnected.

Test Point	Specification	Comment – < Less than, > Greater than
1 to Switched Ignition Relay pin 87	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to J2-15	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to J2-14	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to J2-04	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to J2-06	< 5 Ω	If > 5 Ω, check for OPEN in circuit.

SPN 3216 FMI 2 - Engine Out Nox Sensor Slow Response

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Loss of communication or invalid data from NOx IN sensor module.	Aftertreatment Control module (ACM) loses J1939 data link communications with NOx IN sensor module	Key ON Engine not cranking **NOTE:** Data link-related faults are inhibited for a calibratable amount of time following a Key ON event, a low battery voltage event, an engine cranking event, and a stop / suspend broadcast event. This is to allow reasonable time for data link devices to power up and begin periodic broadcasts before the ECM performs time-out diagnostics.	0.2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the Nitrogen Oxides (NOx) IN sensor module. Diesel exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be severely reduced.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN's 3216 FMI 19, 20, and 21.

Drive Cycle to Determine Fault Status

Drive Cycle 20 in 2013 HD-OBD Diagnostic Reference Manual.

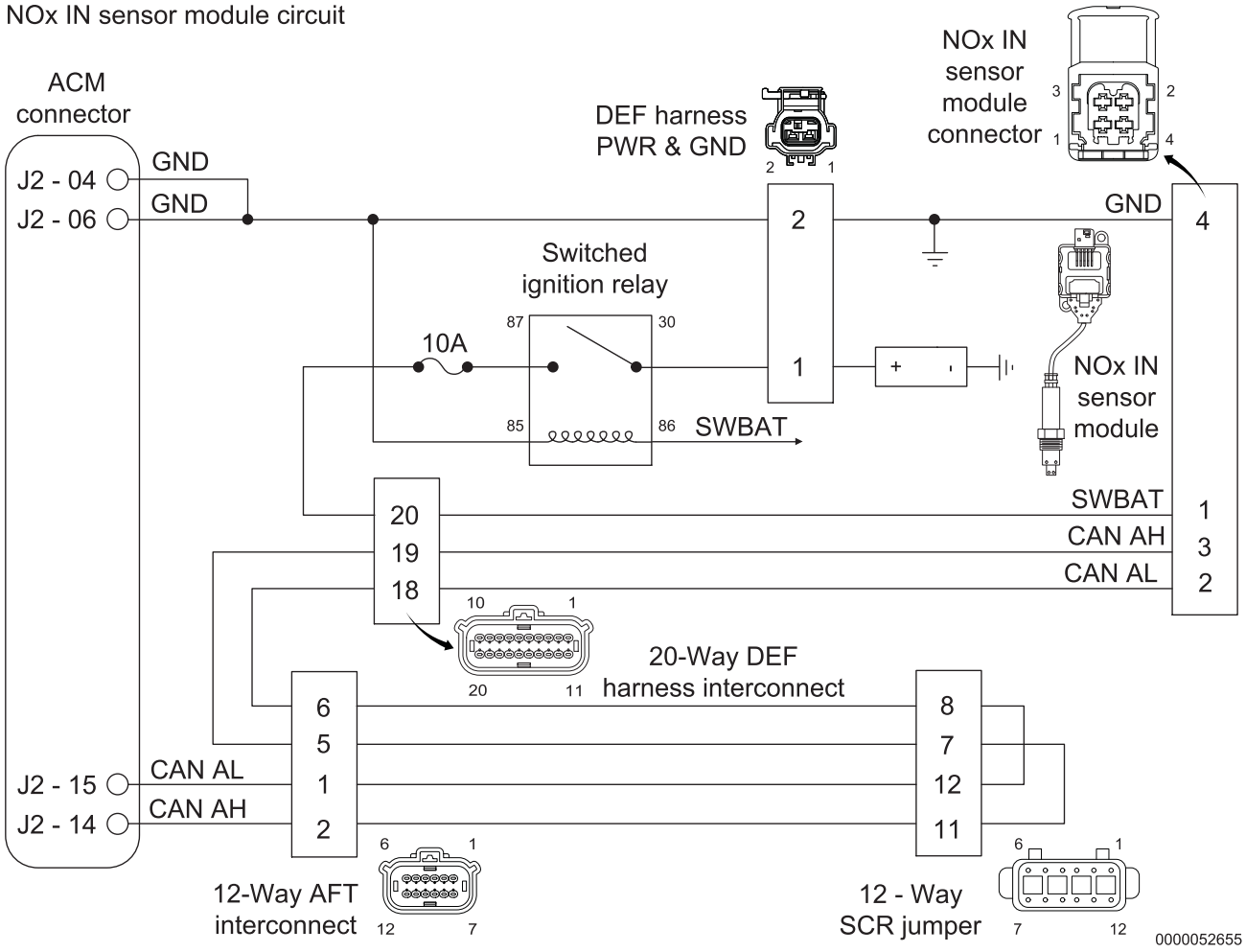

Figure 498 NOx IN Sensor Circuit Diagram

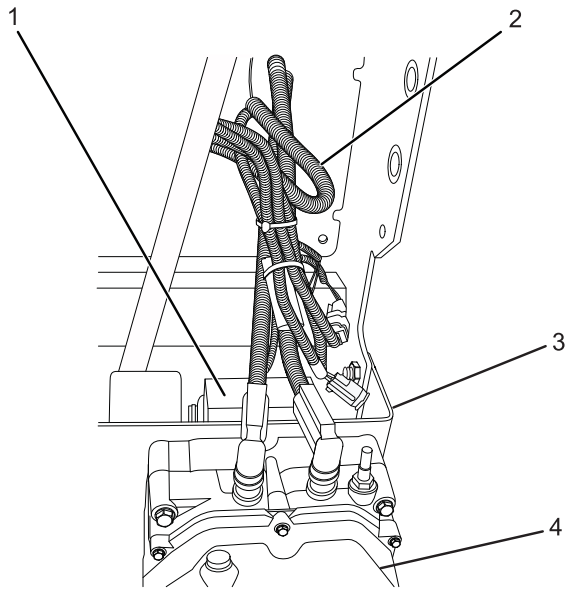

Figure 499 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 3216 FMI 2.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) IN sensor module. Key OFF, disconnect NOx IN sensor module. Check NOx IN sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3216 FMI 2.

Step	Action	Decision
3	Check for low battery voltage. Inspect battery connections and terminals. Are connections tight and corrosion free, and is battery voltage at least 10 volts?	Yes: Go to step 4.
		No: Clean battery terminals, tighten loose connections, and charge batteries as needed. After repairs are complete, retest for SPN 3216 FMI 2.

Step	Action	Decision
4	Check voltage to the NOx IN sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected to NOx IN sensor module, use a DMM to measure voltage between NOx IN sensor module pin-1 and pin-4.	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 2.
	Is voltage within 0.5 volts of battery voltage?	No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected to NOx IN sensor module , use a DMM to measure voltage between NOx IN sensor module pin-1 and a known good ground. Is voltage at pin-1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx IN sensor module pin 4 and ACM connector pins J2-4 and J2-6. After repairs are complete, retest for SPN 3216 FMI 2.
		No: Repair Open or short to ground between NOx IN sensor module connector pin 1 and ACM connector pins J2-3 and J2-5. After repairs are complete, retest for SPN 3216 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 4 - NOx IN Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NOx IN sensor module voltage below normal or shorted to low source.	The percentage of time spent in heating mode, as opposed to automatic mode, is > 5 % or the number of transitions from automatic mode to one of the heating states is > than 5 Counts	Inactive: SPN 3216 FMI 19 and SPN 3218 FMI 2. Time after the sensor has reached working temperature and has entered automatic mode > 30 seconds Exhaust gas velocity < 60 m/sec DOC inlet temperature < 1472°F (800°C) Exhaust gas temperature is above a threshold representing the point there is no longer a concern of condensation on the NOx IN sensor module element. NOx IN sensor module battery supply voltage is ≥ 11.4 volts and ≤ 16.5 volts for more than 0.2 seconds.	60 seconds

Fault Overview

Fault code sets when an internal circuit error is detected in the Nitrogen Oxides (NOx) IN sensor module. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque is severely reduced.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3216 FMI 19 and SPN 3218 FMI 2.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

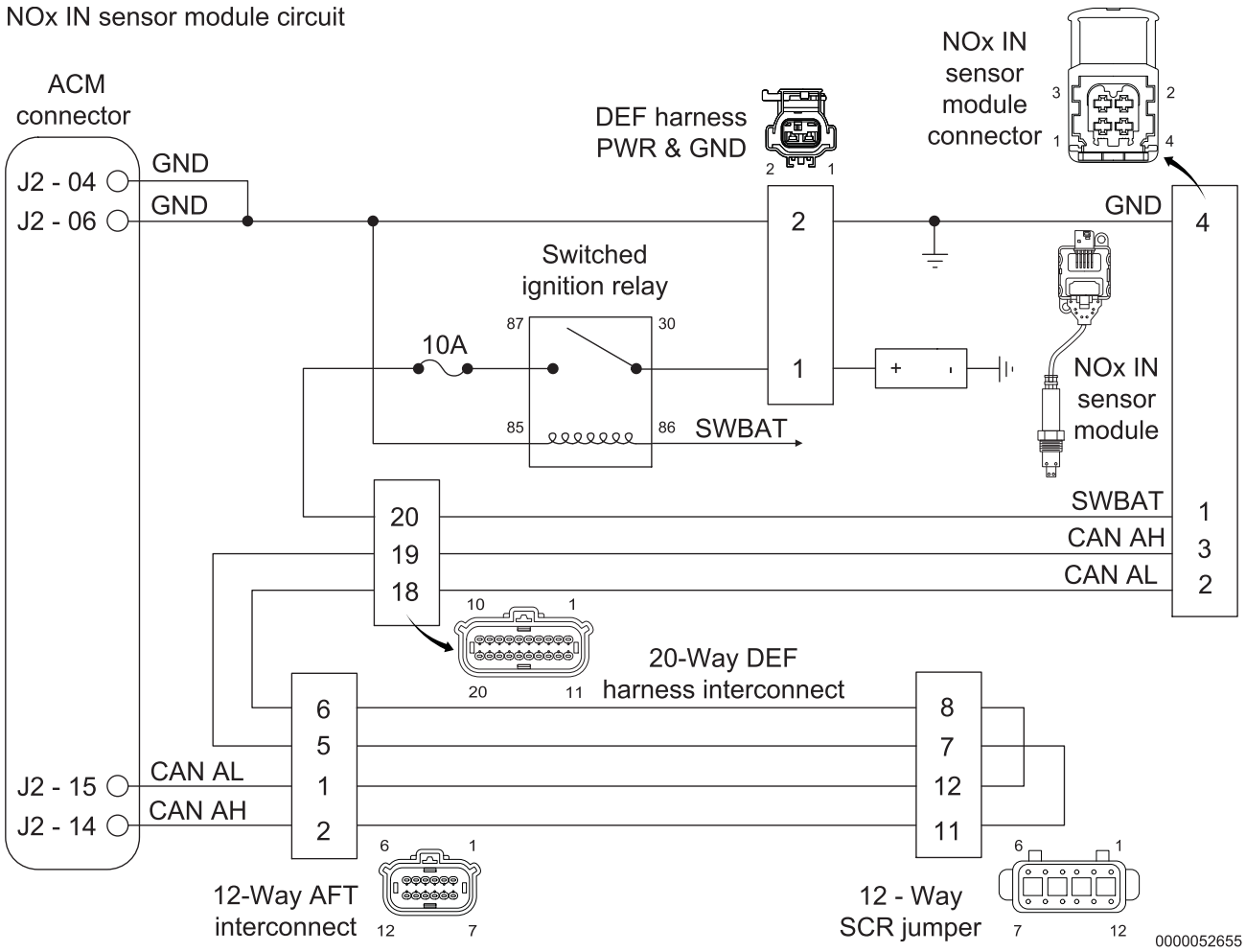

Figure 500 NOx IN Sensor Circuit Diagram

Step	Action	Decision
1	Inspect connections at Nitrogen Oxides (NOx) IN sensor module. Key OFF, disconnect NOx IN sensor module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3216 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 10 - NOx IN Abnormal Rate of Change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NOx IN sensor module reading is not valid.	Percent of time > 50 % when NOx IN sensor module reading is not valid (NOx fault).	Inactive: SPN 3216 FMI 4, SPN 3216 FMI 9, and SPN 3218 FMI 2. Exhaust pipe status pressure must be Data Valid Exhaust pressure change rate < 0 kPa/s Exhaust pipe status mass flow rate must be Data Valid Exhaust mass flow change rate < 0 (g/s^2)	300 seconds

Fault Overview

Fault code sets when the Nitrogen Oxides (NOx) IN sensor module reading is invalid.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3216 FMI 4, 19, and SPN 3218 FMI 2.

Drive Cycle to Determine Fault Status

Drive Cycle 20 in 2013 HD-OBD Diagnostic Reference Manual.

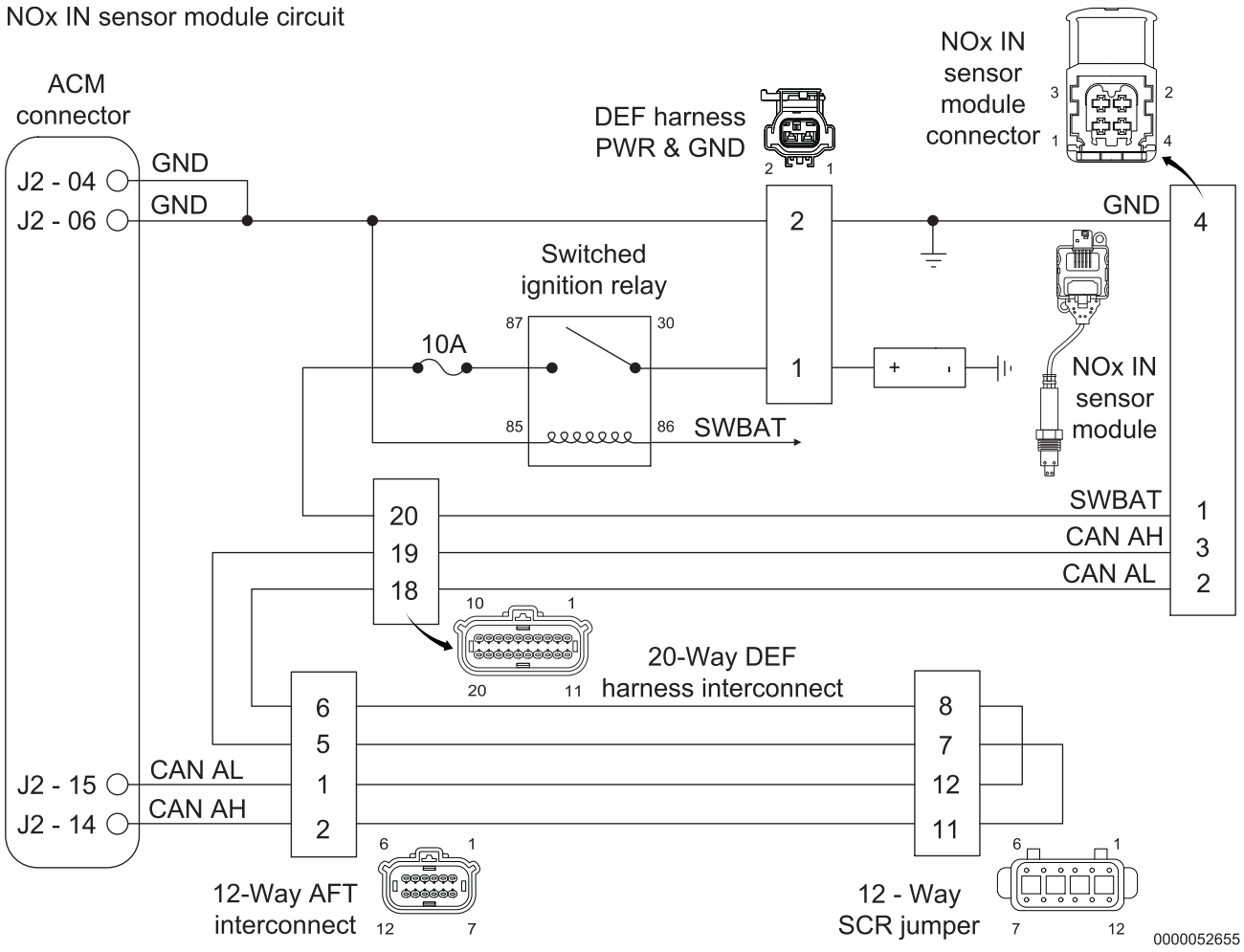

Figure 501 NOx IN Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 FMI 4, 19, and SPN 3218 FMI 2. Is SPN 3216 FMI 10 the only fault code active?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 10.
		No: Repair other fault code(s). After repairs are complete, retest for SPN 3216 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 13- NOx IN Out of Calibration

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Calibration mismatch between NOx IN sensor module and Aftertreatment Control Module (ACM)	Rated NOx Sensor voltage does not match nominal system voltage of 0 Volts	Key ON	0.2 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects a mismatch between the engine's electrical system voltage and the Nitrogen Oxides (NOx) IN sensor module voltage rating.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

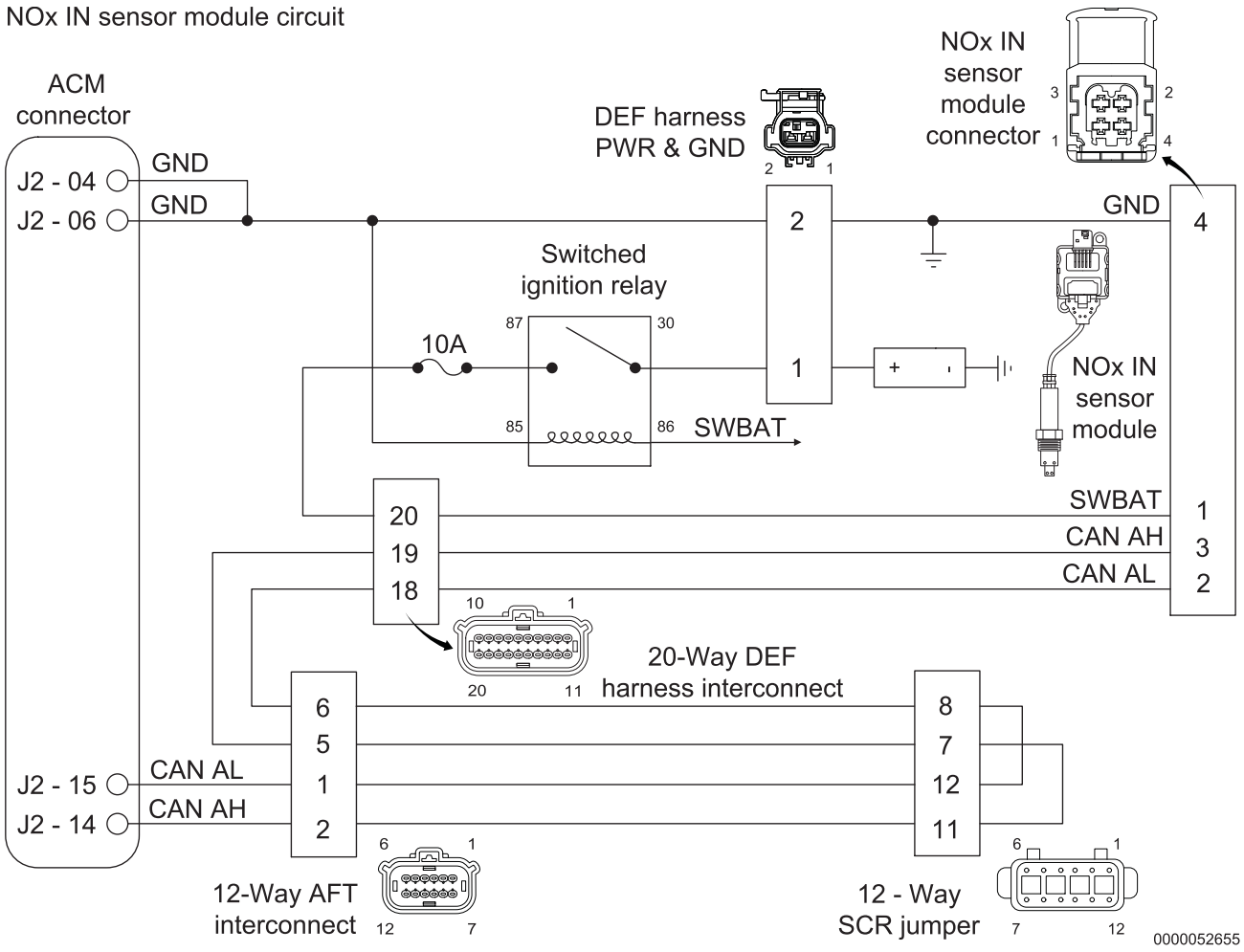

Figure 502 NOx IN Sensor Circuit Diagram

Step	Action	Decision
1	Is SPN 3216 FMI 13 the only fault code active?	Yes: Install correct NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 13.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 19 - NOx IN Not Detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Loss of communication or invalid data from NOx IN sensor module.	ACM loses J1939 data link communications with NOx IN sensor module	Key ON Engine not cranking **NOTE:** Data link-related faults are inhibited for a calibratable amount of time following a key-On event, a low battery voltage event, an engine cranking event, and a stop / suspend broadcast event. This is to allow reasonable time for data link devices to power up and begin periodic broadcasts before the ECM performs time-out diagnostics.	0.2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the Nitrogen Oxides (NOx) IN sensor module. Diesel exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be severely reduced.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN's 3216 FMI 2, 20, and 21.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

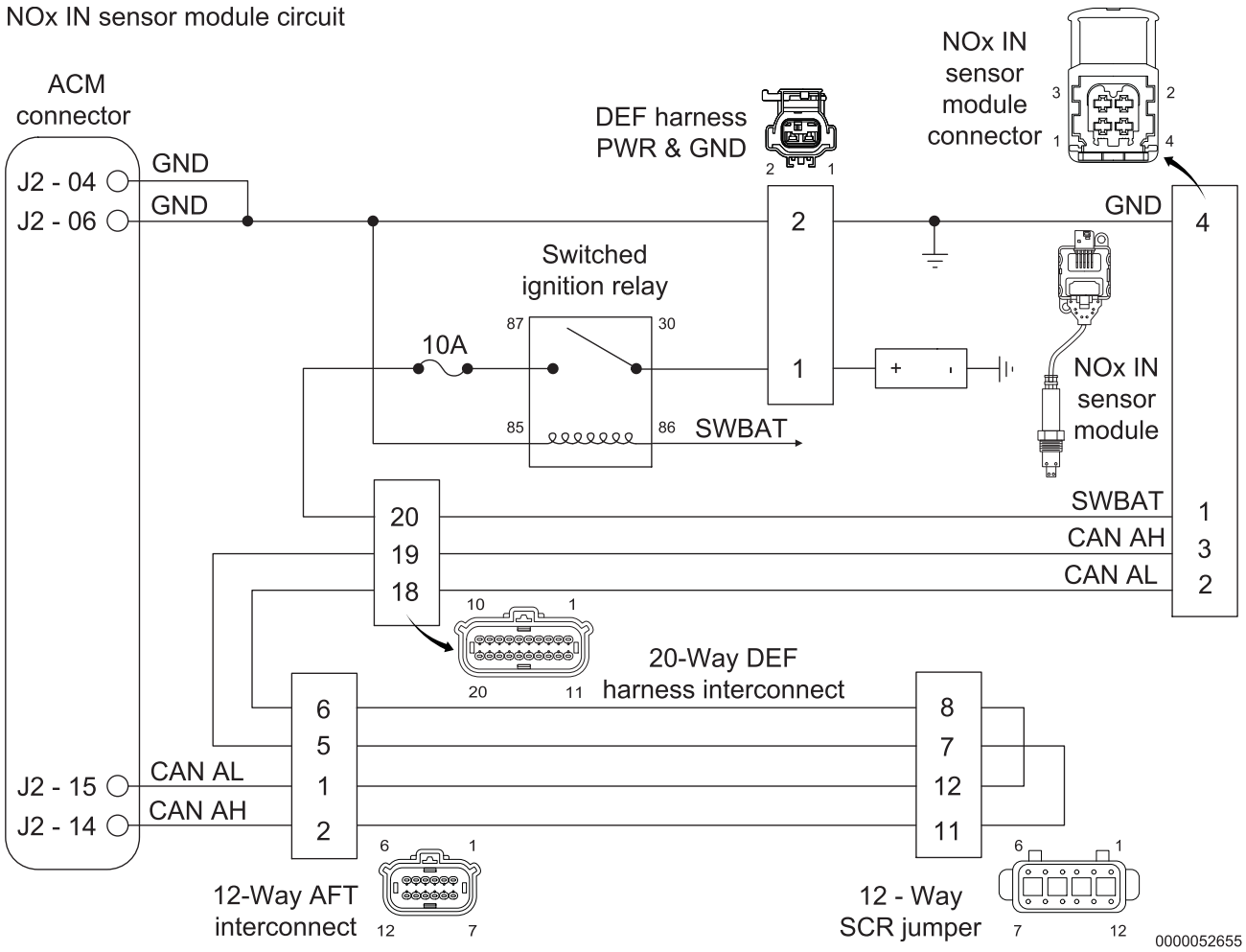

Figure 503 NOx IN Sensor Circuit Diagram

Possible Causes

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed Nitrogen Oxides (NOx) IN sensor module

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits: DOC / DPF temperature sensor module, SCR temperature sensor module, Ammonia Sensor Module, NOx OUT sensor module, NOx IN sensor module, and DEFTLT sensor module.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Inspect connections at Nitrogen Oxides (NOx) IN sensor module. Key OFF, disconnect NOx IN sensor module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
2	Check voltage to the NOx IN sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between NOx IN sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between NOx IN sensor module pin-1 and a known good ground. Is voltage at pin-1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx IN sensor module pin-4 and ground. After repairs are complete, retest for SPN 3216 FMI 19. No: Repair Open or short to ground between NOx IN sensor module connector pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between NOx IN sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between NOx IN sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between NOx IN sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between NOx IN sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between NOx IN sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 3216 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-648-01 connected between NOx IN sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 19. No: Repair short between NOx IN sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 3216 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 20 - NOx IN Signal Drifted HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Control Module (ACM) determines Nitrogen Oxides (NOx) IN sensor module signal drifted HIGH.	When idle conditions are detected, compare NOx (ppm) from NOx sensor to NOx model (> 2500 ppm and < 3500 ppm).	Engine speed < 3000 rpm Key ON Battery voltage > 10.7 volts Battery voltage < 15 volts Ambient Temp > -40°F (-40°C) and < 302°F (150°C) Ambient Pressure > 0 psi (0 kPa) and < 87 psi (600 kPa) Engine Coolant Temperature > -40°F (-40°C) and < 302°F (150°C)	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) determines the signal from the Nitrogen Oxides (NOx) sensor is high compared to it's modeled value for conditions. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be severely reduced. Vehicle speed will be limited if code is active for an extended period of time.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 3216 FMI 4, 19, and SPN 3218 FMI 2.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

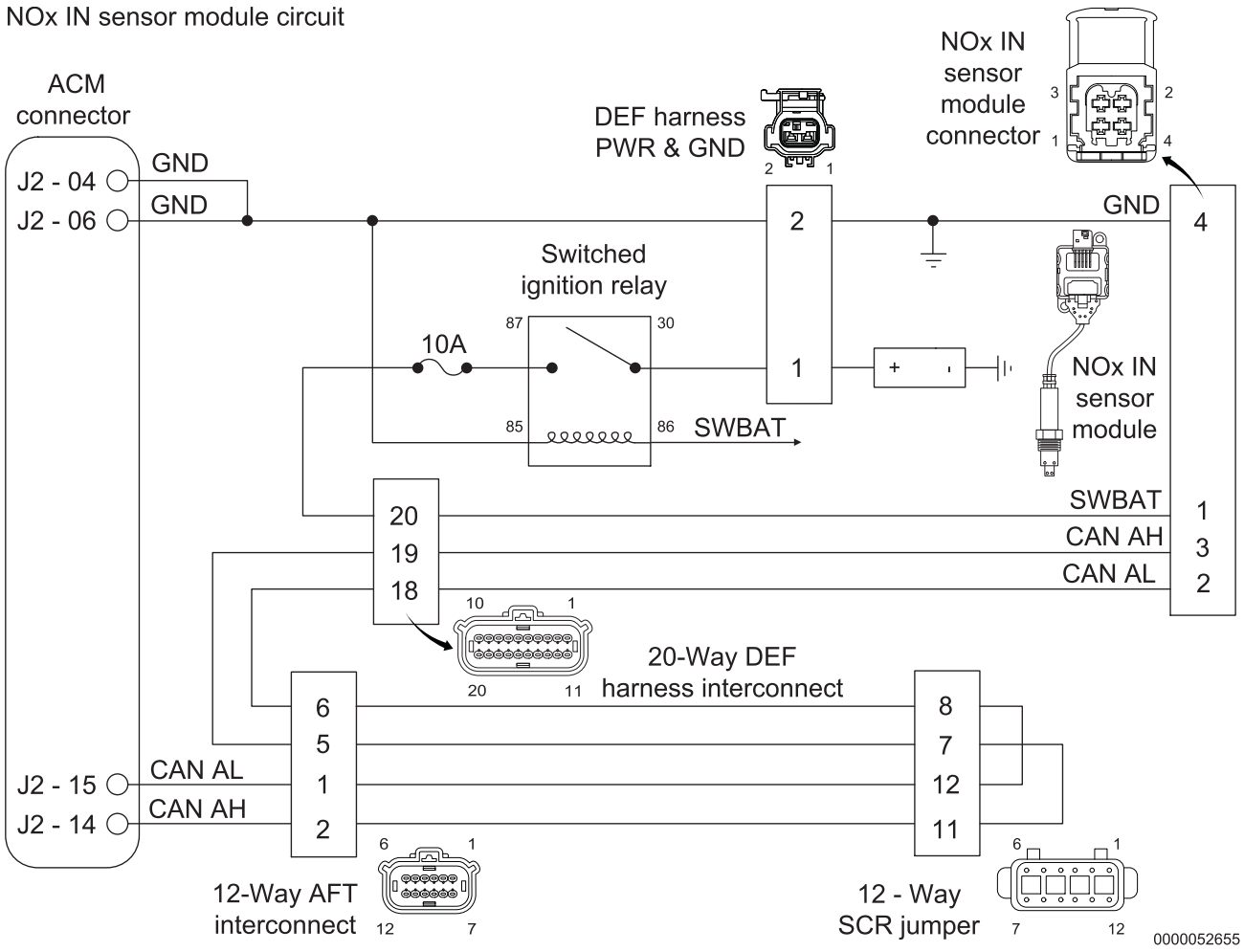

Figure 504 NOx IN Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 FMI 4, 19, and SPN 3218 FMI 2. Is SPN 3216 FMI 20 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 3216 FMI 20.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) IN sensor module . Key OFF, disconnect NOx IN sensor module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 20. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3216 FMI 20.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 20 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3216 FMI 21 - NOx IN Signal Drifted LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Control Module (ACM) determines Nitrogen Oxides (NOx) IN sensor module signal drifted LOW.	When steady-state conditions are detected, compare NOx (ppm) from NOx sensor to NOx model (> -500 ppm and < -50 ppm).	Key ON Engine speed < 3000 rpm Ambient Temp between -40°F (-40°C) and 302°F (150°C) Ambient Pressure between 0 psi (0 kPa) and 87 psi (600 kPa) Engine Coolant Temperature between -40°F (-40°C) and 302°F (150°C)	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) determines the signal from the Nitrogen Oxides (NOx) sensor is low compared to it's modeled value for conditions. Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be severely reduced. Vehicle speed will be limited if code is active for an extended period of time.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 3216 FMI 4, 19, and SPN 3218 FMI 2.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

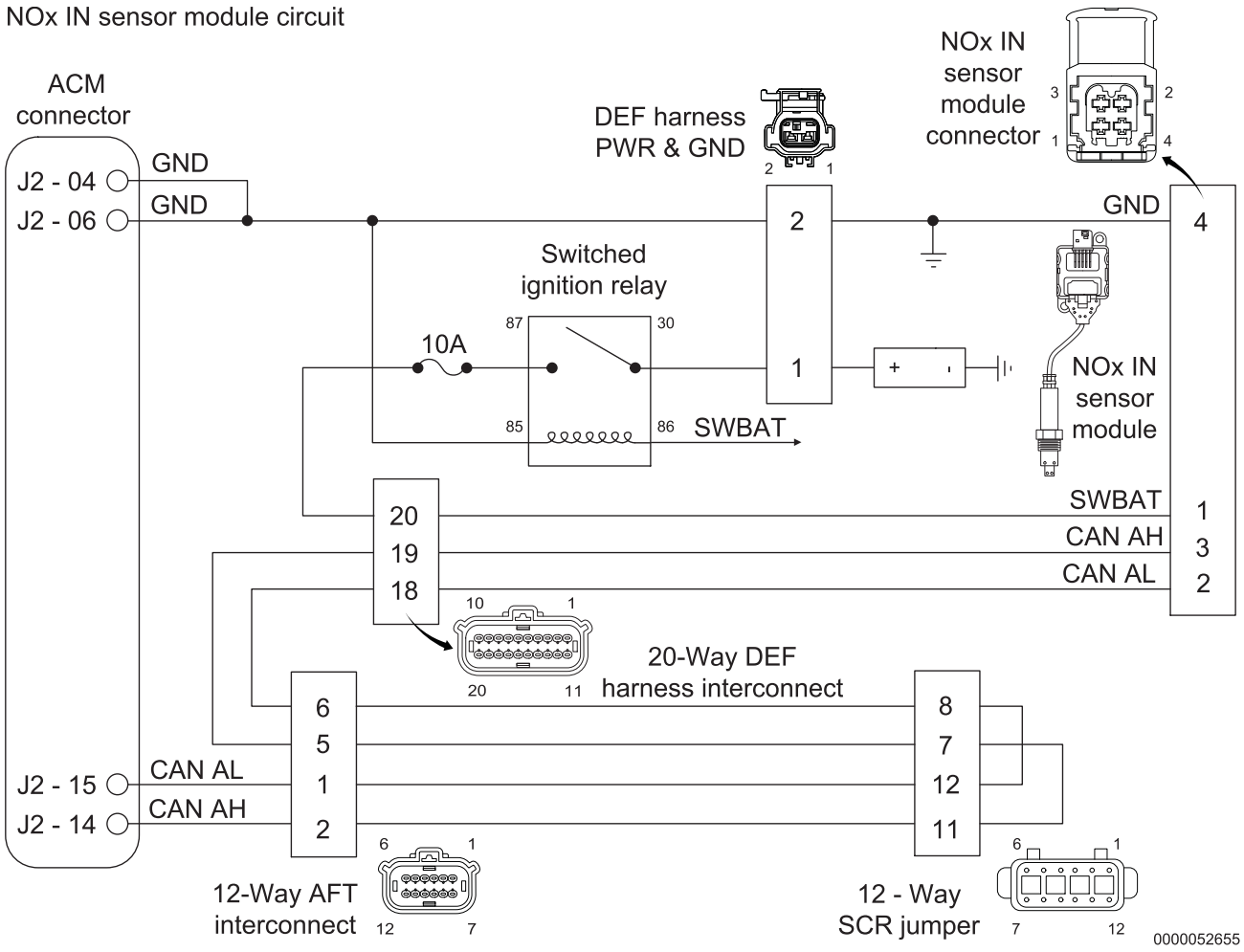

Figure 505 NOx IN Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 FMI 4, 19, and SPN 3218 FMI 2. Is SPN 3216 FMI 21 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 3216 FMI 21.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) IN sensor module. Key OFF, disconnect NOx IN sensor module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3216 FMI 21. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3216 FMI 21.

NOTE: After performing all diagnostic steps, if SPN 3216 FMI 21 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3218 FMI 2 - NOx IN Power Supply Signal Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The NOx IN sensor module circuitry has detected that its battery supply voltage is outside the desired range.	NOx IN sensor module supply voltage > 16.5 V for 10 seconds NOx IN sensor module supply voltage < 11.4 V for 10 seconds	160 seconds after Exhaust gas temperature is above a threshold representing the point there is no condensation on the NOx IN sensor module element. 100 seconds after the NOx sensor has reached it's operating temperature. SPN 3216 FMI 9 inactive	10 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects the power supply to the Nitrogen Oxides (NO IN) sensor is above or below a calibratable threshold.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 20 in 2013 HD-OBD Diagnostic Reference Manual.

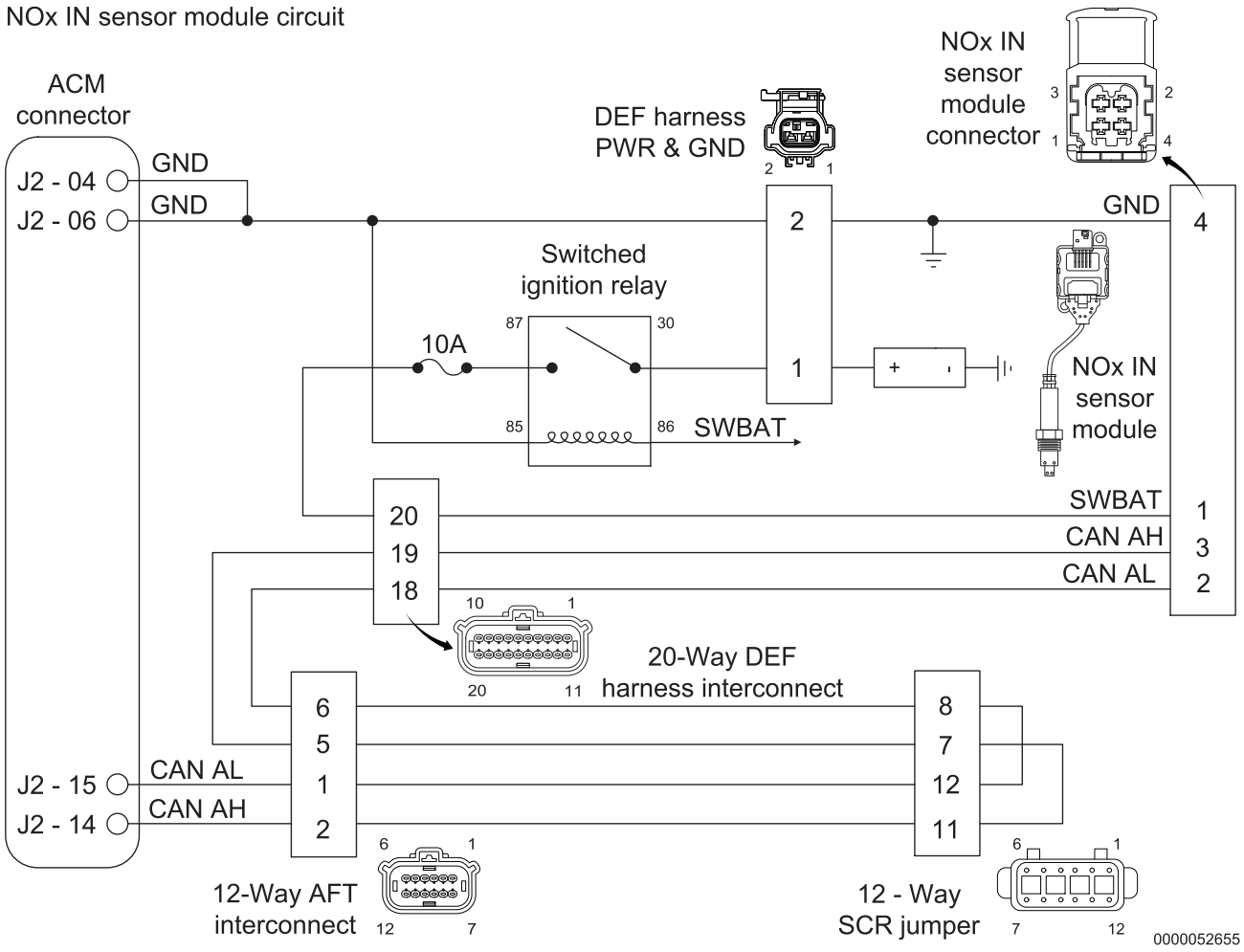

Figure 506 NOx IN Sensor Circuit Diagram

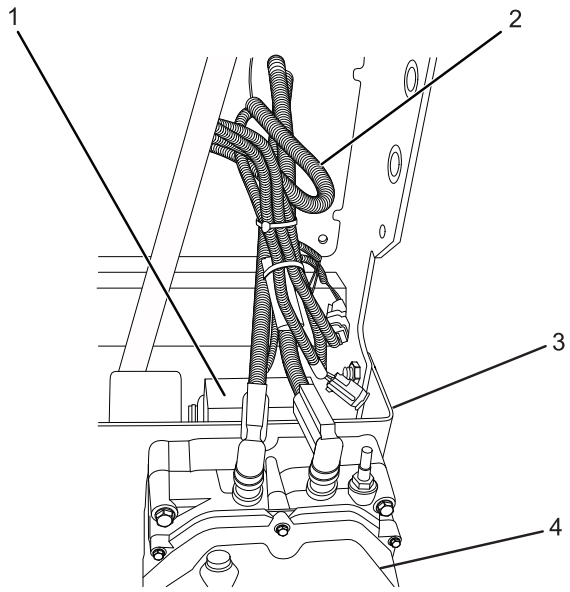

Figure 507 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
1	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 2.
		No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 3218 FMI 2.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) IN sensor module. Key OFF, disconnect NOx module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3218 FMI 2.

Step	Action	Decision
3	Check for low battery voltage. Inspect battery connections and terminals. Are connections tight and corrosion free, and is battery voltage at least 10 volts?	Yes: Go to step 4. No: Clean battery terminals, tighten loose connections, and charge batteries as needed. After repairs are complete, retest for SPN 3218 FMI 2.

Step	Action	Decision
4	Check voltage to the NOx IN sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected to NOx IN sensor module, use a DMM to measure voltage between NOx IN sensor module pin–1 and pin–4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 6. No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected to NOx IN sensor module, use a DMM to measure voltage between NOx IN sensor module pin–1 and a known good ground. Is voltage at pin–1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx IN sensor module pin 4 and ACM connector J2 pins 4 and 6. After repairs are complete, retest for SPN 3218 FMI 2. No: Repair Open or short to ground between NOx IN sensor module connector pin 1 and ACM connector J2 pins 3 and 5. After repairs are complete, retest for SPN 3218 FMI 2.

Step	Action	Decision
6	Check for incorrect NOx IN sensor module installed. Is the correct NOx IN sensor module installed?	Yes: Replace NOx IN sensor module. After repairs are complete, retest for SPN 3218 FMI 2. No: Install correct NOx IN sensor module. After repairs are complete, retest for SPN 3218 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 3218 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5024 FMI 10 - NOx IN Sensor Heater Abnormal Rate of Change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The NOx IN sensor heater is unable to maintain its operating temperature.	NOx IN sensor heater temperature does not match Aftertreatment Control Module (ACM) predetermined values.	Diesel Oxidation Catalyst Inlet Temperature (DOCIT) > 302°F (150°C) for 5 seconds	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Nitrogen Oxides (NOx) IN sensor heater was unable to maintain its normal operating temperature.

Lamp Reaction

When fault is active, MIL will not illuminate.

Associated Faults

SPN 3216 FMI 4 and 9 (NOx IN), SPN 3218 FMI 2 (NOx IN), and SPN 4765 FMI 2, 3, and 4 (DOCIT).

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

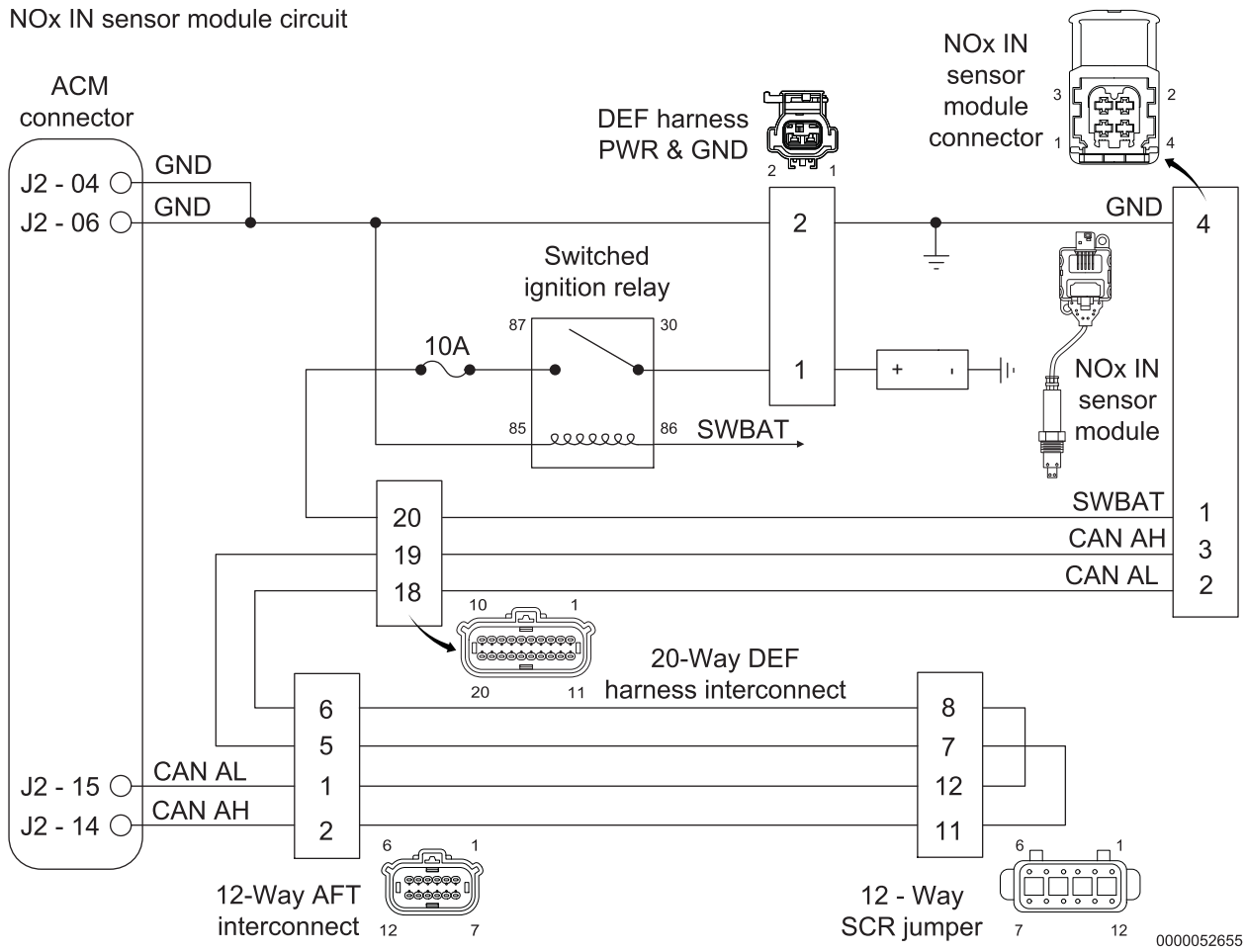

Figure 508 NOx IN Sensor Circuit Diagram

Possible Causes

- Failed NOx IN sensor module
- GND circuit Open or high resistance
- SWBAT circuit Open or high resistance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 FMI 4 and 9 (NOx IN); SPN 3218 FMI 2 (NOx IN); SPN 4765 FMI 2, 3, and 4 (DOCIT). Is EST DTC list free of SPN 3216 FMI 4 and 9; SPN 3218 FMI 2; and SPN 4765 FMI 2, 3, and 4?	Yes: Go to step 2. No: Repair SPN 3216 FMI 4 and 9; SPN 3218 FMI 2; and SPN 4765 FMI 2, 3, and 4. After repairs are complete, retest for SPN 5024 FMI 10.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) IN sensor. Key OFF, disconnect NOx IN sensor. Check NOx IN sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx IN sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5024 FMI 10.

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or switched ignition relay problem. The following components share power and ground circuits with the NOx IN sensor module:

- DOC / DPF temperature sensor module
- NOx OUT sensor module
- Ammonia (NH_3) sensor module
- NOx IN sensor module
- DEFTLT sensor module

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Check voltage to the NOx IN sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected to NOx IN sensor module, use a DMM to measure voltage between Breakout Harness 18-648-01 pin-1 and pin-4. Is voltage less than 0.5 volts of battery voltage?	Yes: Go to step 4. No: Replace NOx IN sensor module. After repairs are complete, retest for SPN 5024 FMI 10.

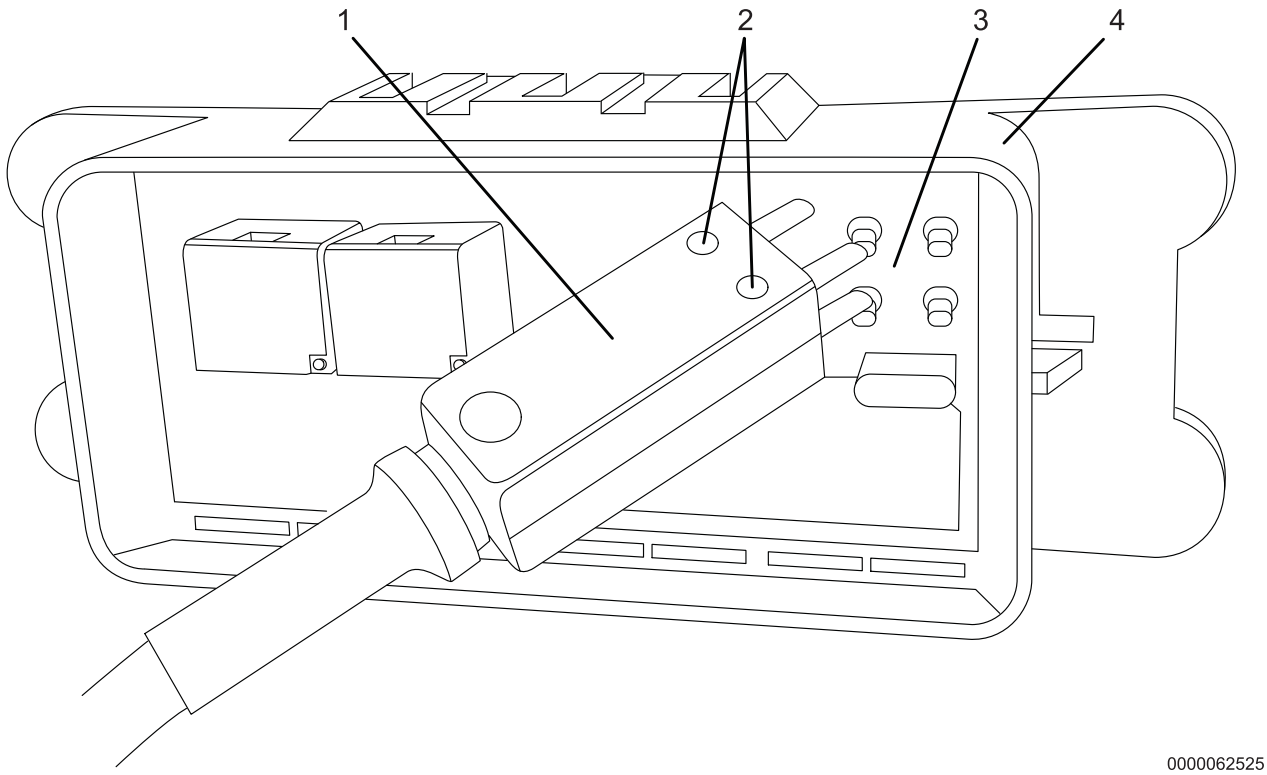

Figure 509 Installation of Breakout Harness ZTSE4908 (typical)

1. Breakout Harness ZTSE4908
2. Relay socket

CAUTION: For correct diagnosis, Breakout Harness ZTSE4908 MUST be installed with the dimples toward the top of the PDM, as shown. Reversed installation WILL result in incorrect measurements.

Step	Action	Decision
4	Check SWBAT circuit for Open or high resistance. Connect Breakout Harness 18-648-01 to NOx IN sensor module and leave disconnected. Connect Breakout Harness ZTSE4908 to switched ignition relay and leave disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness 18-648-01 pin-1 and Breakout Harness ZTSE4908 pin-87. Is resistance less than 5 ohms?	Yes: Repair Open or high resistance between NOx IN sensor module pin-4 and ground. After repairs are complete, retest for SPN 5024 FMI 10. No: Repair Open or high resistance between NOx IN sensor module pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5024 FMI 10.

NOTE: After performing all diagnostic steps, if SPN 5024 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

NOx (Nitrogen Oxides) OUT Sensor Module

Overview of NOx OUT Sensor Module Group

SPN	FMI	Condition	Possible Causes	Actions
3226	2	NOx OUT signal erratic, intermittent or incorrect	• Failed Nitrogen Oxides (NOx) OUT sensor module • SWBAT circuit intermittent short to GND or Open • Power Distribution Module (PDM) loose fuse or relay • GND circuit Open or high resistance	Step-Based Diagnostics (page 1273)
3226	4	NOx OUT signal Out of Range LOW	• Failed NOx OUT sensor module	Step-Based Diagnostics (page 1276)
3226	10	NOx OUT signal abnormal rate of change	• Failed NOx OUT sensor module	Step-Based Diagnostics (page 1278)
3226	13	NOx OUT Out of Calibration	• Incorrect NOx OUT sensor module installed	Step-Based Diagnostics (page 1279)
3226	19	NOx OUT not detected on J1939	• SWBAT circuit short to GND or Open • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power • CAN-AL circuit short to power • GND circuit Open or high resistance • CAN-AH short to CAN-AL • Failed Nitrogen Oxides (NOx) OUT sensor module	Step-Based Diagnostics (page 1281)

3226	20	NOx OUT signal drifted HIGH	• Failed NOx OUT sensor module • Diesel Exhaust Fluid (DEF) crystallization or deposits • Improperly installed NOx OUT sensor	Step-Based Diagnostics (page 1285)
3226	21	NOx OUT signal drifted LOW	• Failed NOx OUT sensor module • Improperly installed NOx OUT sensor	Step-Based Diagnostics (page 1287)
3228	2	NOx OUT power supply signal erratic, intermittent or incorrect	• Failed NOx OUT sensor module • SWBAT circuit intermittent short to GND or Open • GND circuit Open or high resistance • Power Distribution Module (PDM) loose fuse or relay • Low battery voltage • Incorrect NOx OUT sensor module installed	Step-Based Diagnostics (page 1289)
5031	10	NOx OUT Sensor Heater not reading correctly	• Failed NOx OUT sensor module • GND circuit Open or high resistance • SWBAT circuit Open or high resistance	Step-Based Diagnostics(page 1293)

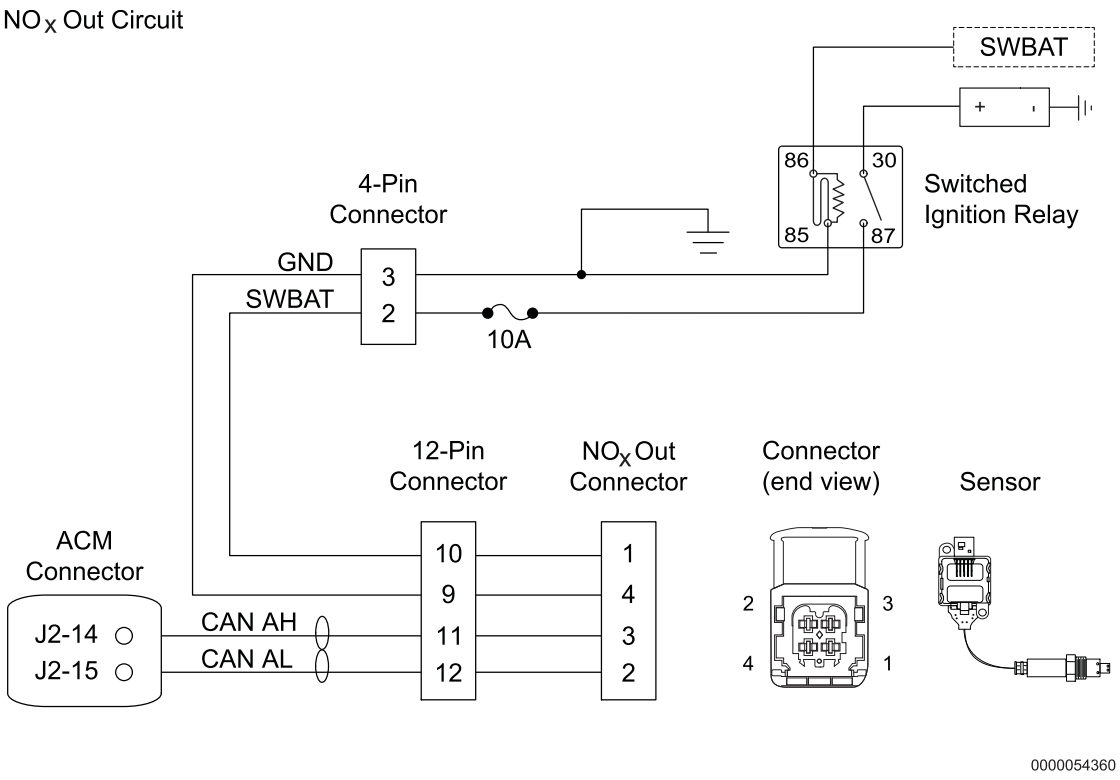

Figure 510 NOx OUT Sensor Circuit Diagram

Overview

The Nitrogen Oxides (NOx) OUT sensor module is a smart device used to measure the NOx emissions at the outlet of the Selective Catalyst Reduction (SCR) Catalyst. The NOx OUT sensor module performs internal diagnostics and reports malfunctions back to the Aftertreatment Control Module (ACM) using the J1939 data link. The NOx OUT sensor is permanently attached to the NOx control module. They are serviced as a single component and can not be replaced individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- SCR (ACM) Breakout Harness 18-537-01 (58-Pin)
- Breakout Harness 18-649-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

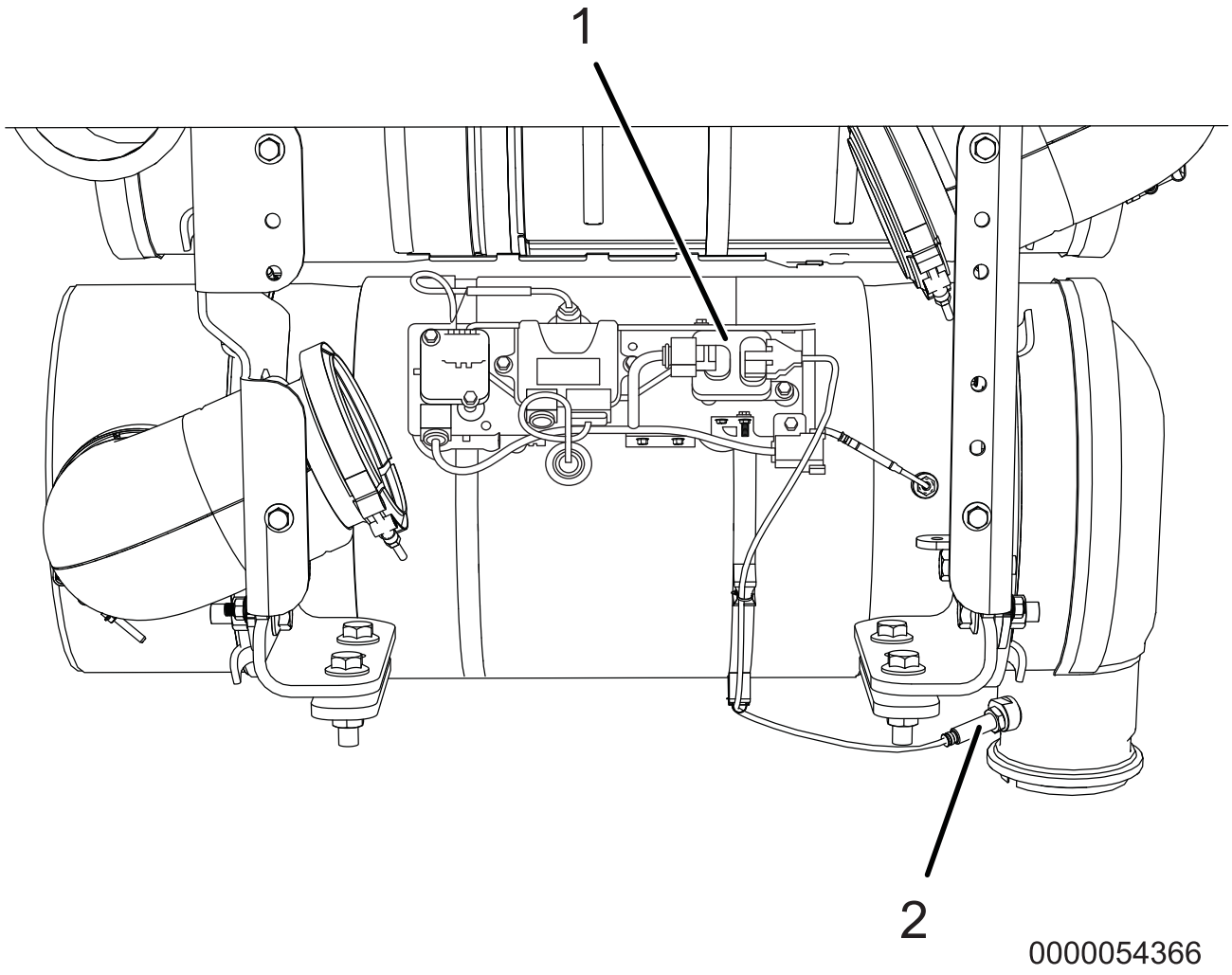

Figure 511 NOx OUT Sensor Module Location

1. Nitrogen Oxides (NOx) OUT Sensor Module
2. NOx OUT Sensor

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness 18-649-01, leave NOx OUT sensor module disconnected. Turn ignition switch to ON. Use a DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN or short to GND.
2 to GND	1 V to 4 V	The sum of 2 to GND and 3 to GND should = 4 V to 5 V.
3 to GND	1 V to 4 V	The sum of 2 to GND and 3 to GND should = 4 V to 5 V.
4 to GND	0 V	If > 0 V, check for short to PWR.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect the 180-Pin Breakout Box and SCR (ACM) Breakout Harness 18–100–01 (58–Pin) to ACM. Leave ACM and NOx OUT sensor module disconnected.

Test Point	Specification	Comment – < Less than, > Greater than
1 to Switched Ignition Relay pin 87	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to J2-15	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to J2-14	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to J2-04	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to J2-06	< 5 Ω	If > 5 Ω, check for OPEN in circuit.

SPN 3226 FMI 2 - NOx OUT Signal Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Control Module (ACM) has detected that the Nitrogen Oxides (NOx) OUT sensor module output is in range, but not varying as expected.	The difference between the maximum and minimum NOx OUT sensor module output < 10 ppm during 3 valid monitoring events	SCR-inlet NOx flow rate> 0.2 g/sec Rate of change of SCR-inlet NOx flow rate > 0.1 g/sec Exhaust mass flow rate > 150 g/sec NOx OUT sensor module reading is valid, no active faults detected by the sensor, the sensor's battery supply voltage is within the desired range, and dew point temperature has been met for a sufficient time to allow the sensor to light off. None of the Abort Conditions are satisfied Inactive: SPN 3226 FMI 4, 10, and 13; SPN 3228 FMI 2; SPN 3242 FMI 2, 3, and 4; SPN 4765 FMI 2, 3, and 4; SPN 5031 FMI 10; SPN 5742 FMI 3, 4, 11, and 12.	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Nitrogen Oxides (NOx) OUT sensor module is not reading zero, or is not changing with engine conditions.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN’s 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 21 in 2013 HD-OBD Diagnostic Reference Manual.

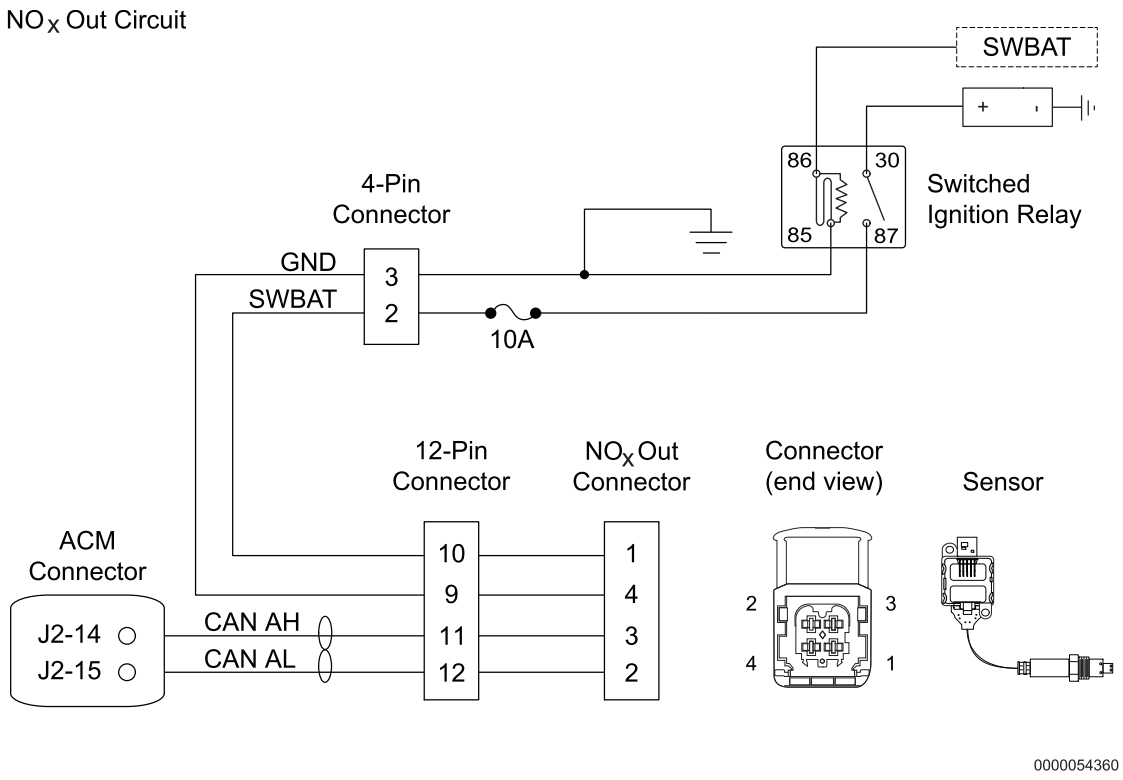

Figure 512 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT).	Yes: Go to step 2.
		No: Repair SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10. After repairs are

	Is EST DTC list free of SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10?	complete, retest for SPN 3226 FMI 2.

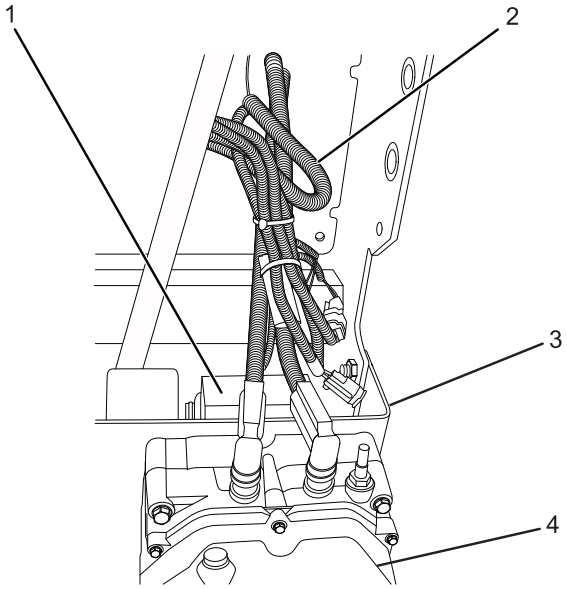

Figure 513 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
2	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 3. No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 3226 FMI 2.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Inspect connections at Nitrogen Oxides (NOx) OUT sensor module. Key OFF, disconnect NOx OUT sensor module. Check NOx OUT sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx OUT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3226 FMI 2.

Step	Action	Decision
4	Check voltage to the NOx OUT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-649-01 connected to NOx OUT sensor module, use a DMM to measure voltage between NOx OUT sensor module pin-1 and pin-4.	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 2.
	Is voltage within 0.5 volts of battery voltage?	No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-649-01 connected to NOx OUT sensor module , use a DMM to measure voltage between NOx OUT sensor module pin-1 and a known good ground.	Yes: Repair Open or high resistance between NOx OUT sensor module pin-4 and ACM connector J2-04 and J2-06. After repairs are complete, retest for SPN 3226 FMI 2.
	Is voltage at pin-1 within 0.5 volts of battery voltage?	No: Repair Open or short to ground between NOx OUT sensor module connector pin-1 and ACM connector J2-03 and J2-05. After repairs are complete, retest for SPN 3226 FMI 2.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 4 - NOx OUT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NOx OUT sensor module voltage below normal or shorted to low source.	Failed NOx OUT sensor module	Processing of fail messages from the sensor enabled 160 seconds after dew point reached. Dew point is defined as: Exhaust gas temperature is above a threshold representing the point at which there is no longer a concern of condensation on the NOx OUT sensor element.	10 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects an internal circuit error in the Nitrogen Oxides (NOx) OUT sensor module. Engine torque will be reduced if the engine is operated for a limited period of time with the fault code active. Engine torque will be severely reduced and vehicle speed will be limited after extended engine operation with the fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3228 FMI 2 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

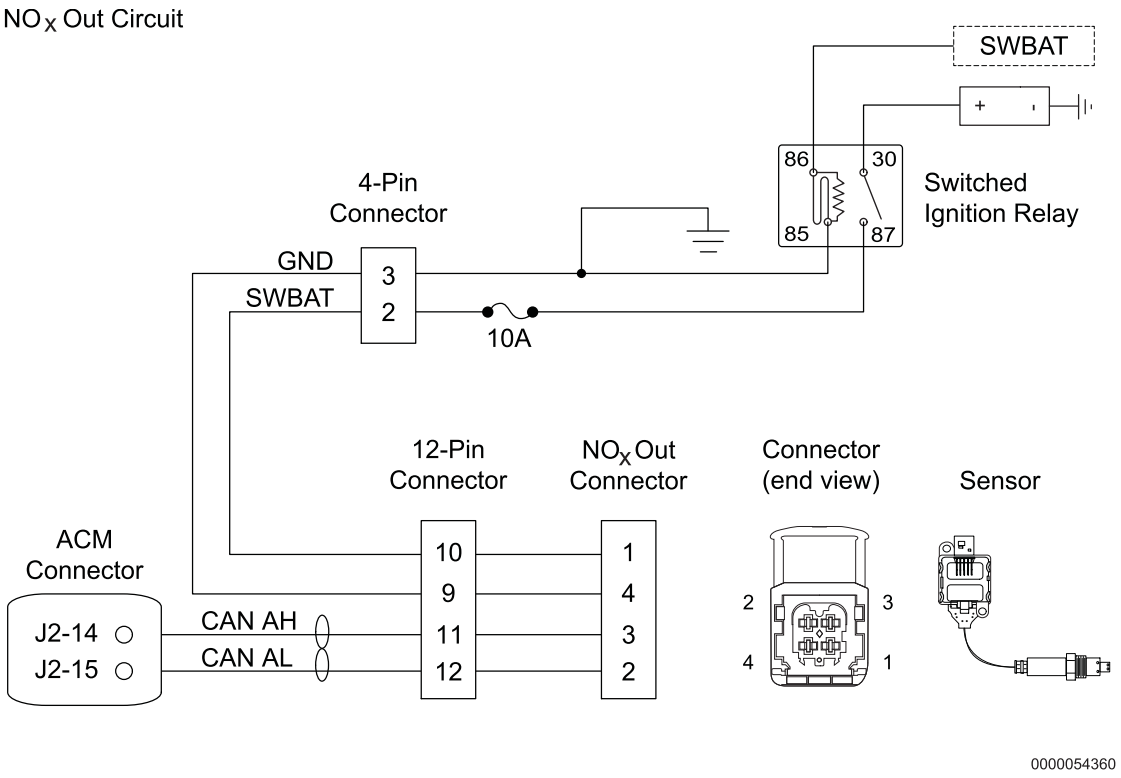

Figure 514 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3228 FMI 2 (NOx OUT). Is EST DTC list free of SPN 3228 FMI 2?	Yes: Go to step 2. No: Repair SPN 3228 FMI 2. After repairs are complete, retest for SPN 3226 FMI 4.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) OUT sensor module. Key OFF, disconnect NOx OUT sensor module. Check NOx OUT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx OUT sensor module connector, harness, and terminals clean and undamaged?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3226 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 10 - NOx OUT Abnormal Rate of Change

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NOx OUT sensor reading is not valid.	Percent of time > 50 % when NOx OUT sensor module reading is valid since the internal control loops within the sensor have stabilized	Inactive: SPN 3226 FMI 4, SPN 3226 FMI 9, and SPN 3228 FMI 3. Engine total fueling > 0.01 and rate of active / intrusive injection of fuel in exhaust < 0.2 g/sec for 30 seconds. Internal NOx sensor temperature > 1472°F (800°C) The changing range of exhaust O_2 concentration within a 12 second moving window ≤ 9.96 The changing range of exhaust O_2 concentration within a 6 second moving window ≤ 5.43 Exhaust gas temperature is above a threshold representing the point at which there is no longer a concern of condensation on the NOx sensor element and sensor supply power ≥ 6 V for 150 seconds	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Nitrogen Oxides (NOx) OUT sensor module signal is invalid.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3228 FMI 2 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 20 in 2013 HD-OBD Diagnostic Reference Manual.

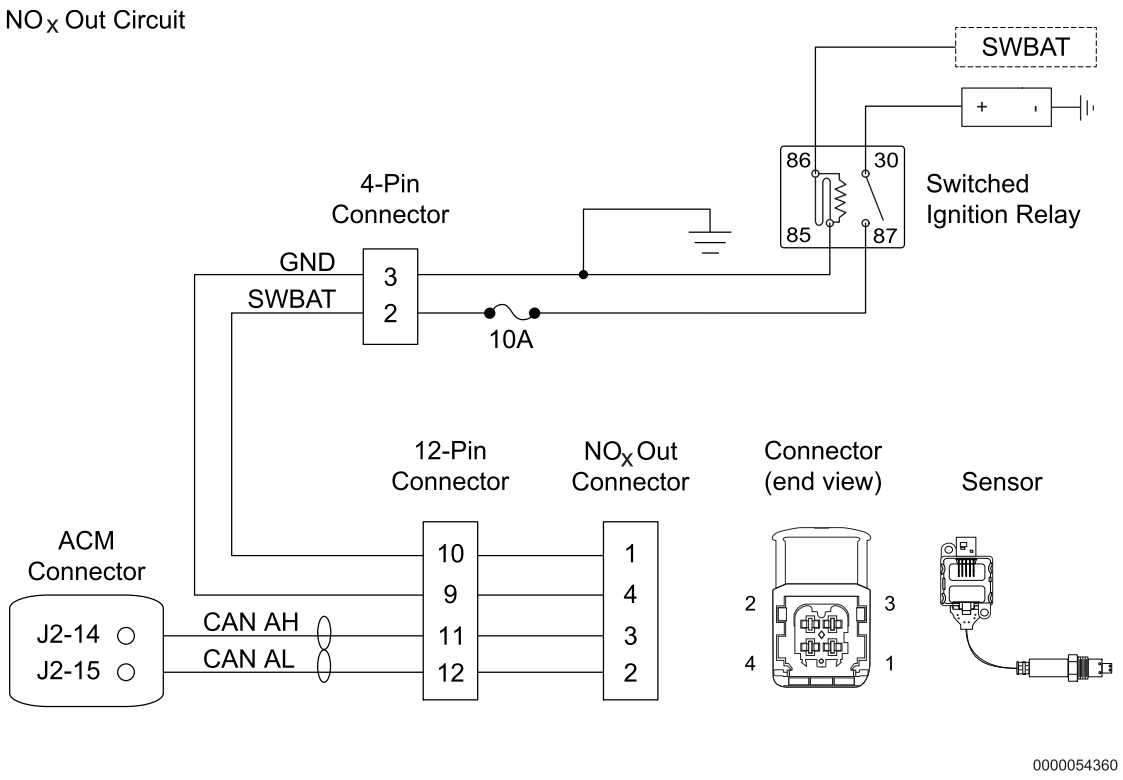

Figure 515 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 FMI 4 and (NOx OUT) SPN 3228 FMI 2 (NOx OUT). Is EST DTC list free of SPN 3226 FMI 4 (NOx OUT) and SPN 3228 FMI 2?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 10.
		No: Repair SPN 3226 FMI 4 and SPN 3228 FMI 2. After repairs are complete, retest for SPN 3226 FMI 10.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 13- NOx OUT Out of Calibration

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Calibration mismatch between the NOx OUT sensor module and the Aftertreatment Control Module (ACM).	Rated NOx OUT sensor module voltage does not match nominal system voltage	Key ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Nitrogen Oxides (NOx) OUT sensor module voltage rating does not match the engine's electrical system voltage.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

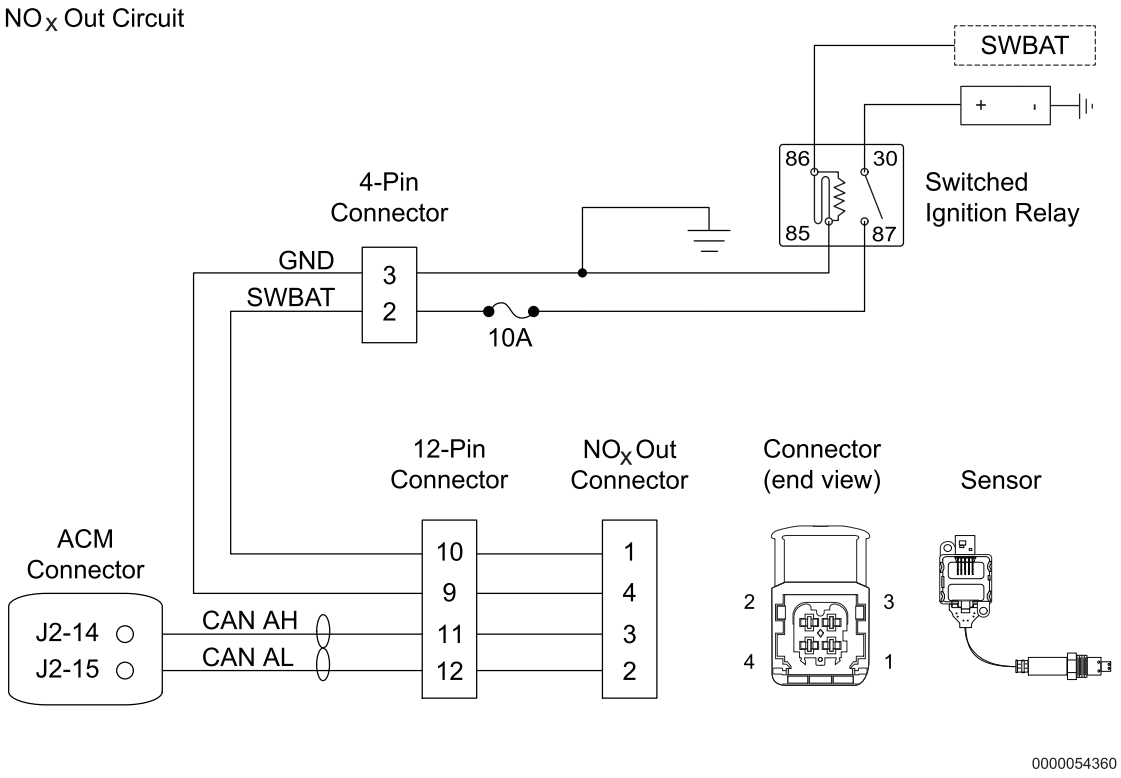

Figure 516 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Verify correct NOx OUT sensor module is installed. Is the correct NOx OUT sensor module installed?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 13.
		No: Install correct NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 13.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 13 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 19 - NOx OUT Not Detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Loss of communication or invalid data from NOx OUT sensor module.	ACM loses J1939 data link communications with NOx OUT sensor module	Key ON Engine not cranking **NOTE:** Data link-related faults are inhibited for a calibratable amount of time following a Key-On event, a low battery voltage event, an engine cranking event, and a stop / suspend broadcast event. This is to allow reasonable time for data link devices to power up and begin periodic broadcasts before the ECM performs time-out diagnostics.	0 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) loses J1939 data link communications with the Nitrogen Oxides (NOx) OUT sensor module. Diesel exhaust Fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be severely reduced.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

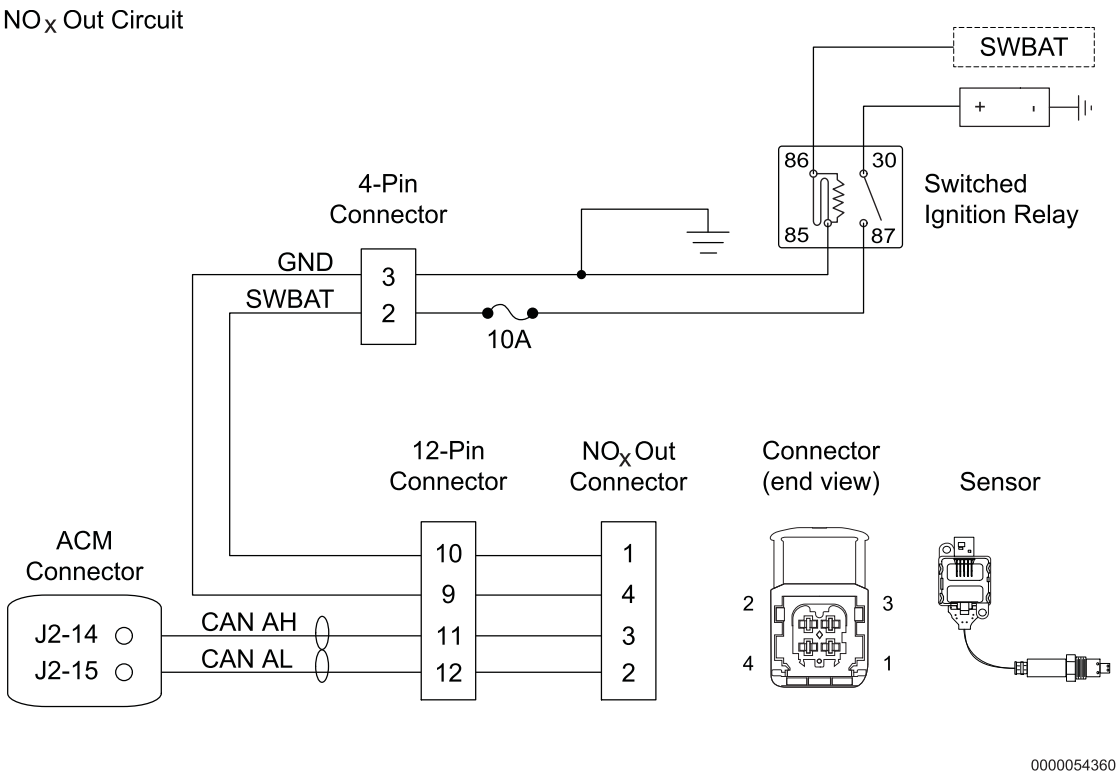

Figure 517 NOx OUT Sensor Circuit Diagram

Possible Causes

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed Nitrogen Oxides (NOx) OUT sensor module

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or Switched Ignition Relay problem. The following components share power and ground circuits: DOC / DPF temperature sensor module, SCR temperature sensor module, Ammonia Sensor Module, NOx OUT sensor module, NOx IN sensor module, and DEFTLT sensor module.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Inspect connections at Nitrogen Oxides (NOx) OUT sensor module. Key OFF, disconnect NOx OUT sensor module. Check NOx IN sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx OUT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
2	Check voltage to the NOx OUT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between NOx OUT sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between NOx OUT sensor module pin-1 and a known good ground. Is voltage at pin-1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx OUT sensor module pin-4 and ground. After repairs are complete, retest for SPN 3226 FMI 19. No: Repair Open or short to ground between NOx OUT sensor module connector pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between NOx OUT sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between NOx OUT sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between NOx OUT sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between NOx OUT sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between NOx OUT sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 3226 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-648-01 connected between NOx OUT sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 19. No: Repair short between NOx OUT sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 3226 FMI 19.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 20 - NOx OUT Signal Drifted HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Control Module (ACM) determines Nitrogen Oxides (NOx) OUT sensor signal drifted HIGH.	Average value of NOx OUT sensor module offset measurement at the decision point > 40 ppm	Engine total fueling ≤ 0.01 mg/stroke NOx OUT sensor module reading is valid since the internal control loops within the sensor have stabilized. Engine is operating in base mode. Exhaust Flow ≥ 100 g/sec Commanded DEF injection rate < 0.1 ml/sec None of the Abort Conditions are satisfied The other Enable Conditions must be true for at least 6 seconds The OBD Arbitrator allows the diagnostic to run. The OBD arbitrator allows the Tail Pipe NOx OUT sensor module gain diagnostics to run.	2.6 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) determines the signal from the Nitrogen Oxides (NOx) OUT sensor module is high during monitoring conditions, or is not changing with engine conditions.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 21 in 2013 HD-OBD Diagnostic Reference Manual.

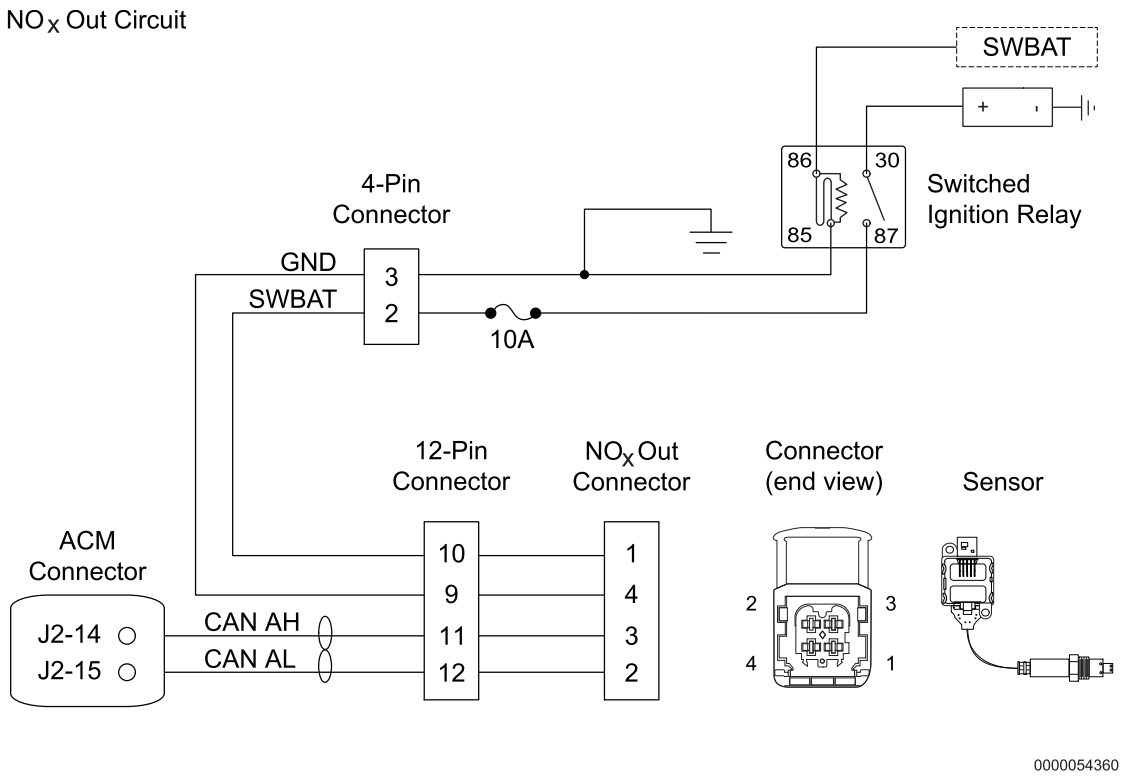

Figure 518 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT). Is EST DTC list free of SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10?	Yes: Go to step 2. No: Repair SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10. After repairs are complete, retest for SPN 3226 FMI 20.

Step	Action	Decision
2	Verify proper installation of the Nitrogen Oxides (NOx) OUT sensor module. Check the NOx OUT sensor retaining nut and NOx OUT sensor module retaining cap screws for proper torque. Is the NOx OUT sensor module properly installed?	Yes: Go to step 3. No: Properly install the NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 20.

Step	Action	Decision
3	Check decomposition tube for crystallization. Disconnect decomposition tube from exhaust system (see Exhaust Aftertreatment with DPF and SCR Service Manual) and inspect for Diesel Exhaust Fluid (DEF) crystallization. Is decomposition tube free of DEF crystallization?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 20. No: Remove DEF crystallization from decomposition tube (see Exhaust Aftertreatment with DPF and SCR Service Manual). After repairs are complete, retest for SPN 3226 FMI 20.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 20 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3226 FMI 21 - NOx OUT Signal Drifted LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Control Module (ACM) determines Nitrogen Oxides (NOx) OUT sensor module signal drifted LOW.	Average value of NOx OUT sensor module offset measurement at the decision point < –40 ppm	Engine total fueling ≤ 0.01 mg/stroke NOx OUT sensor module reading is valid since the internal control loops within the sensor have stabilized. Engine is operating in base mode. Exhaust Flow ≥ 100 g/sec Commanded DEF injection rate < 0.1 ml/sec The OBD Arbitrator allows the Tail Pipe NOx OUT sensor module gain diagnostics to run. None of the Abort Conditions are satisfied The other Enable Conditions must be true for at least 6 seconds The OBD Arbitrator allows the diagnostic to run. The OBD arbitrator allows the Tail Pipe NOx OUT sensor module gain diagnostics to run.	2.6 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the reading from the Nitrogen Oxides (NOx) OUT sensor module is low during monitoring conditions, or is not changing with engine conditions.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 21 in 2013 HD-OBD Diagnostic Reference Manual.

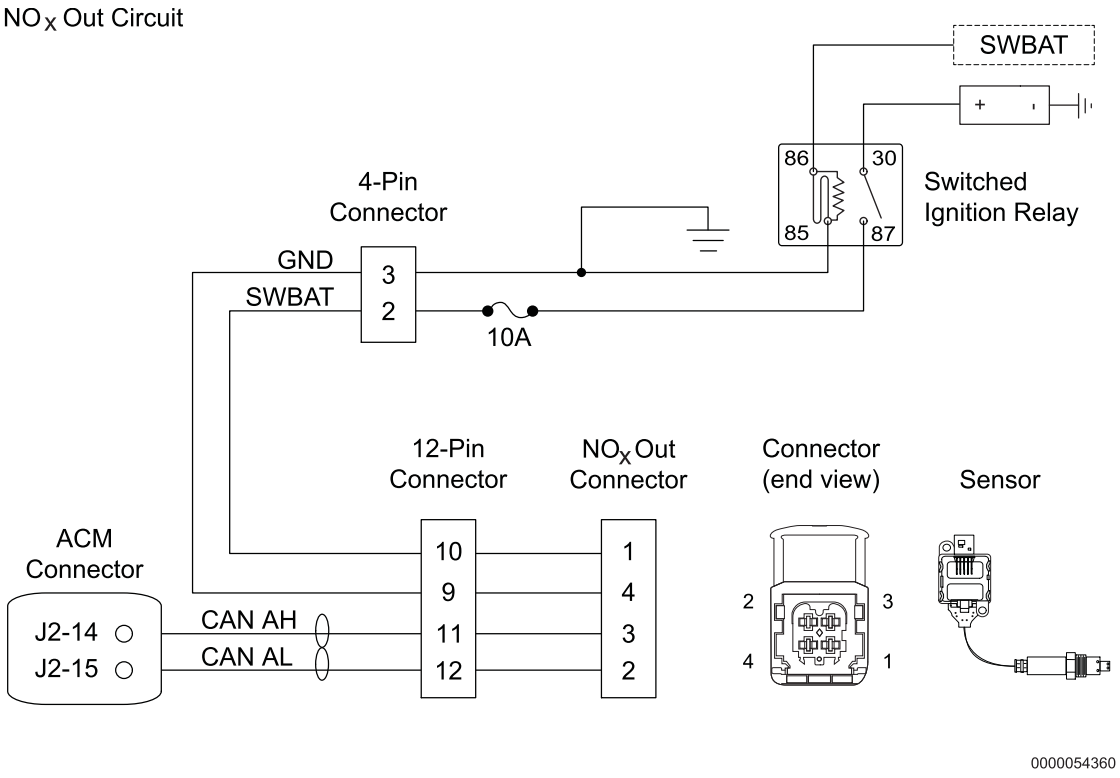

Figure 519 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), and SPN 5031 FMI 10 (NOx OUT). Is EST DTC list free of SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10?	Yes: Go to step 2. No: Repair SPN 3226 FMI 4, SPN 3228 FMI 2, and SPN 5031 FMI 10. After repairs are complete, retest for SPN 3226 FMI 21.

Step	Action	Decision
2	Verify proper installation of the Nitrogen Oxides (NOx) OUT sensor module. Check the NOx OUT sensor retaining nut and NOx OUT sensor module retaining cap screws for proper torque. Is the NOx OUT sensor module properly installed?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 21.
		No: Properly install the NOx OUT sensor module. After repairs are complete, retest for SPN 3226 FMI 21.

NOTE: After doing all diagnostic steps, if SPN 3226 FMI 21 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3228 FMI 2 - NOx OUT Power Supply Signal Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
NOx OUT sensor module circuitry has detected that its battery supply voltage is outside the desired range.	NOx OUT sensor module supply voltage > 16.5 V for 10 seconds or NOx OUT sensor module supply voltage < 11.4 V for 10 seconds.	160 seconds after exhaust gas temperature is above a threshold representing the point there is no on the NOx sensor element.	10 seconds

Fault Overview

Fault code sets when the Engine Control Module (ECM) detects the power supply to the Nitrogen Oxides (NOx) OUT sensor module is above or below a calibratable threshold.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 168 FMI 16, and 18 (ACM PWR), and SPN 3226 FMI 9 (NOx OUT).

Drive Cycle to Determine Fault Status

Drive Cycle 21 in 2013 HD-OBD Diagnostic Reference Manual.

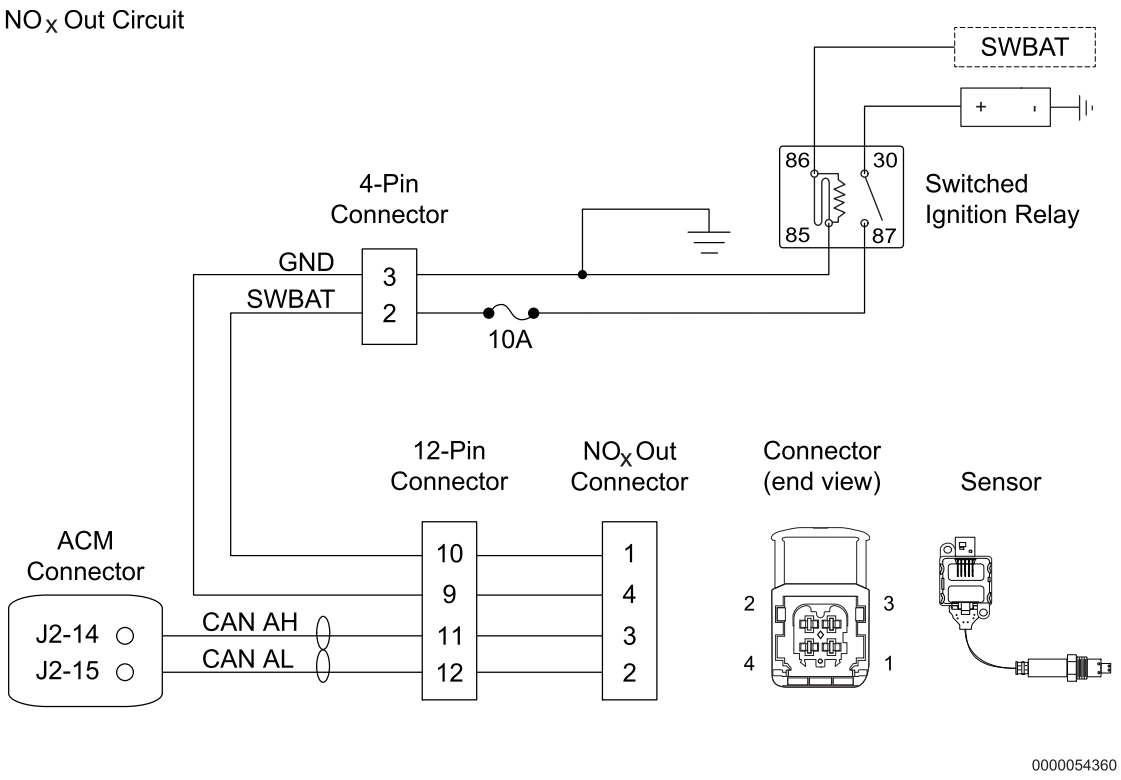

Figure 520 NOx OUT Sensor Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 168 FMI 16 and 18 (ACM PWR). Is EST DTC list free of SPN 168 FMI 16 and 18?	Yes: Go to step 2. No: Repair SPN 168 FMI 16 and 18. After repairs are complete, retest for SPN 3228 FMI 2.

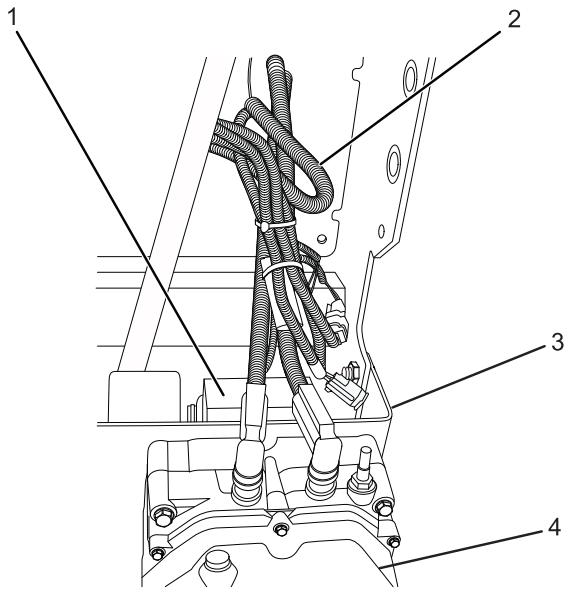

Figure 521 PDM Location (typical)

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) tank assembly
3. DEF supply module bracket
4. DEF supply module

Step	Action	Decision
2	Check Power Distribution Module (PDM) fuse(s) and relay(s) for blown fuses; loose, missing, or intermittent connections. Are all fuses and relays securely attached and in good condition?	Yes: Go to step 3.
		No: Secure or replace failed fuse(s) or relay(s) to PDM connector. After repairs are complete, retest for SPN 3228 FMI 2.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Inspect connections at Nitrogen Oxides (NOx) OUT sensor module. Key OFF, disconnect NOx OUT sensor module. Check NOx OUT sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx OUT sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4.
		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3228 FMI 2.

Step	Action	Decision
4	Check voltage to the NOx OUT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness Breakout Harness 18-649-01 connected to NOx OUT sensor module, use a DMM to measure voltage between NOx OUT sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 6. No: Go to step 5.

Step	Action	Decision
5	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-649-01 connected to NOx OUT sensor module, use a DMM to measure voltage between NOx OUT sensor module pin-1 and a known good ground. Is voltage at pin-1 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx OUT sensor module pin-4 and ACM connector J2-04 and J2-06. After repairs are complete, retest for SPN 3228 FMI 2. No: Repair Open or short to ground between NOx OUT sensor module connector pin-1 and ACM connector J2-03 and J2-05. After repairs are complete, retest for SPN 3228 FMI 2.

Step	Action	Decision
6	Check for incorrect NOx OUT sensor module installed. Is the correct NOx OUT sensor module installed?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 3228 FMI 2. No: Install correct NOx OUT sensor module. After repairs are complete, retest for SPN 3228 FMI 2.

NOTE: After doing all diagnostic steps, if SPN 3228 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5031 FMI 10 - NOx OUT Sensor Heater Not Reading Correctly

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The NOx OUT sensor heater is unable to maintain normal operating temperature.	NOx OUT sensor heater temperature does not match Aftertreatment Control Module (ACM) predetermined values	DOCIT > 302°F (150°C) for 5 seconds SCROT < 800°C Key-On Engine-Running (KOER) Inactive: SPN 3226 FMI 4 and 13; SPN 3228 FMI 2; SPN 4360 FMI 2; SPN 4363 FMI 2, 3, and 4; SPN 5742 FMI 9; SPN 5743 FMI 3, 4, 9, 11, and 12. Exhaust gas velocity < 60 m/sec Exhaust gas temperature is above a threshold representing the point at which there is no longer a concern of condensation on the NOx OUT sensor element. Time after NOx OUT sensor has reached its working temperature and has entered automatic mode > 30 seconds	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Nitrogen Oxides (NOx) OUT sensor heater was unable to maintain its normal operating temperature.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3226 FMI 4 (NOx OUT), SPN 3228 FMI 2 (NOx OUT), SPN 4360 FMI 2 (SCRIT); and SPN 4363 FMI 2, 3, and 4 (SCROT)

Drive Cycle to Determine Fault Status

Drive Cycle 1 in 2013 HD-OBD Diagnostic Reference Manual.

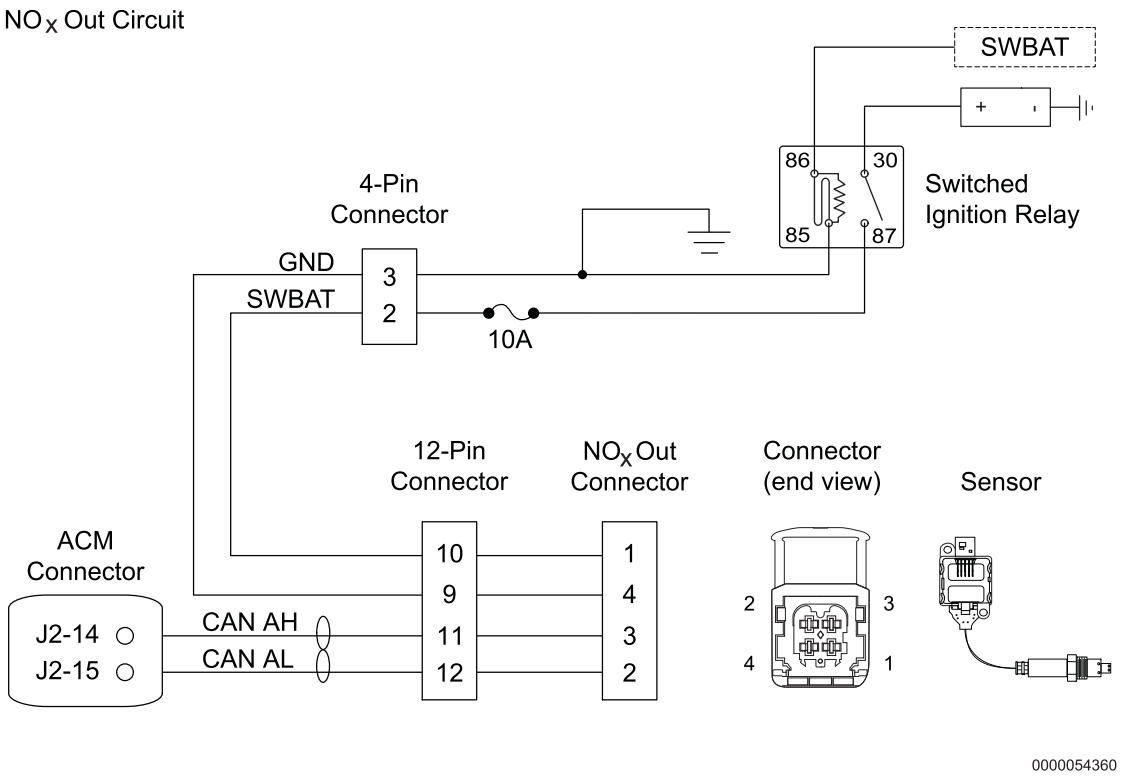

Figure 522 NOx OUT Sensor Circuit Diagram

Possible Causes

- Failed NOx OUT sensor module
- GND circuit Open or high resistance
- SWBAT circuit Open or high resistance

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3226 FMI 4 (NOx OUT); SPN 3228 FMI 2 (NOx OUT); SPN 4360 FMI 2 (SCRIT); and SPN 4363 FMI 2, 3, and 4 (SCROT). Is EST DTC list free of SPN 3226 FMI 4; SPN 3228 FMI 2; SPN 4360 FMI 2; and SPN 4363 FMI 2, 3, and 4?	Yes: Go to step 2. Repair SPN 3226 FMI 4; SPN 3228 FMI 2; SPN 4360 FMI 2; and SPN 4363 FMI 2, 3, and 4. After repairs are complete, retest for SPN 5031 FMI 10.

Step	Action	Decision
2	Inspect connections at Nitrogen Oxides (NOx) OUT sensor. Key OFF, disconnect NOx OUT sensor. Check NOx OUT sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the NOx OUT sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5031 FMI 10.

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit , ground circuit, or switched ignition relay problem. The following components share power and ground circuits with the NOx OUT sensor module:

- DOC / DPF temperature sensor module
- NOx OUT sensor module
- Ammonia (NH_3) sensor module
- SCR temperature sensor module
- DEFTLT sensor

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
3	Check power and ground to the NOx OUT sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-649-01 connected to NOx OUT sensor module, use a DMM to measure voltage between Breakout Harness 18-649-01 pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Replace NOx OUT sensor module. After repairs are complete, retest for SPN 5031 FMI 10. No: Go to step 4.

Step	Action	Decision
4	Check SWBAT circuit for Open or high resistance. KOEO, with Breakout Harness 18-649-01 connected to NOx OUT sensor module, use a DMM to measure voltage between Breakout Harness 18-649-01 pin-1 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between NOx OUT sensor module pin-4 and ground. After repairs are complete, retest for SPN 5031 FMI 10.
		No: Repair Open or high resistance between NOx OUT sensor module pin-1 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5031 FMI 10.

NOTE: After doing all diagnostic steps, if SPN 5031 FMI 10 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

O_2S (Oxygen Sensor)

Overview of O_2S Sensor Group

SPN	FMI	Actions
724	2	O_2S Slow response detecting fueling to non-fueling (page 1325)
724	3	O_2S circuit Fault: Open or short to PWR (page 1325)
724	4	O_2S circuit Fault: Short to GND (page 1325)
724	5	O_2S circuit fault: Open circuit (page 1325)
724	20	O_2S adaptation above maximum limit (page 1307)
724	21	O_2S adaptation below minimum limit (page 1310)
3223	0	O_2S heater temperature above maximum (page 1313)
3223	1	O_2S heater temperature below minimum (page 1327)
3223	3	O_2S heater short to PWR (page 1325)
3223	4	O_2S heater short to GND (page 1325)
3223	5	O_2S heater open load/circuit (page 1322)
3223	17	O_2S heater temperature below minimum at low battery PWR (page 1327)

Overview

The Oxygen Sensor (O_2S) is a wide band oxygen sensor used to control engine fueling and provide input for Exhaust Gas Recirculation (EGR) valve position. The O_2S is a six wire sensor that provides a variable voltage signal to the Engine Control Module (ECM) to determine the amount of oxygen entering the exhaust system. A heating element is used during initial engine warm-up to bring the sensor up to a normal operating temperature of 1,436°F (780°C). The O_2S heater element is only activated when engine coolant temperature reaches 104°F (40°C), and exhaust gas temperature exceeds 212°F (100°C) for more than 30 seconds.

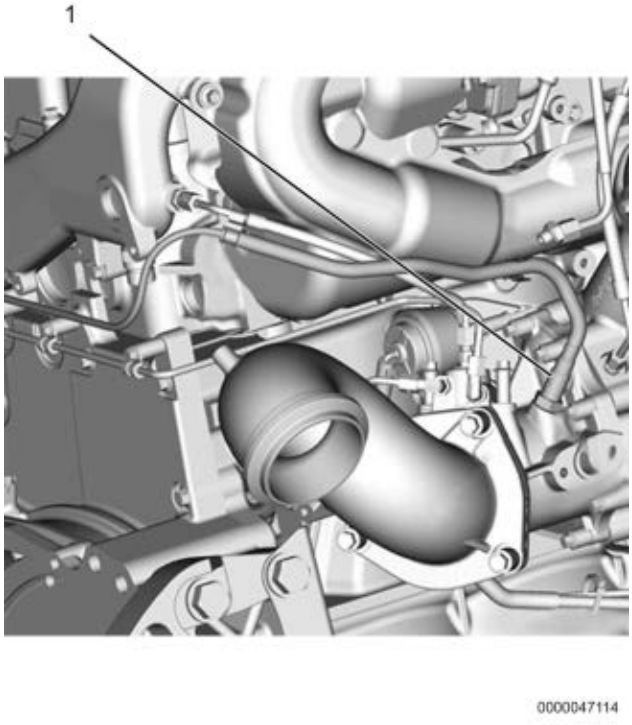

Figure 523 Oxygen Sensor Location

1. Oxygen Sensor (O_2S)

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

SPN 724 FMI 2 - O2S Slow Response Detected Fueling to Non-Fueling

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, verify DTC is active for this sensor.
   - If code is previously active, wiggle the harness of the suspect sensor. If the circuit is interrupted, the DTC will go active.
   - If code is active, proceed to Connector Voltage Check.

NOTE: Inspect connectors for damaged, corrosion, or loose pins. Repair if necessary.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
2 to GND	2.6 V ± 1 V	If < 1.6 V, check for OPEN or short to GND.
3 to GND	4.8 V ± 1 V	If < 3.8 V, check for OPEN or short to GND.
4 to GND	12V ± 2 V	If < 10 V, check for OPEN circuit or short to GND.
5 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
6 to GND	3 V ± 1 V	If < 2 V , check for OPEN or short to GND.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C1-52	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to C1-40	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to C1-46	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to C1-33	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to GND	>1k Ω	If < 1k Ω, check for short to GND.
5 to C1-53	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
5 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
6 to C1-39	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
6 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
If measurements are in specification, calibrate and install new O_2S.		

SPN 724 FMI 3 - O2S Circuit Fault: Open or Chort to PWR

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, verify DTC is active for this sensor.
   - If code is previously active, wiggle the harness of the suspect sensor. If the circuit is interrupted, the DTC will go active.
   - If code is active, proceed to Connector Voltage Check.

NOTE: Inspect connectors for damaged, corrosion, or loose pins. Repair if necessary.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
2 to GND	2.6 V ± 1 V	If < 1.6 V, check for OPEN or short to GND.
3 to GND	4.8 V ± 1 V	If < 3.8 V, check for OPEN or short to GND.
4 to GND	12V ± 2 V	If < 10 V, check for OPEN circuit or short to GND.
5 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
6 to GND	3 V ± 1 V	If < 2 V , check for OPEN or short to GND.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C1-52	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to C1-40	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to C1-46	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to C1-33	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to GND	>1k Ω	If < 1k Ω, check for short to GND.
5 to C1-53	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
5 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
6 to C1-39	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
6 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
If measurements are in specification, calibrate and install new O_2S.		

SPN 724 FMI 4 - O2S Circuit Fault: Short to GND

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, verify DTC is active for this sensor.
   - If code is previously active, wiggle the harness of the suspect sensor. If the circuit is interrupted, the DTC will go active.
   - If code is active, proceed to Connector Voltage Check.

NOTE: Inspect connectors for damaged, corrosion, or loose pins. Repair if necessary.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
2 to GND	2.6 V ± 1 V	If < 1.6 V, check for OPEN or short to GND.
3 to GND	4.8 V ± 1 V	If < 3.8 V, check for OPEN or short to GND.
4 to GND	12V ± 2 V	If < 10 V, check for OPEN circuit or short to GND.
5 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
6 to GND	3 V ± 1 V	If < 2 V , check for OPEN or short to GND.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C1-52	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to C1-40	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to C1-46	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to C1-33	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to GND	>1k Ω	If < 1k Ω, check for short to GND.
5 to C1-53	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
5 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
6 to C1-39	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
6 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
If measurements are in specification, calibrate and install new O_2S.		

SPN 724 FMI 5 - O2S Circuit Fault: Open Circuit

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, verify DTC is active for this sensor.
   - If code is previously active, wiggle the harness of the suspect sensor. If the circuit is interrupted, the DTC will go active.
   - If code is active, proceed to Connector Voltage Check.

NOTE: Inspect connectors for damaged, corrosion, or loose pins. Repair if necessary.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
2 to GND	2.6 V ± 1 V	If < 1.6 V, check for OPEN or short to GND.
3 to GND	4.8 V ± 1 V	If < 3.8 V, check for OPEN or short to GND.
4 to GND	12V ± 2 V	If < 10 V, check for OPEN circuit or short to GND.
5 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
6 to GND	3 V ± 1 V	If < 2 V , check for OPEN or short to GND.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C1-52	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to C1-40	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to C1-46	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to C1-33	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to GND	>1k Ω	If < 1k Ω, check for short to GND.
5 to C1-53	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
5 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
6 to C1-39	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
6 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
If measurements are in specification, calibrate and install new O_2S.		

SPN 724 FMI 20 - O_2S adaptation above maximum limit

Condition / Description	Setting Criteria	Enable Conditions / Values
Stored adaptation value for the Oxygen Sensor (O_2S) correction factor beyond limit high	O_2S > 1.1 correction factor	Time in overrun (motoring) > 0 seconds Exhaust Backpressure Valve (EBPV) not closed Ambient Air Temperature (AAT) < 212°F (100°C) Oxygen sensor temperature >1400°F (760°C) and < 1472°F (800°C) Fresh air flow during overrun > 420 g Not in regeneration mode [Release from dewpoint detection: dew point: ECT1, > 10.06 C dew point: DOCIT > 100.1 C DOCIT exceeded for > 30 seconds] Difference between filtered and unfiltered O_2 concentration < 0.0018 Not in SCR warm up mode

Fault Overview

Fault code sets when the learned Oxygen Sensor (O_2S) adaptation value exceeds 1.1.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 724 FMI 3, 4, and 5 (O_2S)			

Fault Facts

None

Drive Cycle to Determine Fault Status

Road Test.

Possible Causes

- Oxygen Sensor contamination
- Failed oxygen sensor

Step 1	Verify ECM has latest calibration.	Decision
Check calibration scorecard on Service Portal. Is calibration current?		Yes: Go to step 2. No: Update calibration. After update is complete, go to step 2.

Step 2	Check for Associated Faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 1307). Is EST DTC list free of Associated Faults?		Yes: Go to step 3. No: Repair Associated Faults. After repairs are complete, retest for SPN 724 FMI 20.

Step 3	Check Oxygen Sensor (O_2S) sensor adaptation value.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the parameter session. Find parameter ID 99162: Lambda sensor adaptation value, and document the value. Is the adaptation value greater than 0.045?		Yes: Go to step 4. No: Clear fault. After repairs are complete, retest for SPN 724 FMI 20.

Step 4	Check value of parameter 99162.	Decision
Run the Relative Compression Test to add oxygen to the exhaust and then run O_2S Sensor Calibration. A. Connect a battery charger. B. Go to O_2 Sensor Calibration(page 1568), and run O_2S sensor calibration without removing the O_2S sensor. C. Check the value of parameter 99162: Lambda sensor adaptation value Is the adaptation value greater than 0.045?		Yes: Replace Oxygen Sensor (O_2S) and perform O_2 Sensor Calibration(page 1568). After repairs are complete, go to step 5. No: Clear fault. After repairs are complete, retest for SPN 724 FMI 20.

Step 5	Check the value of parameter 99162 after O_2S replacement.	Decision
A. Connect a battery charger. B. Go to O_2 Sensor Calibration(page 1568), and run O_2S sensor calibration without removing the O_2S sensor. C. Check the value of parameter 99162: Lambda sensor adaptation value		Yes: Verify steps were performed in proper sequence and completed correctly. Notify supervisor if fault remains.
Is the adaptation value greater than 0.045?		No: Go to step 6.

Step 6	Verify ECM has the latest calibration.	Decision
Reset relevant ECM parameters in ServiceMaxx™ software. **Not all calibrations have all parameters available.** Using EST, load the parameter session. • Set parameters 99520, 99530, and 99540 to 0. • Set parameter 99550 to 780°C.		Yes: Clear fault. After repairs are complete, retest for SPN 724 FMI 20.
Were parameters programmed successfully?		No: Verify steps were performed in proper sequence and completed correctly. Notify supervisor if fault remains.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 724 FMI 20 fault code diagnostics.

SPN 724 FMI 21 - O_2S adaptation below minimum limit

Condition / Description	Setting Criteria	Enable Conditions / Values
Stored adaptation value for the Oxygen Sensor (O_2S) correction factor beyond limit low	O_2S < 0.95 correction factor	Time in overrun (motoring) > 0 seconds Exhaust Backpressure Valve (EBPV) not closed Ambient Air Temperature (AAT) < 212°F (100°C) Oxygen sensor temperature >1400°F (760°C) and < 1472°F (800°C) Fresh air flow during overrun > 420 g Not in regeneration mode [Release from dewpoint detection: dew point: ECT1, > 10.06 C dew point: DOCIT > 100.1 C DOCIT exceeded for > 30 seconds] Difference between filtered and unfiltered O_2 concentration < 0.0018 Not in SCR warm up mode

Fault Overview

Fault code sets when the learned Oxygen Sensor (O_2S) adaptation value is less than 0.95.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

• SPN 724 FMI 3, 4, and 5 (O_2S)	• SPN 5541 (TC1TOP)		

Fault Facts

None

Drive Cycle to Determine Fault Status

Road Test.

Possible Causes

- Air leak in EBPV system
- Failed oxygen sensor

Step 1	Verify ECM has latest calibration.	Decision
Check calibration scorecard on Service Portal. Is calibration current?		Yes: Go to step 2. No: Update calibration. After update is complete, go to step 2.

Step 2	Check for Associated Faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 1310).		Yes: Go to step 3.
Is EST DTC list free of Associated Faults?		No: Repair Associated Faults. After repairs are complete, retest for SPN 724 FMI 21.

Step 3	Check Oxygen Sensor (O_2S) sensor adaptation value.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, load the parameter session. Find parameter ID 99162: Lambda sensor adaptation value, and document the value.		Yes: Go to step 4.
Is the adaptation value greater than 0.045?		No: Clear fault. After repairs are complete, retest for SPN 724 FMI 21.

Step 4	Check value of parameter 99162.	Decision
Run the Relative Compression Test to add oxygen to the exhaust and then run O_2S Sensor Calibration. A. Connect a battery charger. B. Go to O_2 Sensor Calibration(page 1568), and run O_2S sensor calibration without removing the O_2S sensor. C. Check the value of parameter 99162: Lambda sensor adaptation value		Yes: Replace Oxygen Sensor (O_2S) and perform O_2 Sensor Calibration(page 1568). After repairs are complete, go to step 5.
Is the adaptation value greater than 0.045?		No: Clear fault. After repairs are complete, retest for SPN 724 FMI 21.

Step 5	Check the value of parameter 99162 after O_2S replacement.	Decision
A. Connect a battery charger. B. Go to O_2 Sensor Calibration(page 1568), and run O_2S sensor calibration without removing the O_2S sensor. C. Check the value of parameter 99162: Lambda sensor adaptation value		Yes: Verify steps were performed in proper sequence and completed correctly. Notify supervisor if fault remains.
Is the adaptation value greater than 0.045?		No: Go to step 6.

Step 6	Verify ECM has the latest calibration.	Decision
Reset relevant ECM parameters in ServiceMaxx™ software. **Not all calibrations have all parameters available.** Using EST, load the parameter session. • Set parameters 99520, 99530, and 99540 to 0. • Set parameter 99550 to 780°C.		Yes: Clear fault. After repairs are complete, retest for SPN 724 FMI 21.
Were parameters programmed successfully?		No: Verify steps were performed in proper sequence and completed correctly. Notify supervisor if fault remains.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 724 FMI 21 fault code diagnostics.

SPN 3223 FMI 0 - O2S Heater Temperature Above Maximum

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
O_2S temperature too high.	O_2S Temperature ≥ 1472°F (800°C)	Exhaust back pressure valve open < 80% Engine speed > 300 rpm Heater duty cycle > 98% for 6,500 seconds (1.8 hours) Regeneration mode inactive or Oxygen sensor temp > 1202°F (650°C)	30 seconds

Fault Overview

The Oxygen sensor (O_2S) heater element is designed to increase sensor temperature. The O_2S heater is supplied with battery voltage from ECM PWR Out 1 through pin 4 of the O_2S connector. The O_2S heater is active when the Engine Control Module (ECM) supplies ground to the O_2S Heater CTL circuit through ECM connector 1 pin 46. If O_2S temperature is above 1472°F (800°C) this fault will set.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

See 2013 HD-OBD Diagnostic Reference Manual.

O2S Circuit

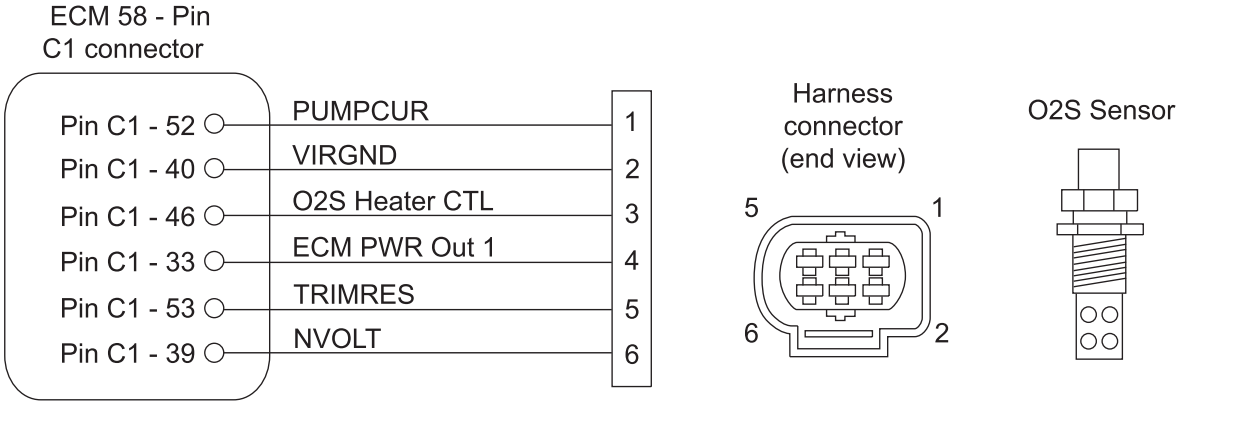

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Figure 524 O_2S circuit diagram

Step	Action	Decision
1	Inspect connections at Oxygen Sensor (O_2S). Key OFF, disconnect O_2S connector. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the O_2S connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal. After repairs are complete, retest for SPN 3223 FMI 0.

Step	Action	Decision
2	Check Heater control circuit for short to ground. Connect Breakout Harness ZTSE4735A and leave sensor disconnected. Run engine, using Electronic Service Tool (EST) with ServiceMaxx™ software, monitor O_2S Temp. When O_2S Temp reaches 1,382°F (750°C) or higher (O_2S heater inactive), use a DMM to measure resistance between Breakout Harness ZTSE4735A test point 3, and a known good ground. Is resistance greater than 1,000 ohms?	Yes: Replace Oxygen Sensor. After repairs are complete retest for SPN 3223 FMI 0. No: Repair short to ground between O_2S harness pin 3 and ECM connector 1 pin 46. After repairs are complete, retest for SPN 3223 FMI 0.

NOTE: After doing all diagnostic steps, if SPN 3223 FMI 0 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3223 FMI 1 - O2S Heater Temperature Below Minimum

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, verify DTC is active for this sensor.
   - If code is previously active, wiggle the harness of the suspect sensor. If the circuit is interrupted, the DTC will go active.
   - If code is active, proceed to Connector Voltage Check.

NOTE: Inspect connectors for damaged, corrosion, or loose pins. Repair if necessary.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
2 to GND	2.6 V ± 1 V	If < 1.6 V, check for OPEN or short to GND.
3 to GND	4.8 V ± 1 V	If < 3.8 V, check for OPEN or short to GND.
4 to GND	12V ± 2 V	If < 10 V, check for OPEN circuit or short to GND.
5 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
6 to GND	3 V ± 1 V	If < 2 V , check for OPEN or short to GND.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C1-52	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to C1-40	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to C1-46	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to C1-33	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to GND	>1k Ω	If < 1k Ω, check for short to GND.
5 to C1-53	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
5 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
6 to C1-39	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
6 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
If measurements are in specification, calibrate and install new O_2S.		

SPN 3223 FMI 1– O_2S heater temperature below minimum

SPN 3223 FMI 17 – O_2S heater temperature below minimum at low battery PWR

NOTE: SPN 3223 FMI 17 will set if battery voltage is below 10 V when the O_2S heater is commanded ON.

1. Check for other active or previously active DTCs. Repair any electrical fault before continuing with this procedure.
2. Verify batteries and changing system are working within specifications. See "PERFORMANCE DIAGNOSTICS."
   - If charging system and battery voltage are working within specification, check for circuit faults to the O_2S. If circuits are within specification, calibrate and install new O_2S.

SPN 3223 FMI 3 - O2S Heater Short to PWR

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, verify DTC is active for this sensor.
   - If code is previously active, wiggle the harness of the suspect sensor. If the circuit is interrupted, the DTC will go active.
   - If code is active, proceed to Connector Voltage Check.

NOTE: Inspect connectors for damaged, corrosion, or loose pins. Repair if necessary.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
2 to GND	2.6 V ± 1 V	If < 1.6 V, check for OPEN or short to GND.
3 to GND	4.8 V ± 1 V	If < 3.8 V, check for OPEN or short to GND.
4 to GND	12V ± 2 V	If < 10 V, check for OPEN circuit or short to GND.
5 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
6 to GND	3 V ± 1 V	If < 2 V , check for OPEN or short to GND.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C1-52	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to C1-40	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to C1-46	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to C1-33	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to GND	>1k Ω	If < 1k Ω, check for short to GND.
5 to C1-53	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
5 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
6 to C1-39	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
6 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
If measurements are in specification, calibrate and install new O_2S.		

SPN 3223 FMI 4 - O2S Heater Short to GND

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, verify DTC is active for this sensor.
   - If code is previously active, wiggle the harness of the suspect sensor. If the circuit is interrupted, the DTC will go active.
   - If code is active, proceed to Connector Voltage Check.

NOTE: Inspect connectors for damaged, corrosion, or loose pins. Repair if necessary.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
2 to GND	2.6 V ± 1 V	If < 1.6 V, check for OPEN or short to GND.
3 to GND	4.8 V ± 1 V	If < 3.8 V, check for OPEN or short to GND.
4 to GND	12V ± 2 V	If < 10 V, check for OPEN circuit or short to GND.
5 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
6 to GND	3 V ± 1 V	If < 2 V , check for OPEN or short to GND.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C1-52	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to C1-40	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to C1-46	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to C1-33	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to GND	>1k Ω	If < 1k Ω, check for short to GND.
5 to C1-53	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
5 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
6 to C1-39	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
6 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
If measurements are in specification, calibrate and install new O_2S.		

SPN 3223 FMI 5 - O2S Heater Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Open circuit detected in Oxygen Sensor (O_2S) heater.	O_2S heater current >-100 µA and < 100 µA	Key ON	5 seconds

Fault Overview

Fault code sets when Electronic Control Module (ECM) detects an Open circuit in the Oxygen Sensor (O_2S) heater.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 724 FMI 3, 4 (O_2S); SPN 3223 FMI 3, 4 (O_2S); SPN 3597 FMI 4 (ECM PWR).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

O2S Circuit

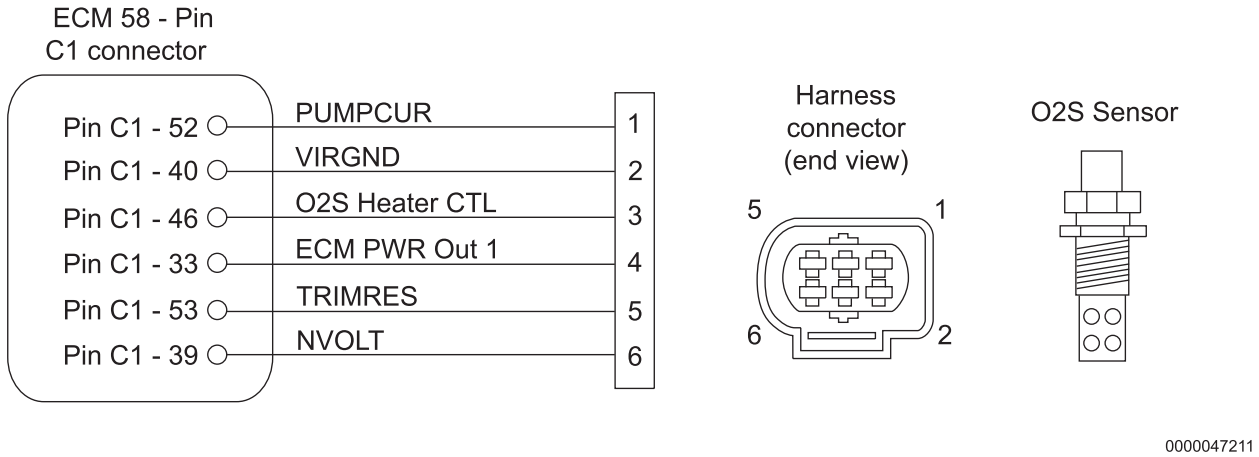

Figure 525 O_2S circuit diagram

Possible Causes

- HTR CTL circuit short to GND
- ECM PWR OUT 1 circuit Open or high resistance
- HTR CTL circuit Open or high resistance
- Failed O_2S

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 724 FMI 3, 4 (O_2S); SPN 3223 FMI 3, 4 (O_2S); SPN 3597 FMI 4 (ECM PWR). Is EST DTC list free of SPN 724 FMI 3, 4; SPN 3223 FMI 3, 4; SPN 3597 FMI 4?	Yes: Go to step 2. No: Repair SPN 724 FMI 3, 4; SPN 3223 FMI 3, 4; SPN 3597 FMI 4. After repairs are complete, retest for SPN 3223 FMI 5.

Step	Action	Decision
2	Inspect connections at Oxygen Sensor (O_2S). Key OFF, disconnect O_2S. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the O_2S connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3223 FMI 5.

Step	Action	Decision
3	Inspect connections at ECM C1 connector. Key OFF, disconnect ECM C1 connector. Check connector and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM C1 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 3223 FMI 5.

Step	Action	Decision
4	Check for short to GND in the HTR CTL circuit. Connect Breakout Harness ZTSE4735A to O_2S harness, and leave sensor disconnected. Key-On, using a DMM, measure voltage between ZTSE4735A pin-3 and pin-4. Is voltage less than 5 volts?	Yes: Go to step 5 No: Repair short to GND in HTR CTL circuit between O_2S connector pin-3 and ECM pin C1-46. After repairs are complete, retest for SPN 3223 FMI 5.

Step	Action	Decision
5	Check for Open or high resistance in the HTR CTL circuit. Connect 180-pin Breakout Box and ECM C1 & C2 Breakout Harness to vehicle harness, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S harness, and leave sensor disconnected. Key-Off, using a DMM, measure resistance between ZTSE4735A pin-3 and ECM pin C1-46. Is resistance less than 5 ohms?	Yes: Go to step 6 No: Repair Open in HTR CTL circuit between O_2S connector pin-3 and ECM pin C1-46. After repairs are complete, retest for SPN 3223 FMI 5.

Step	Action	Decision
6	Check for Open or high resistance in the ECM PWR OUT 1 circuit. Connect 180-pin Breakout Box and ECM C1 & C2 Breakout Harness to vehicle harness, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S harness, and leave sensor disconnected. Key-Off, using a DMM, measure resistance between ZTSE4735A pin-4 and ECM pin C1-33. Is resistance less than 5 ohms?	Yes: Replace O_2S. After repairs are complete, retest for SPN 3223 FMI 5.
		No: Repair Open in ECM PWR OUT 1 circuit between O_2S connector pin-4 And ECM pin C1-33. After repairs are complete, retest for SPN 3223 FMI 5.

NOTE: After performing all diagnostic steps, if SPN 3223 FMI 5 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3223 FMI 17 - O2S Heater Temperature Below Minimum at Low Battery PWR

Pinpoint Diagnostics With ServiceMaxx™ Software

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, verify DTC is active for this sensor.
   - If code is previously active, wiggle the harness of the suspect sensor. If the circuit is interrupted, the DTC will go active.
   - If code is active, proceed to Connector Voltage Check.

NOTE: Inspect connectors for damaged, corrosion, or loose pins. Repair if necessary.

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
2 to GND	2.6 V ± 1 V	If < 1.6 V, check for OPEN or short to GND.
3 to GND	4.8 V ± 1 V	If < 3.8 V, check for OPEN or short to GND.
4 to GND	12V ± 2 V	If < 10 V, check for OPEN circuit or short to GND.
5 to GND	2.9 V ± 1 V	If < 1.9 V, check for OPEN or short to GND.
6 to GND	3 V ± 1 V	If < 2 V , check for OPEN or short to GND.
If measurements are within specification, do Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE4735A to O_2S vehicle harness, and leave O_2S sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C1-52	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
1 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2 to C1-40	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
3 to C1-46	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
3 to GND	>1k Ω	If < 1k Ω, check for short to GND.
4 to C1-33	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
4 to GND	>1k Ω	If < 1k Ω, check for short to GND.
5 to C1-53	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
5 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
6 to C1-39	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
6 to GND	> 1k Ω	If < 1k Ω, check for short to GND.
If measurements are in specification, calibrate and install new O_2S.		

SPN 3223 FMI 1– O_2S heater temperature below minimum

SPN 3223 FMI 17 – O_2S heater temperature below minimum at low battery PWR

NOTE: SPN 3223 FMI 17 will set if battery voltage is below 10 V when the O_2S heater is commanded ON.

1. Check for other active or previously active DTCs. Repair any electrical fault before continuing with this procedure.
2. Verify batteries and changing system are working within specifications. See "PERFORMANCE DIAGNOSTICS."
   - If charging system and battery voltage are working within specification, check for circuit faults to the O_2S. If circuits are within specification, calibrate and install new O_2S.

RAPP (Remote Accelerator Pedal Position) Sensor

Overview of RAPP Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
974	3	Remote APP signal Out of Range HIGH	• RPS signal circuit short to PWR • SIG GND circuit OPEN • Failed RAPP system component	Circuit Checks (page 1329)
974	4	Remote APP signal Out of Range LOW	• RPS signal circuit OPEN or short to GND • VREF4 circuit OPEN • Failed RAPP system component	Circuit Checks (page 1329)

Overview

The Remote Accelerator Pedal Position (RAPP) feature allows the operator to set and maintain a constant engine speed from outside the vehicle cab. This feature may also be know as Remote Engine Speed Control (RESC). Control over engine speed is accomplished by using remote mounted switches to turn on the RESC and select the desired engine speed.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 974 FMI 3 - Remote APP Signal Out of Range HIGH

Sensor Circuit Check With ServiceMaxx™ Software

Disconnect Body Builder Connector 2. Turn ignition switch to ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Run Continuous Monitor Test and monitor APP1v Short pins 2-A and 2-B	4.5 V to 5 V	If < 4.5 V, check APP1 signal circuit for OPEN. Do Harness Resistance Check (page 1330).
DMM — Measure voltage 2-B to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF4 for short to PWR. If < 4.5 V, check VREF4 for OPEN or short to GND. Do Harness Resistance Check (page 1330).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Disconnect Body Builder Connector 2. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
2-A to C1-13	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2-A to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2-B to C1-37	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2-B to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2-C to C1-24	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2-C to GND	>1k Ω	If < 1k Ω, check for short to GND.

SPN 974 FMI 4 - Remote APP Signal Out of Range LOW

Sensor Circuit Check With ServiceMaxx™ Software

Disconnect Body Builder Connector 2. Turn ignition switch to ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Run Continuous Monitor Test and monitor APP1v Short pins 2-A and 2-B	4.5 V to 5 V	If < 4.5 V, check APP1 signal circuit for OPEN. Do Harness Resistance Check (page 1330).
DMM — Measure voltage 2-B to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF4 for short to PWR. If < 4.5 V, check VREF4 for OPEN or short to GND. Do Harness Resistance Check (page 1330).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Disconnect Body Builder Connector 2. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
2-A to C1-13	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2-A to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2-B to C1-37	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2-B to GND	> 1k Ω	If < 1k Ω, check for short to GND.
2-C to C1-24	< 5 Ω	If > 5 Ω, check for OPEN in circuit.
2-C to GND	>1k Ω	If < 1k Ω, check for short to GND.

SCR (Selective Catalyst Reduction) Sensor

Overview of SCR Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
1569	31	SCR tamper proof warning & protection system inducement severe	• Aftertreatment sensor or actuator circuit Open or disconnected	Step-Based Diagnostics (page 1333)
3826	18	DEF Adaption maxed out with low NOx conversion	• Frozen or restricted lines • Restricted filter • Failed / restricted supply module	Step-Based Diagnostics(page 1334)
4364	18	Low NOx Conversion Detected	• Exhaust system leak(s) • DEF tank, supply module, or doser valve line or connection loose, leaking, damaged, or restricted • Contaminated or degraded DEF • Failed or Restricted Diesel Exhaust Fluid Dosing Valve (DEF: DV) • Restricted DEF supply module filter • DEF crystallization or deposits in exhaust piping • Failed Selective Catalyst Reduction (SCR) Catalyst	Step-Based Diagnostics(page 1337)
4792	7	SCR Catalyst System - Mechanical system not responding or out of adjustment	• Failed SCR catalyst	Step-Based Diagnostics(page 1342)
4792	10	Aftertreatment 1 SCR System abnormal rate of change	•	Step-Based Diagnostics(page 1344)
4792	14	SCR Catalyst System - Out of Calibration	• Failed SCR temperature sensor module	Step-Based Diagnostics(page 1345)

4792	31	Improper Reductant in DEF Tank	•	Step-Based Diagnostics(page 1346)
5246	15	SCR Tamper Proof Inducement Level 1 status	• Aftertreatment sensor or actuator circuit Open or disconnected	Step-Based Diagnostics(page 1347)
7424	3	DEF Lamp Short to PWR		
7424	4	DEF Lamp Short to GND		
7424	5	DEF LampOpen Load / Circuit		

SPN 1569 FMI 31 - SCR Tamperproof Warning and Protection System Inducement Severe

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
The Aftertreatment Control Module (ACM) detects an open circuit in the aftertreatment system or bad Urea quality.	No signal return from an aftertreatment component or bad Urea quality.	Key ON	0 seconds

Fault Overview

Fault sets when any aftertreatment sensor or actuator is Open, disconnected, or bad Urea quality is detected for at least one hour. After one hour (level 2) the engine will be de-rated by 25%. After 4 hours (level 3 and 4) the engine will be de–rated by 40%, and the Engine Control Module (ECM) will illuminate the Red Stop Lamp (RSL) and turn on the warning buzzer. Five MPH Vehicle Speed Limit will be activated on Key OFF/ON event OR Fuel Refill OR when idling for 60 minutes while Level 3 is active. Repeated Offence event (second instance of activating any SCR fault) will also trigger this DTC (Level 3).

Lamp Reaction

The MIL will illuminate when this fault is detected. The Red Stop Lamp (RSL) will illuminate when this fault is active for 4 hours or any of the triggering conditions: Key OFF event OR Fuel Refill OR when idling for 60 minutes took place while Level 3 was active.

Associated Faults

Any Aftertreatment Open circuit faults or bad Urea quality.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Aftertreatment sensor or actuator circuit Open or disconnected or bad Urea quality.

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for active aftertreatment Open circuit fault code(s). Are any aftertreatment Open circuit fault code(s) active?	Yes: Repair active aftertreatment Open circuit fault code(s). In case of bad Urea quality, replace the Urea. After repairs are complete, reset the NVM by setting PP 77-76 to value 1, than retest for SPN 1569 FMI 31.

NOTE: After performing all diagnostic steps, if SPN 1569 FMI 31 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 3826 FMI 18 - DEF Reagent Consumption Below Setpoint

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Restriction in the DEF pressure line between the DEF supply module and DEF Doser Valve (DEF: DV), or in the DEF supply module. Difference between commanded and actual DEF injection.	Measured pressure drop at first test point < 7.25 psi (50 kPa [gauge]) OR Measured pressure drop at second test point < 5.8 psi (40 kPa [gauge]) OR 7.25 psi (50 kPa [gauge]) <= Measured pressure drop at first test point < 26 psi (180 kPa [gauge]) AND 5.8 psi (40 kPa [gauge]) <= Measured pressure drop at second test point < 13.05 psi (90 kPa [gauge]) AND (Pressure drop measured at the first test point minus the pressure drop measured at the second test point) > 2.9 psi (20 kPa [gauge]) First Test Point: Monitor measures pressure drop at test point one if the monitor made a pass or fail decision in the previous operation cycle. Second Test Point: Monitor measures pressure drop at test point two if the monitor measured a pressure drop at test point one in the previous operation cycle AND the measured pressure drop falls in a given range and the monitor was unable to determine the cause of failure and report a pass / fail decision.	Inactive: SPN 3361 FMI 3, 4 (DEFSP); SPN 3362 FMI 31 (DEFSP), SPN 4334 FMI 2, 3, 4, 16, 18 (DEF: LP); SPN 4360 FMI 3, 4 (SCRIT); SPN 4363 FMI 3, 4 (SCROT); SPN 5394 FMI 5 (DEF: DV); SPN 5742 FMI 9 (DOC/DPF Temp); SPN 5743 FMI 3, 4, 9, 11, 12 (SCR Temp) Exhaust gas flow rate >30 g/sec Exhaust gas temperature between 356°F and 1112°F (180°C and 600°C) SCR catalyst temperature between 392°F and 932°F (200°C and 500°C) The monitor has not already measured a pressure drop at either the first or second test point, and made a pass or fail decision in this current operation cycle. The monitor has not already measured a pressure drop at the first test point, and set a parameter in run-time memory indicating that the monitor is unable to determine the cause of failure and whether a pass or fail decision should be reported, so is requesting that a second intrusive test is performed in the next operation cycle. Amount of DEF injected since DEF supply module last primed: ≥ 0.028 L DEF supply module has completed priming and is actively maintaining the target DEF line pressure.	9.4 seconds

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects a restriction in the Diesel Exhaust Fluid (DEF) lines, DEF Doser Valve (DEF: DV), or in the DEF supply module. Maximum adaption limits reached for DEF injection, and NOx conversion remains low.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHV); SPN 4334 FMI 2, 16 and 18 (DEF: LP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEF: DV); SPN 5745 (DEF: SMH); SPN 5746 (DEF: SMH); SPN 5798 (DEF: SMH); SPN 520668 (AFT system); and SPN 520669 (AFT system)

SPN 3216 (NOx IN); SPN 3218 (NOx IN); SPN 3226 (NOx OUT); SPN 3228 (NOx OUT)

SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5742 (DOC / DPF Temp);SPN 5743 (SCR Temp)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Frozen or restricted DEF pressure line
- Restricted DEF supply module filter
- Failed / restricted DEF supply module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 (NOx IN), SPN 3218 (NOx IN), SPN 3226 (NOx OUT), and SPN 3228 (NOx OUT). Is EST DTC list free of SPN 3216, SPN 3218, SPN 3226, and SPN 3228?	Yes: Go to step 2. No: Repair SPN 3216, SPN 3218, SPN 3226, and SPN 3228. After repairs are complete, retest for SPN 3826 FMI 18.

Step	Action	Decision
2	Using EST with ServiceMaxx™ software, check DTC list for SPN 4377 (NH_3), SPN 4380 (NH_3), and SPN 4382 (NH_3). Is EST DTC list free of SPN 4377, SPN 4380, and SPN 4382?	Yes: Go to step 3. No: Repair SPN 4377, SPN 4380, and SPN 4382. After repairs are complete, retest for SPN 3826 FMI 18.

Step	Action	Decision
3	Using EST with ServiceMaxx™ software, check DTC list for SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5742 (DOC / DPF Temp); and SPN 5743 (SCR temp sensor module). Is EST DTC list free of SPN 4360 FMI 2, 3, and 4; SPN 4363 FMI 2, 3, and 4; SPN 5742; and SPN 5743?	Yes: Go to step 4. No: Repair SPN 4360 FMI 2, 3, and 4; SPN 4363 2, 3, and 4; SPN 5742; and SPN 5743. After repairs are complete, retest for SPN 3826 FMI 18.

Step	Action	Decision
4	Using EST with ServiceMaxx™ software, check DTC list for SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHV); SPN 4334 FMI 2, 16, and 18 (DEF: LP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEF: DV); SPN 5745 (DEF: SMH); SPN 5746 (DEF: SMH); SPN 5798 (DEF: SMH); SPN 520668 (AFT system); and SPN 520669 (AFT system). Is EST DTC list free of SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16, and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 5745; SPN 5746; SPN 5798; SPN 520668; and SPN 520669?	Yes: Go to step 5. No: Repair SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16, and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 5745; SPN 5746; SPN 5798; SPN 520668; and SPN 520669. After repairs are complete, retest for SPN 3826 FMI 18.

Step	Action	Decision
5	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEF: DV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections; and restrictions. Are the DEF tank, DEF supply module, and DEF: DV lines and connections in good condition and unrestricted?	Yes: Go to step 6. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 3826 FMI 18.

Step	Action	Decision
6	Check DEF supply module pressure line for restrictions. Disconnect both ends of pressure line and blow compressed air through the line. Does compressed air flow freely through the pressure line?	Yes: Perform DEF supply module flush . If DEF: DV still does not operate correctly, replace DEF supply module. After repairs are complete, retest for SPN 3826 FMI 18. No: Clean or replace DEF supply module pressure line. After repairs are complete, retest for SPN 3826 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 3826 FMI 18 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4364 FMI 18 - Low NOx Conversion Detected

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment system Nitrogen Oxides (NOx) conversion less than expected.	Control system detects low NOx conversion rate in aftertreatment system.	Inactive: SPN 3242 FMI 2, 3, and 4 (DPFIT); SPN 3480 FMI 2, 3, 4, and 17 (AFT: FP1); SPN 3482 FMI 2, 3, 4, and 7 (AFTFSV); SPN 3490 FMI 3 and 4 (AFT: PAV); SPN 3556 FMI 2 and 5 (AFTFI); SPN 3610 FMI 2, 3, and 4 (DPFDP / outlet pressure sensor); SPN 4360 FMI 0 (SCRIT); SPN 4363 FMI 0 (SCROT); SPN 4765 FMI 2, 3, and 4 (DOCIT); SPN 4794 FMI 31 (SCR); SPN 5742 FMI 3, 4, 11, and 12 (DOC / DPF temp sensor module) EGR Off Engine Protection is not active. Estimated SCR catalyst bed temperature between 356°F (180°C) to 842°F (450°C) Exhaust Flow rate 100 g/s to 440 g/s NOx IN 100 ppm to 826 ppm NOx OUT 0 ppm to 766 ppm DEF injection rate > 0.07 ml/sec Ambient pressure (absolute) 12 psi (80 kPa) to 23 psi (160 kPa) Ambient air temperature ≥ 19.9°F (-6.7°C) Rate of change of NOx IN < 40 ppm/sec Rate of change of estimated SCR bed temperature ≤ 0.5 °C/sec	7 seconds

		Rate of change of estimated exhaust mass flow < 10 g/sec SCR system NOx conversion efficiency is > -70%, urea deposit timer is < 150 hours, and DPFDP high error is not present for longer than 29 seconds. Ammonia to NOx ratio is ≥ 0.01 for 5 seconds. Timer to exit this enable condition is enabled if Ammonia to NOx Ratio is < 0.01 for 3 seconds consecutively 0.1 < Filtered ammonia to NOx ratio < 3.	

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Nitrogen Oxides (NOx) conversion efficiency of the Selective Catalyst Reduction (SCR) catalyst is less than expected. Engine torque will be reduced if fault is active for an extended period of time.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHV); SPN 4334 FMI 2, 16 and 18 (DEF: LP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEF: DV); SPN 520668 (AFT system); and SPN 520669 (AFT system)

SPN 3216 (NOx IN), SPN 3218, SPN 3226 (NOx OUT) ; SPN 3228 (NOx OUT)

SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT), SPN 5743 (SCR temp sensor module)

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 4 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Exhaust system leak(s)
- DEF tank, supply module, or doser valve line or connection loose, leaking, damaged, or restricted
- Contaminated or degraded DEF
- Failed or Restricted Diesel Exhaust Fluid Dosing Valve (DEF: DV)
- Restricted DEF supply module filter
- DEF crystallization or deposits in exhaust piping
- Failed Selective Catalyst Reduction (SCR) Catalyst

Step	Action	Decision
1	Check for active Nitrogen Oxides (NOx) sensor module fault codes. Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 3216 (NOx IN), SPN 3218 (NOx IN), SPN 3226 (NOx OUT), and SPN 3228 (NOx OUT). Is EST DTC list free of SPN 3216, SPN 3218, SPN 3226, and SPN 3228?	Yes: Go to step 2. No: Repair SPN 3216, SPN 3218, SPN 3226, and SPN 3228. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
2	Check for active Ammonia (NH_3) sensor module fault codes. Using EST, check DTC list for SPN 4377 (NH_3), SPN 4380 (NH_3), and SPN 4382 (NH_3). Is EST DTC list free of SPN 4377, SPN 4380, and SPN 4382?	Yes: Go to step 3. No: Repair SPN 4377, SPN 4380, and SPN 4382. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
3	Check for active Selective Catalyst Reduction (SCR) temperature sensor module fault codes. Using EST, check DTC list for SPN 4360 FMI 2, 3 and 4 (SCRIT); SPN 4363 2, 3, and 4 (SCROT); and SPN 5743 (SCR temp sensor module). Is EST DTC list free of SPN 4360 FMI 2, 3 and 4; SPN 4363 2, 3, and 4; and SPN 5743?	Yes: Go to step 4. No: Repair SPN 4360 FMI 2, 3 and 4; SPN 4363 2, 3, and 4; and SPN 5743. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
4	Check for active Diesel Exhaust Fluid (DEF) dosing system fault codes. Using EST, check DTC list for SPN 3361 FMI 2, 3, and 4 (DEFSP); SPN 3362 FMI 31 (DEFSP); SPN 3363 FMI 3, 4, and 7 (DEFTHV); SPN 4334 FMI 2, 16 and 18 (DEF: LP); SPN 4340 FMI 3 and 5 (DEFPLH); SPN 4342 FMI 3 and 5 (DEFRLH); SPN 4344 FMI 3 and 5 (DEFSLH); SPN 5394 FMI 5 and 7 (DEF: DV); SPN 520668 (AFT system); and SPN 520669 (AFT system). Is EST DTC list free of SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16 and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 520668; and SPN 520669?	Yes: Go to step 5. No: Repair SPN 3361 FMI 2, 3, and 4; SPN 3362 FMI 31; SPN 3363 FMI 3, 4, and 7; SPN 4334 FMI 2, 16 and 18; SPN 4340 FMI 3 and 5; SPN 4342 FMI 3 and 5; SPN 4344 FMI 3 and 5; SPN 5394 FMI 5 and 7; SPN 520668; and SPN 520669. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
5	Inspect exhaust system for leaks and physical damage. Is the exhaust system free of leaks and physical damage?	Yes: Go to step 6. No: Repair leaks or physical damage. After repairs are complete, retest for SPN 4364 FMI 18.

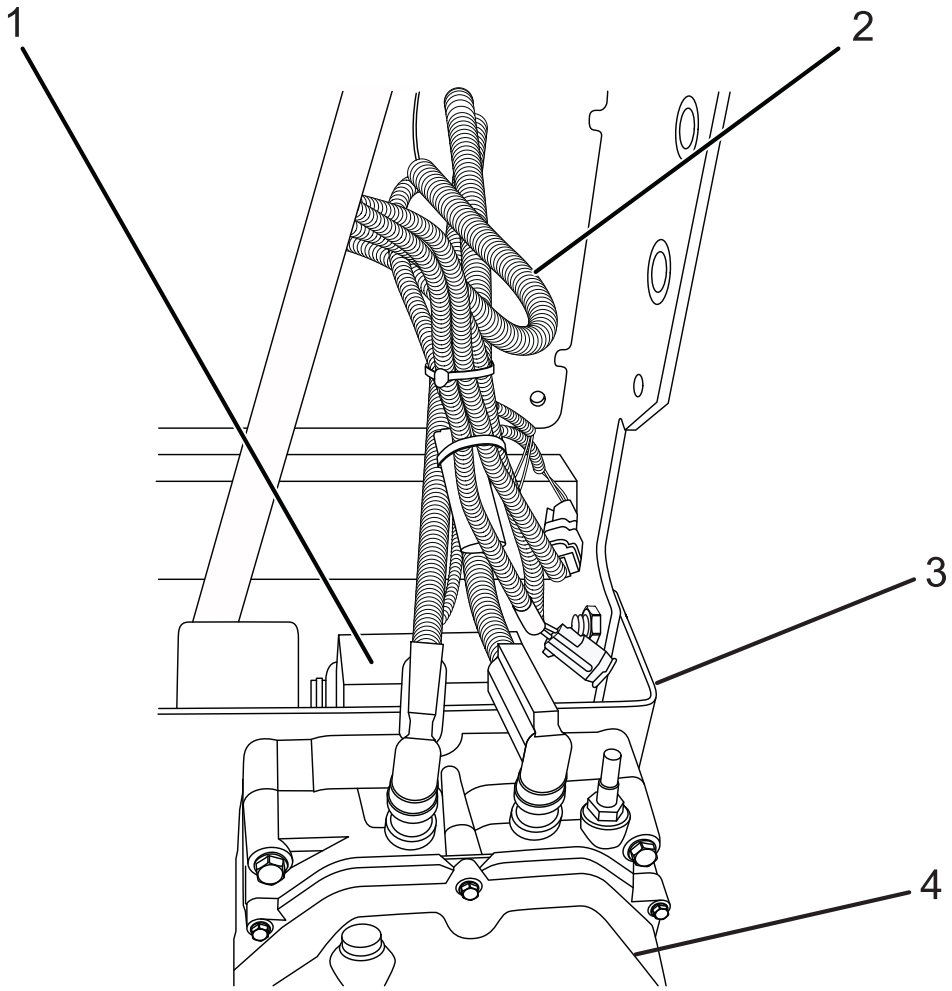

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Figure 526 DEF Supply Module Location

1. Power Distribution Module (PDM)
2. Diesel Exhaust Fluid (DEF) lines
3. DEF tank bracket
4. DEF supply module

Step	Action	Decision
6	Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser Valve (DEF: DV) lines and connections for: cracks and pitting; loose, leaking, or damaged connections; and restrictions. Are the DEF tank, DEF supply module, and DEF: DV lines and connections in good condition and unrestricted?	Yes: Go to step 7. No: Repair or replace failed line or connection. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
7	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 8. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
8	Check decomposition tube for crystallization. Disconnect decomposition tube from exhaust system (see Exhaust System Service Manual) and inspect for DEF crystallization. Is decomposition tube free of DEF crystallization?	Yes: Go to step 9. No: Remove DEF crystallization from decomposition tube. After repairs are complete, retest for SPN 4364 FMI 18.

Step	Action	Decision
9	Verify correct Diesel Exhaust Fluid Doser Valve (DEF: DV) operation. Using EST, do the DEF Doser Pump Override Test . Is the DEF: DV operating correctly?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4364 FMI 18. No: Perform DEF supply module flush using 18-200-01. See DEF Supply Module Flush . If DEF: DV still does not operate correctly, replace DEF: DV. After repairs are complete, retest for SPN 4364 FMI 18.

NOTE: After performing all diagnostic steps, if SPN 4364 FMI 18 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4792 FMI 7 - Mechanical System Not Responding or out of Adjustment

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
A malfunctioning Selective Catalyst Reduction (SCR) catalyst has been detected.	NOx conversion rate does not meet ACM predetermined value.	Key-On Engine-Running (KOER) DPF Filter Regeneration procedure running	1 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that the Nitrogen Oxides (NOx) conversion across the Selective Catalyst Reduction (SCR) catalyst is lower than expected, indicating a malfunctioning SCR catalyst.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4094 FMI 31 (contaminated or degraded DEF); SPN 4364 FMI 18 (Low NOx conversion); and SPN 4794 FMI 31 (missing SCR catalyst)

Drive Cycle to Determine Fault Status

Drive Cycle 1 in the 2013 HD-OBD Diagnostic Reference Manual.

NOTE: Diagnostics for this fault code only runs during the Electronic Service Tool (EST) DPF Filter Regeneration procedure.

Fault Facts

This fault code is only used to assist in troubleshooting fault codes SPN 4094 FMI 31 (AFT system), SPN 4364 FMI 18 (AFT system), and SPN 4794 FMI 31 (AFT system). One of these associated fault codes being active while SPN 4792 FMI 7 is active indicate the following conditions must be present:

- Diesel Exhaust Fluid (DEF) uncontaminated and in good condition
- Properly functioning DEF dosing system (no leaks, restrictions, or failed components)
- No exhaust system leaks
- Decomposition reactor tube free of DEF crystallization and deposits
- Properly installed SCR catalyst

Possible Causes

- Failed SCR catalyst

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4094 FMI 31 (contaminated or degraded DEF); SPN 4364 FMI 18 (Low NOx conversion); and SPN 4794 FMI 31 (missing SCR catalyst). Is EST DTC list free of SPN 4094 FMI 31, SPN 4364 FMI 18, and SPN 4794 FMI 31?	Yes: Clear fault and retest for SPN 4792 FMI 7. No: Replace the SCR catalyst. After repairs are complete, retest for SPN 4792 FMI 7.

NOTE: After performing all diagnostic steps, if SPN 4792 FMI 7 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4792 FMI 10 - Aftertreatment 1 SCR System abnormal rate of change

Condition / Description	Setting Criteria	Enable Conditions / Values
TBD	TBD	Key ON

Fault Overview

Lamp Reaction

Associated Faults

Fault Facts

Drive Cycle to Determine Fault Status

Possible Causes

•

CONTENT
UNDER
DEVELOPMENT

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SPN 4792 FMI 14 - Out of Calibration

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Internal failure of the Selective Catalyst Reduction (SCR) temperature sensor module	Aftertreatment Control Module (ACM) detects an internal circuit failure of the SCR temperature sensor module.	Key ON	2 event

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects an internal circuit error in the Selective Catalytic Reduction (SCR) temperature sensor module, or wrong SCR temperature sensor module installed. Active and parked regeneration of the aftertreatment system is disabled, and the Exhaust Gas Recirculation (EGR) valve is closed.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

None

Drive Cycle to Determine Fault Status

Drive Cycle 2 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4792 FMI 14 (AFT). Is SPN 4792 FMI 14 active?	Yes: Replace the SCR temperature sensor module. After repairs are complete, retest for SPN 4792 FMI 14.

NOTE: After performing all diagnostic steps, if SPN 4792 FMI 14 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 4792 FMI 31 - Improper Reductant in DEF Tank

Condition / Description	Setting Criteria	Enable Conditions / Values
TBD	TBD	Key ON

Fault Overview

Lamp Reaction

Associated Faults

Fault Facts

Drive Cycle to Determine Fault Status

Possible Causes

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CONTENT
UNDER
DEVELOPMENT

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SPN 5246 FMI 15 - SCR Tamper Proof Inducement Level 1 Status

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Detects an Open circuit in the aftertreatment system.	No signal return from an aftertreatment component	Key ON	0 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects that any Aftertreatment (AFT) sensor or actuator is Open or disconnected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

Any Aftertreatment Open circuit faults.

Drive Cycle to Determine Fault Status

Drive Cycle 1 in the 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Aftertreatment sensor or actuator circuit Open or disconnected

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for active aftertreatment Open circuit fault code(s). Are any aftertreatment Open circuit fault code(s) active?	Yes: Repair active aftertreatment Open circuit fault code(s). After repairs are complete, retest for SPN 5246 FMI 15.

NOTE: After performing all diagnostic steps, if SPN 5246 FMI 15 remains, verify each step was completed correctly, and the proper decision was made. Notify supervisor for further action.

SPN 7424 FMI 3 - DEF Lamp Short to PWR

CONTENT
UNDER
DEVELOPMENT

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SPN 7424 FMI 4 - DEF Lamp Short to GND

CONTENT
UNDER
DEVELOPMENT

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SPN 7424 FMI 5 - DEF Lamp Open Load / Circuit

CONTENT
UNDER
DEVELOPMENT

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SCR Temperature Sensor Module

Overview of SCR TemperatureSensor Group

SPN	FMI	Condition	Possible Causes	Actions
5743	3	SCR Temperature Sensor Module Out of Range HIGH	• Failed SCR temperature sensor module • Incorrect Battery Wiring (in series instead of in parallel) • Charging voltage excessive	Step-Based Diagnostics (page 1354)
5743	4	SCR Temperature Sensor Module Out of Range LOW	• Failed SCR temperature sensor module • GND circuit intermittent Open or high resistance • SWBAT circuit intermittent short to ground or Open	Step-Based Diagnostics (page 1356)
5743	11	SCR Temperature Sensor Module signal erratic, intermittent, or incorrect	• Missing, damaged, or restricted air flow across SCR temperature sensor module • SWBAT circuit intermittent Open or short to GND • GND circuit intermittent Open or short to PWR • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1358)

5743	16	SCR Temperature Sensor Module above Maximum Temperature	• Missing, damaged, or restricted air flow across SCR temperature sensor module • Exhaust leak(s) • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1361)
5743	19	SCR Temperature sensor module not detected on J1939	•	

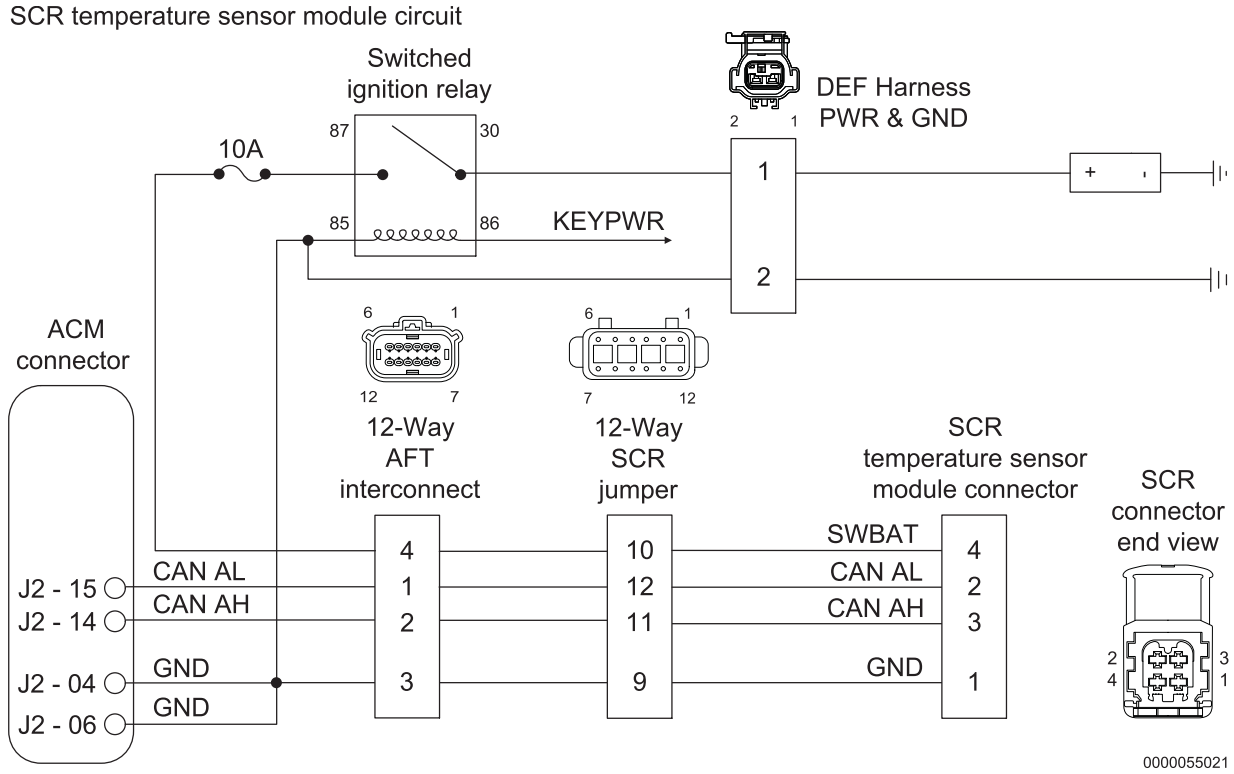

Figure 532 SCR Temperature Sensor Module Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Selective Catalyst Reduction (SCR) temperature sensor module monitors signals from the SCR Inlet Temperature (SCRIT), and SCR Outlet Temperature (SCROT) sensors, and communicates to the Aftertreatment Control Module (ACM) over the Controller Area Network (CAN). Engine torque will be reduced if the engine

is operated for a limited period of time with this fault code active. Engine torque will be reduced and vehicle speed will be limited after extended engine operation with the fault active.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- Breakout Harness 18-537-01 (58-pin)
- Breakout Harness 18-648-01
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

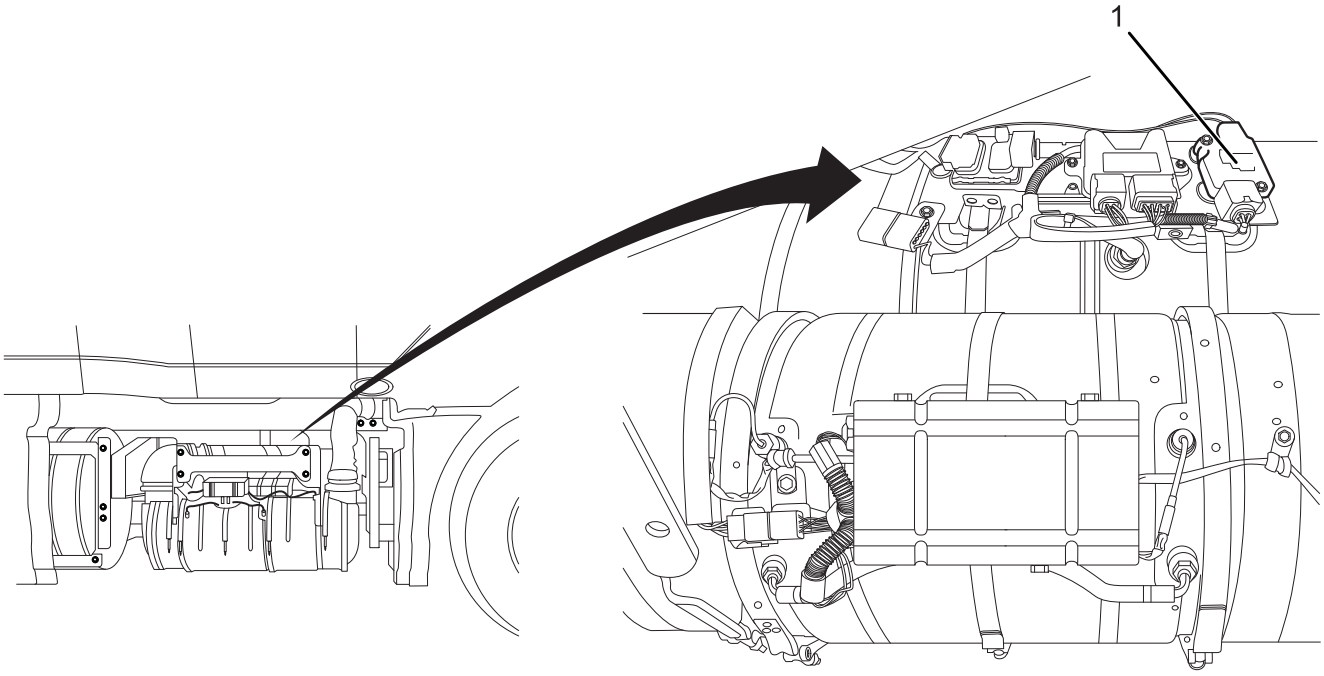

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Figure 533 SCR Temperature Sensor Module Location

1. Selective Catalyst Reduction (SCR) temperature sensor module

SPN 5743 FMI 3 - SCR Thermocouple Controller Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module has detected high supply voltage.	SCR temperature sensor module supply voltage > 18 V ± 1 V	Key ON	4.2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction (SCR) temperature sensor module supply voltage is high.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 168 FMI 16 (ACM).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

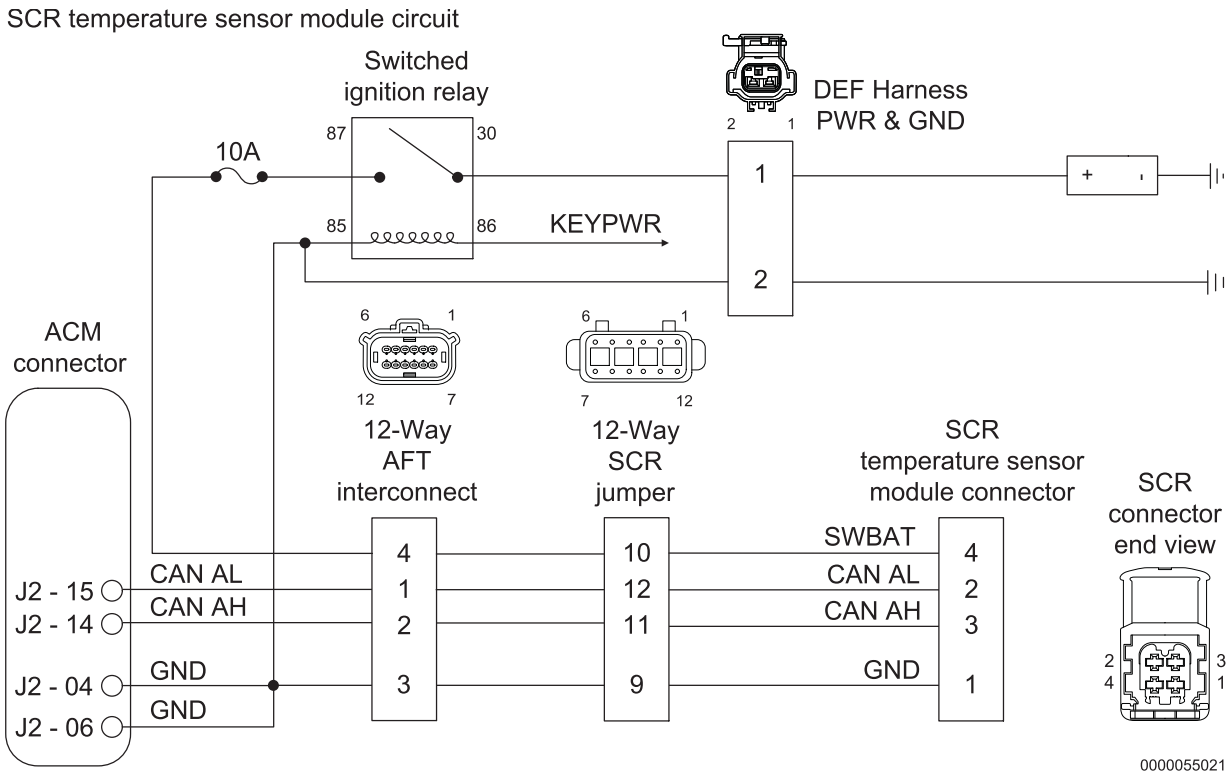


Figure 534 SCR Temperature Sensor Module Circuit Diagram

Possible Causes

- Failed SCR temperature sensor module
- Incorrect battery wiring (series instead of in parallel)
- Charging voltage excessive

Step	Action	Decision
1	Inspect connections at Selective Catalyst Reduction (SCR) temperature sensor module. Key OFF, disconnect SCR temperature sensor module connector. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5743 FMI 3.

NOTE: Verify charging system is charging at specified voltage.

Step	Action	Decision
2	Check for PWR to the SCR temperature sensor module. Connect 18-648-01 to vehicle harness and leave SCR temperature sensor module disconnected. Key-On Engine-Off (KOEO) use a DMM to measure voltage between breakout harness pin-1 and pin-4. Is voltage between pin-1 and pin-4 within 0.5 volts of battery voltage?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 5743 FMI 3 No: Repair incorrect Battery Wiring. After repairs are complete, retest for SPN 5743 FMI 3

NOTE: After performing all diagnostic steps, if SPN 5743 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5743 FMI 4 - SCR Thermocouple Controller Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module has detected low supply voltage.	SCR temperature sensor module supply voltage < 6.3 V ± 0.3 V	Key ON	4.2 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction (SCR) temperature sensor module supply voltage is low.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 168 FMI 18 (ACM).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

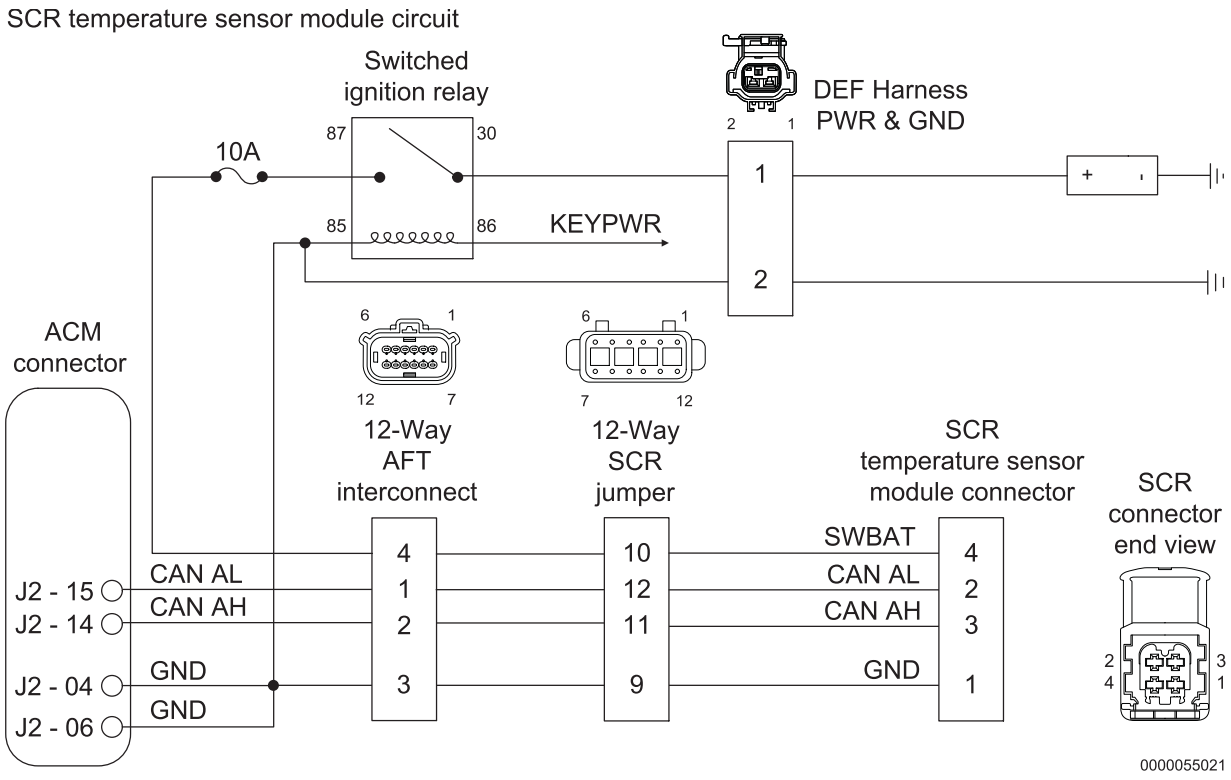


Figure 535 SCR Temperature Sensor Module Circuit Diagram

Possible Causes

- Failed SCR temperature sensor module
- GND circuit intermittent Open or high resistance
- SWBAT circuit intermittent short to GND orr Open

Step	Action	Decision
1	Inspect connections at Selective Catalyst Reduction (SCR) temperature sensor module. Key OFF, disconnect SCR temperature sensor module connector. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5743 FMI 4.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
2	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 168 FMI 16 and 18. Is EST DTC list free of SPN 168 FMI 16 and 18?	Yes: Go to step 3. No: Repair SPN 168 FMI 16 and 18. After repairs are complete, retest for SPN 5743 FMI 4.

Step	Action	Decision
3	Check SCR temperature sensor module for battery voltage and ground. With SCR temperature sensor module connector disconnected, connect Breakout Harness 18-648-01. Key-On Engine Off (KOEO), use a DMM to measure voltage between SCR temperature sensor module pin-4 and pin-1. Is voltage within 0.5 volts of battery voltage?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 5743 FMI 4. No: Go to step 4.

Step	Action	Decision
4	Check SWBAT circuit for Open or short to ground. With SCR temperature sensor module connector disconnected, connect Breakout Harness 18-648-01. KOEO, use a DMM to measure voltage between SCR temperature sensor module pin-4 and a known good ground. Is voltage within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance in GND circuit between SCR temperature sensor module connector pin-1 and ground. After repairs are complete, retest for SPN 5743 FMI 4 No: Repair Open or short to ground in SWBAT circuit between SCR temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5743 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 5743 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5743 FMI 11 - SCR Thermocouple Controller Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module has detected an intermittent power supply voltage drop that results in a reset internal to the module.	Number of SCR temperature sensor module power reset events within a 300 second window is ≥ 5	Key ON Time after Key ON ≥ 5 seconds	5 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the number of SCR temperature sensor module power reset events within a 300 second window is ≥ 5 counts. Active and parked regeneration is disabled. Exhaust Gas Recirculation (EGR) valve operation will be disabled.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN's 168 FMI 16 and 18 (ACM).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

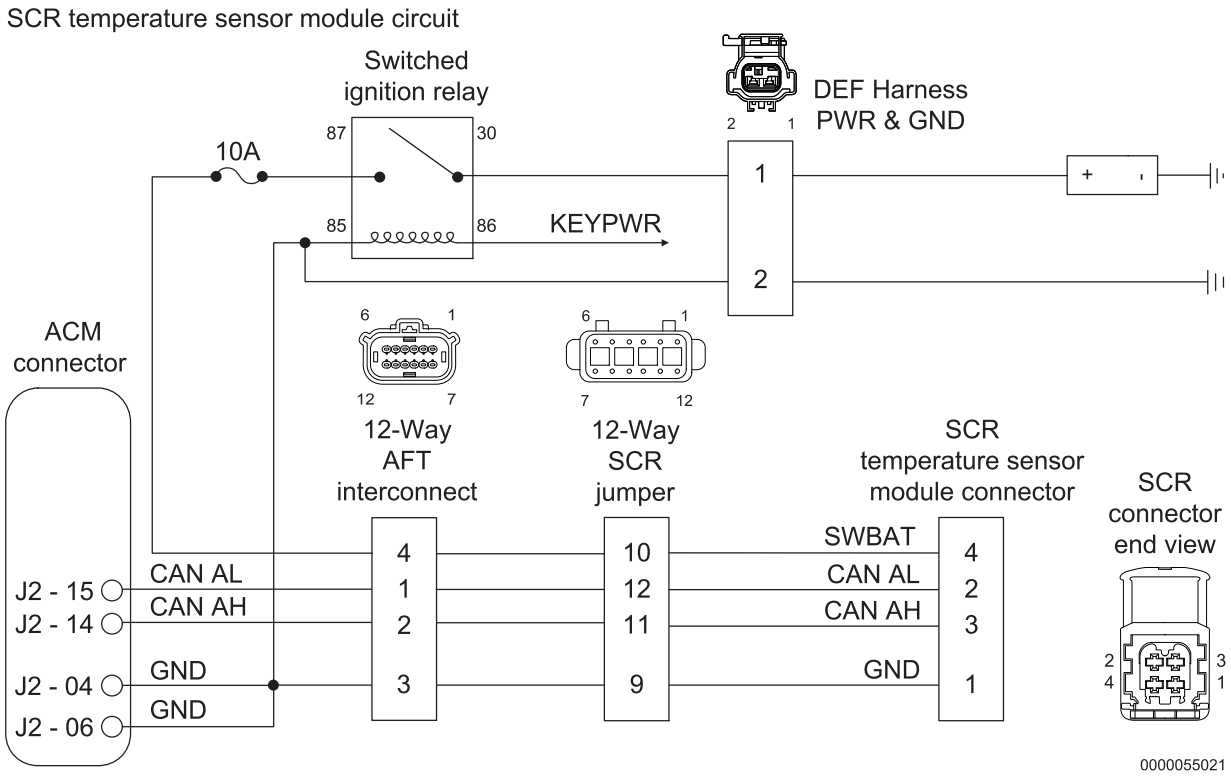


Figure 536 SCR Temperature Sensor Module Circuit Diagram

Possible Causes

- Missing, damaged, or restricted air flow across SCR temperature sensor module
- SWBAT circuit intermittent Open or short to GND
- GND circuit intermittent Open or short to PWR
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 168 FMI 16 and 18 (ACM PWR). Is EST DTC list free of SPN 168 FMI 16, and 18?	Yes: Go to step 2. No: Repair SPN 168 FMI 16, and 18. After repairs are complete, retest for SPN 5743 FMI 11.

Step	Action	Decision
2	Inspect for damaged or missing Selective Catalyst Reduction (SCR) temperature sensor module heat shield. Check for air flow restrictions around SCR temperature sensor module (mud, aftermarket shields, flaps, or brackets installed). Is SCR temperature sensor module heat shield free of air restrictions and is not missing or damaged?	Yes: Go to step 3. No: Remove air restriction, or replace or repair SCR temperature sensor module heat shield. After repairs are complete, retest for SPN 5743 FMI 11.

Step	Action	Decision
3	Inspect connections at SCR temperature sensor module. Key OFF, disconnect SCR temperature sensor module. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5743 FMI 11.

Step	Action	Decision
4	Check SWBAT circuit for intermittent Open or short to ground. With SCR temperature sensor module connector disconnected, connect Breakout Harness 18-648-01. Key-On Engine-Off (KOEO), use a DMM to measure voltage between SCR temperature sensor module pin-4 and a known good ground. (Wiggle test may be required). Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 5. No: Repair intermittent, Open or short to ground in SWBAT circuit between SCR temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5743 FMI 11.

Step	Action	Decision
5	Check GND circuit for intermittent Open or short to PWR. With SCR temperature sensor module connector disconnected, connect Breakout Harness 18-648 -01. Key-On Engine-Off (KOEO), use a DMM to measure voltage between SCR temperature sensor module pin-1 and pin-4. (Wiggle test may be required). Is voltage within 0.5 volts of battery voltage?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 5743 FMI 11. No: Repair intermittent, Open or short to PWR in GND circuit between SCR temperature sensor module connector pin-1 and GND. After repairs are

		complete, retest for SPN 5743 FMI 11.

NOTE: After performing all diagnostic steps, if SPN 5743 FMI 11 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5743 FMI 16 - SCR Thermocouple Controller Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module has detected internal temperature too high.	SCR temperature sensor module > 302°F (150°C)	Key-On Engine-Running (KOER)	3.8 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction (SCR) temperature sensor module is greater than 302˚F (150˚C). Active and parked regeneration is disabled. Exhaust Gas Recirculation (EGR) valve operation will be disabled.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Fault Facts

This fault will go inactive after the SCR temperature sensor module temperature drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage.

Associated Faults

SPN 4360 FMI 0, 15, 16 (SCRIT); and SPN 4363 FMI 0, 15, 16 (SCROT).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Missing, damaged, or restricted air flow across SCR temperature sensor module
- Exhaust leak(s)
- Failed SCR temperature sensor module

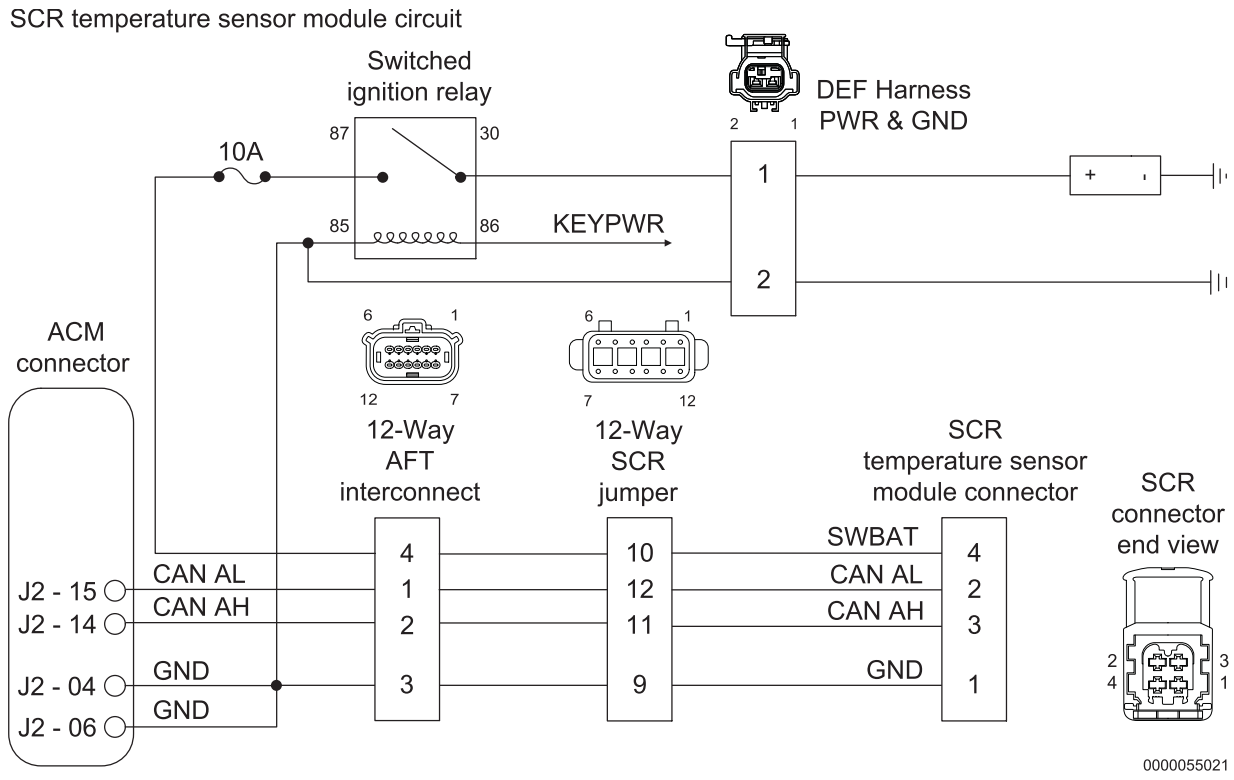


Figure 537 SCR Temperature Sensor Module Circuit Diagram

Possible Causes

- Missing, damaged, or restricted air flow across SCR temperature sensor module
- Exhaust leak(s)
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 4360 FMI 0, 15, 16 (SCRIT); and SPN 4363 FMI 0, 15, 16 (SCROT). Is EST DTC list free of SPN 4360 FMI 0, 15, 16; and SPN 4363 FMI 0, 15, 16?	Yes: Go to step 2. No: Repair SPN 4360 FMI 0, 15, 16; and SPN 4363 FMI 0, 15, 16. After repairs are complete, retest for SPN 5743 FMI 16.

Step	Action	Decision
2	Inspect for damaged or missing Selective Catalyst Reduction (SCR) temperature sensor module heat shield. Check for air flow restrictions around SCR temperature sensor module (mud, aftermarket shields, flaps, or brackets installed). Is SCR temperature sensor module heat shield free of air restrictions and is not missing or damaged?	Yes: Go to step 3. No: Remove air restriction, or replace or repair SCR temperature sensor module heat shield. After repairs are complete, retest for SPN 5743 FMI 16.

Step	Action	Decision
3	Inspect exhaust system for leaks and physical damage. Is exhaust system free of leaks and physical damage?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 5743 FMI 16.
		No: Repair or replace leaking or damaged exhaust components. Refer to Fault Facts. After repairs are complete, retest for SPN 5743 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 5743 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 5743 FMI 19 - EGTS Module (SCR) Not Detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
DPF temperature sensor module not detected on J1939 Controller Area Network (CAN).	Aftertreatment Control Module (ACM) loses J1939 data link communications with DOC / DPF temperature sensor module.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 data link communications with the Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) temperature sensor module.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

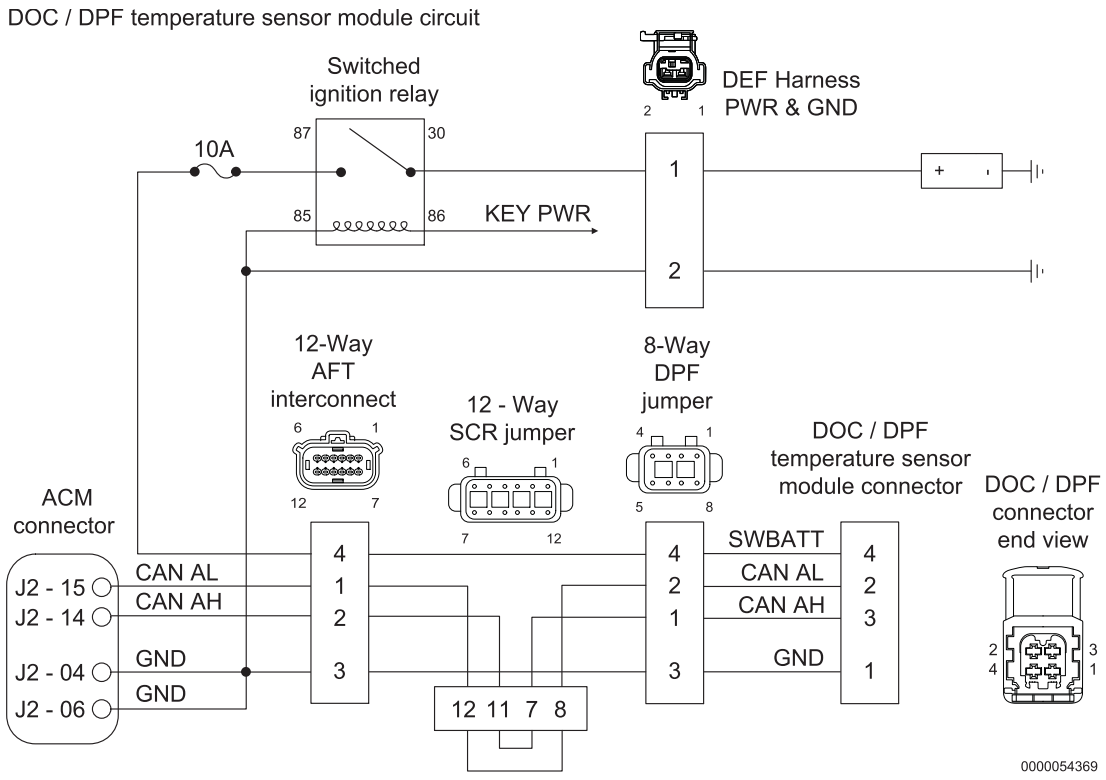


Figure 538 DOC / DPF Temperature Sensor Module Circuit Diagram

Possible Cause

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed DOC / DPF temperature sensor module

NOTE: If more than one of the following sensor modules fail (or set a fault), suspect a common power circuit, ground circuit, or switched ignition relay problem. The following components share power and ground circuits: DOC / DPF temperature sensor module, SCR temperature sensor module, NH_3 sensor module, NOx OUT sensor module, NOx IN sensor module, and DEFTLT sensor module.

NOTE: Verify batteries are fully charged and connections are clean.

Step	Action	Decision
1	Inspect connections at DOC / DPF temperature sensor module. Key OFF, disconnect temperature sensor module. Check DOC / DPF temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DOC / DPF temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
2	Check voltage to the DOC / DPF temperature sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-649-01 connected between temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-4 and a known good ground. Is voltage at pin-4 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between DOC / DPF temperature sensor module pin-1 and ground. After repairs are complete, retest for SPN 5742 FMI 19. No: Repair Open or short to ground between DOC / DPF temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between DOC / DPF temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between DOC / DPF temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between DOC / DPF temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between DOC / DPF temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 5742 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-649-01 connected between DOC / DPF temperature sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace DOC / DPF temperature sensor module. After repairs are complete, retest for SPN 5742 FMI 19. No: Repair short between DOC / DPF temperature sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 5742 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 5742 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SCRIT (Selective Catalyst Reduction Inlet Temperature) Sensor

Overview of SCRIT Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
4360	0	SCRIT above Critical Temperature	• Contaminated Diesel Exhaust Fluid (DEF) • Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1369)
4360	2	SCRIT signal erratic, intermittent, or incorrect	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1373)
4360	3	SCRIT signal Out of Range HIGH	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1374)
4360	4	SCRIT signal Out of Range LOW	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1375)
4360	16	SCRIT Above Maximum Temperature	• Contaminated Diesel Exhaust Fluid (DEF) • Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV))	Step-Based Diagnostics

			• Failed SCR temperature sensor module
4360	19	SCRIT signal not detected on J1939	•

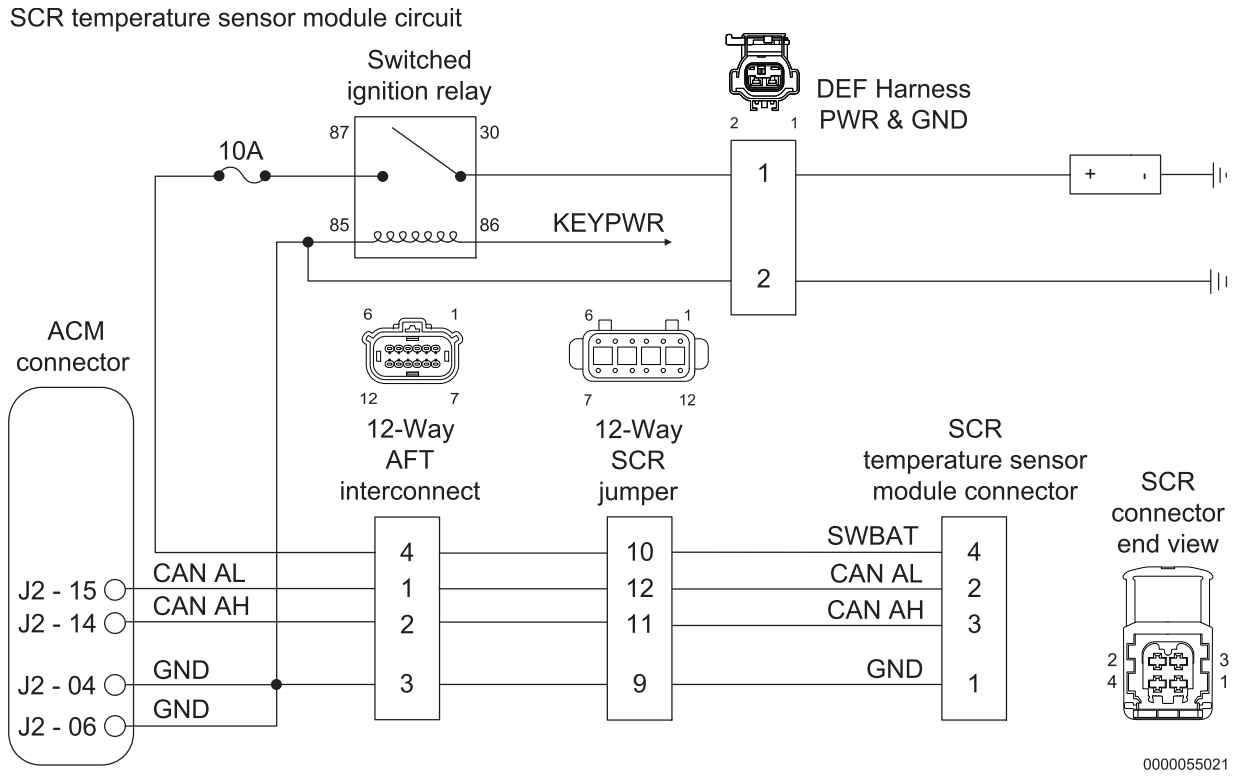


Figure 539 SCR Temperature Sensor Module Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor measures the exhaust temperature at the inlet of the SCR catalyst. The SCR temperature sensor module is a smart device that communicates with the Aftertreatment Control Module (ACM) via the Controller Area Network (CAN). The SCRIT sensor is part of the SCR temperature sensor module, and is not serviceable individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18-537-01 (58-pin)
- Breakout Harness 18-648-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software

- Interface cable (RP1210B compliant supporting J1939 and J1708)

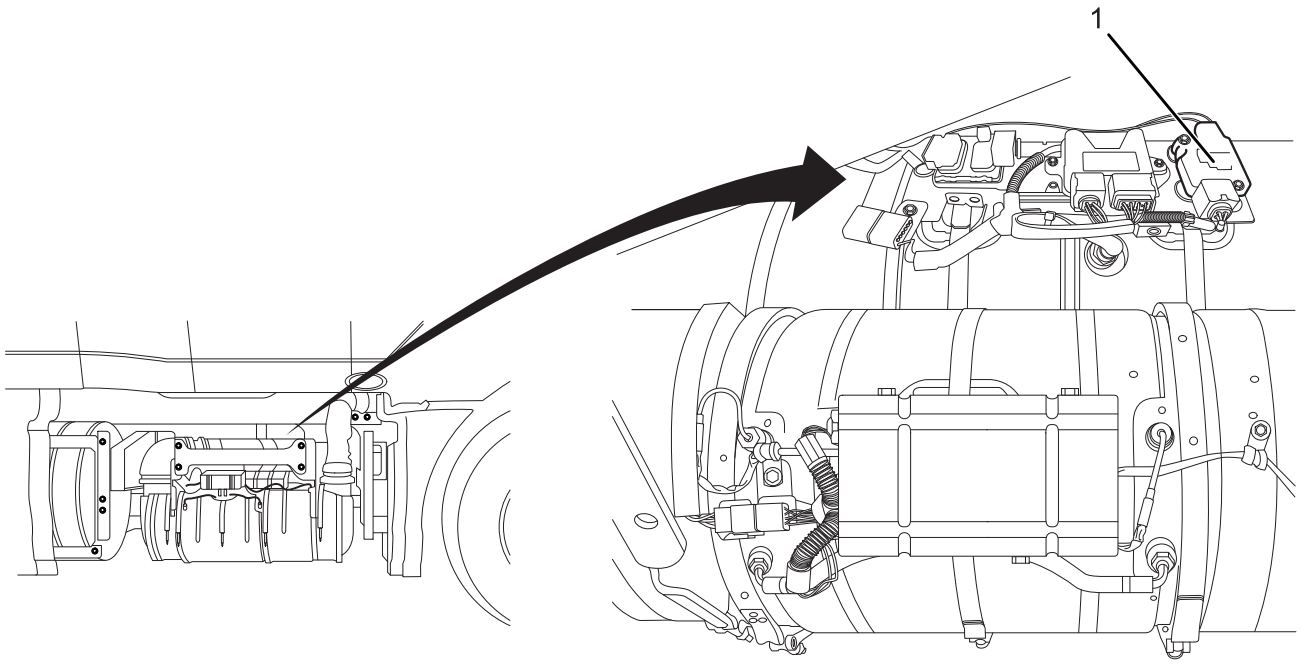


Figure 540 SCR Temperature Sensor Module Location

1. Selective Catalyst Reduction (SCR) temperature sensor module

SPN 4360 FMI 0 - SCRIT Above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction Inlet Temperature (SCRIT) continuously above a severe, high threshold.	SCRIT > 1472°F (800 °C)	Key-On Engine-Running (KOER) Inactive: SPN 4360 FMI 2, 3, and 4 (SCRIT); and SPN 5743 FMI 3, 4 and 11 (SCR).	20 seconds

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor reading is greater than 1472°F (800°C) for more than 20 seconds. The Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled and the engine can possibly be shut down.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); and SPN 5743 FMI 3, 4, 11, and 16 (SCR).

Fault Fact

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the SCRIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

NOTE: If more than one DOC, DPF and / or SCR temperature sensor over temperature fault code(s) are present, check for unregistered fuel or oil in the exhaust.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated Diesel Exhaust Fluid (DEF)
- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR) fault codes. Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4360 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4360 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
2	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use special tool DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30-34 percent and Not contaminated?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4360 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4360 FMI 0. No: Repair failed valve train components. After repairs are complete retest for SPN 4360 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove the exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil or fuel contamination?	Yes: Go to step 7. No: Repair lube oil or fuel leak to exhaust. See Lube Oil to Exhaust , or See Fuel to Exhaust . After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
10	Compare SCR Inlet, and SCR outlet temperatures. Perform Hot Run Sensor Comparison Test . Is the SCR inlet, and SCR outlet temperature sensors with in 77°F (43°C) of each other?	Yes: Go to step 11. No: Replace SCR temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 0.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4360 FMI 0. No: Go to step 12.

Step	Action	Decision
12	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DPF. Check the intake face of the DPF for soot accumulation, face plugging, and damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4360 FMI 0.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 2 - SCRIT Signal Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalytic Reduction Inlet Temperature (SCRIT) is not changing with engine operating conditions (in-range but not rational).	Average temperature difference across the SCR > 162°F (90°C) OR average temperature difference across the SCR < -162°F (-90°C) SCRIT < 374°F (190°C) OR SCR Outlet Temperature (SCROT) < 392°F (200°C)	Ambient Air Temperature ≥ -68°F (-20°C) Engine coolant temperature > 140°F (60°C) [302°F (150°C) < SCRIT < (600°C) OR 302°F (150°C) < SCROT < 302°F (600°C)] Ambient air pressure (BARO) ≥ 75 kPa (gauge) Engine Speed > 200 RPM for 600 seconds Engine Speed > 800 RPM for 300 seconds Elapsed time since last active regeneration > 1,200 sec 250 g/sec < Exhaust flow < 1,000 g/sec Inactive: SPN 3246 FMI 3 and 4 (DPFOT); SPN 4360 FMI 3, 4 (SCRIT); SPN 4363 FMI 3, 4 (SCROT); SPN 5742 FMI 3, 4, and 11 (DPF); SPN 5743 FMI 3, 4, and 11 (SCR)	300 seconds

Fault Overview

Fault code sets when Aftertreatment Control Module (ACM) has determined the SCR Inlet Temperature (SCRIT) sensor does not match engine operating conditions for more than 5 minutes. Diesel exhaust fluid (DEF) injection into the aftertreatment system is disabled, and engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 3246 FMI 3 and 4 (DPFOT); SPN 4360 FMI 3 and 4 (SCRIT); SPN 4363 FMI 3 and 4 (SCROT); SPN 5742 FMI 3, 4, and 11 (DPF); and SPN 5743 FMI 3, 4, 11, and 16 (SCR)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 3246 FMI 3 and 4 (DPFOT); SPN 4360 FMI 3 and 4 (SCRIT); SPN 4363 FMI 3 and 4 (SCROT); SPN 5742 FMI 3, 4, and 11 (DPF); and SPN 5743 FMI 3, 4, 11, and 16 (SCR). Is EST DTC list free of SPN 3246 FMI 3 and 4; SPN 4360 FMI 3 and 4; SPN 4363 FMI 3 and 4; SPN 5742 FMI 3, 4, and 11; and SPN 5743 FMI 3, 4, 11, and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4360 FMI 2. No: Repair SPN 3246 FMI 3 and 4; SPN 4360 FMI 3 and 4; SPN 4363 FMI 3 and 4; SPN 5742 FMI 3, 4, and 11; and SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 3 - SCRIT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module shorted to battery or Open circuit in SCR Inlet Temperature (SCRIT) sensor circuit.	SCRIT sensor input voltage ≥ 5 volts or SCRIT sensor thermocouple impedance ≥ 10 Ohms	Key ON	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor circuit is shorted to battery or Open. Active and parked regeneration will be disabled, and engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5743 FMI 3, 4, 11, and 16 (SCR)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 5743 FMI 3, 4, 11, and 16 (SCR). Is EST DTC list free of SPN 5743 FMI 3, 4, 11, and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4360 FMI 3.
		No: Repair SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 4 - SCRIT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module shorted to ground in the SCR Inlet Temperature (SCRIT) sensor circuit.	SCRIT ≤ 1 volts	Key ON	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the aftertreatment Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor signal voltage is less than 1 volt. Active and parked regeneration will be disabled and engine torque reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5743 FMI 3, 4, 11, and 16 (SCR)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 5743 FMI 3, 4, 11, and 16 (SCR). Is EST DTC list free of SPN 5743 FMI 3, 4, 11, and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4360 FMI 4.
		No: Repair SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 16 - SCRIT Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
SCR Inlet Temperature (SCRIT) continuously above a maximum temperature.	SCRIT > 1472°F (800°C)	Inactive: SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 5743 FMI 3, 4 and 11 (SCR).	20 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the SCR Inlet Temperature (SCRIT) reading is greater than 1472°F (800°C) for more than 20 seconds. The engine may shut down and Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR).

Fault Fact

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination; inspect the entire aftertreatment system for casual damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the SCRIT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

NOTE: If more than one DOC, DPF and / or SCR temperature sensor over temperature fault code(s) are present, check for unregistered fuel or oil in the exhaust.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated diesel exhaust fluid
- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR) fault codes. Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4360 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4360 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
2	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use special tool DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4360 FMI 16.
		No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5.
		No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4360 FMI 16.
		No: Repair failed valve train components. After repairs are complete retest for SPN 4360 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel in the aftertreatment system from the engine. Remove the exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil or fuel contamination?	Yes: Go to step 7.
		No: Repair lube oil or fuel leak to exhaust. See Lube Oil to Exhaust , or See Fuel to Exhaust . After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8.
		No: Replace AFTFSV. After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 9.
		No: Replace AFTFI. After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10.
		No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
10	Compare SCR Inlet, and SCR outlet temperatures. Perform Hot Run Sensor Comparison Test . Is the SCR inlet, and SCR outlet temperature sensors with in 77°F (43°C) of each other?	Yes: Go to step 11.
		No: Replace SCR temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 16.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4360 FMI 16.
		No: Go to step 12.

Step	Action	Decision
12	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DPF. Check the intake face of the DPF for soot accumulation, face plugging, and damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4360 FMI 16.
		No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4360 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4360 FMI 19 - EGTS Module (SCR) not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction Inlet Temperature (SCRIT) signal not detected on J1939 Controller Area Network (CAN).	Aftertreatment Control Module (ACM) loses J1939 data link communications with SCRIT sensor.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 CAN data link communications with the SCR inlet temperature sensor. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

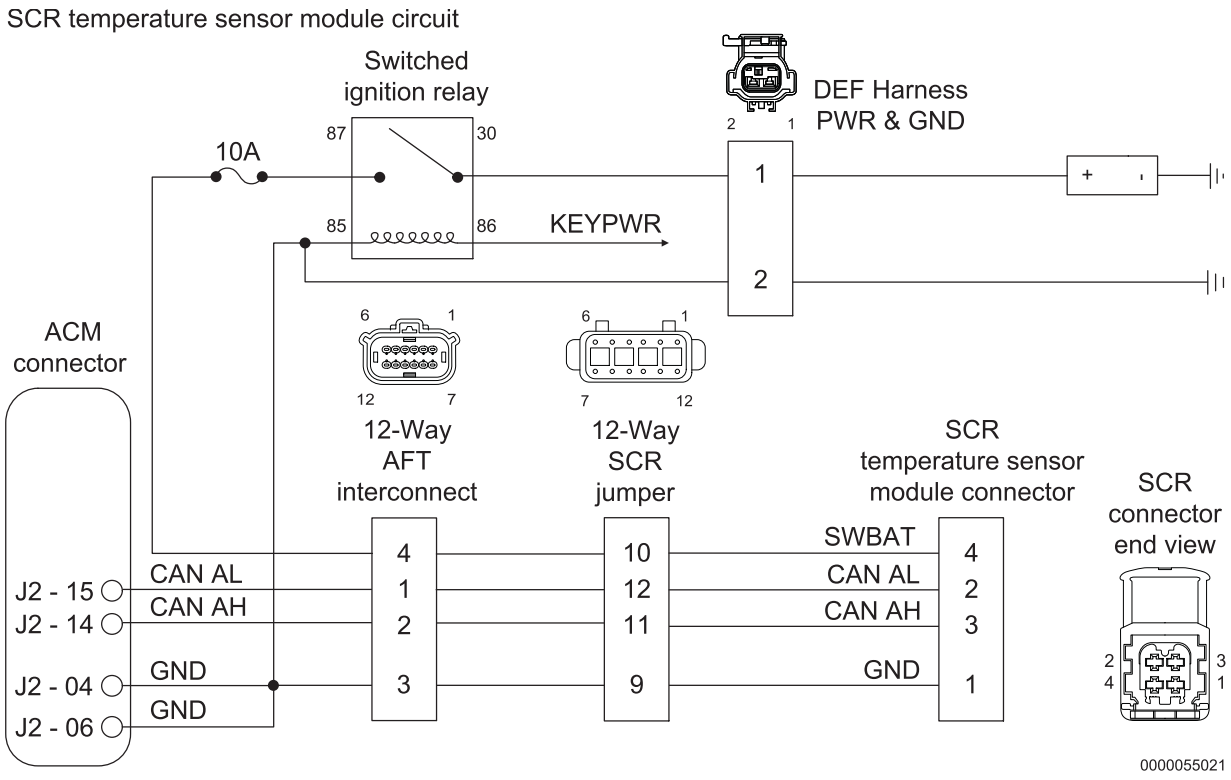


Figure 541 SCR Temperature Sensor Module Circuit Diagram

Possible Cause

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed SCR temperature sensor module

Step	Action	Decision
1	Inspect connections at SCR temperature sensor module. Key OFF, disconnect temperature sensor module. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
2	Check voltage to the SCR temperature sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected between temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-4 and a known good ground. Is voltage at pin-4 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between SCR temperature sensor module pin-1 and ground. After repairs are complete, retest for SPN 4360 FMI 19. No: Repair Open or short to ground between SCR temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: Repair Open or short to ground between SCR temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between SCR temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between SCR temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between SCR temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 4360 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4360 FMI 19. No: Repair short between SCR temperature sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 4360 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 4360 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SCROT (Selective Catalyst Reduction Inlet Temperature) Sensor

Overview of SCROT Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
4363	0	SCROT above Critical Temperature	• Contaminated Diesel Exhaust Fluid (DEF) • Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV) • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1388)
4363	2	SCROT signal erratic, intermittent or incorrect	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1392)
4363	3	SCROT signal Out of Range HIGH	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1393)
4363	4	SCROT signal Out of Range LOW	• Failed SCR temperature sensor module	Step-Based Diagnostics (page 1394)
4363	16	SCROT above Maximum Temperature	• Contaminated Diesel Exhaust Fluid (DEF) • Leaking fuel injector • Lube oil leak to exhaust • Fuel leak to exhaust • Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI) • Leaking or stuck Open Aftertreatment Fuel Shutoff Valve (AFTFSV)	Step-Based Diagnostics (page 1395)

			• Failed SCR temperature sensor module	
4363	19	SCROT signal not detected on J1939	• SWBAT circuit short to GND or Open • CAN-AH circuit Open or short to GND • CAN-AL circuit Open or short to GND • CAN-AH circuit short to power • CAN-AL circuit short to power • GND circuit Open or high resistance • CAN-AH short to CAN-AL • Failed SCR temperature sensor module	Step-Based Diagnostics (page 1398)

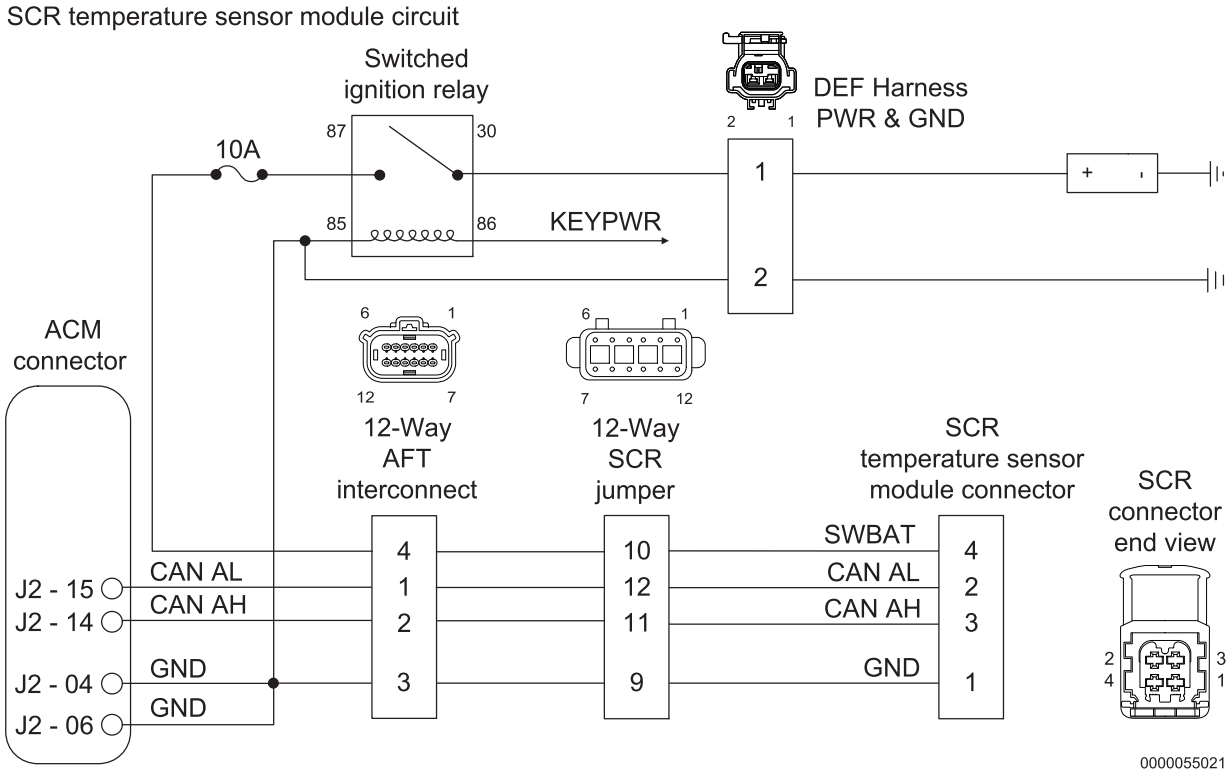


Figure 542 SCR Temperature Sensor Module Circuit Diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000002203 for additional circuit information.

Overview

The Selective Catalyst Reduction Outlet Temperature (SCROT) measures the exhaust temperature at the outlet of the SCR. The SCR temperature sensor module is a smart device that communicates with the Aftertreatment Control Module (ACM) via the Controller Area Network (CAN). The SCROT sensor is part of the SCR temperature sensor module, and is not serviceable individually.

Tools Required

- 180-Pin Breakout Box 00-00956-08
- ACM Breakout Harness 18–100–01 (58–Pin)
- Breakout Harness 18-648-01
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

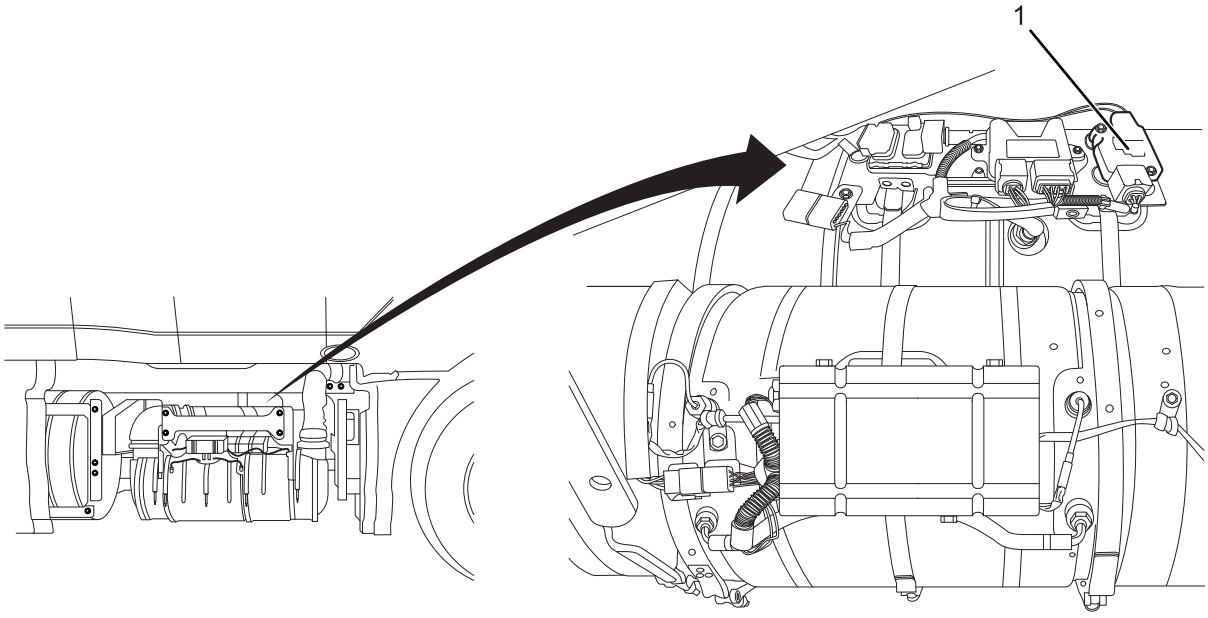


Figure 543 SCR Temperature Sensor Module Location

1. Selective Catalyst Reduction (SCR) temperature sensor module

SPN 4363 FMI 0 - SCROT Above Critical Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Aftertreatment Selective Catalyst Reduction Outlet Temperature (SCROT) continuously above a severe, high threshold.	SCROT > 1472°F (800°C) for more than 20 seconds.	Key-On Engine-Running (KOER). Inactive: SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5743 FMI 3, 4 and 11 (SCR). SCROT ≥ 392°F (200°C). SCRIT ≥ 392°F (200°C).	180 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the aftertreatment Selective Catalyst Reduction Outlet Temperature (SCROT) sensor reading is greater than 1472°F (800°C) for more than 20 seconds. The Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled and the engine can be shut down.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the SCROT drops below the warning limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

NOTE: If more than one DOC, DPF and / or SCR temperature sensor over temperature fault codes are present, check for unregistered fuel or oil in the exhaust.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated Diesel Exhaust Fluid (DEF)
- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust

- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open (AFTFSV) Fuel Shutoff Valve
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4363 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR) fault codes. Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4363 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4363 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
2	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use special tool DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 – 34 percent and Not contaminated?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4363 FMI 0. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4363 FMI 0.
		No: Repair failed valve train components. After repairs are complete retest for SPN 4363 FMI 0.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel to the aftertreatment system. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7.
		No: Repair lube oil or fuel leak to exhaust. See Lube Oil to Exhaust , or See Fuel to Exhaust . After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8.
		No: Replace AFTFSV. After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 9.
		No: Replace AFTFI. After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10.
		No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 0.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
10	Compare SCR Inlet, and SCR outlet temperatures. Perform Hot Run Sensor Comparison Test . Is the SCR inlet, and SCR outlet temperature sensors with in 77°F (43°C) of each other?	Yes: Go to step 11. No: Replace SCR temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 0.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine, and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4363 FMI 0. No: Go to step 12.

Step	Action	Decision
12	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DPF. Check the intake face of the DPF for soot accumulation, face plugging, and damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4363 FMI 0. No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 0.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 0 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 2 - SCROT Signal Erratic, Intermittent or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalytic Reduction Outlet Temperature (SCROT) is not changing with engine operating conditions (in-range but not rational).	Average of the temperature difference across the SCR catalyst > 162˚F (90˚C). OR average of the temperature difference across the SCR catalyst < -162˚F (-90˚C) -162˚F (-90˚C) < average of (DPF outlet temperature - SCR inlet temperature) < 162˚F (90˚C).	Key ON. Engine Speed > 200 RPM. 302˚F (150˚C) < SCR inlet temperature < 1112˚F (600˚C). OR 302˚F (150˚C) < SCR outlet temperature < 1112˚F (600˚C). Elapsed time since last active regeneration > 1200 seconds. Engine Coolant temperature > 140°F (60°C). Inactive: SPN 4360 FMI 3 and 4 (SCRIT); SPN 4363 FMI 3 and 4 (SCROT); and SPN 5743 FMI 3, 4, and 11 (SCR temp sensor module	300 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Outlet Temperature (SCROT) sensor does not match engine operating conditions for more than 5 minutes. A default value for SCROT is used and Diesel Exhaust Fluid (DEF) injection into the aftertreatment system is disabled. Engine torque will be reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 4360 FMI 3 and 4 (SCRIT); SPN 4363 FMI 3 and 4 (SCROT); and SPN 5743 FMI 3, 4, 11, and 16 (SCR)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR Temperature Sensor Module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 4360 FMI 3 and 4 (SCRIT); SPN 4363 FMI 3 and 4 (SCROT); and SPN 5743 FMI 3, 4, 11 and 16 (SCR). Is EST DTC list free of SPN 4360 FMI 3 and 4; SPN 4363 FMI 3 and 4; and SPN 5743 FMI 3, 4, 11 and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4363 FMI 2. No: Repair SPN 4360 FMI 3 and 4; SPN 4363 FMI 3 and 4; and SPN 5743 FMI 3, 4, 11 and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 3 - SCROT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module shorted to battery or Open circuit in SCR Outlet Temperature (SCROT) sensor circuit.	SCROT sensor input voltage ≥ 5 volts OR SCROT sensor resistance ≥ 10 Ohms	Key ON.	16 seconds

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Outlet Temperature (SCROT) sensor circuit is shorted to battery or Open. Active and parked regeneration will be disabled and engine torque reduced. Engine torque will be severely reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5743 FMI 3, 4, 11, 16 (SCR).

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 5743 FMI 3, 4, 11 and 16 (SCR). Is EST DTC list free of SPN 5743 FMI 3, 4, 11 and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4363 FMI 3.
		No: Repair SPN 5743 FMI 3, 4, 11 and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 3.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 3 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 4 - SCROT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction (SCR) temperature sensor module shorted to ground in the SCR Outlet Temperature (SCROT) sensor circuit.	SCROT input voltage ≤ 1 volt	Key ON.	16 seconds

Fault Overview

The Aftertreatment Control Module (ACM) has detected an internal circuit error in the Selective Catalyst Reduction (SCR) temperature sensor module, and the SCR Outlet Temperature (SCROT) sensor signal voltage is less than 1 Volt. Active and parked regeneration will be disabled and engine torque reduced if the engine is operated for an extended period of time with this fault active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 5743 FMI 3, 4, 11, and 16, (SCR)

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code list for SPN 5743 FMI 3, 4, 11 and 16 (SCR). Is EST DTC list free of SPN 5743 FMI 3, 4, 11 and 16?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN 4363 FMI 4.
		No: Repair SPN 5743 FMI 3, 4, 11 and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 4.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 4 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 16 - SCROT Above Maximum Temperature

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction Outlet Temperature (SCROT) continuously above maximum temperature.	SCROT > 1202°F (650°C) for 60 seconds.	Key-On Engine-Running (KOER). Inactive: SPN 4360 FMI 2, 3, and 4 (SCRIT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 5743 FMI 3, 4 and 11 (SCR). Active regeneration not occurring.	60 seconds

Fault Overview

Aftertreatment Control Module (ACM) detects the Selective Catalyst Reduction Outlet Temperature (SCROT) sensor reading is greater than 1202°F (650°C) for more than 60 seconds. The diesel exhaust fluid (DEF) injection into the aftertreatment system is disabled.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4363 FMI 2, 3, and 4 (SCROT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR).

Fault Facts

If aftertreatment system has had excess fuel, oil, coolant, metal, or other contamination, inspect the entire aftertreatment system for causal damage before re-installing. Inspect for overheated aftertreatment components, cracked exhaust system welds, leaking exhaust system seams, or other damage. This fault will go inactive after the SCROT drops below the maximum limit, and will likely be inactive when the vehicle is in the shop. For this reason, these diagnostics must be used for both active and inactive fault codes.

NOTE: If more than one DOC, DPF and / or SCR temperature sensor over temperature fault code(s) are present, check for unregistered fuel or oil in the exhaust.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Contaminated Diesel Exhaust Fluid (DEF)
- Leaking fuel injector
- Lube oil leak to exhaust
- Fuel leak to exhaust
- Leaking or stuck Open Aftertreatment Fuel Injector (AFTFI)
- Leaking or stuck Open (AFTFSV) Fuel Shutoff Valve
- Failed SCR temperature sensor module

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1322-1328 FMI 31 (CYL); SPN 3242 FMI 0, 15, and 16 (DPFIT); SPN 3246 FMI 0, 15, and 16 (DPFOT); SPN 4363 FMI 2, 3, and 4 (SCRIT); SPN 4765 FMI 0, 15, and 16 (DOCIT); SPN 5743 FMI 3, 4, 11, and 16 (SCR) fault codes. Is EST DTC list free of SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4363 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, 16?	Yes: Go to step 2. No: Repair SPN 1322-1328 FMI 31; SPN 3242 FMI 0, 15, and 16; SPN 3246 FMI 0, 15, and 16; SPN 4363 FMI 2, 3, and 4; SPN 4765 FMI 0, 15, and 16; SPN 5743 FMI 3, 4, 11, and 16 fault code(s). After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
2	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use special tool DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 3. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
3	Determine if the engine has a mechanical cylinder balance problem (compression loss). Perform Crankcase Pressure Test (page 1725). Does engine have excessive crankcase pressure?	Yes: Repair base engine compression imbalance. After repairs are complete, retest for SPN 4363 FMI 16. No: Go to step 4

Step	Action	Decision
4	Determine if engine has a fuel injector problem. Perform Multiple Cylinder Cutout Test (page 1636). Did one or more cylinders have significant speed difference(s) than the others?	Yes: Go to step 5. No: Go to step 6.

Step	Action	Decision
5	Inspect for failed valve train components. Remove upper valve cover (see Engine Service Manual). Inspect for bent valves, fallen bridges, and valves out of adjustment. Is valve train free of failed valve train components?	Yes: Replace injector suspected by Multiple Cylinder Cutout Test. After repairs are complete, retest for SPN 4363 FMI 16. No: Repair failed valve train components. After repairs are complete retest for SPN 4363 FMI 16.

Step	Action	Decision
6	Inspect the turbocharger exhaust outlet for oil or fuel to the aftertreatment system. Remove exhaust plumbing from the turbocharger outlet. Was the turbocharger exhaust outlet free of oil and fuel contamination?	Yes: Go to step 7. No: Repair lube oil or fuel leak to exhaust. See Lube Oil to Exhaust , or See Fuel to Exhaust . After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
7	Check for leaking or stuck open Aftertreatment Fuel Shutoff Valve (AFTFSV). Perform AFT Fuel Shutoff Valve Leak Test (page 1650). Is the AFT Fuel Injector (AFTFI) dry and free of fuel?	Yes: Go to step 8. No: Replace AFTFSV. After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
8	Check for leaking or stuck open AFTFI. Perform AFT Fuel Injector Leak Test (page 1652). Is the AFTFI dry and free of fuel?	Yes: Go to step 9. No: Replace AFTFI. After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
9	Check for failed AFT fuel flow. Perform AFT Dosing System Test (page 1648). Was 225 to 500 ml of fuel dispensed within 2.5 minutes?	Yes: Go to step 10. No: Replace AFTFI. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 16.

WARNING: Warning: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

Step	Action	Decision
10	Compare SCR Inlet, and SCR outlet temperatures. Perform Hot Run Sensor Comparison Test . Is the SCR inlet, and SCR outlet temperature sensors with in 77°F (43°C) of each other?	Yes: Go to step 11. No: Replace SCR temperature sensor module. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 16.

Step	Action	Decision
11	Test for black smoke from the exhaust. Idle the engine and snap the throttle to 100 percent. Perform this test multiple times, if necessary. Is the exhaust free of black smoke?	Yes: Replace SCR catalyst. After repairs are complete, retest for SPN 4363 FMI 16. No: Go to step 12.

Step	Action	Decision
12	Remove the Diesel Oxidation Catalyst (DOC). Inspect the DPF. Check the intake face of the DPF for soot accumulation, face plugging, and damage. Is less than 50 percent of the cells on the intake face completely blocked by soot and undamaged?	Yes: Reinstall DOC and perform a Parked Regeneration. After repairs are complete, retest for SPN 4363 FMI 16. No: Clean or replace DOC. Refer to Fault Facts. After repairs are complete, retest for SPN 4363 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 4363 FMI 19 - EGTS Module (SCR) not detected on J1939

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Selective Catalyst Reduction Outlet Temperature (SCROT) signal not detected on J1939 Controller Area Network (CAN).	Aftertreatment Control Module (ACM) loses J1939 data link communications with SCROT sensor.	Key ON	2 events

Fault Overview

Fault code sets when the Aftertreatment Control Module (ACM) loses J1939 CAN data link communications with the SCR outlet temperature sensor module. Engine torque will be reduced if fault is active for a limited period of time. Engine torque will be severely reduced and vehicle speed will be limited after extended engine operation with this fault code active.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Drive Cycle to Determine Fault Status

Drive Cycle 2 in 2013 HD-OBD Diagnostic Reference Manual.

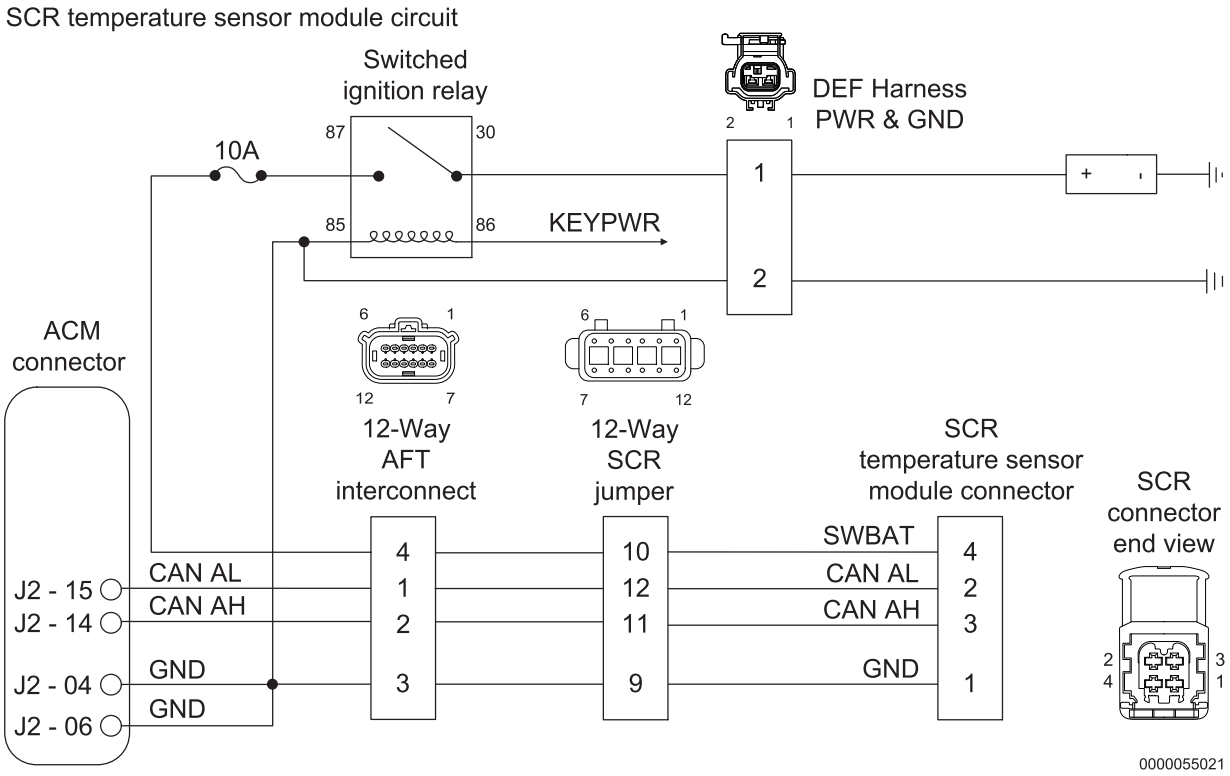


Figure 544 SCR Temperature Sensor Module Circuit Diagram

Possible Cause

- SWBAT circuit short to GND or Open
- CAN-AH circuit Open or short to GND
- CAN-AL circuit Open or short to GND
- CAN-AH circuit short to power
- CAN-AL circuit short to power
- GND circuit Open or high resistance
- CAN-AH short to CAN-AL
- Failed SCR temperature sensor module

Step	Action	Decision
1	Inspect connections at SCR temperature sensor module. Key OFF, disconnect SCR temperature sensor module. Check SCR temperature sensor module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the SCR temperature sensor module connector, harness, and terminals clean and undamaged?	Yes: Go to step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
2	Check voltage to the SCR temperature sensor module. Key-On Engine-Off (KOEO), with Breakout Harness 18-648-01 connected between temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-1 and pin-4. Is voltage within 0.5 volts of battery voltage?	Yes: Go to step 4. No: Go to step 3.

Step	Action	Decision
3	Check SWBAT circuit for Open or short to ground. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-4 and a known good ground. Is voltage at pin-4 within 0.5 volts of battery voltage?	Yes: Repair Open or high resistance between SCR temperature sensor module pin-1 and ground. After repairs are complete, retest for SPN 4363 FMI 19. No: Repair Open or short to ground between SCR temperature sensor module connector pin-4 and switched ignition relay pin-87. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
4	Check CAN-AH circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 5. No: No: Repair Open or short to ground between SCR temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
5	Check CAN-AH circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-3 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 6. No: Repair short to power between SCR temperature sensor module connector pin-3 and ACM connector J2-14. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
6	Check CAN-AL circuit for Open or short to GND. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage greater than 1 volt?	Yes: Go to step 7. No: Repair Open or short to ground between SCR temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
7	Check CAN-AL circuit for short to power. KOEO, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure voltage between temperature sensor module pin-2 and a known good ground. Is voltage less than 4 volts?	Yes: Go to step 8. No: Repair short to power between SCR temperature sensor module connector pin-2 and ACM connector J2-15. After repairs are complete, retest for SPN 4363 FMI 19.

Step	Action	Decision
8	Check CAN-AL circuit for short to CAN-AH. Key OFF, with Breakout Harness 18-648-01 connected between SCR temperature sensor module and vehicle harness, use a DMM to measure resistance between temperature sensor module pin-2 and pin-3. Is resistance greater than 50 ohms?	Yes: Replace SCR temperature sensor module. After repairs are complete, retest for SPN SPN 4363 FMI 19. No: Repair short between SCR temperature sensor module connector pin-2 and pin-3. After repairs are complete, retest for SPN 4363 FMI 19.

NOTE: After performing all diagnostic steps, if SPN 4363 FMI 19 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

Service

Overview of Service Sensor Group

SPN	FMI	Condition	Possible Causes
1378	31	Change Engine Oil Service Interval	• Change oil and re-set interval counter

SPN 1378 FMI 31 - Change Engine Oil Service Interval

Service Interval Messages Operation

The service interval messages are displayed on the instrument cluster message center and include engine oil and fuel filter change reminders.

The change oil reminder can be programmed for kilometers, miles, hours or calculated fuel consumption. These service interval limits may be adjusted at the owner's discretion. The change engine oil message below the odometer illuminates after a preselected parameter is reached.

The fuel filter change message displays when the fuel filter needs replacement due to high filter restriction.

TC1TOP (Turbocharger 1 Turbine Outlet Pressure) Sensor

Overview of TC1TOP Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
5541	2	TC1TOP signal does not agree with BARO	• Biased TC1TOP sensor or circuit • Intermittent TC1TOP circuit fault • Restricted EBPV tube	Pin-Point Diagnostics (page 1408)
5541	3	TC1TOP signal Out of Range HIGH	• TC1TOP signal circuit OPEN or short to PWR • SIG GND circuit OPEN • Failed TC1TOP sensor	Pin-Point Diagnostics (page 1408)
5541	4	TC1TOP signal Out of Range LOW	• TC1TOP signal circuit short to GND • Failed TC1TOP sensor	Pin-Point Diagnostics (page 1408)
5542	15	TC1TOP above desired	• Restricted Exhaust • Stuck or sticking closed EBPV	Circuit Checks (page 1412)
5542	17	TC1TOP below desired — Check Exhaust Back Pressure Valve	• EBPV not closing when commanded	Circuit Checks (page 1412)

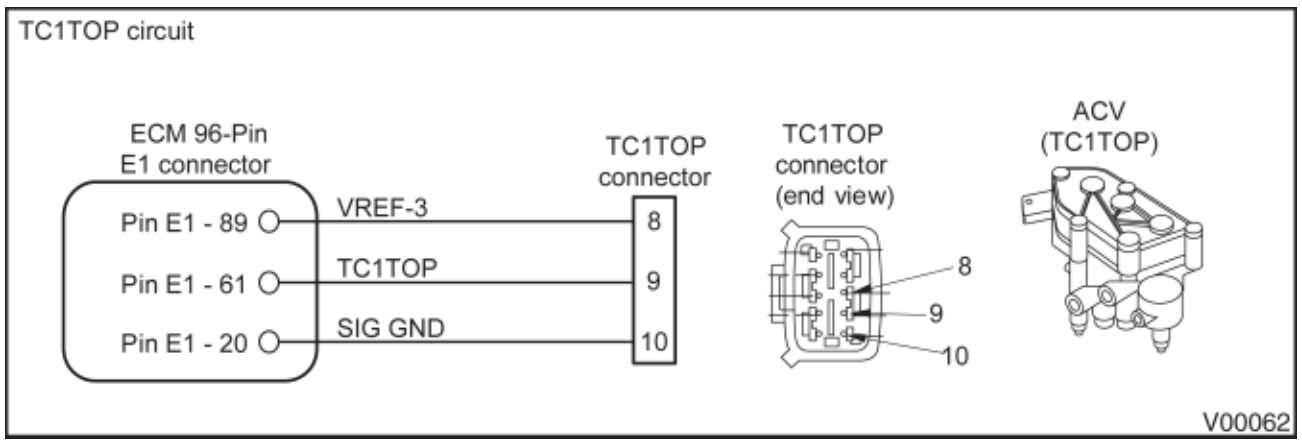


Figure 545 TC1TOP circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6003 (TC1TOP)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Note: The TC1TOP, TC2WC, and EBPV circuits share the same connector to the ACV assembly.

SPN 5541 FMI 2 - TC1TOP Signal Erratic, Intermittent, or Incorrect

Biased Sensor or Circuit Check

1. Turn ignition switch ON, engine OFF
2. Using ServiceMaxx™ software, run the Continuous Monitor test.
3. Verify S_TC1TOP volts are within specification (lightly wiggle circuits while monitoring TC1TOP signal for spikes). See “APPENDIX A: PERFORMANCE SPECIFICATIONS."
   - If TC1TOP voltage is not within specification, check circuitry for poor continuity. If circuits are acceptable, replace TC1TOP sensor.
4. Check Exhaust Back Pressure Valve (EBPV) tube between Air Control Valve (ACV) and EBPV for restriction.

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Biased Sensor or Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor TC1TOPv	4.5 V to 5 V	If < 4.5 V, check TC1TOP signal circuit for short to GND. Do Harness Resistance Check (page 1410).
DMM — Measure voltage 8 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF3 for short to PWR. If < 4.5 V, check VREF3 for OPEN or short to GND. Do Harness Resistance Check (page 1410).
DMM — Measure voltage 8 to 10	5 V ± 0.5 V	If < 4.5 V, check SIG GND for OPEN. Do Harness Resistance Check (page 1410).
EST – Monitor TC1TOPv Short across Breakout Harness pins 9 and 10	0 V	If > 0.25 V, check TC1TOP signal for OPEN. Do Harness Resistance Check (page 1410).
If checks are within specification, connect sensor and clear DTCs. Verify sensor voltage is within KOEO specification. See “APPENDIX A: PERFORMANCE SPECIFICATIONS." If sensor voltage is not within specification, replace the sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
8 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF3 for short to PWR. If < 4.5 V, check VREF3 for OPEN or short to GND. Do Harness Resistance Check (page 1410).
10 to GND	0 V	If > 0.25 V, check SIG GND circuit for short to PWR.
9 to GND	4.5 V to 5 V	If < 4.5 V, check TC1TOP signal circuit for short to GND. Do Harness Resistance Check (page 1410).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
8 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
8 to E1-89	< 5 Ω	If > 5 Ω, check for OPEN circuit.
9 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
9 to E1-61	< 5 Ω	If > 5 Ω, check for OPEN circuit.
10 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
10 to E1–20	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 5541 FMI 3 - TC1TOP Signal Out of Range HIGH

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Biased Sensor or Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 5541 FMI 2 – TC1TOP signal does not agree with BARO

Biased Sensor or Circuit Check

1. Turn ignition switch ON, engine OFF
2. Using ServiceMaxx™ software, run the Continuous Monitor test.
3. Verify S_TC1TOP volts are within specification (lightly wiggle circuits while monitoring TC1TOP signal for spikes). See “APPENDIX A: PERFORMANCE SPECIFICATIONS."
   - If TC1TOP voltage is not within specification, check circuitry for poor continuity. If circuits are acceptable, replace TC1TOP sensor.
4. Check Exhaust Back Pressure Valve (EBPV) tube between Air Control Valve (ACV) and EBPV for restriction.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor TC1TOPv	4.5 V to 5 V	If < 4.5 V, check TC1TOP signal circuit for short to GND. Do Harness Resistance Check (page 1410).
DMM — Measure voltage 8 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF3 for short to PWR. If < 4.5 V, check VREF3 for OPEN or short to GND. Do Harness Resistance Check (page 1410).
DMM — Measure voltage 8 to 10	5 V ± 0.5 V	If < 4.5 V, check SIG GND for OPEN. Do Harness Resistance Check (page 1410).
EST – Monitor TC1TOPv Short across Breakout Harness pins 9 and 10	0 V	If > 0.25 V, check TC1TOP signal for OPEN. Do Harness Resistance Check (page 1410).
If checks are within specification, connect sensor and clear DTCs. Verify sensor voltage is within KOEO specification. See “APPENDIX A: PERFORMANCE SPECIFICATIONS." If sensor voltage is not within specification, replace the sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
8 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF3 for short to PWR. If < 4.5 V, check VREF3 for OPEN or short to GND. Do Harness Resistance Check (page 1410).
10 to GND	0 V	If > 0.25 V, check SIG GND circuit for short to PWR.
9 to GND	4.5 V to 5 V	If < 4.5 V, check TC1TOP signal circuit for short to GND. Do Harness Resistance Check (page 1410).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
8 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
8 to E1-89	< 5 Ω	If > 5 Ω, check for OPEN circuit.
9 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
9 to E1-61	< 5 Ω	If > 5 Ω, check for OPEN circuit.
10 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
10 to E1–20	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 5541 FMI 4 - TC1TOP Signal Out of Range LOW

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Using Electronic Service Tool (EST) with ServiceMaxx™ software, run the Continuous Monitor test.
2. Monitor sensor voltage and verify an active DTC for this sensor.
   - If DTC is previously active, monitor signal while wiggling harness of suspect sensor. If circuit is interrupted, signal will spike and DTC will go active or pending.
   - If DTC is active, continue to Biased Sensor or Circuit Check.

NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.

SPN 5541 FMI 2 – TC1TOP signal does not agree with BARO

Biased Sensor or Circuit Check

1. Turn ignition switch ON, engine OFF
2. Using ServiceMaxx™ software, run the Continuous Monitor test.
3. Verify S_TC1TOP volts are within specification (lightly wiggle circuits while monitoring TC1TOP signal for spikes). See “APPENDIX A: PERFORMANCE SPECIFICATIONS."
   - If TC1TOP voltage is not within specification, check circuitry for poor continuity. If circuits are acceptable, replace TC1TOP sensor.
4. Check Exhaust Back Pressure Valve (EBPV) tube between Air Control Valve (ACV) and EBPV for restriction.

Sensor Circuit Check With ServiceMaxx™ Software

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV sensor disconnected. Turn ignition ON.

Test Point	Specification	Comment – < Less than, > Greater than
EST – Monitor TC1TOPv	4.5 V to 5 V	If < 4.5 V, check TC1TOP signal circuit for short to GND. Do Harness Resistance Check (page 1410).
DMM — Measure voltage 8 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF3 for short to PWR. If < 4.5 V, check VREF3 for OPEN or short to GND. Do Harness Resistance Check (page 1410).
DMM — Measure voltage 8 to 10	5 V ± 0.5 V	If < 4.5 V, check SIG GND for OPEN. Do Harness Resistance Check (page 1410).
EST – Monitor TC1TOPv Short across Breakout Harness pins 9 and 10	0 V	If > 0.25 V, check TC1TOP signal for OPEN. Do Harness Resistance Check (page 1410).
If checks are within specification, connect sensor and clear DTCs. Verify sensor voltage is within KOEO specification. See “APPENDIX A: PERFORMANCE SPECIFICATIONS." If sensor voltage is not within specification, replace the sensor.		

Connector Voltage Check Without ServiceMaxx™ Software

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
8 to GND	5.0 V ± 0.5 V	If > 5.5 V, check VREF3 for short to PWR. If < 4.5 V, check VREF3 for OPEN or short to GND. Do Harness Resistance Check (page 1410).
10 to GND	0 V	If > 0.25 V, check SIG GND circuit for short to PWR.
9 to GND	4.5 V to 5 V	If < 4.5 V, check TC1TOP signal circuit for short to GND. Do Harness Resistance Check (page 1410).

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM E1 and E2 harness to ECM E1 and E2 engine harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
8 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
8 to E1-89	< 5 Ω	If > 5 Ω, check for OPEN circuit.
9 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
9 to E1-61	< 5 Ω	If > 5 Ω, check for OPEN circuit.
10 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
10 to E1–20	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 5542 FMI 15 - TC1TOP Above Desired - Check Exhaust Back Pressure Valve

Connector Voltage Check – EBPV Disconnected

NOTE: Excessive backpressure in the exhaust system, such as a restricted Diesel Oxidation Catalyst (DOC), could set this fault. Check for exhaust system damage and proper aftertreatment system operation before performing electrical checks.

Connect Breakout Harness ZTSE6003 to EBPV engine harness, and leave EBPV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN or high resistance. Do Harness Resistance Check (page 1414).
2 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN or high resistance, Do Harness Resistance Check (page 1414).
8 to GND	5 V ± 0.5 V	If > 5.5 V, check VREF for short to PWR. If < 4.5 V, check VREF for OPEN or short to GND. Do Harness Resistance Check (page 1414).
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

1. Connect Breakout Harness ZTSE6003 between EBPV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Exhaust Back Pressure Valve from the drop-down menu.
3. Command Exhaust Back Pressure Valve to 5%.
4. Use DMM to measure voltage.
5. Command Exhaust Back Pressure Valve to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
2 to GND	95% = 1 V ± 1 V	If > 2 V, check for OPEN circuit or failed EBPV.

Actuator Resistance Check

Turn ignition switch to OFF. Connect Breakout Harness ZTSE6003 to EBPV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	4 Ω to 8 Ω	If not within specification, replace the EBPV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with Breakout Harness 00-01468-00 to ECM E1 connector and leave ECM disconnected. Connect Breakout Harness ZTSE6003 to vehicle harness and leave EBPV disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-04	< 5 Ω	If > 5 Ω, check for OPEN circuit.
8 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
8 to E1-89	< 5 Ω	If > 5 Ω, check for OPEN circuit.
10 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
10 to E1-20	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace EBPV.		

SPN 5542 FMI 17 - TC1TOP Below Desired - Check Exhaust Back Pressure Valve

Connector Voltage Check – EBPV Disconnected

NOTE: Excessive backpressure in the exhaust system, such as a restricted Diesel Oxidation Catalyst (DOC), could set this fault. Check for exhaust system damage and proper aftertreatment system operation before performing electrical checks.

Connect Breakout Harness ZTSE6003 to EBPV engine harness, and leave EBPV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	B+	If < B+, check for OPEN or high resistance. Do Harness Resistance Check (page 1414).
2 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN or high resistance, Do Harness Resistance Check (page 1414).
8 to GND	5 V ± 0.5 V	If > 5.5 V, check VREF for short to PWR. If < 4.5 V, check VREF for OPEN or short to GND. Do Harness Resistance Check (page 1414).
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

1. Connect Breakout Harness ZTSE6003 between EBPV and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select Exhaust Back Pressure Valve from the drop-down menu.
3. Command Exhaust Back Pressure Valve to 5%.
4. Use DMM to measure voltage.
5. Command Exhaust Back Pressure Valve to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
2 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
2 to GND	95% = 1 V ± 1 V	If > 2 V, check for OPEN circuit or failed EBPV.

Actuator Resistance Check

Turn ignition switch to OFF. Connect Breakout Harness ZTSE6003 to EBPV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Specifications	Comment
1 to 2	4 Ω to 8 Ω	If not within specification, replace the EBPV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with Breakout Harness 00-01468-00 to ECM E1 connector and leave ECM disconnected. Connect Breakout Harness ZTSE6003 to vehicle harness and leave EBPV disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
1 to E1-54	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
2 to E1-04	< 5 Ω	If > 5 Ω, check for OPEN circuit.
8 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
8 to E1-89	< 5 Ω	If > 5 Ω, check for OPEN circuit.
10 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
10 to E1-20	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace EBPV.		

TC2CIS (Turbocharger 2 Compressor Inlet) Sensor

Overview of TC2CIS Sensor Group

SPN	FMI	Actions
1173	2	TC2CIT signal does not agree with other sensors (page 1416)
1173	3	TC2CIT Out of Range HIGH (page 1419)
1173	4	TC2CIT Out of Range LOW (page 1425)
1173	16	TC2CIT signal above desired (Interstage CAC under cooling) (page 1429)
1177	2	TC2CIP signal erratic, intermittent, or incorrect (page 1432)
1177	3	TC2CIP signal Out of Range HIGH (page 1434)
1177	4	TC2CIP signal Out of Range LOW (page 1441)

Overview

The Turbocharger 2 Compressor Inlet Sensor (TC2CIS) is a combined temperature and pressure sensor located in the piping between the low-pressure compressor outlet and the high-pressure compressor inlet. This sensor monitors boost pressure for the low-pressure turbo and the temperature of the charge-air entering the high-pressure turbo. The ECM uses these measurements for calculating fuel delivery and controlling the wastegate.

SPN 1173 FMI 2 - TC2CIT Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Difference between Turbocharger 2 Compressor Inlet temperature (TC2CIT) sensor reading and Intake Manifold Temperature (IMT) and Inlet Air Temperature (IAT) sensor readings greater than expected.	TC2CIT deviation from IMT and IAT greater than expected	Key ON Engine is cold soaked (8 hours)	Immediate

Fault Overview

Fault code sets when Turbocharger 2 Compressor Inlet temperature (TC2CIT) signal difference compared to Inlet Air Temperature (IAT) and Intake Manifold Temperature (IMT) is greater than expected.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1173 FMI 3 and 4 (TC2CIT), SPN 105 (IMT), SPN 172 (IAT)

Drive Cycle to Determine Fault Status

Drive Cycle 10 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

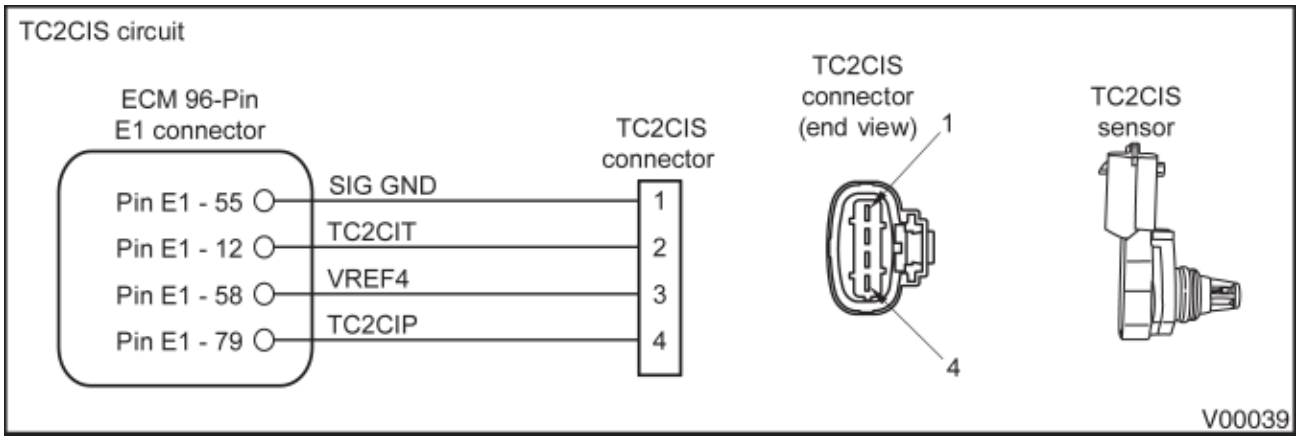


Figure 546 TC2CIS sensor circuit diagram

NOTE: See latest version of Navistar N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Possible Causes

- TC2CIT high resistance
- SIG GND high resistance
- Failed TC2CIS sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1173 FMI 3 and 4 (TC2CIT). Is EST DTC list free of SPN 1173 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 1173 FMI 3 and 4. After repairs are complete, retest for SPN 1173 FMI 2.

Step	Action	Decision
2	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS). Key OFF, disconnect TC2CIS sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the TC2CIS sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1173 FMI 2.

Step	Action	Decision
3	Inspect connections at ECM E1 connector. Key OFF, disconnect ECM E1 connector. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E1 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1173 FMI 2.

Step	Action	Decision
4	Check SIG GND for high resistance. Connect 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 to ECM E1 harness, and leave ECM disconnected. Key-Off with Breakout Harness ZTSE4830 connected to vehicle harness and TC2CIS disconnected, use a DMM to measure resistance between breakout harness pin-1 and breakout box E1 pin-55. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair high resistance between TC2CIS pin-1 and ECM connector E1 pin-55. After repairs are complete, retest for SPN 1173 FMI 2.

Step	Action	Decision
5	Check TC2CIT for high resistance. With 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 connected to ECM E1 harness and Breakout Harness ZTSE4830 connected to vehicle harness with leave ECM and TC2CIS disconnected. Key OFF, use a DMM to measure resistance between breakout harness pin-2 and Breakout Box E1 pin-12. Is resistance less than 5 ohms?	Yes: Replace TC2CIS sensor. After repairs are complete, retest for SPN 1173 FMI 2. No: Repair high resistance between TC2CIS pin-2 and ECM connector E1 pin-12. After repairs are complete, retest for SPN 1173 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 1173 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1173 FMI 3 - TC2CIT Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values
Turbocharger 2 Compressor Inlet Temperature (TC2CIT) signal is above the maximum valid value.	TC2CIT > 4.78 volts	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects signal from Turbocharger 2 Compressor Inlet Temperature (TC2CIT) circuit is greater then 4.78 volts. Turbocharger 2 Compressor Inlet Temperature (TC2CIT) sensor circuit is part of the combination Turbocharger 2 Compressor Inlet Sensor (TC2CIS).

Lamp Reaction

Malfunction Indicator Lamp (MIL)will illuminate immediately when this fault is detected.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- SIG GND circuit Open or High resistance
- TC2CIT circuit Open or high resistance
- TC2CIT circuit short to PWR
- Failed TC2CIS sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 1173 FMI 3.		Yes: Go to Step 2.
Is EST DTC list SPN 1173 FMI 3 active or pending?		No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS) connector.	Decision
A. Key OFF. B. Disconnect TC2CIS connector. C. Check TC2CIS and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to Step 3.
Are TC2CIS connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1173 FMI 3.

Step 3	Check for TC2CIT circuit short to PWR.	Decision
Perform Test 1 (page 1422). Using Digital Multimeter (DMM), measure voltage between Breakout Harness ZTSE4830 pin-2 and a known good ground.		Yes: Repair short to PWR between TC2CIT pin-2 and Engine Control Module (ECM) pin E1-12. After repairs are complete, retest for SPN 1173 FMI 3.
Is voltage greater than 4.9 volts?		No: Go to Step 4.

Step 4	Check for failed TC2CIT sensor.	Decision
Perform Test 2 (page 1423). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor TC2CIT voltage.		Yes: Replace TC2CIS. After repairs are complete, retest for SPN 1173 FMI 3.
Is voltage approximately 0 volts?		No: Go to Step 5.

Step 5	Check for Open in TC2CIT circuit.	Decision
Perform Test 3 (page 1424). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor TC2CIT voltage.		Yes: Repair Open between TC2CIT pin-1 and ECM pin E1-55. After repairs are complete, retest for SPN 1173 FMI 3.
Is voltage approximately 0 volts?		No: Repair Open between TC2CIT pin-2 and ECM pin E1-12. After repairs are complete, retest for SPN 1173 FMI 3.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 1173 FMI 3 fault code diagnostics.

Pin-Point Test SPN 1173 FMI 3

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4830
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

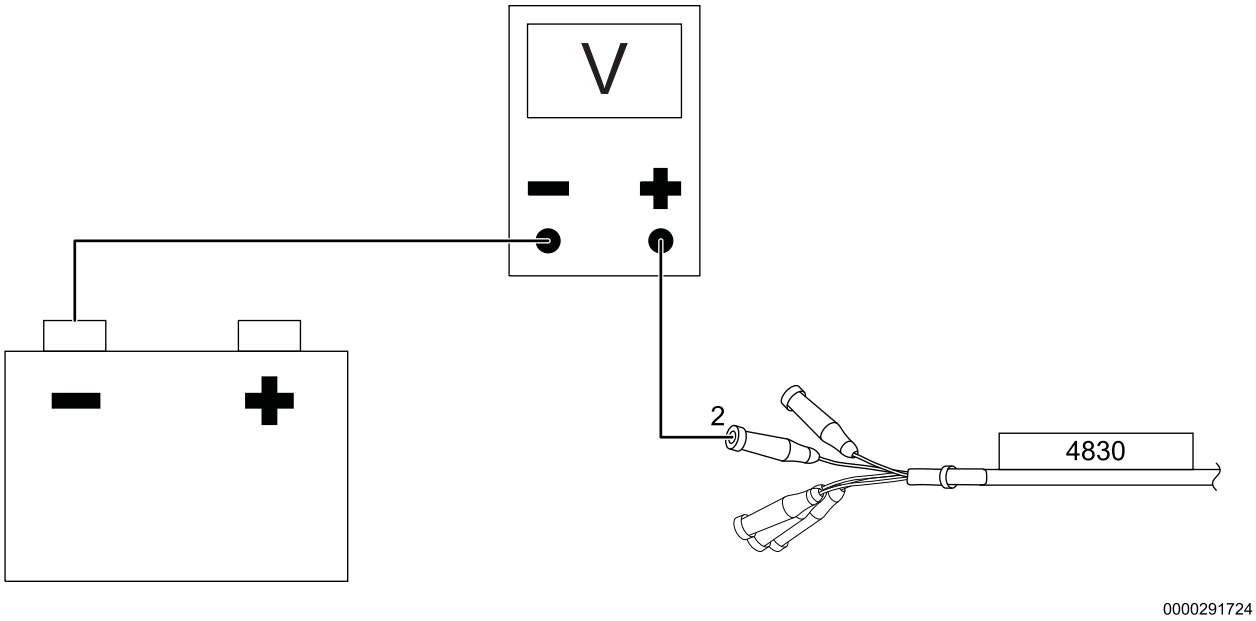


Figure 547 TC2CIT Circuit Voltage Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4830 to vehicle harness and leave Turbocharger 2 Compressor Inlet Temperature (TC2CIT) sensor disconnected. C. Key ON.

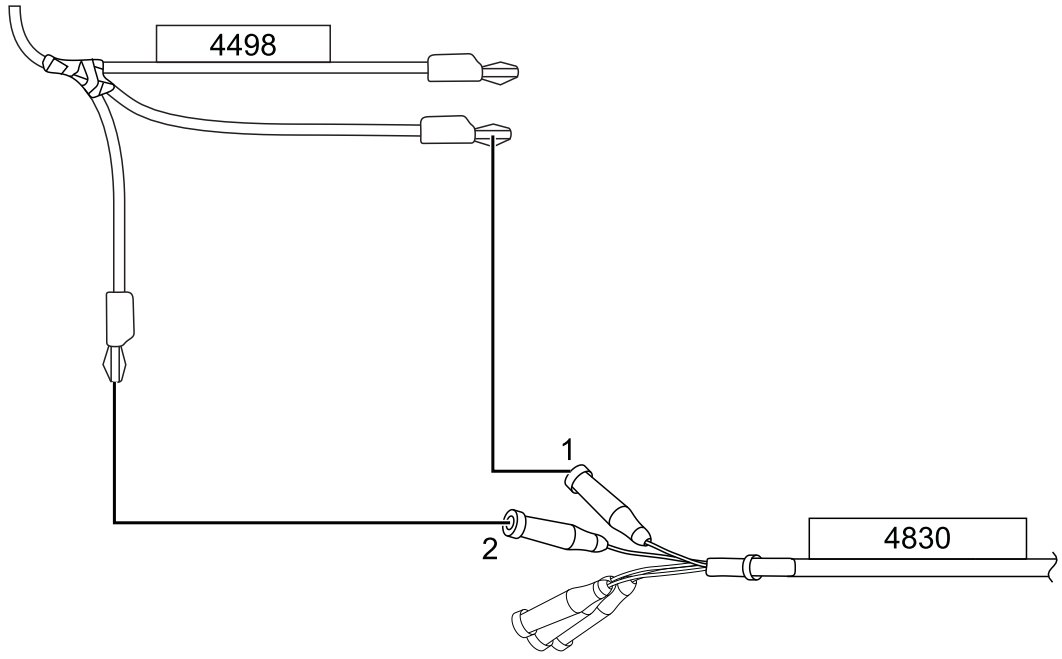


Figure 548 TC2CIT Sensor Circuit Check

Test 2 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4830 to vehicle harness and leave TC2CIT sensor disconnected.
C. Using Breakout Harness ZTSE4498 short pin-1 and pin-2 of Breakout Harness ZTSE4830 together.
D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
E. Key ON, log into ServiceMaxx™ software.

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4830 to vehicle harness and leave TC2CIT sensor disconnected. C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4830 pin-2 to a known good GND. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON, log into ServiceMaxx™ software.

SPN 1173 FMI 4 - TC2CIT Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values
Turbocharger 2 Compressor Inlet Temperature (TC2CIT) signal is below minimum.	TC2CIT less than 0.05 volt	Key ON

Fault Overview

Fault code sets when Engine Control Module detects Turbocharger 2 Compressor Inlet Temperature (TC2CIT) circuit voltage is less than 0.05 volts. Turbocharger 2 Compressor Inlet Temperature (TC2CIT) sensor circuit is part of the combination Turbocharger 2 Compressor Inlet Sensor (TC2CIS).

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate immediately when this fault is detected.

Associated Faults

None.

Fault Facts

None.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- TC2CIT circuit short to GND
- Failed TC2CIT sensor

Step 1	Check for active or pending fault codes.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 1173 FMI 4.		Yes: Go to Step 2.
Is EST DTC list SPN 1173 FMI 4 active or pending?		No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS) connector.	Decision
A. Key OFF. B. Disconnect TC2CIS connector. C. Check TC2CIS and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to Step 3.
Are TC2CIS connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1173 FMI 4.

Step 5	Check for Open in TC2CIT circuit.	Decision
Perform Test 1 (page 1428). Using EST with ServiceMaxx™ software, perform Continuous Monitor Test (page 1588). Monitor TC2CIT voltage.		Yes: Replace TC2CIS. After repairs are complete, retest for SPN 1173 FMI 4.
Is voltage 4.85 volts ± 0.05 volts?		No: Repair short to GND between TC2CIT pin-2 and Engine Control Module pin E1-12. After repairs are complete, retest for SPN 1173 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 1173 FMI 4 fault code diagnostics.

Pin-Point Test SPN 1173 FMI 4

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software

- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF.
B. Disconnect Turbocharger 2 Compressor Inlet Temperature (TC2CIT) sensor
C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
D. Key ON, log into ServiceMaxx™ software.

SPN 1173 FMI 16 - TC2CIT Signal Above Desired (Interstage CAC Under Cooling)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Turbocharger 2 Compressor Inlet Temperature (TC2CIT) signal is greater than expected.	Difference between TC2CIT and engine coolant temperature > a predetermined value, based on engine speed and load.	Engine running Ambient Air Temperature (AAT) between 19°F (-7°C) and 131°F (55°C) Barometric Pressure (BARO) > 10.9 psi (75 kPa) Difference between coolant temperature and expected temperature of the Low Pressure Change Air Cooler (LPCAC) > 68°F (20°C) for 3 seconds or more	3 events

Fault Overview

Fault code sets when Turbocharger 2 Compressor Inlet Temperature (TC2CIT) is above a calculated range, based on operating conditions.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1173 FMI 3 and 4 (TC2CIT); SPN 5546 (CMV); and SPN 5547 (CFV)

Fault Facts

None.

Drive Cycle to Determine Fault Status

Drive Cycle 1 then 2 in 2013 HD-OBD Diagnostic Reference Manual.

Possible Causes

- Failed TC2CIS
- Failed Coolant Control Valve (CCV)
- Restricted or leaking LPCAC
- Inoperative engine cooling fan
- Restricted low-temperature radiator
- Engine fan or shroud problem

NOTE: Repair engine cooling system problems and engine overheating before doing this procedure (see "Engine Symptoms Diagnostics").

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1173 FMI 3 and 4 (TC2CIT); SPN 5546 (CMV); and SPN 5547 (CFV). Is EST DTC list free of SPN 1173 FMI 3, 4; SPN 5546; and SPN 5547?	Yes: Go to step 2. No: Repair SPN 1173 FMI 3, 4; SPN 5546; and SPN 5547. After repairs are complete, retest for SPN 1173 FMI 16.

Step	Action	Decision
2	Inspect for damaged or missing engine cooling fan, fan shroud, and fan hub assembly. Check for air flow restrictions around low temperature radiator. Is engine cooling fan, hub, and shroud, and low temperature radiator free of air restrictions and is not missing or damaged?	Yes: Go to step 3. No: Repair air restriction, or replace engine cooling fan or fan hub assembly. After repairs are complete, retest for SPN 1173 FMI 16.

Step	Action	Decision
3	Check for an inoperative engine cooling fan. Using EST with ServiceMaxx™ software, run Tests > Key-On Engine-Running (KOER) Tests > Engine Fan Tests and determine the engine cooling fan's capability to maintain desired speeds. Is the engine cooling fan operating properly?	Yes: Go to step 4. No: Replace fan hub assembly. After repairs are complete, retest for SPN 1173 FMI 16.

Step	Action	Decision
4	Check for a failed TC2CIS sensor. Run engine at high idle for 20 seconds. Using EST with ServiceMaxx™ software, compare TC2CIT temperature values with ECT1 and ECT2. Is TC2CIT within 10°F (6°C) of ECT1 and ECT2?	Yes: Go to step 5. No: Replace TC2CIS sensor. After repairs are complete, retest for SPN 1173 FMI 16.

Step	Action	Decision
5	Check for a failed Coolant Control Valve (CCV). Using EST with ServiceMaxx™ software, run the Tests > Key-On Engine-Running (KOER) Tests > Coolant Control Valve Test . Follow on screen instructions. Are both Coolant Flow Valve (CFV) and Coolant Mixer Valve (CMV) operating properly?	Yes: Go to step 6. No: Replace CCV. After repairs are complete, retest for SPN 1173 FMI 16.

Step	Action	Decision
6	Check for a restricted or leaking interstage CAC. Install Charge Air Cooler (CAC) Tester ZTSE4341 and test for leakages (see Engine Service Manual). Is the LPCAC free of excessive leaks or other defects?	Yes: Retest for SPN 1173 FMI 16.
		No: Replace the LPCAC. After repairs are complete, retest for SPN 1173 FMI 16.

NOTE: After performing all diagnostic steps, if SPN 1173 FMI 16 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1177 FMI 2 - TC2CIP Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Turbocharger 2 Compressor Inlet Pressure (TC2CIP) signal does not agree with Barometric Pressure (BARO) sensor.	Difference between TC2CIP and BARO > 1.45 psi (12 kpa)	Key-On Engine-Running (KOER)	2 seconds

Fault Overview

Fault code sets when Turbocharger 2 Compressor Inlet Pressure (TC2CIP) signal is not within 12 kpa of the Barometric Pressure (BARO) sensor.

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

Associated Faults

SPN 1177 FMI 3 and 4 (TC2CIT)

Fault Facts

None.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- TC2CIP high resistance
- SIG GND high resistance
- Failed TC2CIS sensor

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for SPN 1177 FMI 3 and 4 (TC2CIP). Is EST DTC list free of SPN 1177 FMI 3 and 4?	Yes: Go to step 2. No: Repair SPN 1177 FMI 3 and 4. After repairs are complete, retest for SPN 1177 FMI 2.

Step	Action	Decision
2	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS). Key OFF, disconnect TC2CIS sensor. Check sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the TC2CIS sensor connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1177 FMI 2.

Step	Action	Decision
3	Inspect connections at ECM E1 connector. Key OFF, disconnect ECM E1 connector. Check ECM and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the ECM E1 connector, harness, and terminals clean and undamaged?	Yes: Go to step 4. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1177 FMI 2.

Step	Action	Decision
4	Check SIG GND circuit for high resistance. Connect 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 to ECM E1 harness, and leave ECM disconnected. Connect Breakout Harness ZTSE4830 to engine harness and leave TC2CIS disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-1 and Breakout Box pin E1-55. Is resistance less than 5 ohms?	Yes: Go to step 5. No: Repair high resistance between TC2CIS pin-1 and ECM connector pin E1-55. After repairs are complete, retest for SPN 1177 FMI 2.

Step	Action	Decision
5	Check TC2CIP circuit for high resistance. With 180-pin Breakout Box and ECM Breakout Harness 00-01468-00 to ECM E1 engine harness connected to ECM E1 harness and Breakout Harness ZTSE4830 to engine harness, leave TC2CIS and ECM disconnected. Key OFF, use a DMM to measure resistance between Breakout Harness pin-4 and Breakout Box E1 pin-79. Is resistance less than 5 ohms?	Yes: Replace TC2CIS sensor. After repairs are complete, retest for SPN 1177 FMI 2. No: Repair high resistance between TC2CIS pin-4 and ECM connector pin E1-79. After repairs are complete, retest for SPN 1177 FMI 2.

NOTE: After performing all diagnostic steps, if SPN 1177 FMI 2 remains, verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1177 FMI 3 - TC2CIP Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values
Turbocharger 2 Compressor Inlet Pressure (TC2CIP) signal is greater than expected.	TC2CIP > 4.9 volts	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) signal from Turbocharger 2 Compressor Inlet Pressure (TC2CIP) circuit is greater then 4.9 volts.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

None.

Fault Facts

None.

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- TC2CIP shorted to PWR
- TC2CIP Open or high resistance
- SIG GND Open or high resistance
- Failed TC2CIS sensor

Step 1	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 1177 FMI 3.		Yes: Go to Step 2.
Is EST DTC list SPN 1177 FMI 3 active?		No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 2	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS).	Decision
A. Key OFF. B. Disconnect TC2CIS connector. C. Check TC2CIS and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 3.
Are TC2CIS connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1177 FMI 3.

Step 3	Check for a short to PWR in TC2CIP circuit.	Decision
Perform Test 1 (page 1438). Perform Continuous Monitor Test (page 1588). Monitor TC2CIP voltage in ServiceMaxx™ software.		Yes: Go to step 4
Is voltage less than 5 volts?		No: Repair short to PWR between TC2CIS pin-4 and ECM pin E1-79. After repairs are complete, retest for SPN 1177 FMI 3.

Step 4	Check for a failed TC2CIS.	Decision
Perform Test 2 (page 1439). Perform Continuous Monitor Test (page 1588). Monitor TC2CIP voltage in ServiceMaxx™ software.		Yes: Replace TC2CIS. After repairs are complete, retest for SPN 1177 FMI 3.
Is voltage 0 ± 0.5 volts?		No: Go to step 5.

Step 5	Check for an Open in TC2CIP circuit.	Decision
Perform Test 3 (page 1440). Perform Continuous Monitor Test (page 1588). Monitor TC2CIP voltage in ServiceMaxx™ software.		No: Repair Open or high resistance between TC2CIS pin-1 and ECM pin E1-55. After repairs are complete, retest for SPN 1177 FMI 3.
Is voltage 0 ± 0.5 volts?		No: Repair Open or high resistance between TC2CIS pin-4 and ECM pin E1-79. After repairs are complete, retest for SPN 1177 FMI 3.

Pin-Point Test SPN 1177 FMI 3

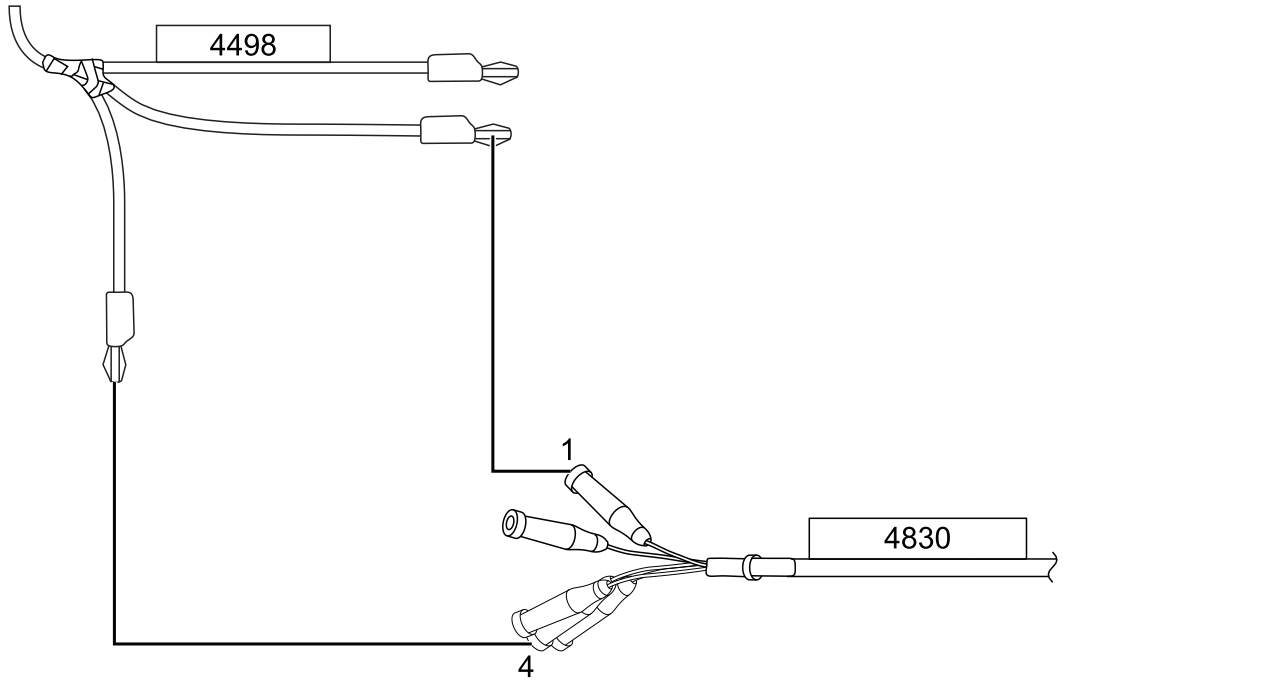
Figure 549 Turbocharger 2 Compressor Inlet Sensor (TC2CIS) Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4830
- Breakout Harness ZTSE4498
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test 1 Setup
A. Key OFF.
B. Disconnect TC2CIS.
C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
D. Key ON, log into ServiceMaxx™ software.



0000305583

Figure 550 TC2CIP Circuit Check

Test 2 Setup
A. Key OFF.
B. Connect Breakout Harness ZTSE4830 to vehicle harness and leave TC2CIS sensor disconnected.
C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4830 pin-1 to pin-4.
D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
E. Key ON, log into ServiceMaxx™ software.

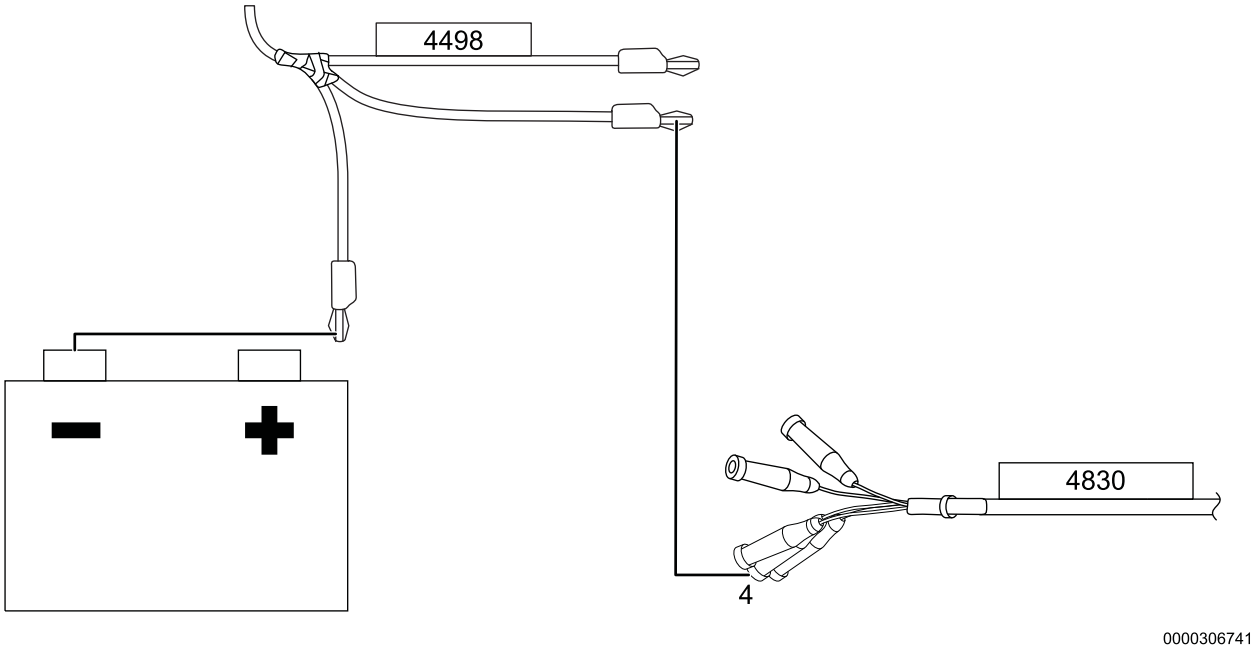


Figure 551 TC2CIP Circuit Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4830 to vehicle harness and leave TC2CIS sensor disconnected. C. Using Breakout Harness ZTSE4498, short Breakout Harness ZTSE4830 pin-4 to a known good GND. D. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571). E. Key ON, log into ServiceMaxx™ software.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 1173 FMI 3 fault code diagnostics.

SPN 1177 FMI 4 - TC2CIP Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values
Turbocharger 2 Compressor Inlet Pressure (TC2CIP) signal is less than expected.	TC2CIP < 0.1 volt	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects signal from the Turbocharger 2 Compressor Inlet Pressure (TC2CIP) circuit is less then 0.1 volts.

Lamp Reaction

Malfunction Indicator Lamp (MIL) will illuminate when this fault is detected during one drive cycle.

Associated Faults

SPN 3512 (VREF4)			

Fault Facts

None.

Drive Cycle to Determine Fault Status

Continuous.

Possible Causes

- TC2CIP circuit shorted to GND
- VREF4 circuit shorted to GND
- VREF4 circuit Open
- Failed TC2CIS sensor

Step 1	Check for Associated Faults.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for Associated Faults (page 1441).		Yes: Go to Step 2.
Is EST DTC list free of Associated Faults?		No: Repair Associated Faults. After repairs are complete, retest for SPN 1177 FMI 4.

Step 2	Check for active or pending fault code.	Decision
Using Electronic Service Tool (EST) with ServiceMaxx™ software. Key ON, check Diagnostic Trouble Codes (DTC) list for SPN 1177 FMI 3.		Yes: Go to Step 3.
Is EST DTC list SPN 1177 FMI 4 active?		No: Go to Intermittent or Inactive Fault Diagnostic Procedure (page 1570).

Step 3	Inspect connections at Turbocharger 2 Compressor Inlet Sensor (TC2CIS).	Decision
A. Key OFF. B. Disconnect TC2CIS connector. C. Check TC2CIS and connector terminals for: damaged or pinched wires; moisture or corroded terminals; loose, bent, or broken pins; or broken connector housing.		Yes: Go to step 4.
Are TC2CIS connector, harness, and terminals clean and undamaged?		No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 1177 FMI 4.

Step 4	Check for a Open or short to GND in VREF 4 circuit.	Decision
Perform Test 1 (page 1445). Using Digital Multimeter (DMM) measure the voltage between Breakout Harness ZTSE4830 pin-3 and a known good GND		Yes: Go to step 5
Is voltage 5 ± 0.5 volts?		No: Repair Open or short to GND between TC2CIS pin-3 and ECM pin E1-58. After repairs are complete, retest for SPN 1177 FMI 4.

Step 5	Check for a Open or short to GND in VREF 4 circuit.	Decision
Perform Test 2 (page 1446). Perform Continuous Monitor Test (page 1588). Monitor TC2CIP voltage in ServiceMaxx™ software.		Yes: Replace TC2CIS. After repairs are complete, retest for SPN 1177 FMI 4.
Is voltage 5 ± 0.5 volts?		No: Repair short to GND between TC2CIS pin-4 and ECM pin E1-79. After repairs are complete, retest for SPN 1177 FMI 4.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 1177 FMI 4 fault code diagnostics.

Pin-Point Test SPN 1177 FMI 4

Figure 552 Turbocharger 2 Compressor Inlet Sensor (TC2CIS) Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4830
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

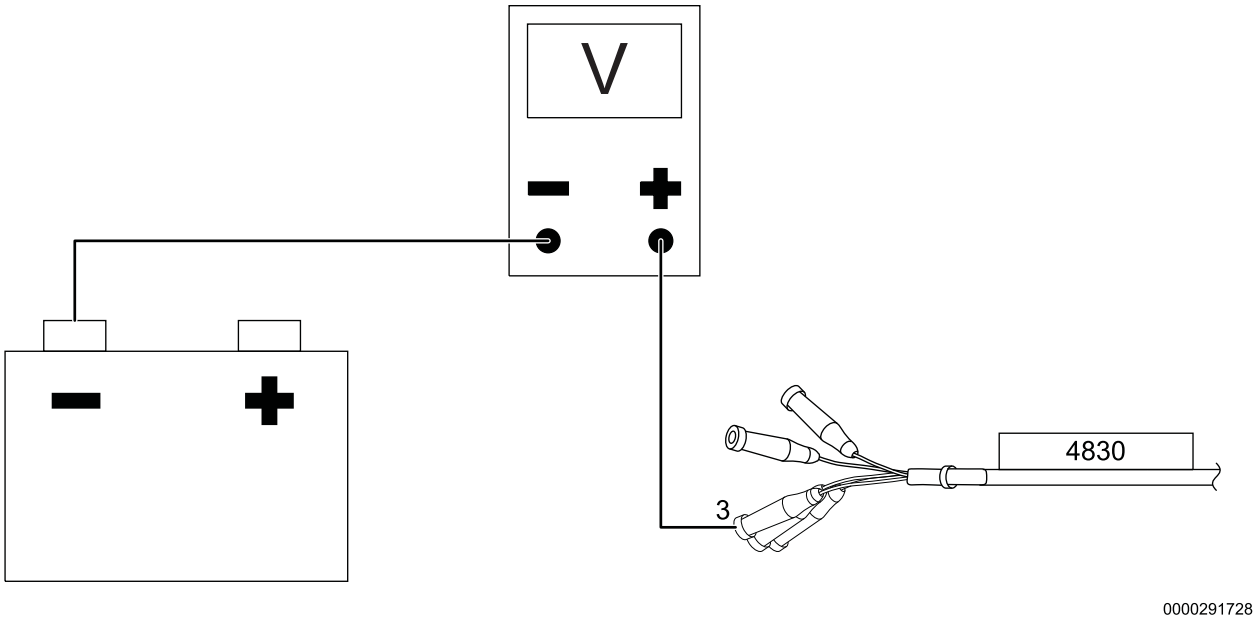


Figure 553 VREF 4 Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4830 to vehicle harness and leave TC2CIS sensor disconnected. C. Key ON.

Test 2 Setup
A. Key OFF.
B. Disconnect TC2CIS.
C. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
D. Key ON, log into ServiceMaxx™ software.

TC2WC (Turbocharger 2 Wastegate Control) Sensor

Overview of TC2WC Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
1189	3	TC2WC short to PWR	• TC2WC control circuit short to PWR • Failed TC2WC solenoid	Circuit Checks (page 1451)
1189	4	TC2WC short to GND	• TC2WC control circuit short to GND • Failed TC2WC solenoid	Circuit Checks (page 1451)
1189	5	TC2WC open load/circuit	• TC2WC control OPEN circuit • Failed TC2WC solenoid	Circuit Checks (page 1451)

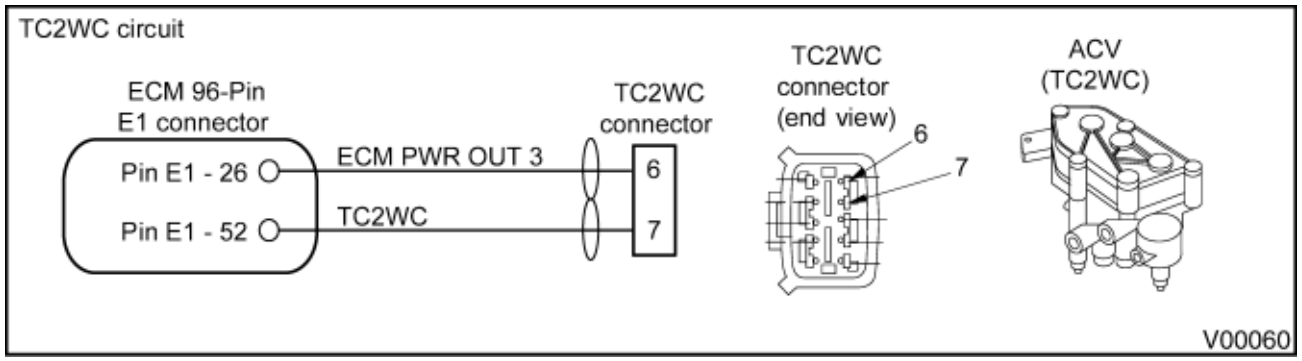


Figure 554 TC2WC circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6003 (TC2WC)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Note: The TC2WC, TC1TOP, and EBPV circuits share the same connector to the Air Control Valve (ACV) assembly.

SPN 1189 FMI 3 - TC2WC Short to PWR

Connector Voltage Check – TC2WC Disconnected

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
6 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
7 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN circuit. Do Harness Resistance Check.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

1. Connect Breakout Harness ZTSE6003 between TC2WC and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select TC2 Wastegate Control from the drop-down menu.
3. Command TC2 Wastegate Control to 5%.
4. Use DMM to measure voltage.
5. Command TC2 Wastegate Control to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
7 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
7 to GND	95% = 0.5 V ± 0.5 V	If > 1 V, check for OPEN circuit or failed ACV.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE6003 to ACV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Spec	Comment
6 to 7	4 Ω to 11 Ω	If not within specification, replace the ACV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box and Breakout Harness ZTSE6003. Leave ECM and TC2WC disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
6 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
6 to E1-26	< 5 Ω	If > 5 Ω, check for OPEN circuit.
7 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
7 to E1-52	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace ACV.		

SPN 1189 FMI 4 - TC2WC Open or Short to GND

Connector Voltage Check – TC2WC Disconnected

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
6 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
7 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN circuit. Do Harness Resistance Check.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

1. Connect Breakout Harness ZTSE6003 between TC2WC and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select TC2 Wastegate Control from the drop-down menu.
3. Command TC2 Wastegate Control to 5%.
4. Use DMM to measure voltage.
5. Command TC2 Wastegate Control to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
7 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
7 to GND	95% = 0.5 V ± 0.5 V	If > 1 V, check for OPEN circuit or failed ACV.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE6003 to ACV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Spec	Comment
6 to 7	4 Ω to 11 Ω	If not within specification, replace the ACV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box and Breakout Harness ZTSE6003. Leave ECM and TC2WC disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
6 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
6 to E1-26	< 5 Ω	If > 5 Ω, check for OPEN circuit.
7 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
7 to E1-52	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace ACV.		

SPN 1189 FMI 5 - TC2WC Open Load / Circuit

Connector Voltage Check – TC2WC Disconnected

Connect Breakout Harness ZTSE6003 to ACV engine harness, and leave ACV disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
6 to GND	B+	If < B+, check for OPEN circuit. Do Harness Resistance Check.
7 to GND	3.5 V ± 1.0 V	If < 2.5 V, check for OPEN circuit. Do Harness Resistance Check.
If measurements are within specifications, do Operational Voltage Check.		

Operational Voltage Check

NOTE: Ensure air tanks have at least 90 psi (621 kPa) of pressure.

1. Connect Breakout Harness ZTSE6003 between TC2WC and engine harness.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Tests > Actuator Test. Select TC2 Wastegate Control from the drop-down menu.
3. Command TC2 Wastegate Control to 5%.
4. Use DMM to measure voltage.
5. Command TC2 Wastegate Control to 95%.
6. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
7 to GND	5% = 12 V ± 2.0 V	If < 10 V, check for OPEN circuit.
7 to GND	95% = 0.5 V ± 0.5 V	If > 1 V, check for OPEN circuit or failed ACV.

Actuator Resistance Check

Turn ignition switch OFF. Connect Breakout Harness ZTSE6003 to ACV and leave engine harness disconnected. Use DMM to measure resistance.

Test Point	Spec	Comment
6 to 7	4 Ω to 11 Ω	If not within specification, replace the ACV.
If measurements are within specifications, go to Harness Resistance Check.		

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box and Breakout Harness ZTSE6003. Leave ECM and TC2WC disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
6 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
6 to E1-26	< 5 Ω	If > 5 Ω, check for OPEN circuit.
7 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
7 to E1-52	< 5 Ω	If > 5 Ω, check for OPEN circuit.
If voltage and resistance checks are within specifications, check for DTCs. If DTC returns, replace ACV.		

TOSS (Transmission Output Shaft Speed) Sensor

Overview of TOSS Sensor Group

SPN	FMI	Actions
191	1	TOSS / VSS not detected while vehicle moving (page 1454)
191	2	TOSS / VSS signal erratic, intermittent, or incorrect (page 1465)
191	3	TOSS / VSS signal out of range HIGH (page 1476)
191	4	TOSS / VSS signal out of range LOW (page 1487)
191	16	TOSS / VSS reading higher than limit (Hard-wired) (page 1497)

Overview

Transmission tailshaft speed is detected by a magnetic pickup mounted on the transmission that senses the rotation of a 16 toothed gear installed on the rear of the transmission. The AC (alternating current) sine wave signal is received by the Engine Control Module (ECM) and is utilized along with tire size and axle ratio, to calculate vehicle speed. Calculated vehicle speed is transmitted to the instrument cluster through the Drive Train Data Link to operate the speedometer within the instrument cluster. Calculated vehicle speed is also utilized in the control strategies that control features such as Cruise Control, PTO operation and Road Speed Limiting.

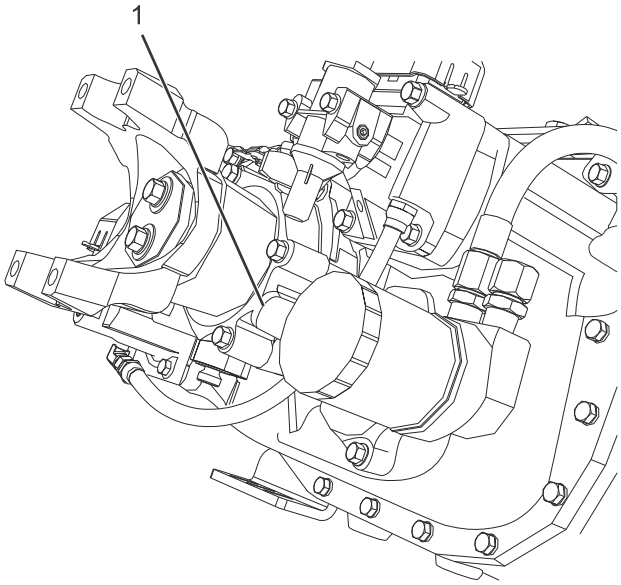


Figure 555 TOSS / VSS Location (Typical)

SPN 191 FMI 1 - TOSS / VSS Not Detected with Vehicle Moving

Condition / Description	Setting Criteria	Enable Conditions / Values
No vehicle speed reading when engine load is high	Vehicle speed	Engine speed > 1500 rpm Key ON Engine torque > 74 lb ft (100 N·m) Speed and torque levels met time > 60 seconds Engine not in PTO mode

Fault Overview

Fault code sets when Engine Control Module (ECM) detects no signal from TOSS / VSS speed sensor.

Lamp Reaction

MIL will illuminate when this fault is detected after two consecutive drive cycles.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- VSS sensor circuit OPEN
- VSS sensor circuit short PWR
- VSS sensor circuit short to GND
- VSS sensor failure
- Air gap too large between VSS sensor and 16 toothed gear
- Damaged 16 toothed gear

Step 1	Inspect connections at Transmission Output Speed Sensor (TOSS) / Vehicle Speed Sensor (VSS)for associated fault code.	Decision
Inspect connections at VSS sensor. Key OFF, disconnect VSS sensor connector. Check VSS sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose bent, or broken pins; or broken connector housing. Is the VSS sensor connector, harness, and terminal clean and undamaged.		Yes: Go to Step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 191 FMI 1.

Step 2	Check for Open on TOSS-H circuit.	Decision
Perform Test 1 (page 1458). Using a DMM, measure voltage between Breakout Harness ZTSE4850 pin-A to GND Is voltage 2.5 volts ± 0.5 volts		Yes: Go to Step 4. No: Go to Step 3.

3	Check for short to PWR on TOSS-H circuit.	Decision
Perform Test 2 (page 1459). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and PWR Is resistance < 100 ohms?		Yes: Repair short to PWR between TOSS / VSS pin-A and Engine Control Module (ECM) pin E1-39. After repairs are complete, retest for SPN 191 FMI 1. No: Repair Open or short to GND between TOSS / VSS pin-A and Engine Control Module (ECM) pin E1-39. After repairs are complete, retest for SPN 191 FMI 1.

Step 4	Check for Open on TOSS-L circuit.	Decision
Perform Test 3 (page 1460). Using a DMM, measure voltage between Breakout Harness ZTSE4850 pin-B to GND Is voltage 2.5 volts ± 0.5 volts		Yes: Go to Step 6. No: Go to Step 5.

Step 5	Check for short to PWR on TOSS-L circuit.	Decision
Perform Test 4 (page 1461). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-B and PWR Is resistance < 100 ohms?		Yes: Repair short to PWR between TOSS / VSS pin-B and Engine Control Module (ECM) pin E1-15. After repairs are complete, retest for SPN 191 FMI 1. No: Repair Open or short to GND between TOSS / VSS pin-B and Engine

	Control Module (ECM) pin E1-15. After repairs are complete, retest for SPN 191 FMI 1.

Step 6	Check for failed TOSS / VOSS.	Decision
Perform Test 5 (page 1462). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and pin-B. Is resistance between 600 and 800 ohms?		Yes: Go to Step 5. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 1.

Step 7	Check for failed TOSS / VOSS.	Decision
Perform Test 6 (page 1463). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and GND. Is resistance > 100 ohms?		Yes: Go to Step 6. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 1.

Step 8	Check for failed TOSS / VOSS.	Decision
Perform Test 7 (page 1464).Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-B and GND. Is resistance > 100 ohms?		Yes: Check TOSS / VSS sensor air gap and 16 toothed gear. Repair as necessary. After repairs are complete, retest for SPN 191 FMI 1. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 1.

Pin-Point Test SPN 191 FMI 1

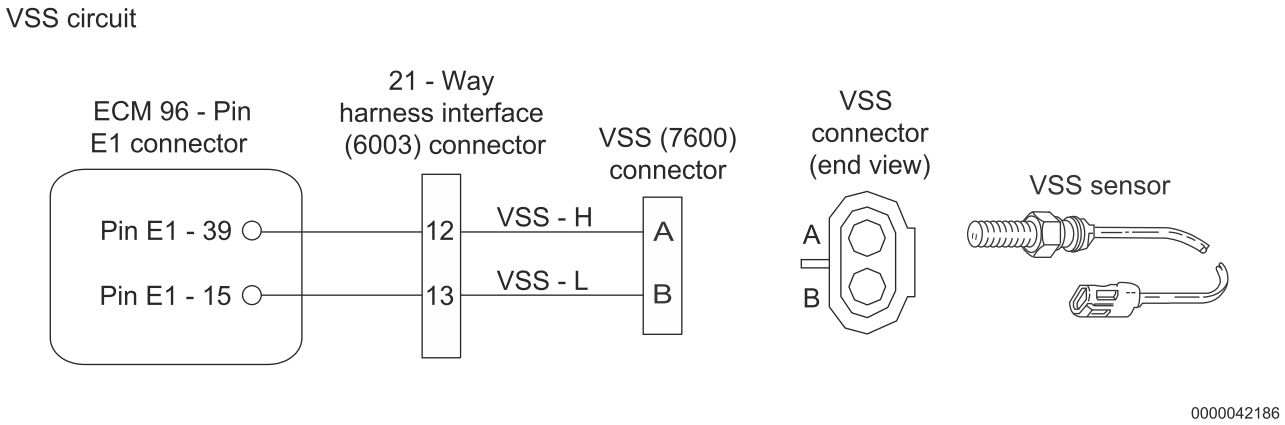


Figure 556 Transmission Output Shaft Speed (TOSS) / Vehicle Speed Sensor (VSS) Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4850
- Digital Multimeter (DMM)

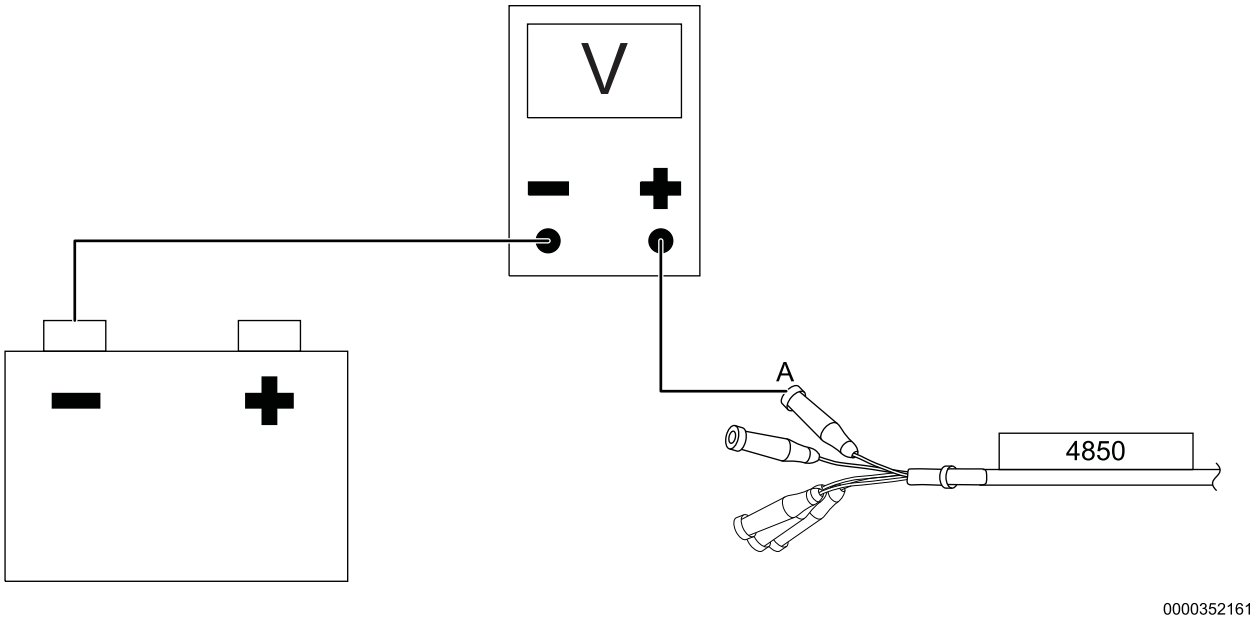


Figure 557 TOSS-H Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave Transmission Output Shaft Speed (TOSS) / Vehicle Speed Sensor (VSS) sensor disconnected. C. Key ON.

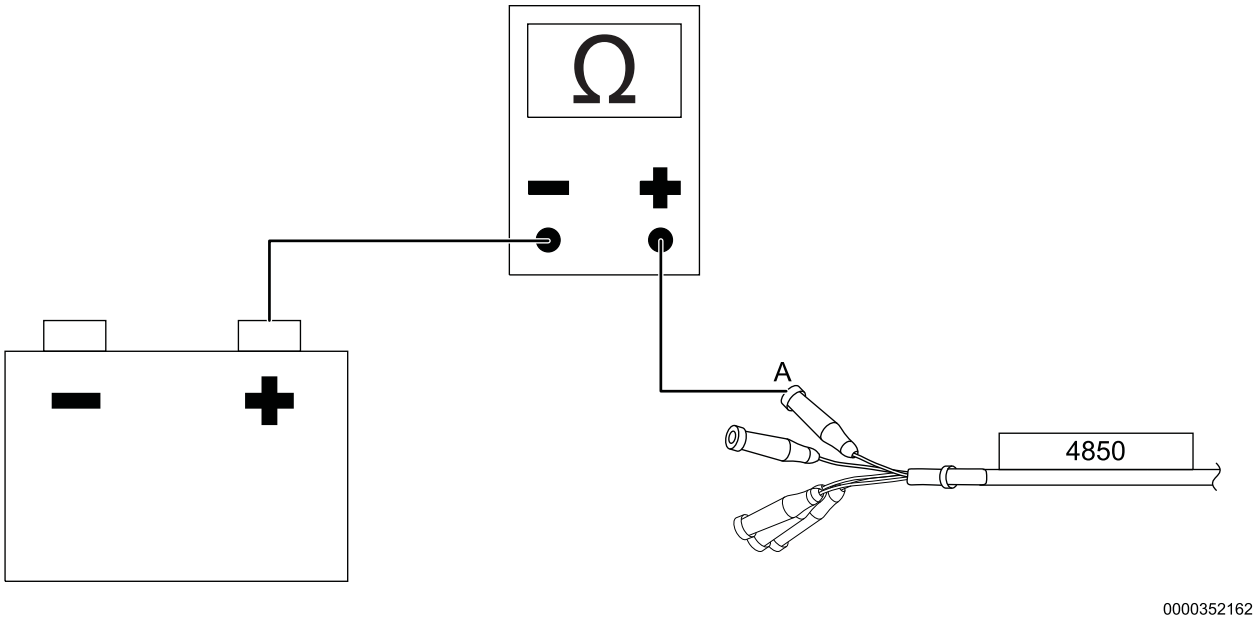


Figure 558 TOSS-H Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected.

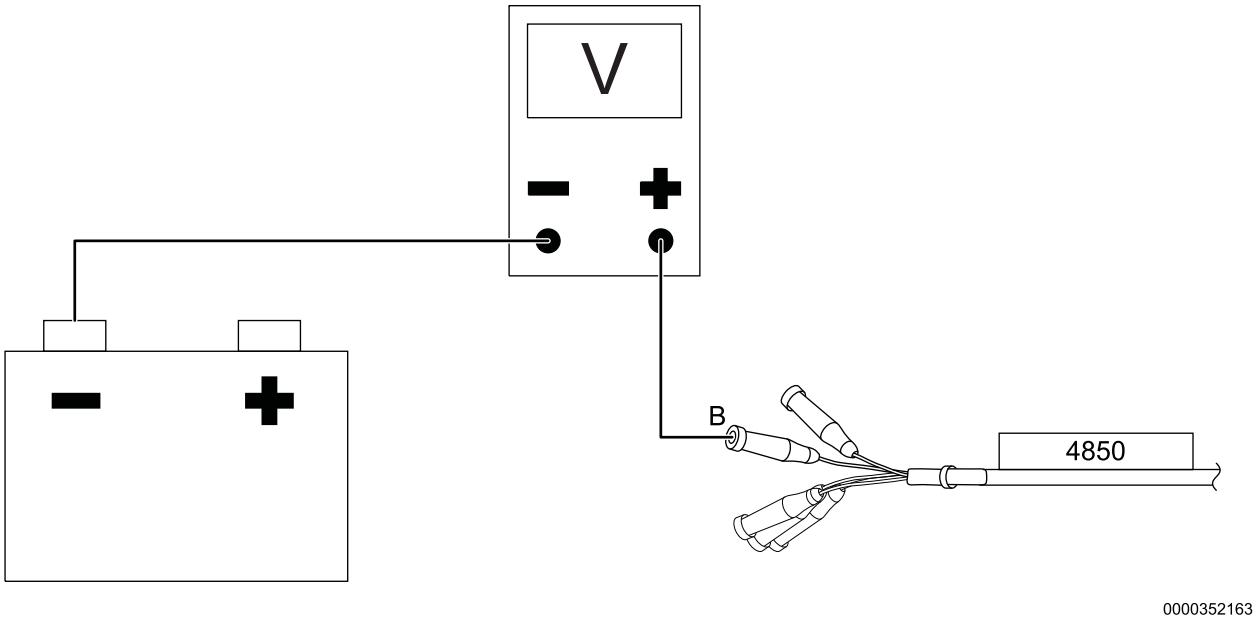


Figure 559 TOSS-L Circuit Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected. C. Key ON.

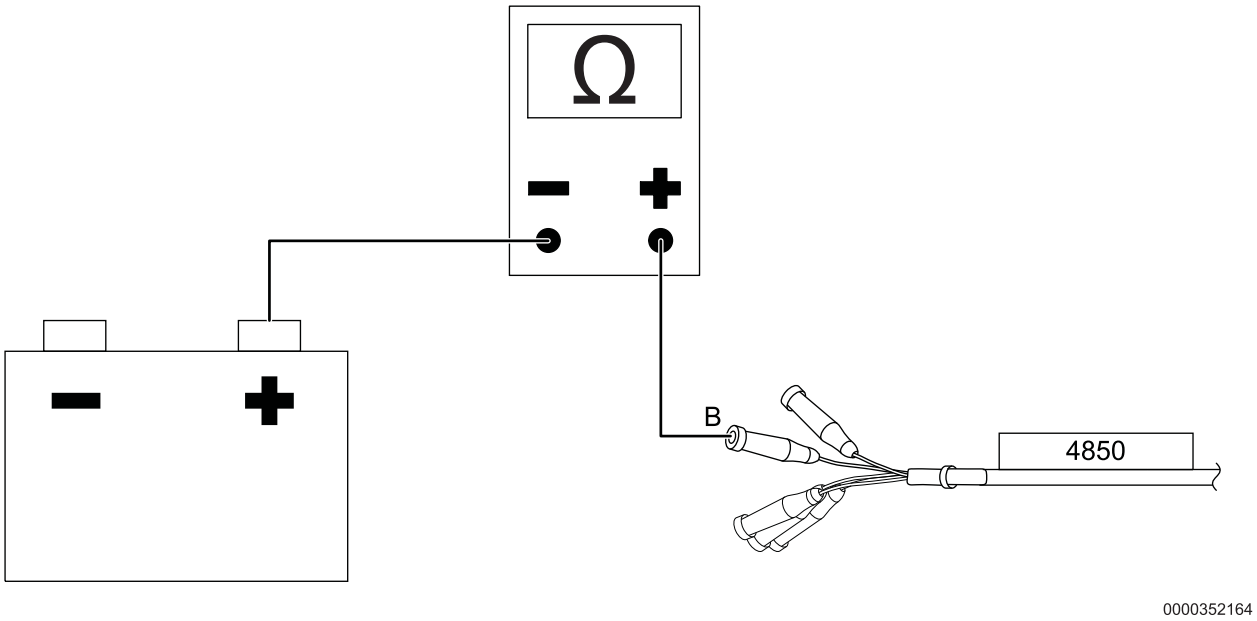
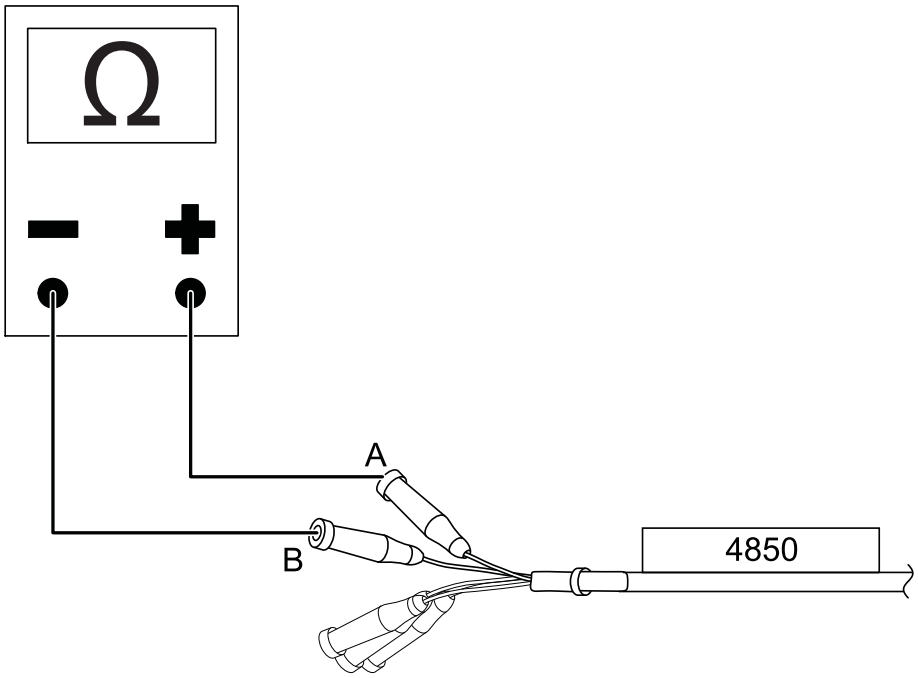


Figure 560 TOSS-L Circuit Check

Test 4 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected.



0000352165

Figure 561 TOSS Circuit Check

Test 5 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

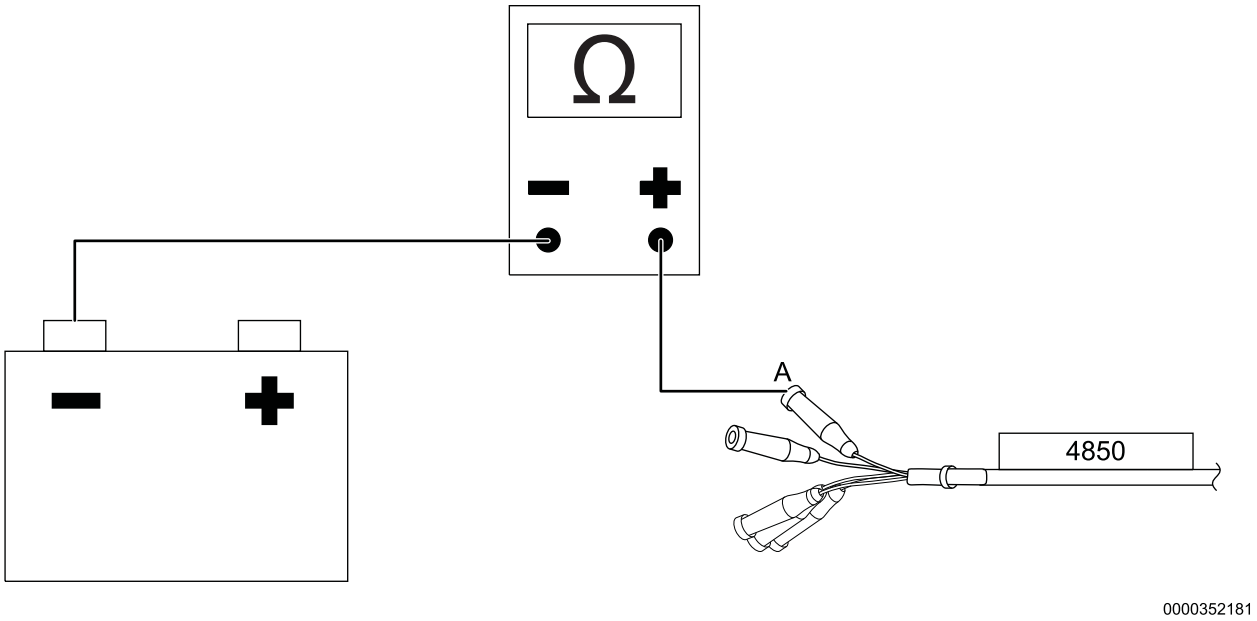


Figure 562 TOSS Circuit Check

Test 6 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

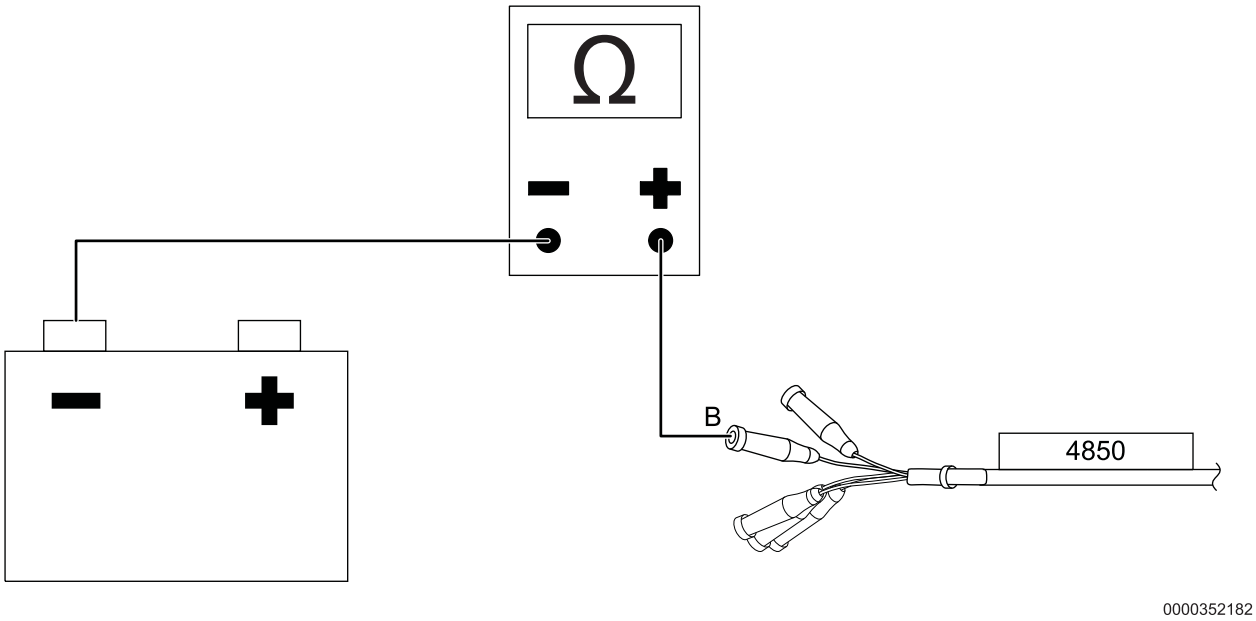


Figure 563 TOSS Circuit Check

Test 7 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 191 FMI 1 fault code diagnostics.

SPN 191 FMI 2 - TOSS/VSS Signal Erratic, Intermittent, or Incorrect

Condition / Description	Setting Criteria	Enable Conditions / Values
VSS signal not detected	Vehicle speed sensor voltage	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects no signal from TOSS / VSS speed sensor.

Lamp Reaction

MIL will illuminate when this fault is detected after two consecutive drive cycles.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Fault Overview

Fault code sets when Engine Control Module (ECM) detects no signal from TOSS / VSS speed sensor.

Lamp Reaction

MIL will illuminate when this fault is detected after two consecutive drive cycles.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- VSS sensor circuit short PWR
- VSS sensor circuit short to GND
- VSS sensor failure
- Air gap too large between VSS sensor and 16 toothed gear
- Damaged 16 toothed gear

Step 1	Inspect connections at Transmission Output Speed Sensor (TOSS) / Vehicle Speed Sensor (VSS)for associated fault code.	Decision
Inspect connections at VSS sensor. Key OFF, disconnect VSS sensor connector. Check VSS sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose bent, or broken pins; or broken connector housing. Is the VSS sensor connector, harness, and terminal clean and undamaged.		Yes: Go to Step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 191 FMI 2.

Step 2	Check for Open on TOSS-H circuit.	Decision
Perform Test 1 (page 1469). Using a DMM, measure voltage between Breakout Harness ZTSE4850 pin-A to GND Is voltage 2.5 volts ± 0.5 volts		Yes: Go to Step 4. No: Go to Step 3.

3	Check for short to PWR on TOSS-H circuit.	Decision
Perform Test 2 (page 1470). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and PWR Is resistance < 100 ohms?		Yes: Repair short to PWR between TOSS / VSS pin-A and Engine Control Module (ECM) pin E1-39. After repairs are complete, retest for SPN 191 FMI 2. No: Repair Open or short to GND between TOSS / VSS pin-A and Engine Control Module (ECM) pin E1-39. After repairs are complete, retest for SPN 191 FMI 2.

Step 4	Check for Open on TOSS-L circuit.	Decision
Perform Test 3 (page 1471). Using a DMM, measure voltage between Breakout Harness ZTSE4850 pin-B to GND Is voltage 2.5 volts ± 0.5 volts		Yes: Go to Step 6. No: Go to Step 5.

Step 5	Check for short to PWR on TOSS-L circuit.	Decision
Perform Test 4 (page 1472). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-B and PWR Is resistance < 100 ohms?		Yes: Repair short to PWR between TOSS / VSS pin-B and Engine Control Module (ECM) pin E1-15. After repairs are complete, retest for SPN 191 FMI 2. No: Repair Open or short to GND between TOSS / VSS pin-B and Engine

	Control Module (ECM) pin E1-15. After repairs are complete, retest for SPN 191 FMI 2.

Step 6	Check for failed TOSS / VOSS.	Decision
Perform Test 5 (page 1473). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and pin-B. Is resistance between 600 and 800 ohms?		Yes: Go to Step 5. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 2.

Step 7	Check for failed TOSS / VOSS.	Decision
Perform Test 6 (page 1474). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and GND. Is resistance > 100 ohms?		Yes: Go to Step 6. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 2.

Step 8	Check for failed TOSS / VOSS.	Decision
Perform Test 7 (page 1475).Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-B and GND. Is resistance > 100 ohms?		Yes: Check TOSS / VSS sensor air gap and 16 toothed gear. Repair as necessary. After repairs are complete, retest for SPN 191 FMI 2. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 2.

Pin-Point Test SPN 191 FMI 2

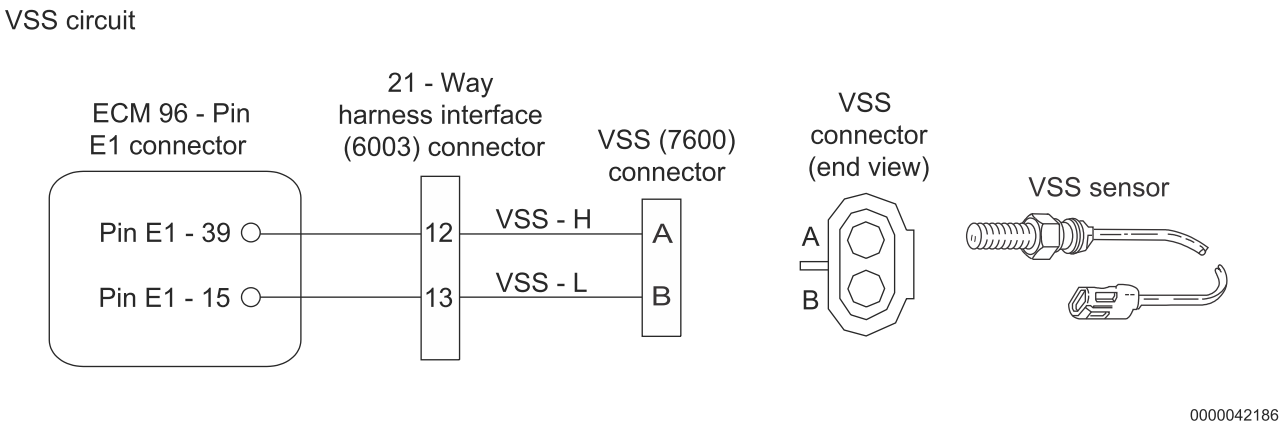


Figure 564 Transmission Output Shaft Speed (TOSS) / Vehicle Speed Sensor (VSS) Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4850
- Digital Multimeter (DMM)

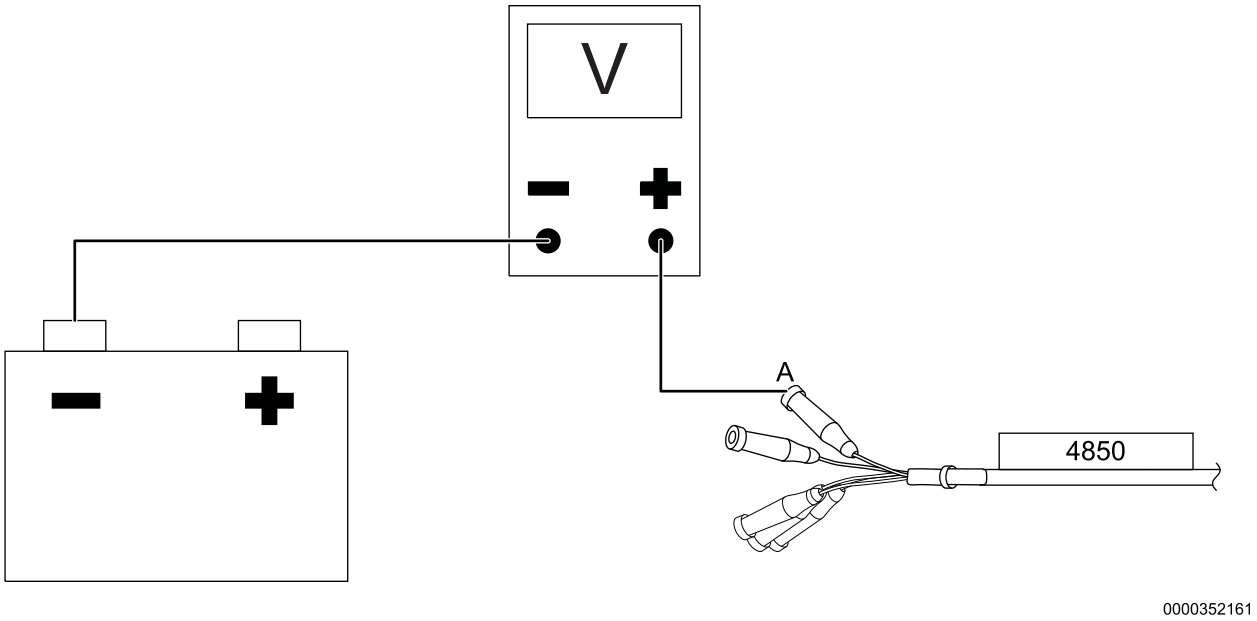


Figure 565 TOSS-H Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave Transmission Output Shaft Speed (TOSS) / Vehicle Speed Sensor (VSS) sensor disconnected. C. Key ON.

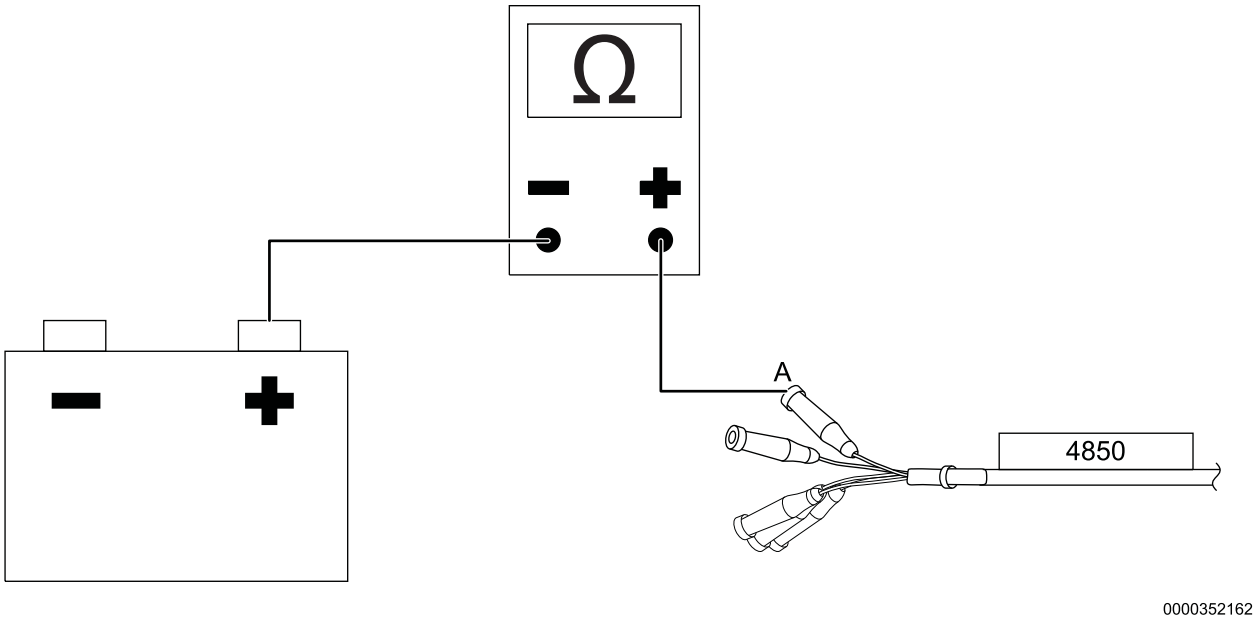


Figure 566 TOSS-H Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected.

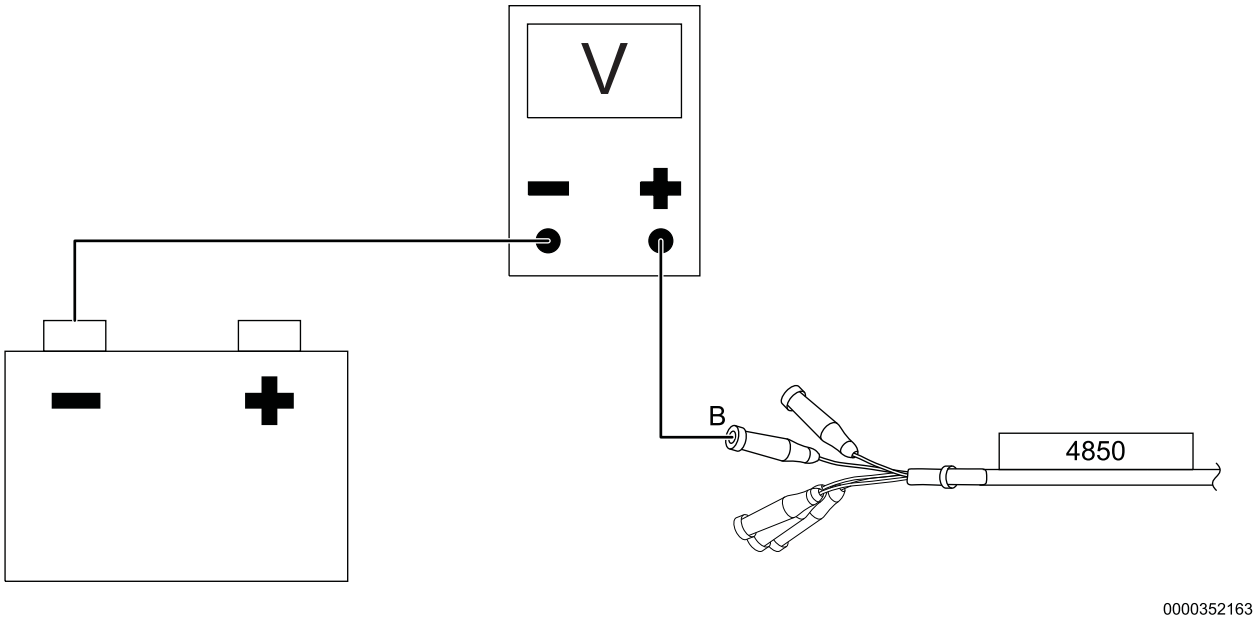


Figure 567 TOSS-L Circuit Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected. C. Key ON.

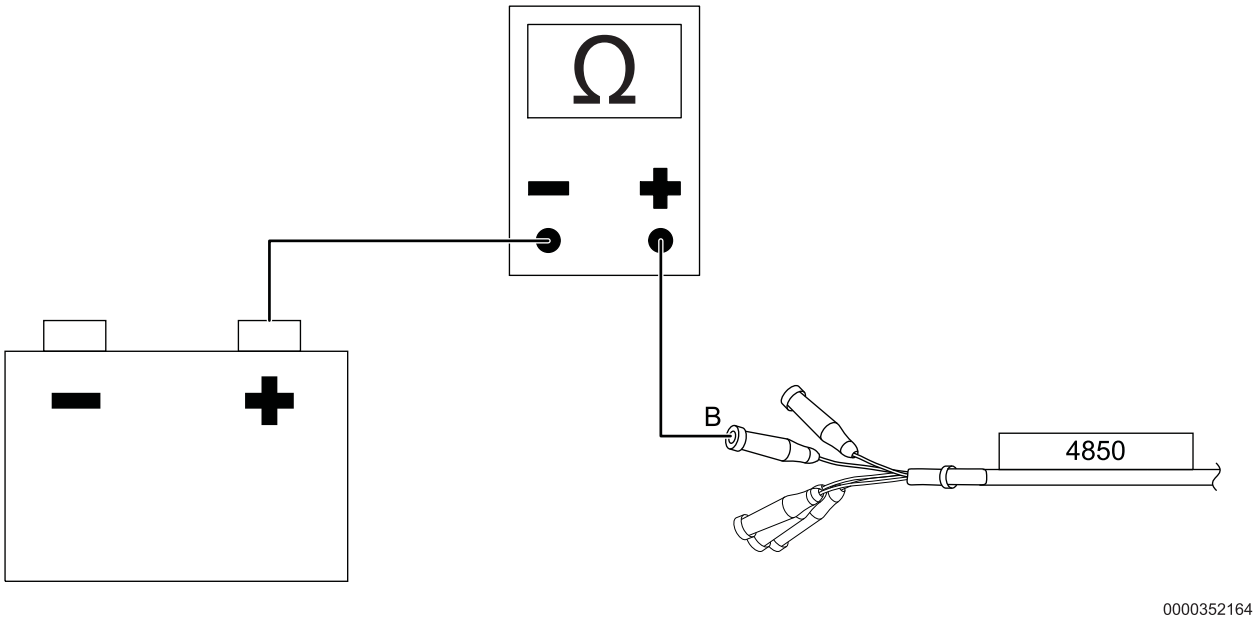


Figure 568 TOSS-L Circuit Check

Test 4 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected.

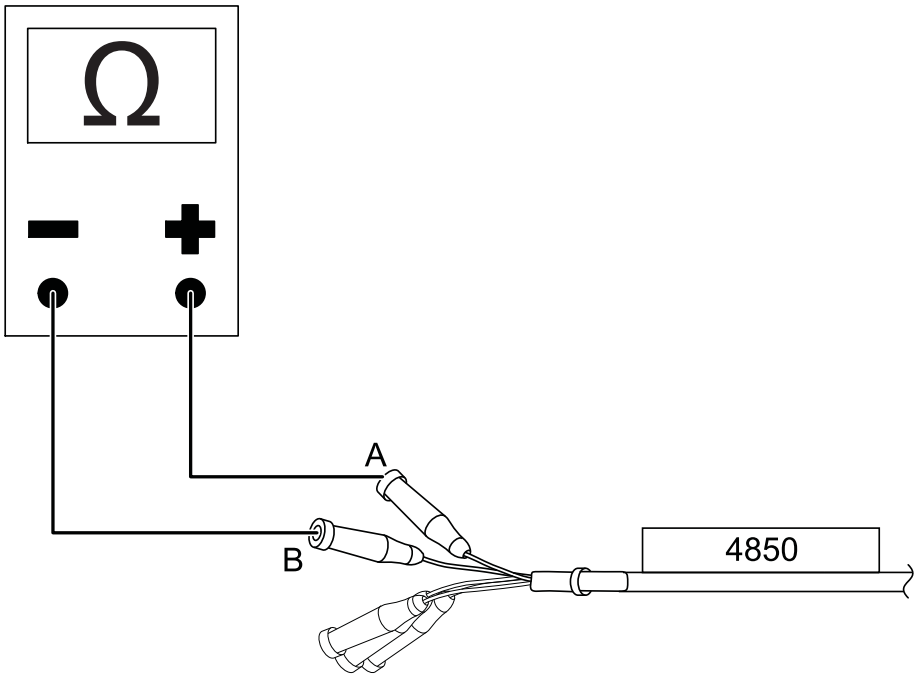


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Figure 569 TOSS Circuit Check

Test 5 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

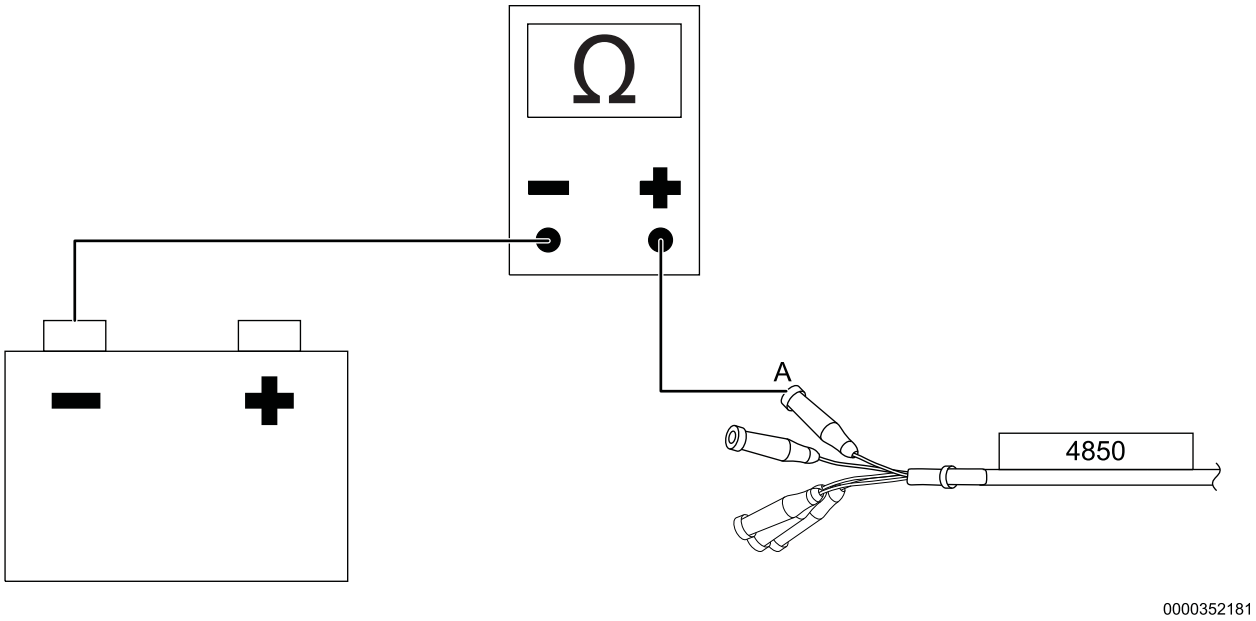

Figure 570 TOSS Circuit Check

Test 6 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

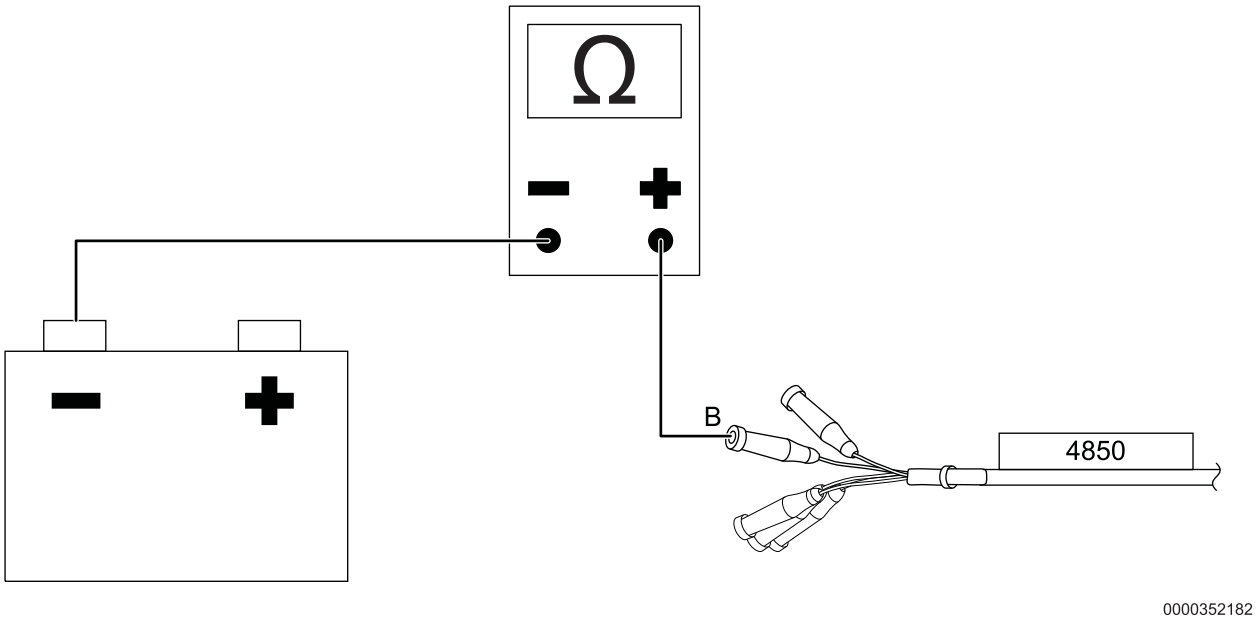

Figure 571 TOSS Circuit Check

Test 7 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 191 FMI 1 fault code diagnostics.

SPN 191 FMI 3 - TOSS/VSS Signal Out of Range HIGH

Condition / Description	Setting Criteria	Enable Conditions / Values
VSS signal out of range HIGH	Vehicle speed sensor voltage	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects TOSS / VSS speed sensor circuit is out of range HIGH.

Lamp Reaction

MIL will illuminate when this fault is detected after two consecutive drive cycles.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- VSS sensor circuit short PWR
- VSS sensor failure

Step 1	Inspect connections at Transmission Output Speed Sensor (TOSS) / Vehicle Speed Sensor (VSS)for associated fault code.	Decision
Inspect connections at VSS sensor. Key OFF, disconnect VSS sensor connector. Check VSS sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose bent, or broken pins; or broken connector housing. Is the VSS sensor connector, harness, and terminal clean and undamaged.		Yes: Go to Step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 191 FMI 3.

Step 2	Check for Open on TOSS-H circuit.	Decision
Perform Test 1 (page 1480). Using a DMM, measure voltage between Breakout Harness ZTSE4850 pin-A to GND Is voltage 2.5 volts ± 0.5 volts		Yes: Go to Step 4. No: Go to Step 3.

3	Check for short to PWR on TOSS-H circuit.	Decision
Perform Test 2 (page 1481). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and PWR Is resistance < 100 ohms?		Yes: Repair short to PWR between TOSS / VSS pin-A and Engine Control Module (ECM) pin E1-39. After repairs are complete, retest for SPN 191 FMI 3. No: Repair Open or short to GND between TOSS / VSS pin-A and Engine Control Module (ECM) pin E1-39. After repairs are complete, retest for SPN 191 FMI 3.

Step 4	Check for Open on TOSS-L circuit.	Decision
Perform Test 3 (page 1482). Using a DMM, measure voltage between Breakout Harness ZTSE4850 pin-B to GND Is voltage 2.5 volts ± 0.5 volts		Yes: Go to Step 6. No: Go to Step 5.

Step 5	Check for short to PWR on TOSS-L circuit.	Decision
Perform Test 4 (page 1483). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-B and PWR Is resistance < 100 ohms?		Yes: Repair short to PWR between TOSS / VSS pin-B and Engine Control Module (ECM) pin E1-15. After repairs are complete, retest for SPN 191 FMI 3. No: Repair Open or short to GND between TOSS / VSS pin-B and Engine

	Control Module (ECM) pin E1-15. After repairs are complete, retest for SPN 191 FMI 3.

Step 6	Check for failed TOSS / VOSS.	Decision
Perform Test 5 (page 1484). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and pin-B. Is resistance between 600 and 800 ohms?		Yes: Go to Step 5. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 3.

Step 7	Check for failed TOSS / VOSS.	Decision
Perform Test 6 (page 1485). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and GND. Is resistance > 100 ohms?		Yes: Go to Step 6. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 3.

Step 8	Check for failed TOSS / VOSS.	Decision
Perform Test 7 (page 1486).Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-B and GND. Is resistance > 100 ohms?		Yes: Check TOSS / VSS sensor air gap and 16 toothed gear. Repair as necessary. After repairs are complete, retest for SPN 191 FMI 3. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 3.

Pin-Point Test SPN 191 FMI 3

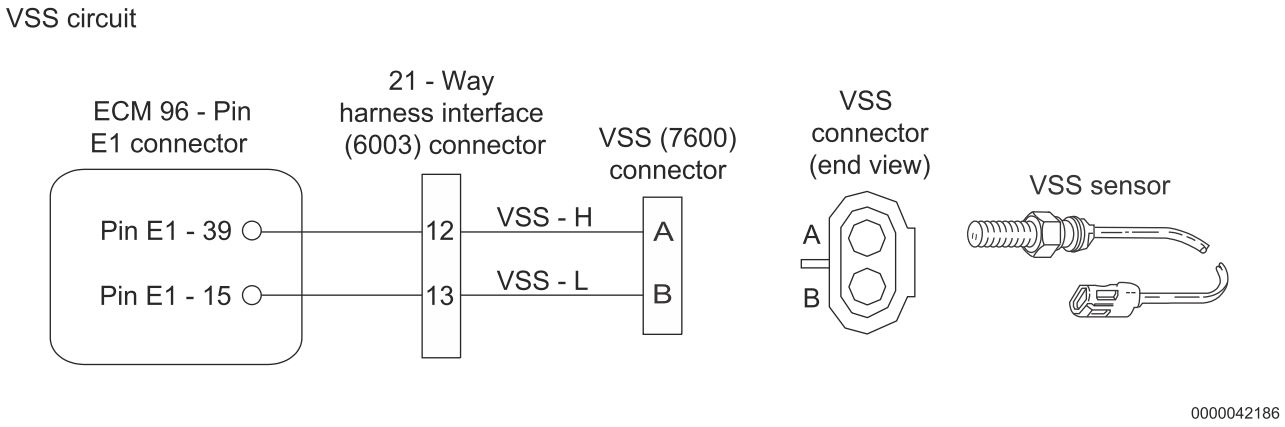

Figure 572 Transmission Output Shaft Speed (TOSS) / Vehicle Speed Sensor (VSS) Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4850
- Digital Multimeter (DMM)

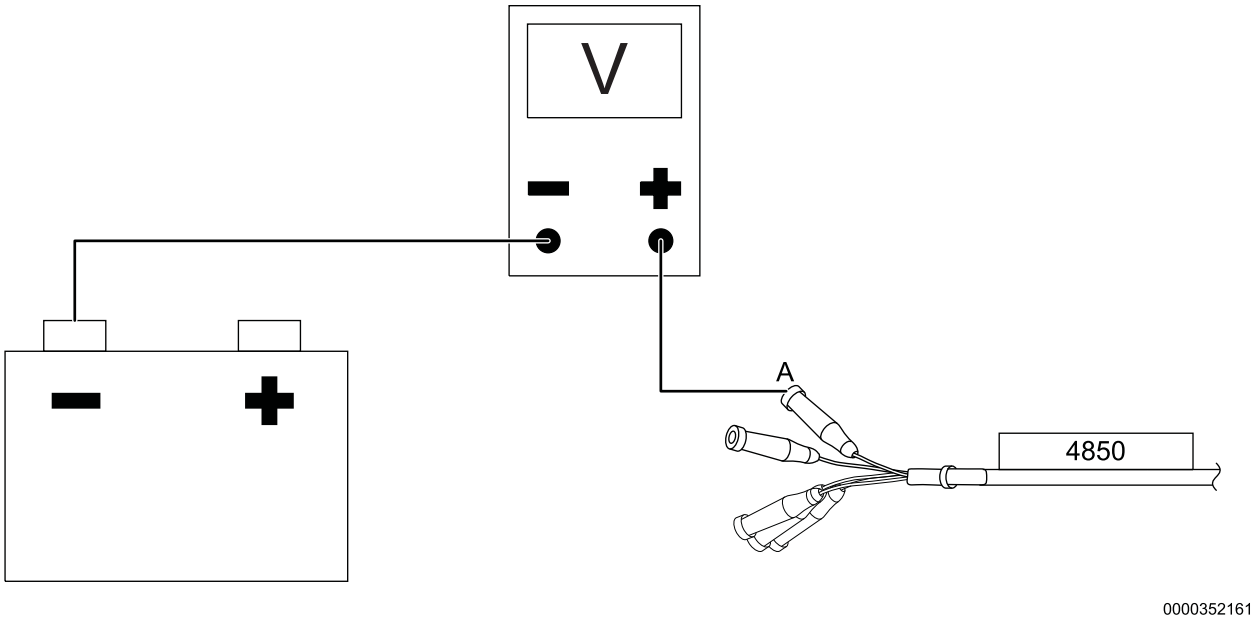

Figure 573 TOSS-H Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave Transmission Output Shaft Speed (TOSS) / Vehicle Speed Sensor (VSS) sensor disconnected. C. Key ON.

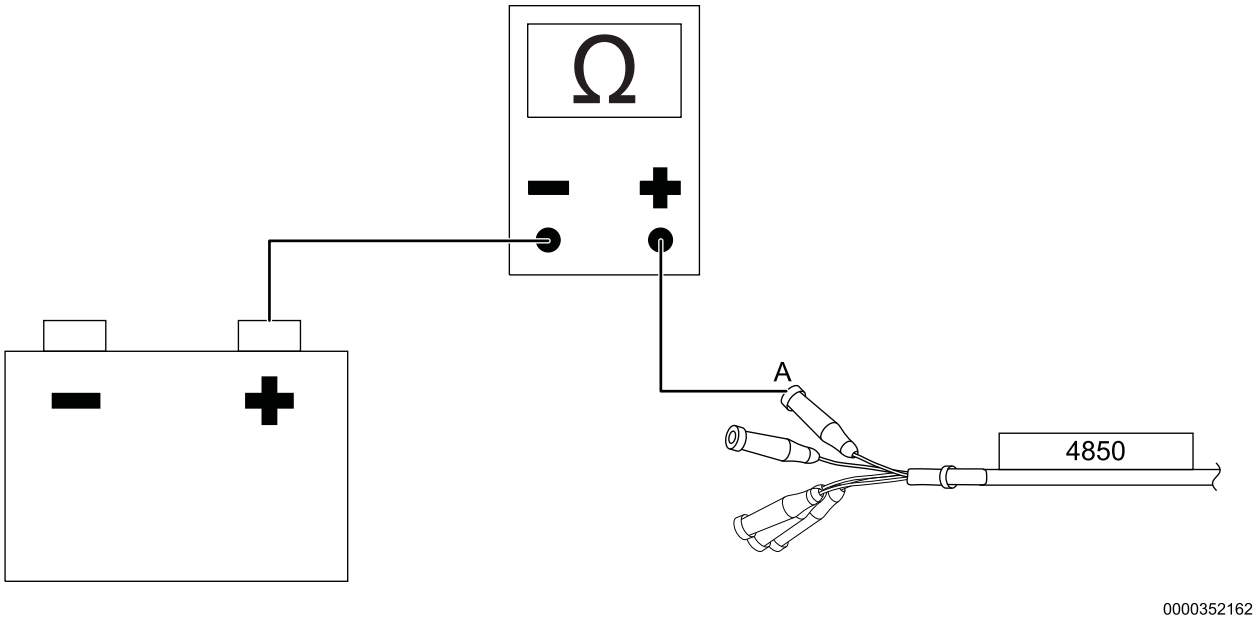

Figure 574 TOSS-H Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected.

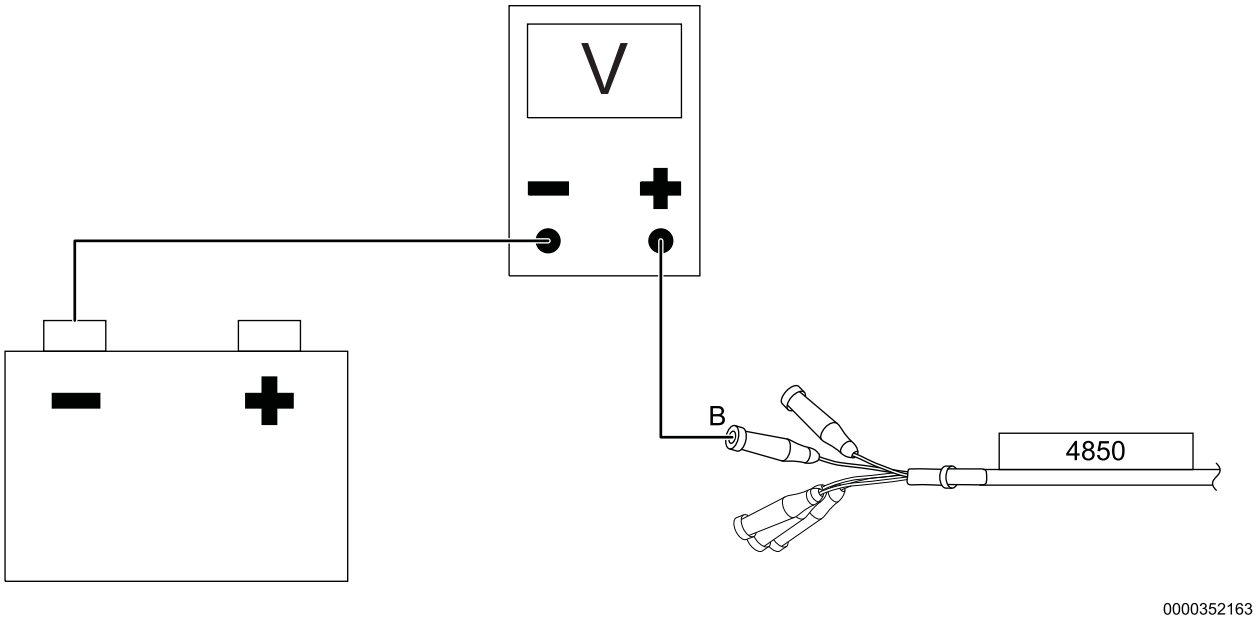

Figure 575 TOSS-L Circuit Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected. C. Key ON.

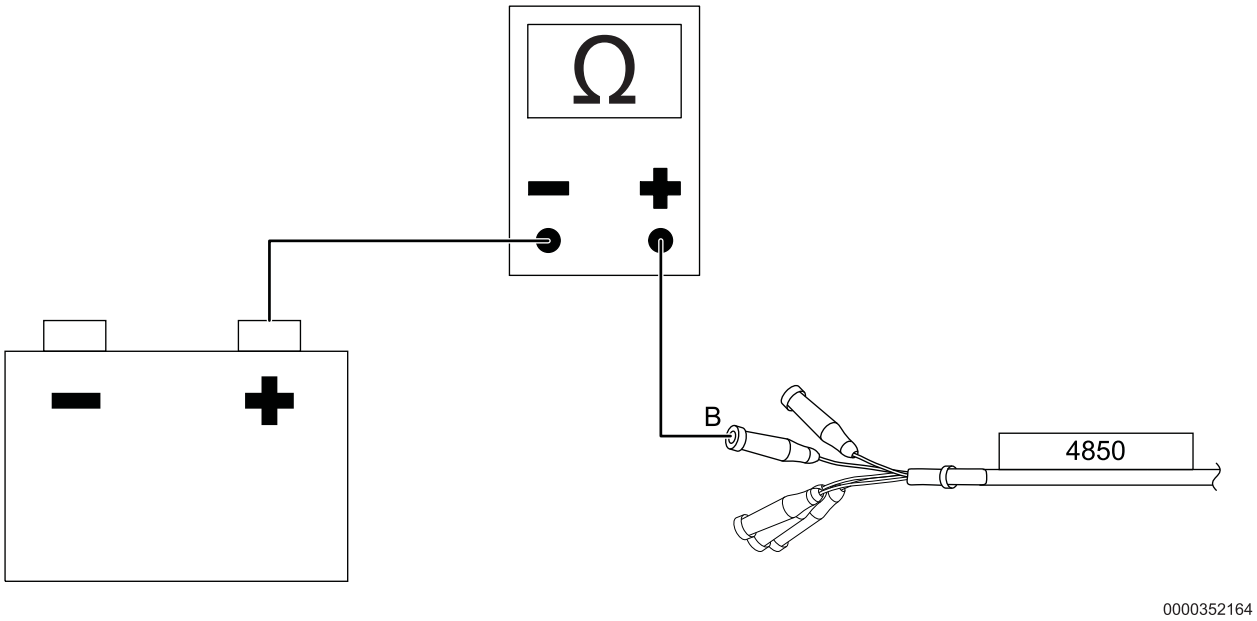

Figure 576 TOSS-L Circuit Check

Test 4 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected.

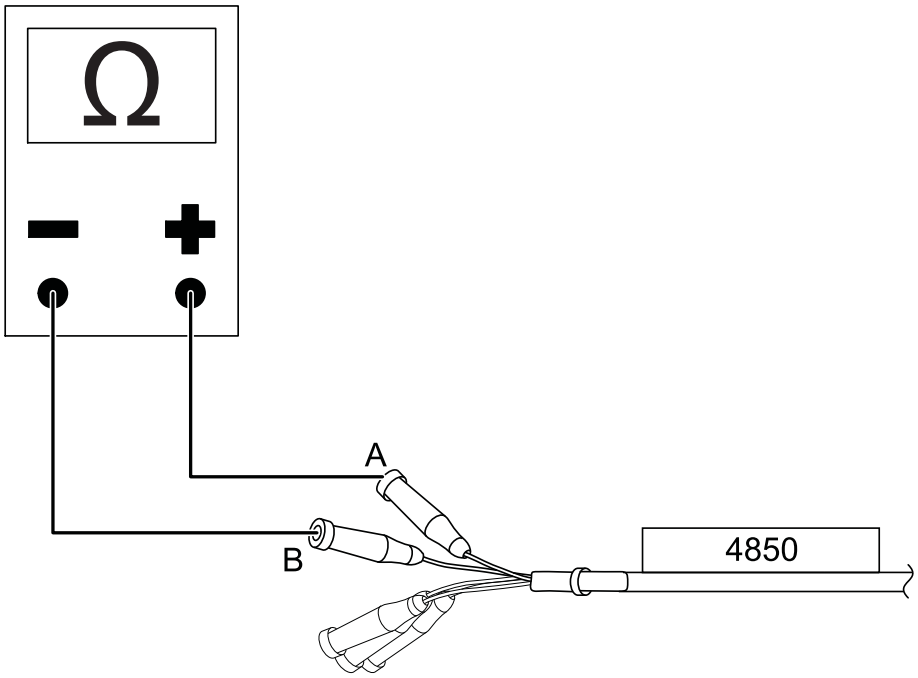

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Figure 577 TOSS Circuit Check

Test 5 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

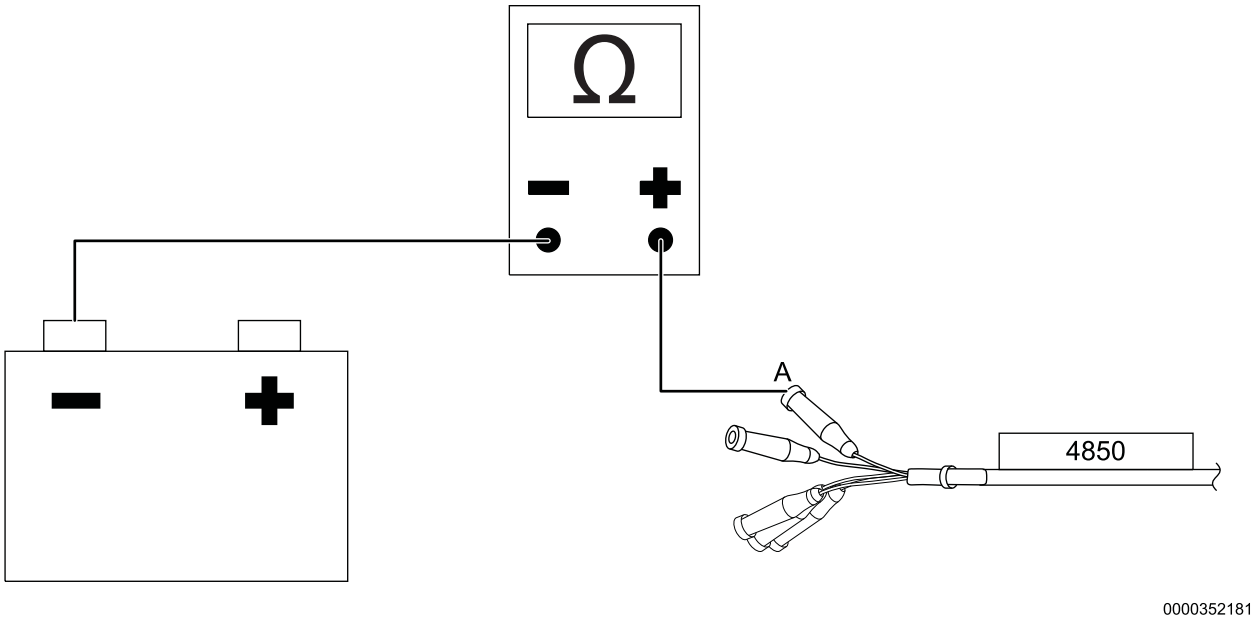

Figure 578 TOSS Circuit Check

Test 6 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

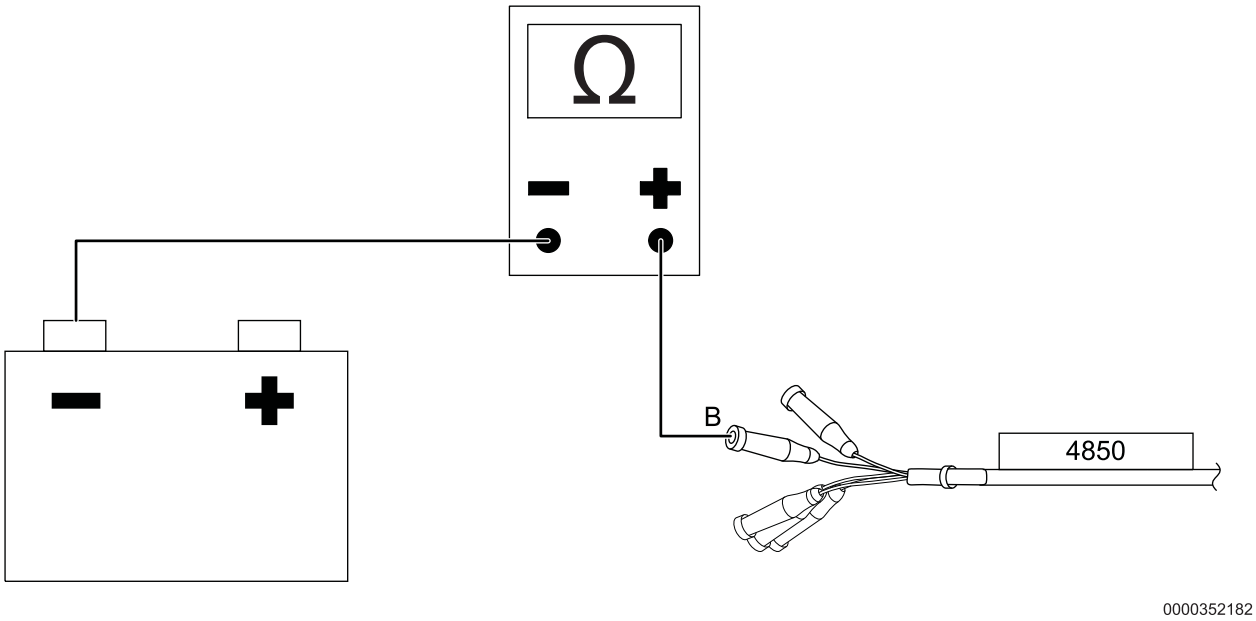

Figure 579 TOSS Circuit Check

Test 7 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 191 FMI 3 fault code diagnostics.

SPN 191 FMI 4 - TOSS/VSS Signal Out of Range LOW

Condition / Description	Setting Criteria	Enable Conditions / Values
VSS signal out of range LOW	Vehicle speed sensor voltage	Key ON

Fault Overview

Fault code sets when Engine Control Module (ECM) detects TOSS / VSS speed sensor circuit is out of range LOW.

Lamp Reaction

MIL will illuminate when this fault is detected after two consecutive drive cycles.

Associated Faults

None

Fault Facts

None

Drive Cycle to Determine Fault Status

Continuous

Possible Causes

- VSS sensor circuit OPEN
- VSS sensor circuit short to GND
- VSS sensor failure

Step 1	Inspect connections at Transmission Output Speed Sensor (TOSS) / Vehicle Speed Sensor (VSS)for associated fault code.	Decision
Inspect connections at VSS sensor. Key OFF, disconnect VSS sensor connector. Check VSS sensor and connector terminals for: damaged or pinched wires; corroded terminals; loose bent, or broken pins; or broken connector housing. Is the VSS sensor connector, harness, and terminal clean and undamaged.		Yes: Go to Step 2. No: Repair connector, harness, or terminal damage. After repairs are complete, retest for SPN 191 FMI 4.

Step 2	Check for Open on TOSS-H circuit.	Decision
Perform Test 1 (page 1491). Using a DMM, measure voltage between Breakout Harness ZTSE4850 pin-A to GND Is voltage 2.5 volts ± 0.5 volts		Yes: Go to Step 4. No: Go to Step 3.

3	Check for short to PWR on TOSS-H circuit.	Decision
Perform Test 2 (page 1492). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and PWR Is resistance < 100 ohms?		Yes: Repair short to PWR between TOSS / VSS pin-A and Engine Control Module (ECM) pin E1-39. After repairs are complete, retest for SPN 191 FMI 4. No: Repair Open or short to GND between TOSS / VSS pin-A and Engine Control Module (ECM) pin E1-39. After repairs are complete, retest for SPN 191 FMI 4.

Step 4	Check for Open on TOSS-L circuit.	Decision
Perform Test 3 (page 1493). Using a DMM, measure voltage between Breakout Harness ZTSE4850 pin-B to GND Is voltage 2.5 volts ± 0.5 volts		Yes: Go to Step 6. No: Go to Step 5.

Step 5	Check for short to PWR on TOSS-L circuit.	Decision
Perform Test 4 (page 1494). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-B and PWR Is resistance < 100 ohms?		Yes: Repair short to PWR between TOSS / VSS pin-B and Engine Control Module (ECM) pin E1-15. After repairs are complete, retest for SPN 191 FMI 4. No: Repair Open or short to GND between TOSS / VSS pin-B and Engine

	Control Module (ECM) pin E1-15. After repairs are complete, retest for SPN 191 FMI 4.

Step 6	Check for failed TOSS / VOSS.	Decision
Perform Test 5 (page 1495). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and pin-B. Is resistance between 600 and 800 ohms?		Yes: Go to Step 5. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 4.

Step 7	Check for failed TOSS / VOSS.	Decision
Perform Test 6 (page 1496). Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-A and GND. Is resistance > 100 ohms?		Yes: Go to Step 6. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 4.

Step 8	Check for failed TOSS / VOSS.	Decision
Perform Test 7 (page 1497).Using a DMM, measure resistance between Breakout Harness ZTSE4850 pin-B and GND. Is resistance > 100 ohms?		Yes: Check TOSS / VSS sensor air gap and 16 toothed gear. Repair as necessary. After repairs are complete, retest for SPN 191 FMI 4. No: Replace TOSS / VOSS. After repairs are complete, retest for SPN 191 FMI 4.

Pin-Point Test SPN 191 FMI 4

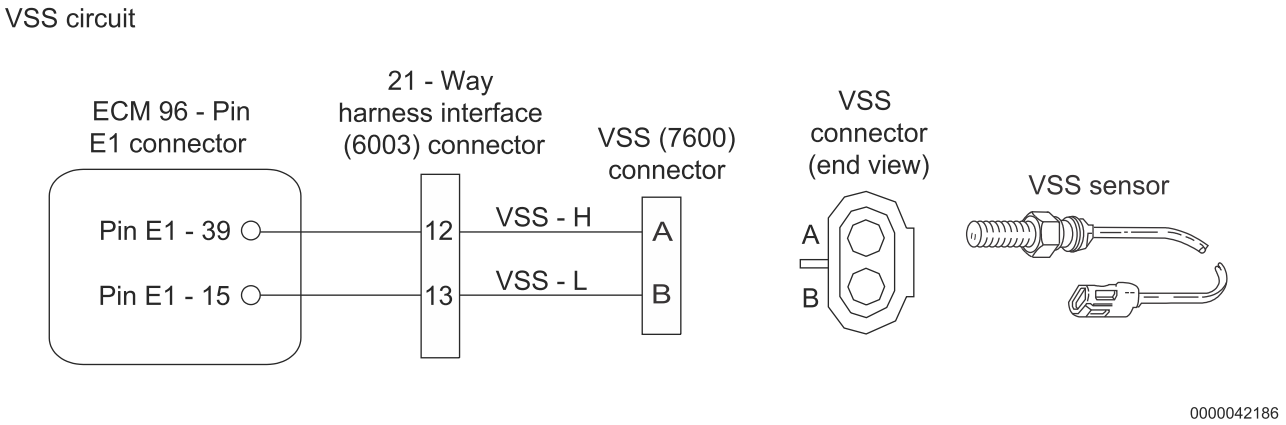

Figure 580 Transmission Output Shaft Speed (TOSS) / Vehicle Speed Sensor (VSS) Circuit Diagram

See the latest version of Navistar® N13 Engine and Aftertreatment Wiring Schematic Form 0000009301 for additional circuit information.

Tools Required

- Breakout Harness ZTSE4850
- Digital Multimeter (DMM)

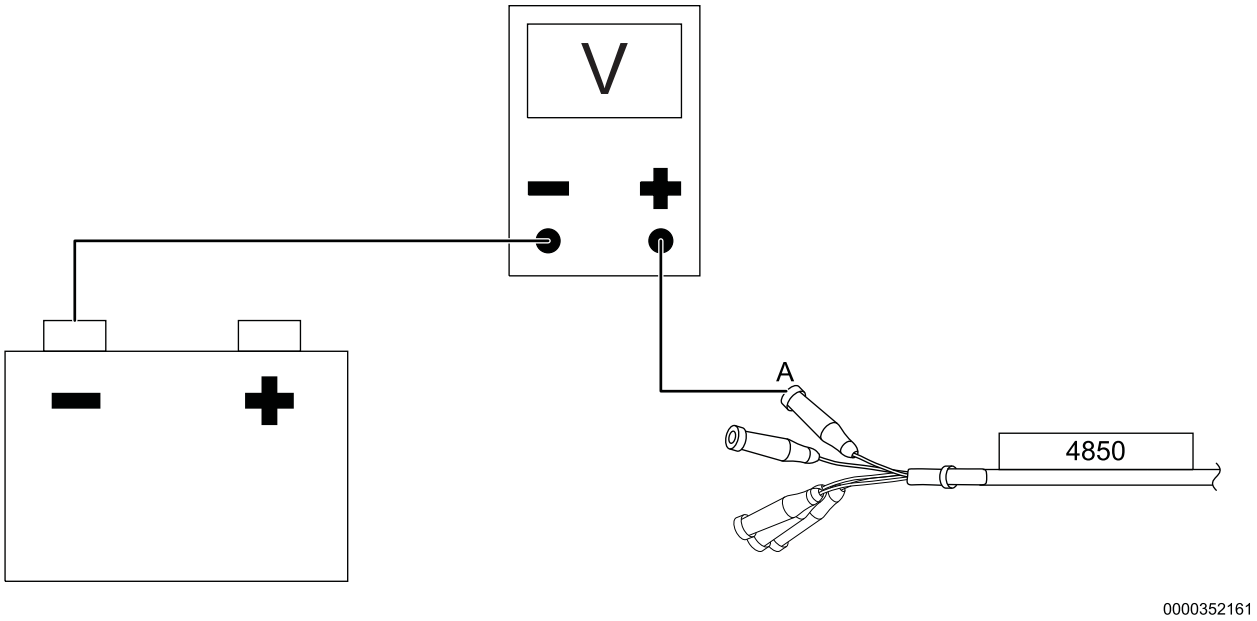

Figure 581 TOSS-H Circuit Check

Test 1 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave Transmission Output Shaft Speed (TOSS) / Vehicle Speed Sensor (VSS) sensor disconnected. C. Key ON.

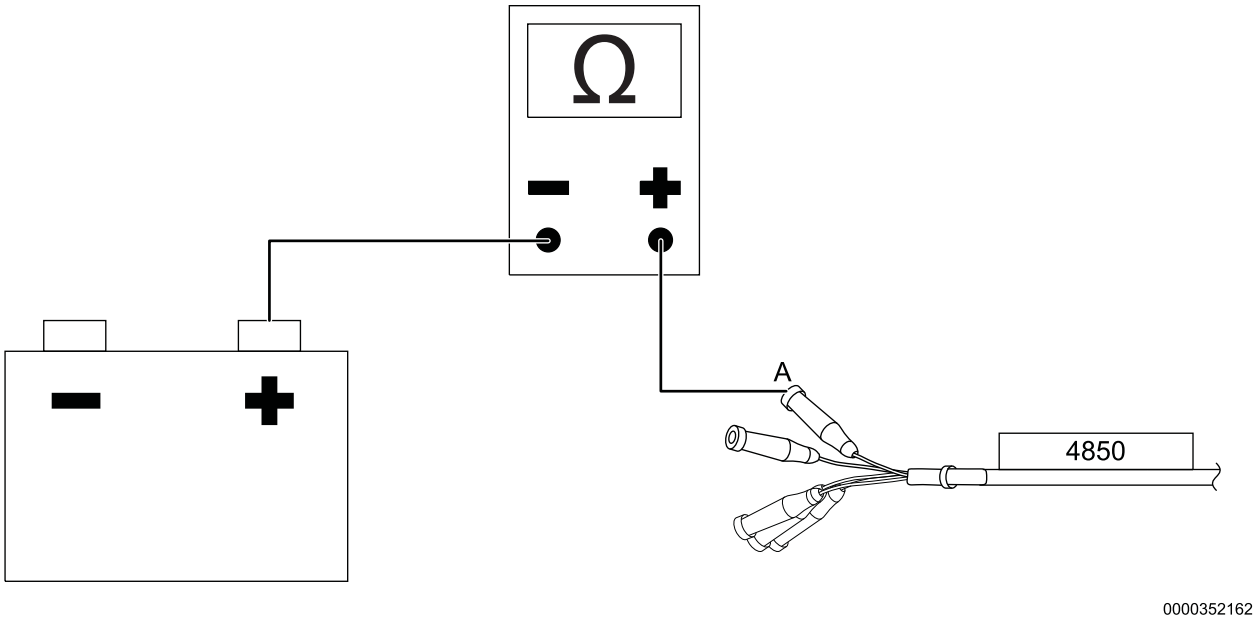

Figure 582 TOSS-H Circuit Check

Test 2 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected.

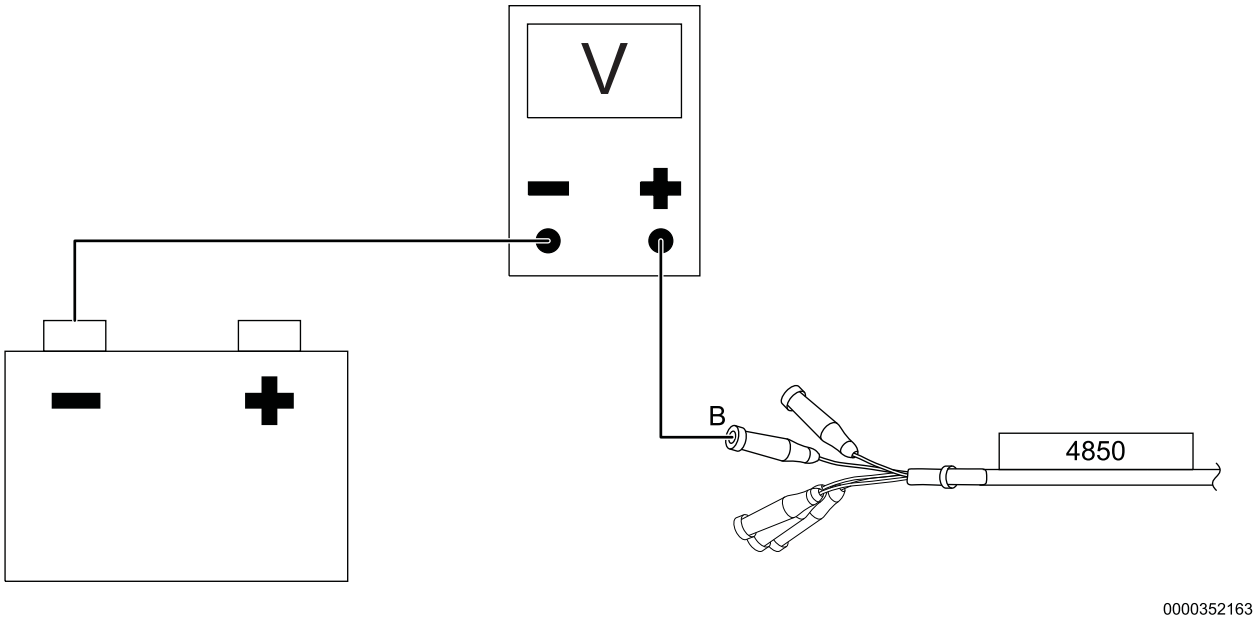

Figure 583 TOSS-L Circuit Check

Test 3 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected. C. Key ON.

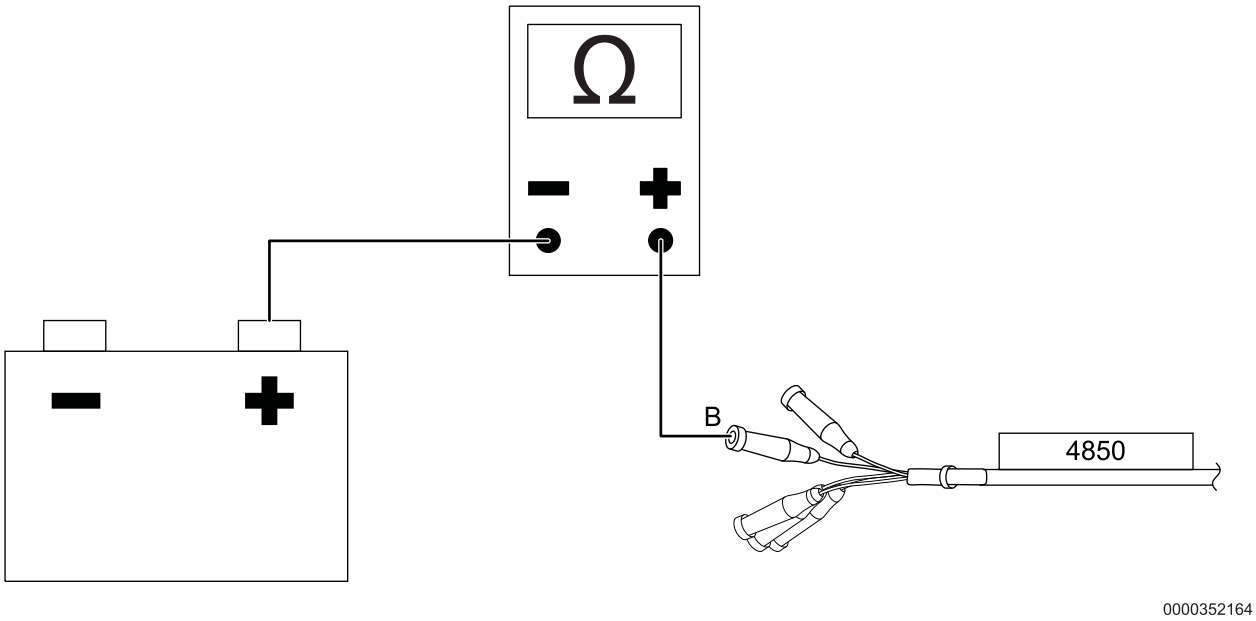

Figure 584 TOSS-L Circuit Check

Test 4 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to vehicle harness and leave TOSS / VSS sensor disconnected.

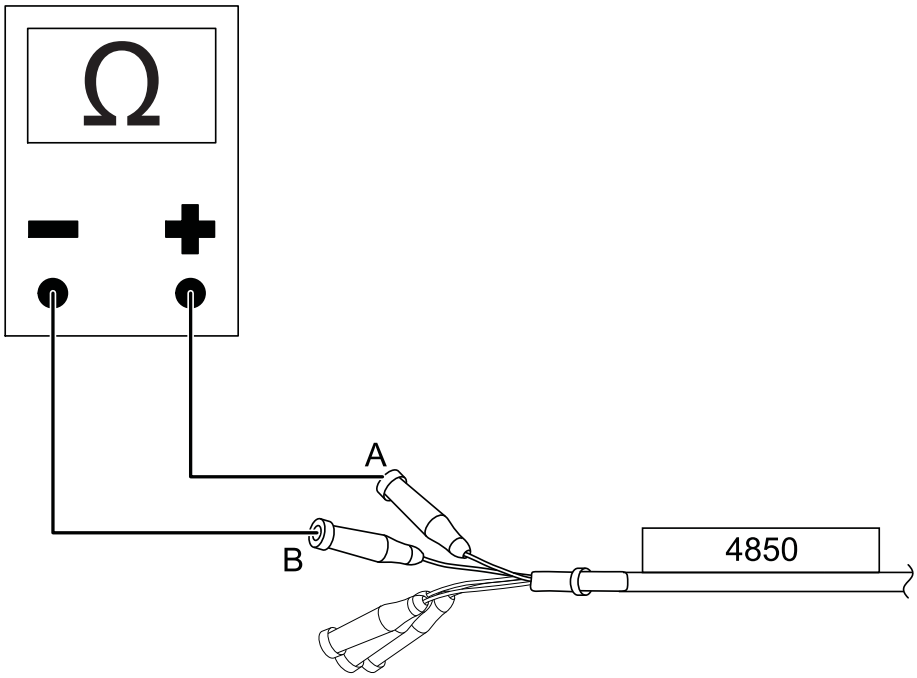

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Figure 585 TOSS Circuit Check

Test 5 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

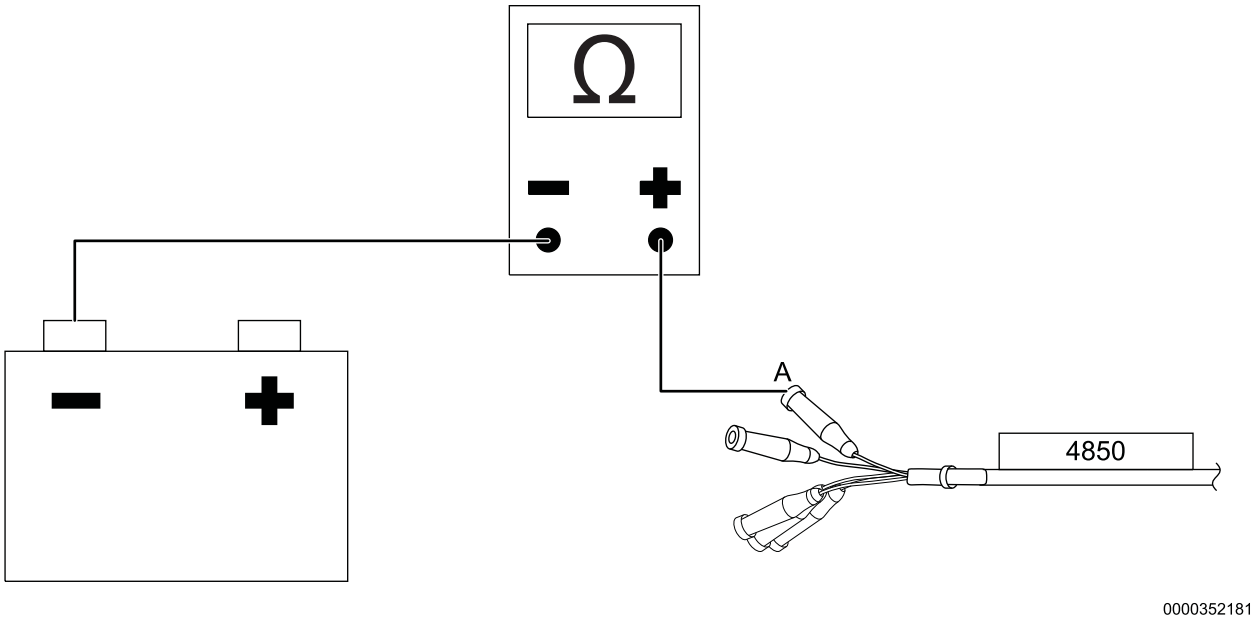

Figure 586 TOSS Circuit Check

Test 6 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

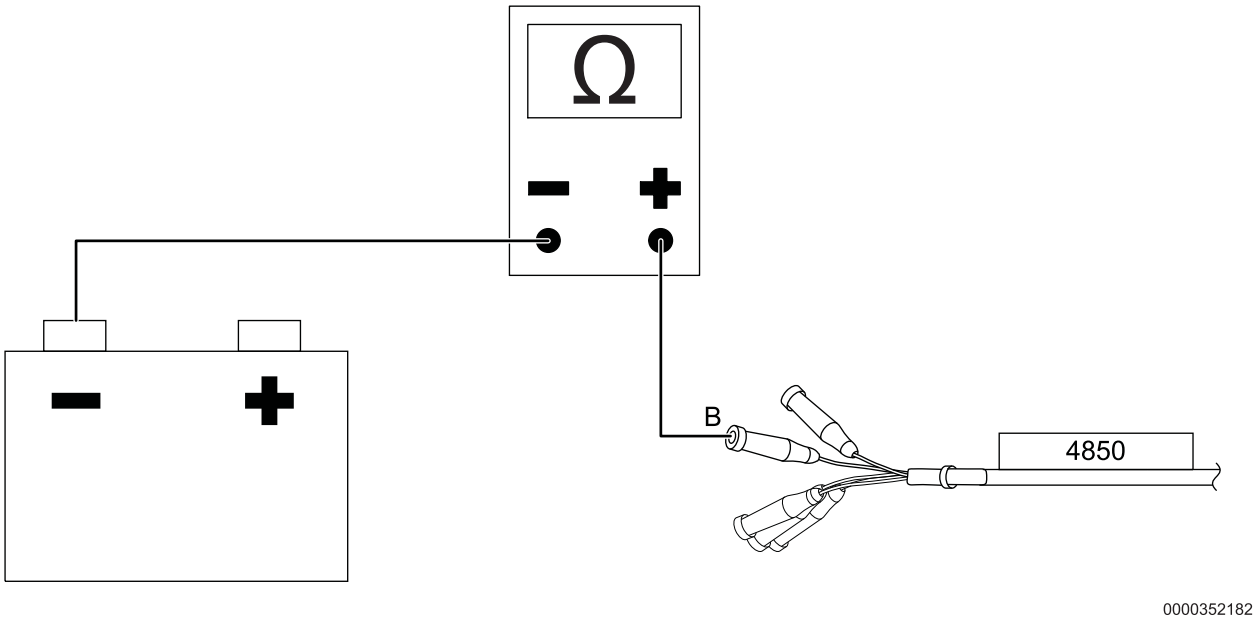

Figure 587 TOSS Circuit Check

Test 7 Setup
A. Key OFF. B. Connect Breakout Harness ZTSE4850 to TOSS / VSS sensor and leave vehicle harness disconnected.

End Diagnostic Tests
After performing all tests, if no problem is found, verify if each step was completed correctly and the proper decision was made. Return to SPN 191 FMI 4 fault code diagnostics.

SPN 191 FMI 16 - TOSS/VSS Reading Higher then Limit (Hardwired)

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
TOSS / VSS reading higher then limit (Hard-wired)	Vehicle speed has exceeded programmable limit	Key ON	0.5 seconds

Overview

This fault is not related to the vehicle speed sensor, wiring or tone ring. It is a reaction to the Vehicle Over Speed Indicator Programmable Parameter 77542. If the customer has requested to turn on vehicle over speed notices to driver then the following parameters need to be programmed accordingly. Once these parameters have been programmed and vehicle reaches a vehicle over speed, SPN 191 FMI 16 will be logged in the ECM.

CAUTION: SPN 191 FMI 16 is a result of an over speed being reached and should not be diagnosed as a hardware issue. Failure to comply will result in misdiagnosis and unnecessary repairs.

Parameter ID	Name	Description
77542	Vehicle Over Speed Indicator	• No Vehicle Over Speed Lamp – Vehicle over speed notifications are turned off • Vehicle Over Speed Level 1 Blinking Lamp – Vehicle over speed notifications are enabled for one level (Level 1) • Vehicle Over Speed Level 2 Blinking Lamp – Vehicle over speed notifications are enabled for two levels (Level 1 and Level 2)
77232	Vehicle Over Speed Level 1	This parameter sets the speed at which the first vehicle over speed warning will occur
77242	Vehicle Over Speed Level 2	This parameter sets the speed at which the second vehicle over speed warning will occur

VREF (Voltage Reference) Sensor

Overview of VREF Sensor Group

SPN	FMI	Condition	Possible Causes	Action
3509	14	VREF1 voltage deviation ECM pins: C1-36	• VREF1 circuit short to GND • VREF1 circuit short to PWR • Failed sensor causing short to GND on VREF1 circuit	Pin-Point Tests (page 1502)
3510	14	VREF2 voltage deviation ECM pins: E1-85 and E1-86	• VREF2 circuit short to GND • VREF2 circuit short to PWR • Failed sensor causing short to GND on VREF2 circuit	Pin-Point Tests (page 1503)
3511	14	VREF3 voltage deviation ECM pins: E1-89	• VREF3 circuit short to GND • VREF3 circuit short to PWR • Failed sensor causing short to GND on VREF3 circuit	Pin-Point Tests (page 1504)
3512	14	VREF4 voltage deviation ECM pins: C1-37, C1-49, C2-08, and E1-58	• VREF4 circuit short to GND • VREF4 circuit short to PWR • Failed sensor causing short to GND on VREF4 circuit	Pin-Point Tests (page 1505)

3513	14	VREF5 voltage deviation ECM pins: C1-50, E1-81, and E1-82	• VREF5 circuit short to GND • VREF5 circuit short to PWR • Failed sensor causing short to GND on VREF5 circuit	Pin-Point Tests (page 1506)
3514	14	VREF6 voltage deviation ECM pin: E1-88	• VREF6 circuit short to GND • VREF6 circuit short to PWR • Failed sensor causing short to GND on VREF6 circuit	Pin-Point Tests (page 1507)
5125	14	VREF7 voltage deviation ACM pin: J1-89	• VREF7 circuit short to GND • VREF7 circuit short to PWR • Failed sensor causing short to GND on VREF7 circuit	Pin-Point Tests(page 1508)
5126	14	VREF8 voltage deviation ACM pin: J2-57	• VREF8 circuit short to GND • VREF8 circuit short to PWR • Failed sensor causing short to GND on VREF8 circuit	Pin-Point Tests(page 1510)
5127	14	VREF9 voltage deviation ACM pin: J2-42	• VREF9 circuit short to GND • VREF9 circuit short to PWR • Failed sensor causing short to GND on VREF9 circuit	Pin-Point Tests(page 1512)

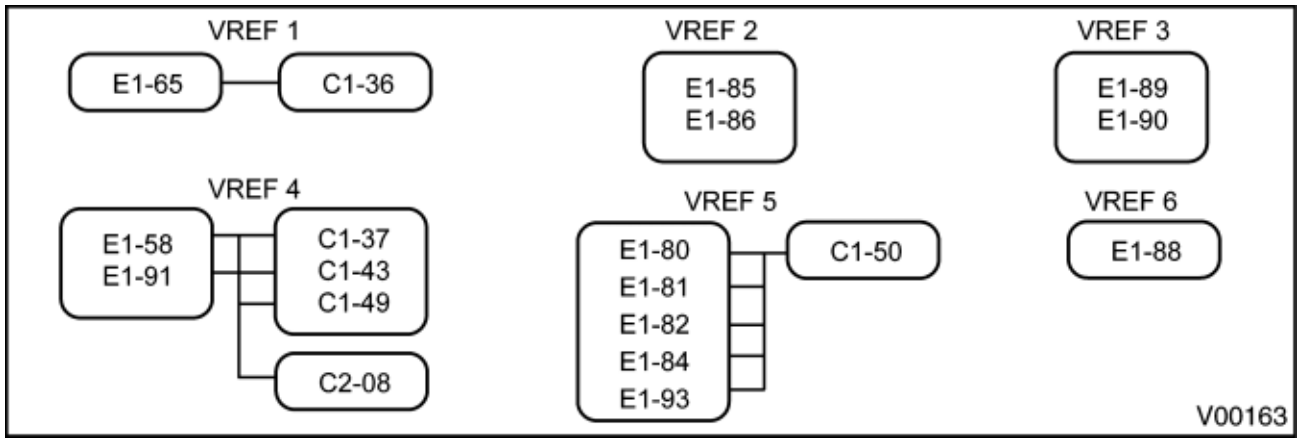

Figure 588 VREF circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 3509 FMI 14 - VREF 1 Voltage Above or Below Normal

Voltage Checks for SPN 3509 FMI 14 – VREF1

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF1 for short to PWR.
   - If voltage is below 4.3 V, check VREF1 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF1 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF1 circuit. Go to Harness Resistance Check (page 1502) and look for VREF1 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
C1-36 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3509 FMI 14 – VREF1

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF1 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-36 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

SPN 3510 FMI 14 - VREF 2 Voltage Above or Below Normal

Voltage Checks for SPN 3510 FMI 14 – VREF2

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF2 for short to PWR
   - If voltage is below 4.3 V, check VREF2 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF2 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF2 circuit. Go to Harness Resistance Check (page 1503) and look for VREF2 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
E1-85 to GND	5 V ± 0.7 V	See Result Comments.
E1-86 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3510 FMI 14 – VREF2

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF2 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-85 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-86 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

SPN 3511 FMI 14 - VREF 3 Voltage Above or Below Normal

Voltage Checks for SPN 3511 FMI 14 – VREF3

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF3 for short to PWR
   - If voltage is below 4.3 V, check VREF3 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF3 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF3 circuit. Go to Harness Resistance Check (page 1504) and look for VREF3 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
E1-89 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3511 FMI 14 – VREF3

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF3 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-89 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

SPN 3512 FMI 14 - VREF 4 Voltage Above or Below Normal

Voltage Checks for SPN 3512 FMI 14 – VREF4

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF4 for short to PWR.
   - If voltage is below 4.3 V, check VREF4 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF4 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF4 circuit. Go to Harness Resistance Check (page 1505) and look for VREF4 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
C1-37 to GND	5 V ± 0.7 V	See Result Comments.
C1-49 to GND	5 V ± 0.7 V	See Result Comments.
C2-08 to GND	5 V ± 0.7 V	See Result Comments.
E1-58 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3512 FMI 14 – VREF4

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF4 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-37 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C1-49 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
C2-08 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-58 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

SPN 3513 FMI 14 - VREF 5 Voltage Above or Below Normal

Voltage Checks for SPN 3513 FMI 14 – VREF5

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF5 for short to PWR
   - If voltage is below 4.3 V, check VREF5 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF5 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF5 circuit. Go to Harness Resistance Check (page 1506) and look for VREF5 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
C1-50 to GND	5 V ± 0.7 V	See Result Comments.
E1-81 to GND	5 V ± 0.7 V	See Result Comments.
E1-82 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3513 FMI 14 – VREF5

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF5 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
C1-50 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-81 to GND	> 1k Ω	If < 1k Ω, check for short circuit.
E1-82 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

SPN 3514 FMI 14 - VREF 6 Voltage Above or Below Normal

Voltage Checks for SPN 3514 FMI 14 – VREF6

NOTE: If circuit fault is intermittent, wiggle harness while measuring voltage.

1. Connect 180-Pin Breakout Box between ECM and engine harness. Use DMM to measure voltage.

   Result Comments

   - If voltage is above 5.7 V, check VREF6 for short to PWR
   - If voltage is below 4.3 V, check VREF6 for short to GND. Go to next step.

2. Disconnect one component at a time on VREF6 circuit.
   - If voltage returns within specification, replace the internally shorted sensor that pulled voltage down.
   - If voltage remains below specification after disconnecting all sensors on VREF6 circuit. Go to Harness Resistance Check (page 1507) and look for VREF6 circuit short to GND.

Test Point	Specification	Comment – < Less than, > Greater than
E1-88 to GND	5 V ± 0.7 V	See Result Comments.

Harness Resistance Check for SPN 3514 FMI 14 – VREF6

NOTE: If circuit fault is intermittent, wiggle harness while measuring resistance.

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Leave VREF6 sensors disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
E1-88 to GND	> 1k Ω	If < 1k Ω, check for short circuit.

SPN 5125 FMI 14 - VREF7 voltage deviation ACM pin: J1-89

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
TBD	TBD	TBD

Fault Overview

Lamp Reaction

Associated Faults

Fault Facts

None

Drive Cycle to Determine Fault Status

Possible Causes

- VREF7 circuit short to GND
- VREF7 circuit short to PWR
- Failed sensor causing short to GND on VREF7 circuit

CONTENT
UNDER
DEVELOPMENT

0000305681

SPN 5126 FMI 14 - VREF8 voltage deviation ACM pin: J2-57

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
TBD	TBD	TBD

Fault Overview

Lamp Reaction

Associated Faults

Fault Facts

None

Drive Cycle to Determine Fault Status

Possible Causes

- VREF8 circuit short to GND
- VREF8 circuit short to PWR
- Failed sensor causing short to GND on VREF8 circuit

CONTENT UNDER DEVELOPMENT

0000305681

SPN 5127 FMI 14 - VREF9 voltage deviation ACM pin: J2-42

Condition / Description	Setting Criteria	Enable Conditions / Condition Values
TBD	TBD	TBD

Fault Overview

Lamp Reaction

Associated Faults

Fault Facts

None

Drive Cycle to Determine Fault Status

Possible Causes

- VREF9 circuit short to GND
- VREF9 circuit short to PWR
- Failed sensor causing short to GND on VREF9 circuit

CONTENT UNDER DEVELOPMENT

0000305681

WIF Sensor (Water In Fuel)

Overview of WIF Sensor Group

SPN	FMI	Condition	Possible Causes	Action
4192	3	WIF signal Out of Range HIGH	• WIF circuit short to PWR	Pin-Point Diagnostics (page 1516)
4192	4	WIF signal Out of Range LOW	• WIF circuit short to GND	Pin-Point Diagnostics (page 1516)

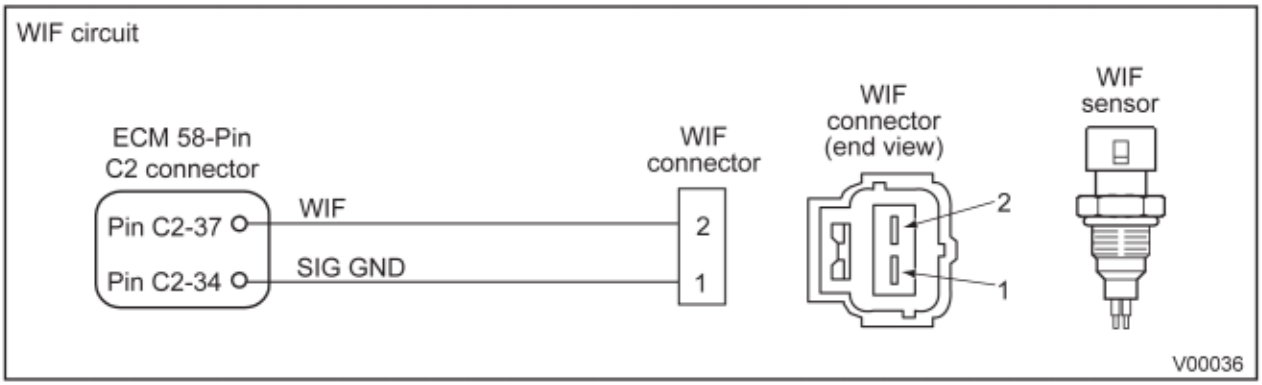

Figure 592 WIF circuit diagram

Tools Required

- 180-Pin Breakout Box 00-00956-08
- 2010 MaxxForce 11 & 13 Harness Kit 00-01462-00
- 3-Banana Plug Harness ZTSE4498
- 500 Ohm Resistor Harness ZTSE4497
- Big Bore Terminal Test Probe Kit ZTSE4899
- Breakout Harness ZTSE6002 (WIF)
- Digital Multimeter (DMM)
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

SPN 4192 FMI 3 - WIF Signal Out of Range HIGH

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Drain a fuel sample from the water drain valve on the primary fuel filter housing. See Drain Water from Primary Fuel Filter in the “ENGINE SYMPTOMS DIAGNOSTICS."
   - If water is present, drain all the water out of the system.
   - If no water is present in the fuel sample, continue to next step.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, open the Continuous Monitor session.

   NOTE: The WIF signal will read YES if there is water in the fuel filter housing, or if the WIF signal circuit is shorted high.
   - If DTC is inactive, monitor the signal while wiggling the connector and all wires at suspected location. If the circuit is interrupted, the signal will change from No to Yes and the DTC will go active.
   - If DTC is active, go to the next step.
3. Disconnect engine harness from sensor.

   NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.
4. Connect Breakout Harness ZTSE6002 to engine harness. Leave sensor disconnected.

Voltage Check

Connect Breakout Harness ZTSE6002 to WIF vehicle harness, and leave WIF sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to B+	B+	If < B+, check SIG GND circuit for OPEN.
2 to GND	4.6 V	If > 5.5 V, check WIF circuit for short to PWR.
		If < 4.0 V, check WIF circuit for short to GND.

Connector Resistance Check to GND

Turn ignition switch OFF. Connect Breakout Harness ZTSE6002 to WIF vehicle harness, and leave WIF sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	< 5 Ω	If > 5 Ω, check SIG GND for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check WIF circuit for short to GND.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6002 to WIF vehicle harness, and leave WIF sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C2-34	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to C2-37	< 5 Ω	If > 5 Ω, check for OPEN circuit.

SPN 4192 FMI 4 - WIF Signal Out of Range LOW

Pinpoint Diagnostics With ServiceMaxx™ Software

WARNING: To prevent personal injury or death, stay clear of rotating parts (belts and fan) and hot engine surfaces.

1. Drain a fuel sample from the water drain valve on the primary fuel filter housing. See Drain Water from Primary Fuel Filter in the “ENGINE SYMPTOMS DIAGNOSTICS."
   - If water is present, drain all the water out of the system.
   - If no water is present in the fuel sample, continue to next step.
2. Using Electronic Service Tool (EST) with ServiceMaxx™ software, open the Continuous Monitor session.

   NOTE: The WIF signal will read YES if there is water in the fuel filter housing, or if the WIF signal circuit is shorted high.
   - If DTC is inactive, monitor the signal while wiggling the connector and all wires at suspected location. If the circuit is interrupted, the signal will change from No to Yes and the DTC will go active.
   - If DTC is active, go to the next step.
3. Disconnect engine harness from sensor.

   NOTE: Inspect connectors for damaged pins, corrosion, or loose pins. Repair if necessary.
4. Connect Breakout Harness ZTSE6002 to engine harness. Leave sensor disconnected.

Voltage Check

Connect Breakout Harness ZTSE6002 to WIF vehicle harness, and leave WIF sensor disconnected. Turn ignition ON. Use DMM to measure voltage.

Test Point	Specification	Comment – < Less than, > Greater than
1 to B+	B+	If < B+, check SIG GND circuit for OPEN.
2 to GND	4.6 V	If > 5.5 V, check WIF circuit for short to PWR.
		If < 4.0 V, check WIF circuit for short to GND.

Connector Resistance Check to GND

Turn ignition switch OFF. Connect Breakout Harness ZTSE6002 to WIF vehicle harness, and leave WIF sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to GND	< 5 Ω	If > 5 Ω, check SIG GND for OPEN circuit.
2 to GND	> 1k Ω	If < 1k Ω, check WIF circuit for short to GND.

Harness Resistance Check

Turn ignition switch to OFF. Connect 180-Pin Breakout Box with ECM C1 and C2 harness to ECM C1 and C2 vehicle harness connectors, and leave ECM disconnected. Connect Breakout Harness ZTSE6002 to WIF vehicle harness, and leave WIF sensor disconnected. Use DMM to measure resistance.

Test Point	Specification	Comment – < Less than, > Greater than
1 to C2-34	< 5 Ω	If > 5 Ω, check for OPEN circuit.
2 to C2-37	< 5 Ω	If > 5 Ω, check for OPEN circuit.

WTSL (Wait to Start Lamp)

Overview of WTSL Sensor Group

SPN	FMI	Condition	Possible Causes	Actions
1081	3	WTSL circuit short to PWR	• Failed WTSL • WTSL circuit shorted to PWR	Step-Based Diagnostics (page 1519)
1081	4	WTSL circuit short to GND	• Failed WTSL • WTSL circuit shorted to GND	Step-Based Diagnostics (page 1520)
1081	5	WTSL open load/circuit	• Failed WTSL • Fuse blown / Open • WTSL circuit Open	Step-Based Diagnostics (page 1521)

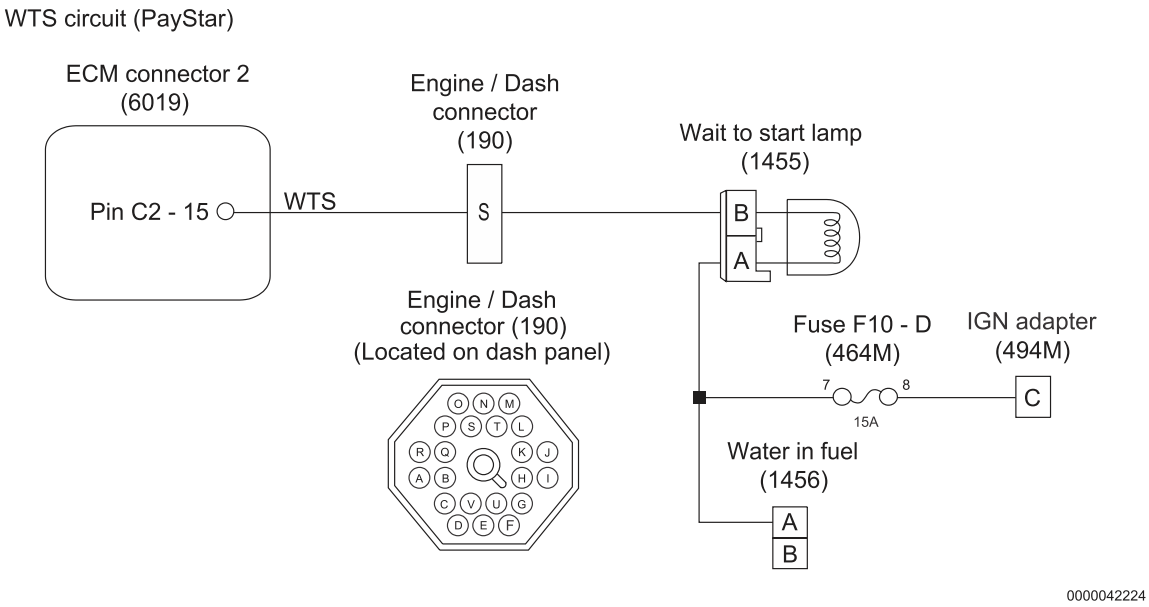

Figure 593 WTSL Circuit Diagram

Overview

The wait-to-start lamp illuminates when the ignition switch is turned ON. For Engine Coolant Temperature (ECT) lower than 50°F (10°C), the Engine Control Module (ECM) activates the Inlet Air Heater Relay (IAHR). The IAHR then energizes the Inlet Air Heater Fuel Igniter (IAHFI) for approximately 35 seconds. Once the IAHFI is heated, the wait-to-start lamp starts to flash and the engine is ready to be started. Once the engine starts, the IAHFI remains energized and the wait-to-start lamp continues to flash for a maximum of four minutes. When the wait-to-start lamp stops flashing, the IAHFI and the IAHS valve are deactivated. If the operator accelerates while the wait-to-start lamp is flashing, the inlet air heater system will shutdown.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software

- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Digital Multimeter (DMM)

SPN 1081 FMI 3 - WTSL Circuit Short to PWR

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Wait to Start Lamp (WTSL) circuit short to power.	ECM indicates short to battery	Key ON	0.5 seconds

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

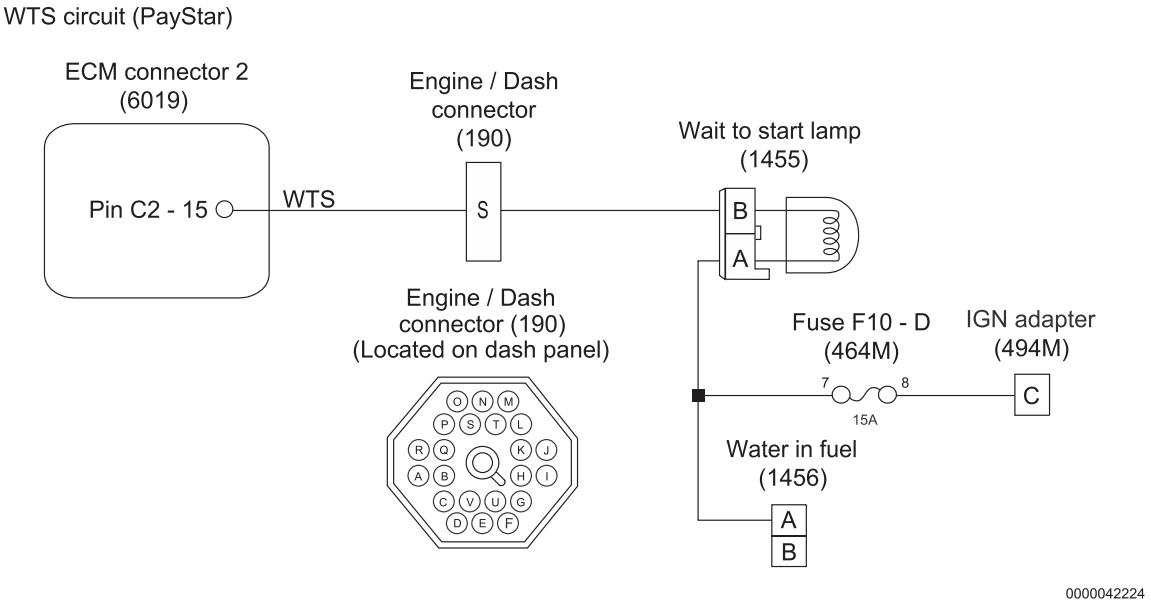

Figure 594 WTSL Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 1081 FMI 3 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 1081 FMI 3.

Step	Action	Decision
2	Measure for short to power on engine side of WTSL circuit. Disconnect WTSL connector (1455) located in the vehicle instrument panel (see WTSL Circuit Diagram and vehicle Electrical Circuit Diagrams manual for additional details). Key ON, measure voltage at pin B of connector (1455). Is voltage less than 4.2 volts?	Yes: Replace Wait to Start Lamp. After repairs are complete, retest for SPN 1081 FMI 3.
		No: Repair short to power between WTSL connector (1455) pin B and ECM 58-pin connector C2-15. After repairs are complete, retest for SPN 1081 FMI 3.

NOTE: After doing all diagnostic steps, if SPN 1081 FMI 3 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1081 FMI 4 - WTSL Circuit Short to GRD

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Wait to Start Lamp (WTSL) circuit short to ground.	ECM indicates short to ground	Key ON	0.5 seconds

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

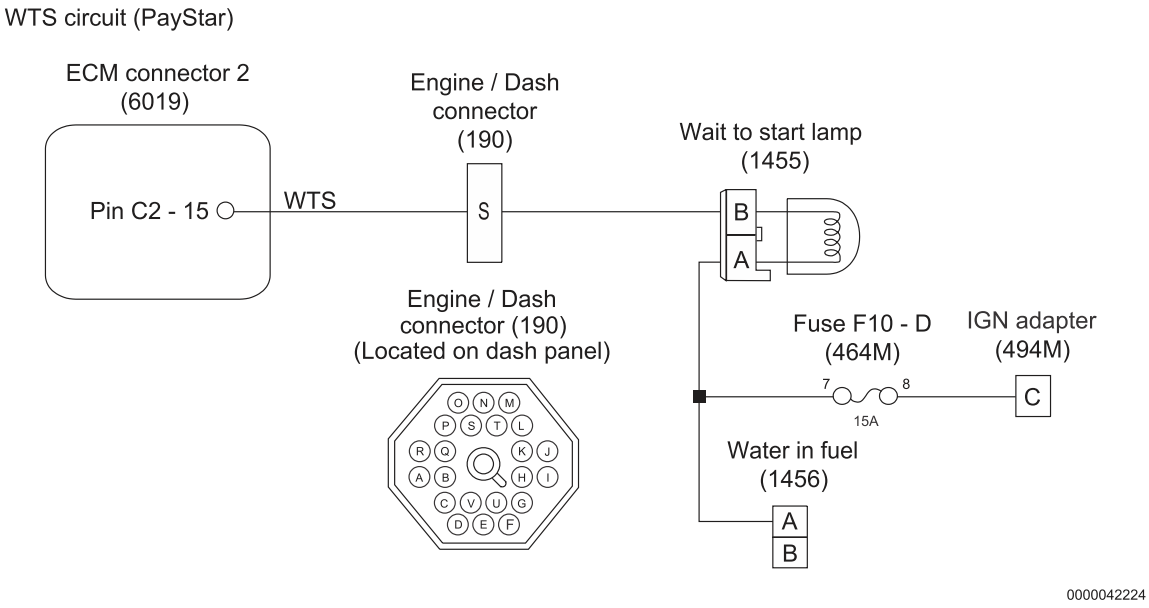

Figure 595 WTSL Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 1081 FMI 4 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 1081 FMI 4.

Step	Action	Decision
2	Measure engine side of WTSL circuit for short to ground. Disconnect WTSL connector (1455) located in the vehicle instrument panel (see vehicle Electrical Circuit Diagrams for additional details). Key OFF, measure resistance between pin B of connector (1455) and a known good ground. Is resistance greater than 1000 ohms?	Yes: Go to step 3. No: Repair short to ground between WTSL connector (1455) pin B and ECM 58–pin connector C2- 15. After repairs are complete, retest for SPN 1081 FMI 4.

Step	Action	Decision
3	Measure vehicle side of WTSL circuit for short to ground. Key OFF, measure resistance between pin A of connector (1455) and a known good ground. Is resistance greater than 1000 ohms?	Yes: Replace Wait to Start Lamp. After repairs are complete, retest for SPN 1081 FMI 4. No: Repair short to ground between WTSL connector (1455) pin A and vehicle wiring (see WTSL Circuit Diagram and vehicle Electrical Circuit Diagrams for additional details). After repairs are complete, retest for SPN 1081 FMI 4.

NOTE: After doing all diagnostic steps, if SPN 1081 FMI 4 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

SPN 1081 FMI 5 - WTSL Open Load / Circuit

Condition / Description	Setting Criteria	Enable Conditions / Values	Time Required
Wait to Start Lamp (WTSL) circuit open.	ECM indicates no load	Key ON	0.5 seconds

Lamp Reaction

MIL will illuminate when this fault is detected during two consecutive drive cycles.

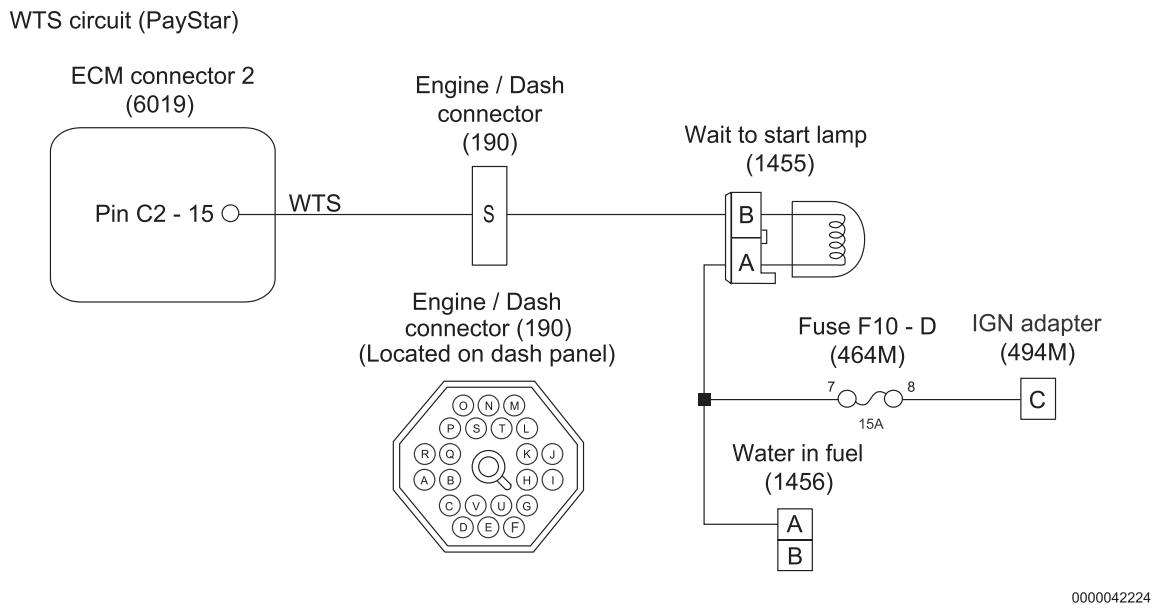

Figure 596 WTSL Circuit Diagram

Step	Action	Decision
1	Using Electronic Service Tool (EST) with ServiceMaxx™ software, check Diagnostic Trouble Code (DTC) list for other fault codes. Is SPN 1081 FMI 5 the only fault code active?	Yes: Go to step 2. No: Repair other fault code(s). After repairs are complete, retest for SPN 1081 FMI 5.

Step	Action	Decision
2	Check 15 amp fuse F10-D (464M) (see vehicle Electrical Circuit Diagrams for additional details). Is fuse in good condition and not blown (Open)?	Yes: Go to step 3. No: Replace 15 amp fuse F10-D (464M). After repairs are complete, retest for SPN 1081 FMI 5.

Step	Action	Decision
3	Test vehicle side of circuit for Open. Key OFF, disconnect WTSL connector (1455) located in the vehicle instrument panel (see vehicle Electrical Circuit Diagrams for additional details). Key ON, measure voltage at pin A of connector (1455). Is voltage 12 volts or greater while the WTSL circuit is activated?	Yes: Go to step 4. No: Repair Open or high resistance between WTSL connector pin A and vehicle wiring (see WTSL Circuit Diagram and vehicle Electrical Circuit Diagrams for additional details). After repairs are complete, retest for SPN 1081 FMI 5.

Step	Action	Decision
4	Measure engine side of WTSL circuit for Open. Key OFF, disconnect Engine Control Module (ECM) C2 connector. Measure resistance between ECM connector C2-15 and WTSL connector pin B. Is resistance more than 5 ohms?	Yes: Repair open or high resistance in circuit between ECM connector C2-15 and WTSL connector pin B. After repairs are complete, retest for SPN 1081 FMI 5.
		No: Replace Wait to Start Lamp. After repairs are complete, retest for SPN 1081 FMI 5.

NOTE: After doing all diagnostic steps, if SPN 1081 FMI 5 remains verify each step was completed correctly and the proper decision was made. Notify supervisor for further action.

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How To Use This Section

Describes how to use this section of the manual

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UNDER
DEVELOPMENT

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ServiceMaxx™ Software Procedures

Connection and Data Recording

Overview

ServiceMaxx™ is an Engine Electronic Control System Diagnostic Tool. It is used to run Service Bay Test, Procedures and Program engine features. It can also monitor and record signals from the Engine Control Module (ECM), Doser Control Unit (DCU), and Aftertreatment Control Module (ACM).

Engine Auto-Detection

Pre 2007 engines can only Auto-Detect at Key-On Engine-Off (KOEO). The N13 Selective Catalytic Reduction (SCR) engine is able to auto-connect at KOEO or engine running. The only difference when connecting with a running engine is most of the parameters will not load. You will notice lot of missing values in the Vehicle Information window.

Connection (Sniffer)

This area will display all the modules communicating on the Public Controller Area Network (CAN) Network.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

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1. Key-On Engine-Off (KOEO) will load signals and parameters.
2. Key-On Engine-Running (KOER) will load signals, but will not load parameters.
3. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector .
4. Start ServiceMaxx™ software.

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NOTE: If ServiceMaxx™ displays the Engine selection window , it was unable to Auto- Detect. The Engine Control Module (ECM) or the Public Controller Area Network (CAN) to the Data Link connector maybe at fault.

Test Procedure

Snapshot Recording Procedure:

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Figure 600 Start Signal Recording

1. Click on the Start Logging Watched Signals button (Figure 600).

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Figure 601 Stop Signal Recording

2. Click on the Stop Logging Watched Signals button (Figure 601) to stop the recording.

Figure 602 Snapshot folder

3. Snapshot recording will be saved in the Snapshot folder (Figure 602) located on your computers desktop.

Snapshot Playback Procedure

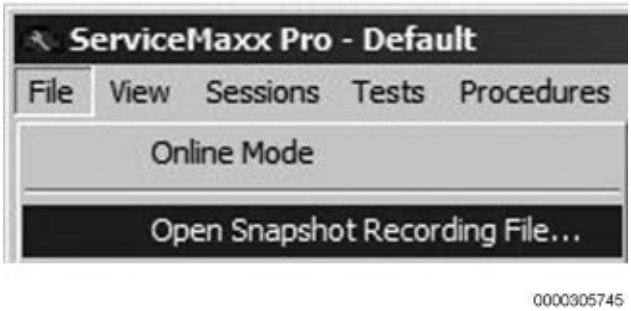

Figure 603 Snapshot

1. Open previously recorded snapshot, Click on the Open Snapshot Recording File (Figure 603) from the File Menu.
2. Select the desired recording you wish to open.

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3. Once the recording is open , you can select any signal you wish to show up in the graph.

Diagnostic Trouble Code Overview

Beginning in 2010, a Diagnostic Trouble Code (DTC) consists of two parts: the Suspect Parameter Number (SPN) and Failure Mode Indicator (FMI). The SPN identifies a component or system with a fault, and the FMI identifies what that fault or condition is.

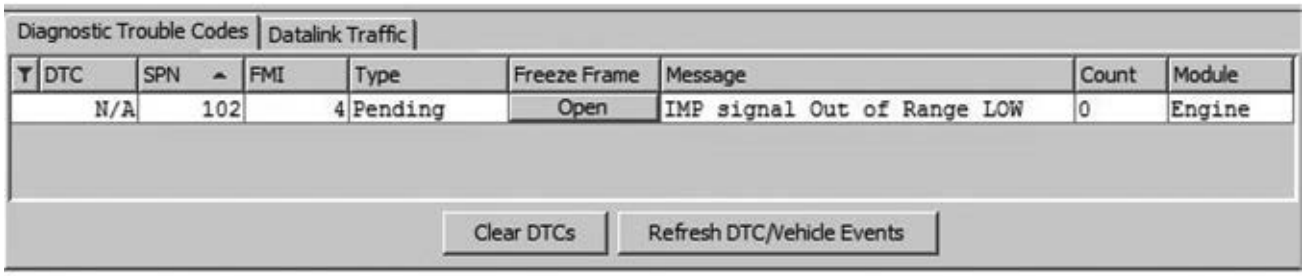

Figure 605 DTC Display

DTC Type:

Pending DTC

Pending Diagnostic Trouble Codes (DTC)s are possible faults that were detected on the first drive cycle. On Heavy Duty Onboard Diagnostic (HD-OBD) faults can be set as Pending. Pending HD-OBD faults do not turn on the Malfunction Indicator Lamp (MIL)

Active DTC

There are 3 types of Active DTCs: Non-HD-OBD faults, 1 drive cycle and 2 drive cycle HD-OBD.

- Active Non HD-OBD faults go active on the first drive cycle and do not turn on the MIL.
- Active HD-OBD 1 drive cycle faults turn on the MIL.
- Active HD-OBD 2 drive cycle faults turn on the MIL.

Healing DTC

Healing DTCs are HD-OBD faults that were active on the previous drive cycle, but were not detected on the current drive cycle. Healing faults do turn on the MIL. If the Healing fault is not detected within the next three consecutive drive cycles, then the fault becomes Previously Active and turns off the MIL.

Previously Active DTC

Previously Active DTCs are historical Active faults that were detected in a previous drive cycle. Previously Active DTCs do not turn on the MIL.

DTC Count

DTC Count logs the amount of times the fault was detected.

Freeze Frame

Freeze Frame data is a snapshot of the engines operating condition at the time the fault was detected.

Check for DTCs

ServiceMaxx™ software displays Diagnostic Trouble Codes (DTC)s at the bottom of the screen.

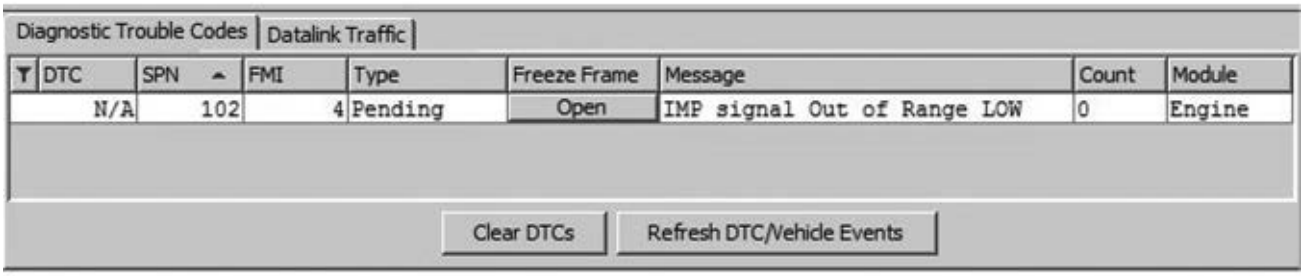

Figure 606 DTC display

Procedure:

ServiceMaxx™ software will update DTC status every 10 seconds and will check for DTCs as soon as the Refresh DTC/Vehicle Events button (Figure 606) is pressed.

Session Files

Overview

ServiceMaxx™ software has a variety of Sessions; Signal Monitoring, Engine Programming and Service Bay Testing.

Service Bay Test and Procedures will automatically load pre-made default sessions. Users are not limited to using pre-made default sessions. Sessions (Figure 607) can be built or modified, saved and loaded (Figure 608) at any time. The operator can use their own saved session to run a Service Bay test as long as the check mark is removed from the Load Test Specific Session (Figure 609) prior to running the test.

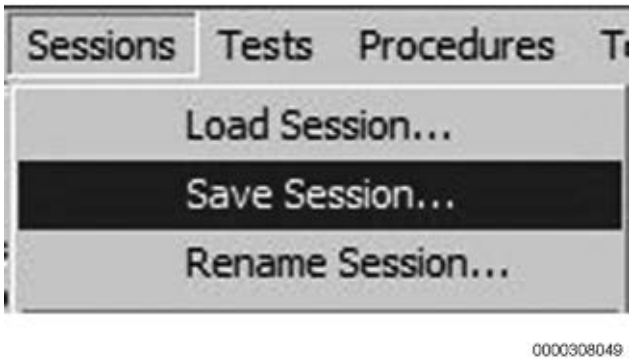

Figure 607 Menu – Save Session

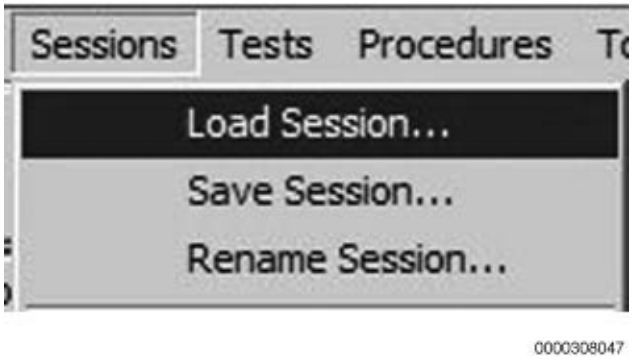

Figure 608 Menu – Load Session

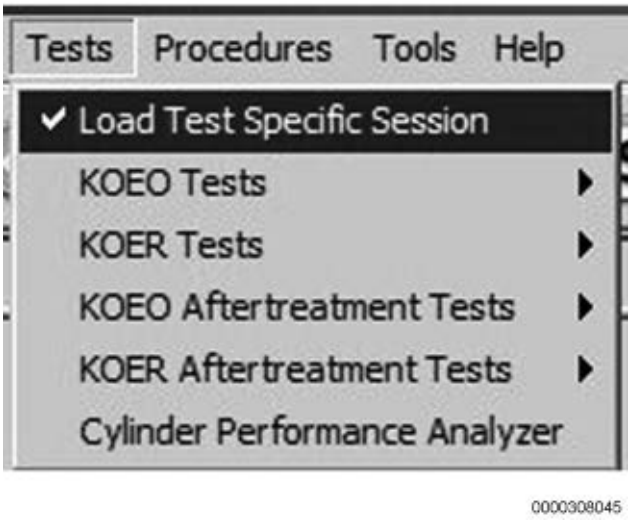

Figure 609 Menu – Load Test Specific Session

Obtain Vehicle Health Report

Overview

Connect Electronic Service Tool (EST) to vehicle and generate a Health Report of current vehicle information:

- Vehicle Identification Number (VIN) validation
- Vehicle mileage
- Engine hours
- Diagnostic Trouble Codes (DTC)
- Engine Control Module (ECM) calibration
- Fuel economy data

Tools Required

- PocketMaxx™, EST with International Graphical User Interface, or Navistar® EZ-Tech Launcher

Equipment Condition

None

Test Setup

None

Test Procedure

1. Key-On Engine-Off (KOEO).
2. Connect interface cable between PocketMaxx™, EST, or EZ-tech Launcher and to vehicle Diagnostic Connector (page 1571).
3. Use PocketMaxx™, EST, or EZ-tech Launcher to retrieve a vehicle Health Report.
4. Connect to internet and upload Health Report to Navistar® Service Portal.
5. Verify Health Report is visible on Navistar® Service Portal. Select Write Up > Vehicle Information.

Expected Outcome

Current vehicle Health Report is viewable on Navistar® Service Portal.

Follow-On Procedure

None

Programmable Features

Overview

Many features can be programmed into the Engine Control Module (ECM) to fit many different applications. To make programming changes using ServiceMaxx™ software, load the Programming session.

Tool Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Condition

None

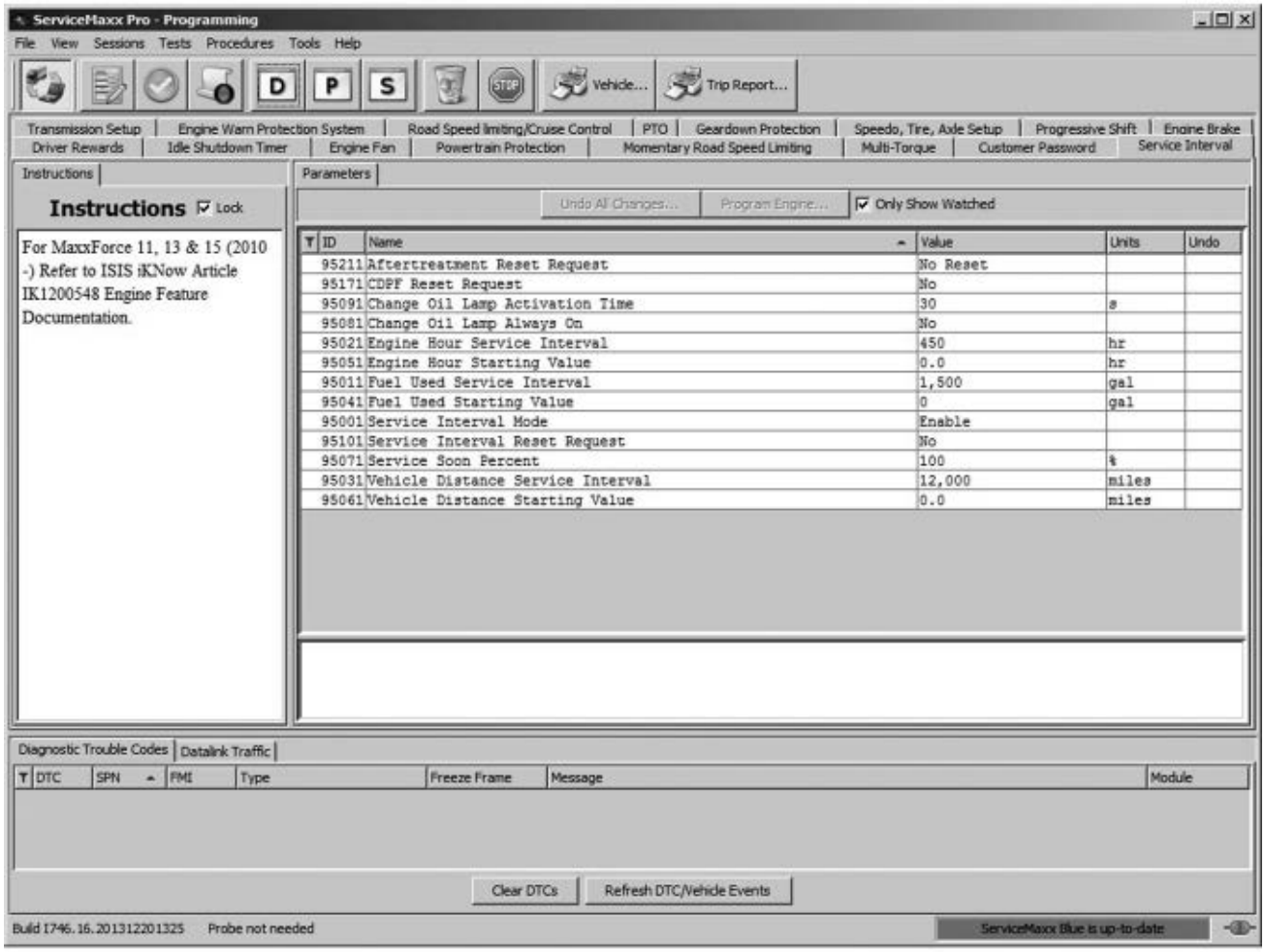

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Figure 610 Programmable Feature

Test Setup

1. Key-On Engine-Off (KOEO)
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™ software.

Test Procedure

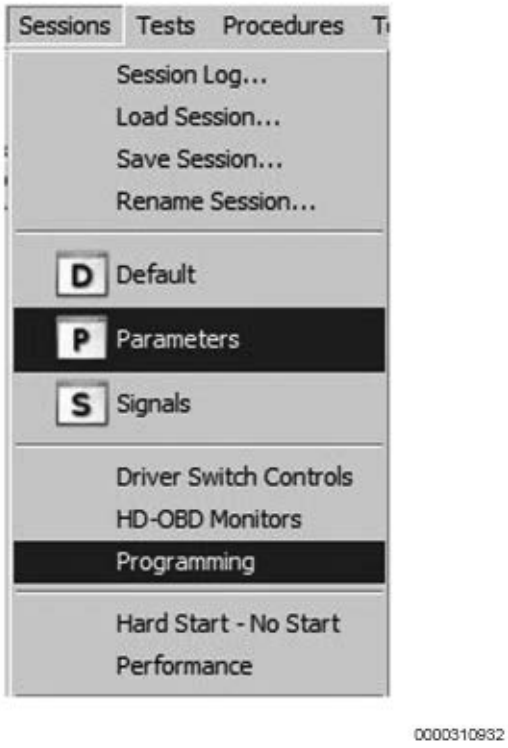

Figure 611 Select Parameters or Programming

1. Select Programming (Figure 611) from the Session drop-down menu.

- Select Parameters to view all Parameters
- Select Programming to view Parameters sorted into categories.

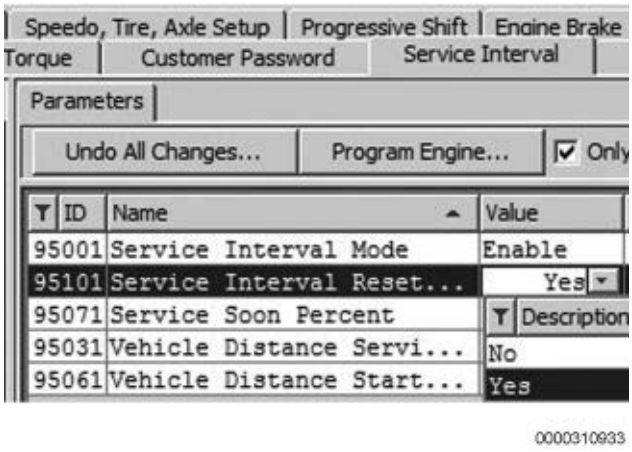

Figure 612 Change Parameter Value

2. Click on the desired parameter value (Figure 612) to be changed.

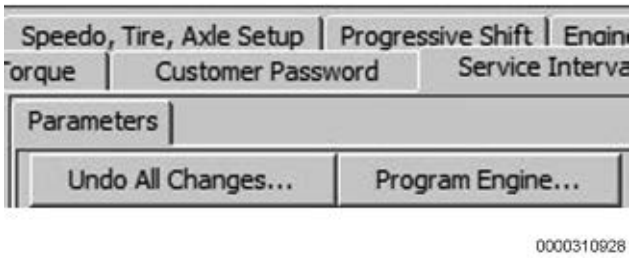

Figure 613 Program Engine

3. Press the Program Engine Button (Figure 613).

Figure 614 Program Engine

4. Turn Key OFF for 15 seconds, so new value change be saved into the module (Figure 614).
5. Turn Key ON.
6. Clear Diagnostic Trouble Code (DTC)s, if any.

Expected Outcome

None

Follow-On Procedure

None

Record Snapshot of KOEO Data

Overview

Record Key-On Engine-Off (KOEO) data to be referenced now, and in the future.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Condition

1. Do not crank or run engine for 3 minutes or more. This will allow Injection Control Pressure (ICP) to bleed off.

Test Setup

1. Key-ON.
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™.

Test Procedure

1. Select Sessions > Performance.
2. Cycle key OFF, then cycle key ON.

NOTE: Fuel pump will run for 10 seconds after the ignition key is cycled.

3. Select Tools > Start Recording Snapshot.
4. Wiggle harness connections on the Under Valve Cover (UVC) harness for ICP connector, ICP harness, and 36-pin Engine Control Module (ECM) connector.
5. Select Tools > Stop Recording Snapshot.

Expected Outcome

KOEO values will be within specification.

Follow-On Procedure

None

DOC/DPF Replacement/Reset Procedure

Overview

The Aftertreatment (AFT) maintenance provides the ability for a technician to install/reset maintenance components. An example would be a new or clean Diesel Oxidation Catalyst (DOC) or Diesel Particulate Filter (DPF). Once a DOC is considered by the Engine Control Module (ECM) to be “Face Plugged”, AFT dosing is disabled. After the DOC is replaced, the technician would need to reset the value to clean in order to enable dosing and re-initiate active regeneration. In order to prevent the misuse of this feature, the reset shall only be available when most severe fault conditions exist on the particular AFT component that is being reset.

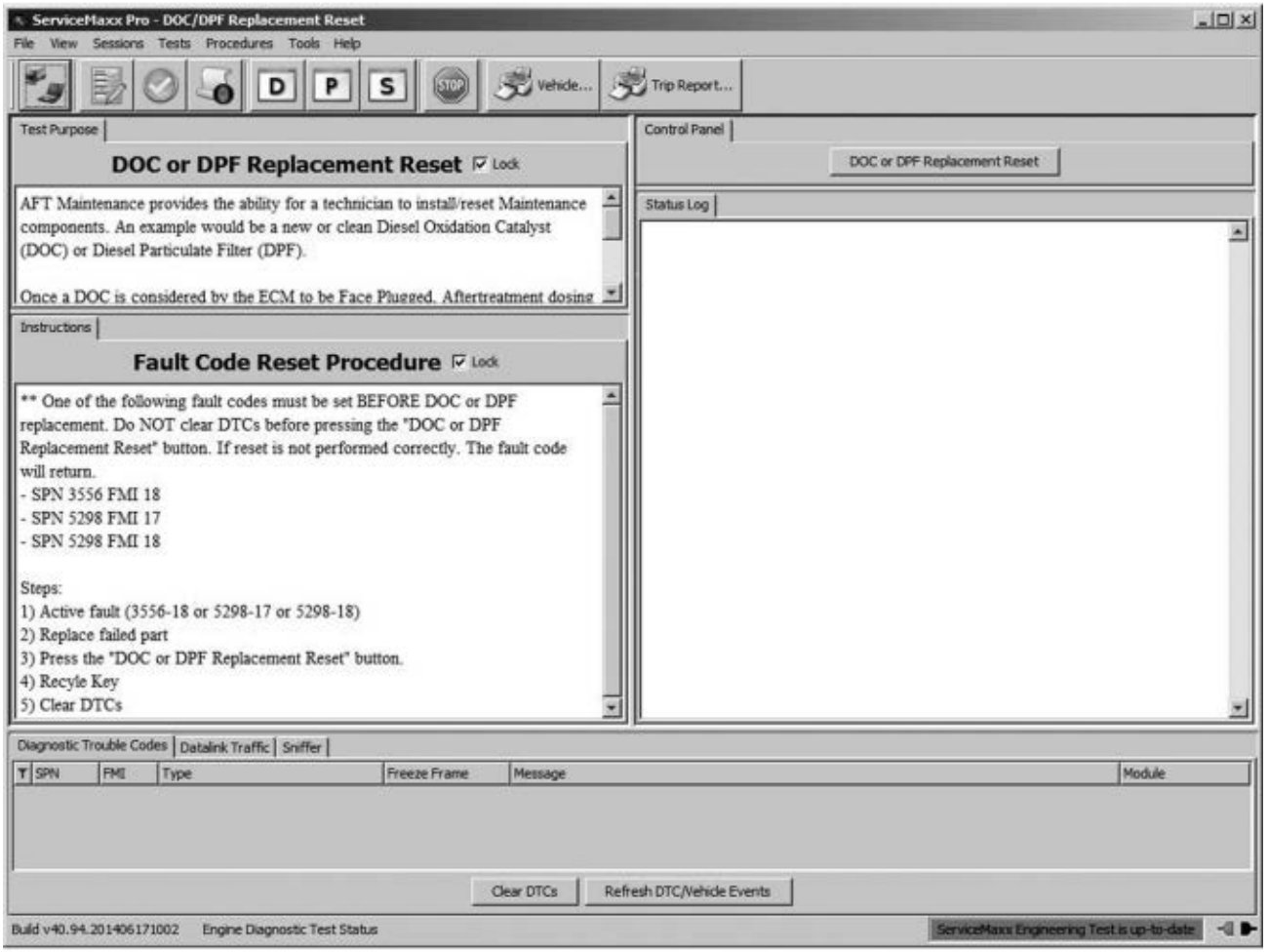

Figure 615 DOC / DPF Replacement Reset

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Condition

One of the following active faults:

- SPN 3556 FMI 18
- SPN 5298 FMI 17
- SPN 5298 FMI 18

Test Setup

1. Key-On Engine-Off (KOEO).
2. Connect interface cable between Electronic Service Tool (EST) and 9-pin Vehicle Data Connector (VDC) (see Connecting EST with ServiceMaxx™ software to engine (page 1571)).
3. Start ServiceMaxx™ software.

Test Procedure

1. Verify that one of the active faults is present:
   - SPN 3556 FMI 18
   - SPN 5298 FMI 17
   - SPN 5298 FMI 18
2. Replace the failed part.

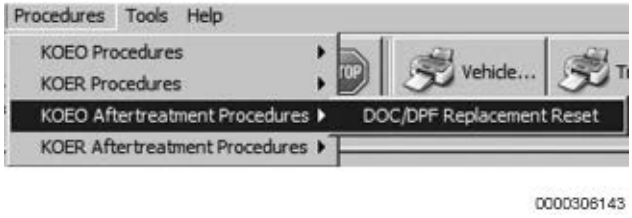

Figure 616 Menu – Select Procedure

3. Select DOC / DPF Replacement Reset from the KOEO Aftertreatment Procedures (Figure 616)drop-down menu.

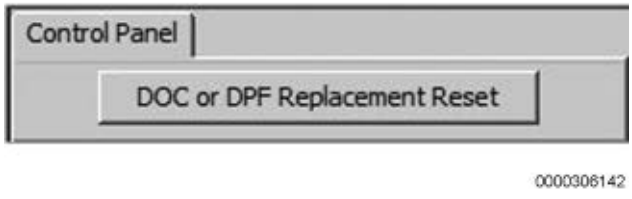

Figure 617 DOC or DPF Replacement Reset Button

4. Press the DOC or DPF Replacement Reset button (Figure 617).

5. Clear Diagnostic Trouble Codes (DTCs).

DPF Regeneration

Overview

The Key On Engine Running (KOER) Aftertreatment Diesel Particulate Filter (DPF) Regeneration Procedure is used to clean Diesel Particulate Filter (DPF). Session is helpful to monitor all components in aftertreatment system.

WARNING: Set parking brake and gear before diagnostic or service test: To prevent personal injury or death, make sure parking brake is set, transmission is in neutral or park, and wheels are blocked before doing diagnostic or service procedures.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- J1939-Compliant Interface Cable

Equipment Condition

1. Engine Speed (below 700 RPM).
2. Engine Coolant Temperature (above 150°F 66°C).
3. No Inhibitors .

Test Setup

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1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™ software.

Test Procedure

Figure 619 Select Procedure

1. Start and Warm Engine Coolant Temperature above 150°F / 66°C.
2. Select KOER Aftertreatment Procedure – DPF Regeneration (Figure 619) from Procedures drop down menu.

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3. Verify DPF Regeneration entry conditions are met and procedure is not inhibited .

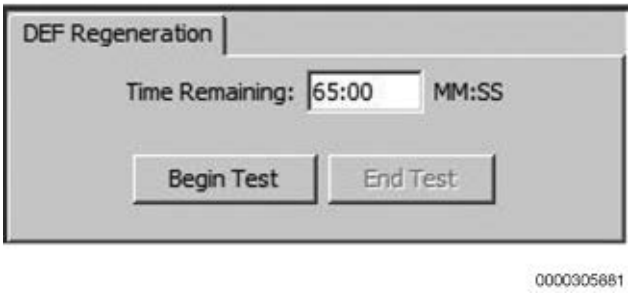

Figure 621 Begin Test

4. Press Begin Test button (Figure 621).
5. Engine Speed will ramp up to increase exhaust flow through the DPF. Procedure will run for 60 minutes and will display any pass or fail results.

Expected Outcome

None

Follow-On Procedure

None

DEF Supply Module Flush

Overview

DEF supply module flushing should be performed when DEF supply module is suspected of being the cause of fault(s) and before being replaced.

CAUTION: Do not disconnect vehicle batteries, DEF supply module 12–way connector, or any DEF lines until the DEF dosing system has completed the purge cycle. Wait at least five minutes after Key OFF for the DEF dosing system to complete the purge cycle. Failure to comply could result in damage to the components.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- 5025 DEF Refractometer
- Rubber-tipped blow gun

Equipment Condition

None

Test Setup

1. If DEF supply module is being removed for service, install protective caps on the 12–way electrical connector and fluid fittings.

Test Procedure

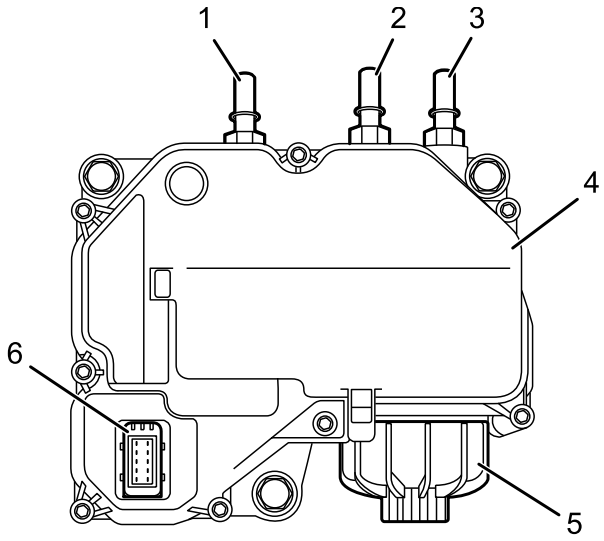

Figure 622 DEF Supply Module

1. DEF supply module suction line fitting
2. DEF supply module return line fitting
3. DEF supply module pressure line fitting
4. DEF supply module housing
5. DEF supply module filter cap
6. DEF supply module 12–way connector

NOTE: If the DEF supply module is being removed for service, install protective caps on the 12–way electrical connector and fluid fittings.

Step	Action	Decision
1	Check Diesel Exhaust Fluid (DEF) supply module housing (Figure 622) (Item 4) for cracks or leaks. Is DEF supply module housing in good condition and Not leaking?	Yes: Go to step 2. No: Replace DEF supply module.

NOTE: The DEF supply module is not internally serviceable. Do not open the case.

Step	Action	Decision
2	Inspect connections at DEF supply module. Key OFF, disconnect DEF supply module 12-way connector (Figure 622) (Item 6). Check DEF supply module and connector terminals for: damaged or pinched wires; corroded terminals; loose, bent, or broken pins; or broken connector housing. Are the DEF supply module connector, harness, and terminals clean and undamaged?	Yes: Go to step 3. No: Repair connector, harness, or terminal damage.

Step	Action	Decision
3	Inspect DEF supply module filter cap (Figure 622) (Item 5) and fluid fittings for white DEF deposits. Is the DEF supply module filter cap free of white deposits?	Yes: Go to step 4. No: Clean the leak areas with warm water and a soft bristled brush. Go to step 4.

CAUTION: Do not immerse the DEF supply module in any kind of solution. Do not wash with any detergents.

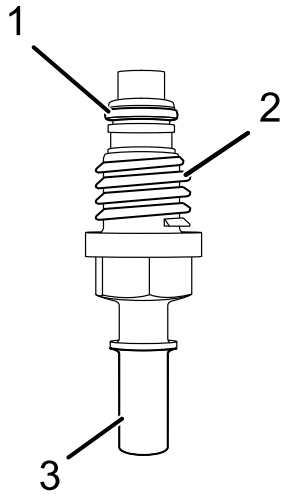

Figure 623 DEF Supply Module Fluid Fitting

1. DEF supply module fluid fitting o-ring
2. DEF supply module fluid fitting threads
3. DEF supply module fluid fitting

Step	Action	Decision
4	Inspect DEF supply module fluid fittings (Figure 622) (Items 1, 2, 3). Remove DEF supply module fluid fittings. Inspect fittings (Figure 623) (Item 3) for cracks or other damage. Are DEF supply module fluid fittings in good condition?	Yes: Go to step 5. No: Obtain new DEF supply module fluid fitting(s). Go to step 6.

Step	Action	Decision
5	Inspect DEF supply module suction fitting for debris. Using a rubber-tipped blow gun, blow air through the threaded side of the fitting onto a sheet of paper. Inspect the paper for debris that has been blown out. Was any debris blown out of the suction fitting?	Yes: Inspect the DEF tank and tank filter for debris and contamination. Replace DEF and DEF tank filter as necessary. Obtain new DEF supply module suction fitting. Go to step 7. No: Go to step 6.

Step	Action	Decision
6	Inspect the DEF supply module pressure and return fittings for debris. • Using a rubber-tipped blow gun, blow air through the threaded side of the return line fitting onto a sheet of paper. Inspect the paper for debris that has been blown out. • Using a rubber-tipped blow gun, blow air through the Non-threaded side of the pressure line fitting onto a sheet of paper. Inspect the paper for debris that has been blown out. Was any debris blown out of the fittings?	Yes: Replace the DEF supply module fluid fitting(s) that had debris. Go to step 7. No: Go to step 7.

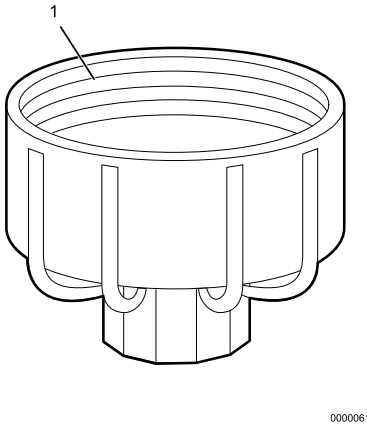

Figure 624 DEF Supply Module Filter Cap Inspection Point

1. DEF supply module filter cap

Step	Action	Decision
7	Remove and Inspect DEF supply module filter cap (Figure 624) (Item 1) for cracks or damage Is the DEF supply module filter cap free of cracks and damage?	Yes: Go to step 8. No: Replace the DEF supply module filter cap. Go to step 8.

Step	Action	Decision
8	Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF fluid. Is urea concentration between 30 - 34 percent and Not contaminated?	Yes: Go to step 9. No: Drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF. Go to step 9.

Step	Action	Decision
9	Re-install DEF supply module fluid fittings using new O-rings and torque to 40 in lb (4.5 nm). **CAUTION:** Do Not use lubricant on the DEF supply module fluid fitting threads or O-rings Fill DEF supply module cleaner bottle 18-200-01-01 with water and connect to the supply module inlet connector. Using Electronic Service Tool (EST) with ServiceMaxx™ software, go to Tests > KOEO Aftertreatment Tests > DEF Doser Pump Override Test. Select Begin Test. Squeeze the DEF supply module cleaner bottle to push water into the DEF supply module, until the supply module draws water on its' own. Does the DEF supply module draw water from the bottle (maximum 3 minutes)?	Yes: Go to step 10. No: Replace DEF supply module.

Step	Action	Decision
10	Install new DEF supply module filter. Tighten DEF supply module filter cap to 177 in. lb. (20 Nm) Reinstall DEF lines. Perform DEFDV Spray Test . Is 85–115 ml of DEF dispensed?	Yes: DEF supply module cleaning is complete. No: Replace DEF supply module.

Viewing graphs of recorded data

Overview

Graph data using ServiceMaxx. View recorded data, and save or print screenshots of playback.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- J1939-Compliant Interface Cable

Equipment Condition

None

Test Setup

1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™ software.

Test Procedure

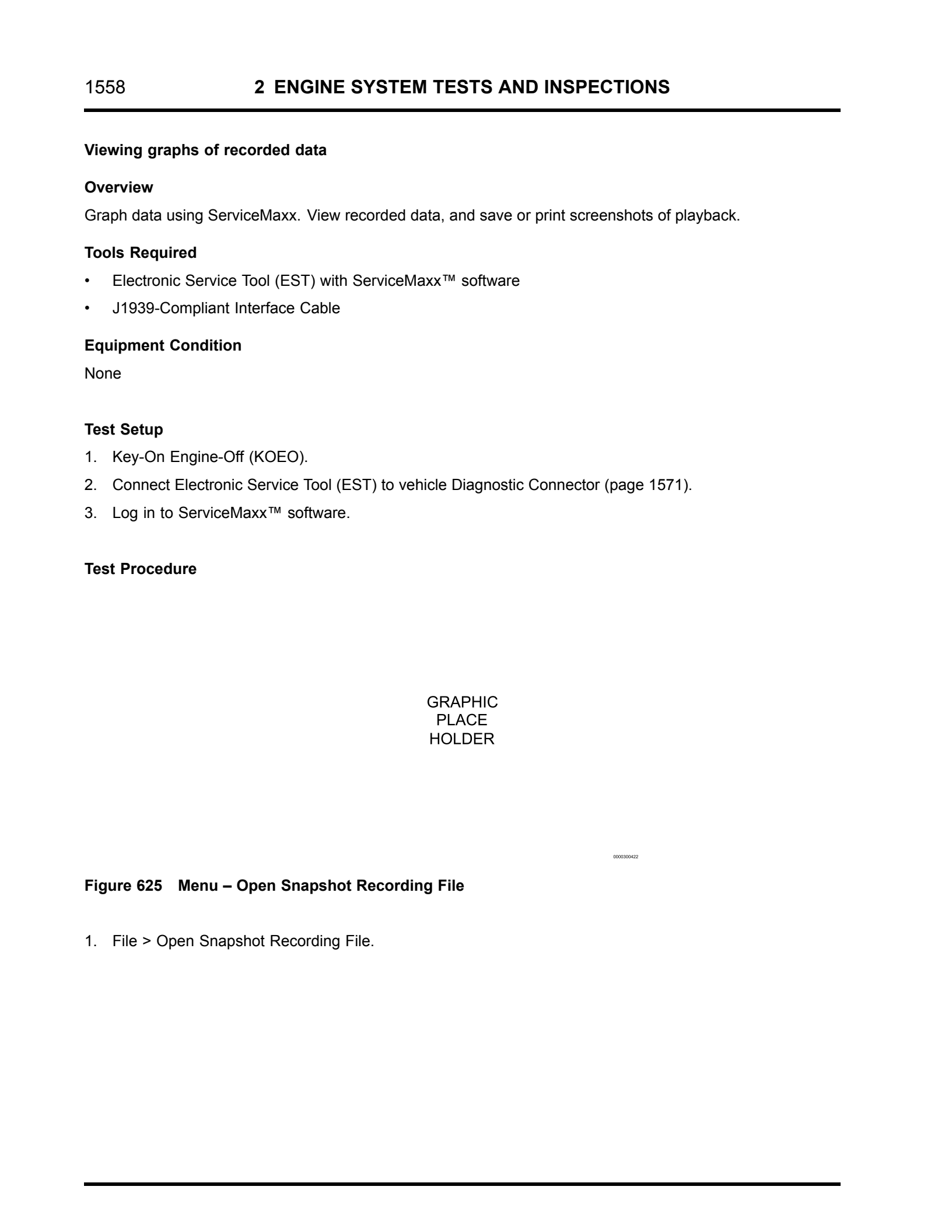

Figure 625 Menu – Open Snapshot Recording File

1. File > Open Snapshot Recording File.

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Figure 626 Snapshot File Selection

2. Select snapshot file to view.

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Figure 627 Parameter Selection

1. Selected Parameters in Graph

3. Select parameters by checking boxes. Selected Parameters will show up on right side of graph.

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Figure 628 Snapshot Playback

4. With parameters selected, there are multiple options to view the snapshot:

- Press Play
- Drag bar across to play snapshot at desired speed
- Utilize Play, Fast Forward, Rewind, or click Play again during snapshot viewing to Pause playback

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Figure 629 Show Graphed Only

5. Click Show Graphed Only allows technician to view the graph only, without the parameters displayed. Show Graphed Only box not checked will display parameters again.

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Figure 630 Save Screenshot

6. Click Save Screenshot to save your screenshot as a picture file at any point during recording. A dialog box will display showing location of saved screenshot picture file. Click OK to save.

GRAPHIC
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Figure 631 Print Screenshot

7. Click Print Screenshot to print. Choose printer and select OK.

Expected Outcome

Technician will be able to view captured graph data, and save or print screenshots.

Follow-on Procedure

None

IQA Adjustment

Overview

Calibrate Engine Control Module (ECM) for newly installed injectors. Each injector is encrypted with an Injection Quantity Adjustment (IQA) code that must be programmed into the ECM anytime an injector has been replaced. IQA injects the correct amount of fuel for each individual injector throughout the operating range of the engine. Injector mechanical tolerances, high flow, and low flow can be evenly balanced with the ECM calibration.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Turn ignition switch to ON, engine OFF.
2. Connect EST to vehicle's Diagnostic Connector (Figure 632).
3. Start ServiceMaxx™ software.

Test Procedure

Figure 632 Injector Quantity Adjustment procedure

1. Select Injection Quantity Adjustment (Figure 632) from Procedures drop-down menu.

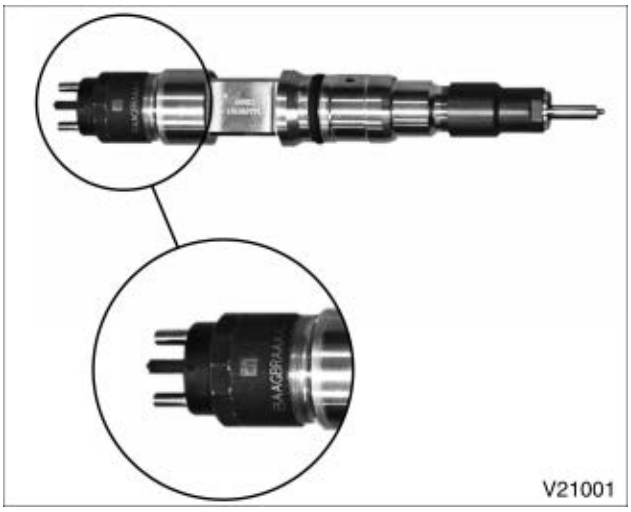


Figure 633 Picture of IQA code location

2. Type in new IQA code(stamped on top portion of injector) (Figure 633) into proper cylinder location.

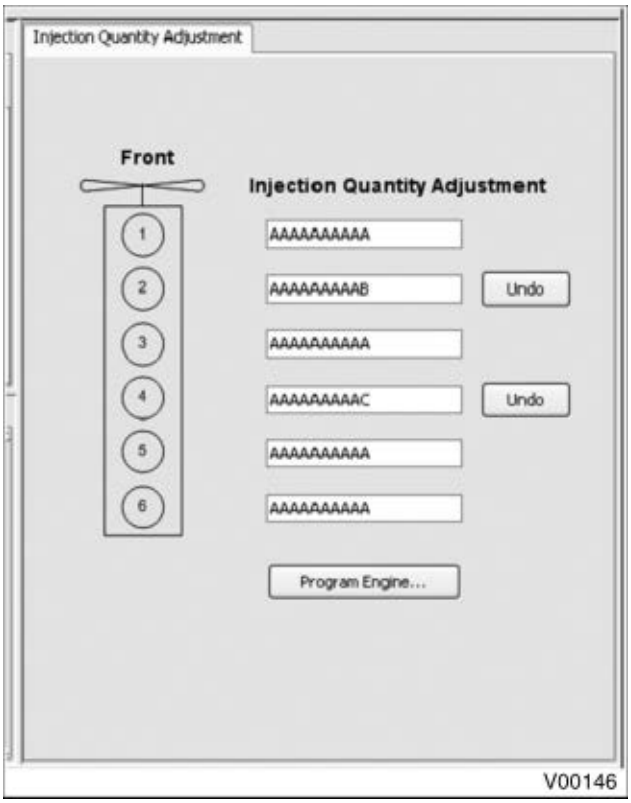


Figure 634 Injector Quantity Adjustment

3. When the Undo button appears, the Program Engine button becomes active. Press the Program Engine button (Figure 634).

4. Replace failed injector following procedures in the *Engine Service Manual*.

Expected Outcome

ECM will have correct fuel injector calibrations.

Followup Procedure

None

Crankshaft Position Sensor Relearn Procedure

Overview

After diagnosing and repairing Crankshaft Position (CKP) sensor, Camshaft Position (CMP) sensor, and base engine concerns, CKP position parameter has to be reprogrammed.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-On Engine-Off (KOEO)
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™
4. Clear Diagnostic Trouble Codes (DTC) if any are displayed
5. If necessary, review the ECM Programmable Features (page 1541) procedure.

Test Procedure

0000311042

Figure 635 Sessions Drop Down Menu

1. Select Sessions > Programming (Figure 635)

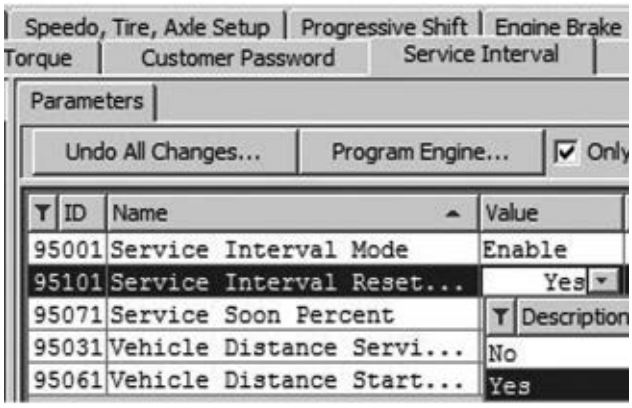
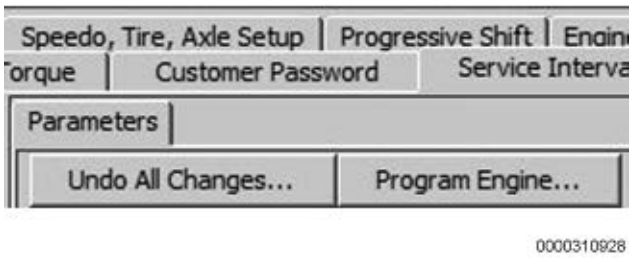


Figure 636 Service Interval Tab and Parameter Values

2. Select Service Interval Tab (Figure 636)
3. Change Parameter Value 95232 CKP Crankshaft Position Learning Reset Request (Figure 636) to Yes



4. Click Program Engine Button (Figure 637)

5. When Engine Parameters Programmed Successfully (Figure 638) pop up box appears, turn Key Off for a minimum of 15 seconds.
6. Turn Key On

7. Clear any Diagnostic Trouble Codes (DTC)

Expected Outcome

Engine will program successfully.

Follow-On Procedure

None

Oxygen (O_2) Sensor Calibration

Overview

Calibrates the Engine Control Module (ECM) to new Oxygen (O_2) Sensor. Do this procedure after replacing the O_2 sensor.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

New O_2 Sensor installed and connected to the engine harness

Test Setup

1. Key-On, Engine-OFF.
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
3. Log into ServiceMaxx™

Test Procedure

1. Clear exhaust fumes by performing Relative Compression Test (page 1592).

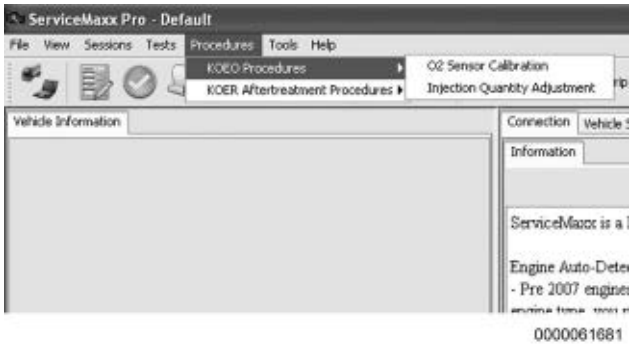


Figure 639 O2 Sensor Calibration Menu

2. Select Procedures > KOEO Procedures > O2 Sensor Calibration (Figure 639).
3. Run O_2 Sensor Calibration Procedure.
4. When calibration is complete, a pop up message will display Test completed, Succesful
5. To complete the calibration go to Programmable Features (page 1541)

   Reset the following parameters - (Not all calibrations have all these parameters)

   - 99520 — Set to 0
   - 99530 — Set to 0

- 99540 — Set to 0
- 99550 — Set to Normal 780° C (1436° F)

Expected Outcome

ECM will be successfully calibrated to new O_2 Sensor.

Follow-up Procedure

None

Intermittent or Inactive Fault Diagnostic Procedure

Overview

Use this test to diagnose inactive and/or intermittent faults. Inactive and/or intermittent faults are currently healing, previously active, or inactive.

NOTE: For component faults that are pending or active, follow specific step based diagnostics for fault.

NOTE: Permanent faults are historic faults and are used for reporting purposes only. They should never be treated as a current issue or used for diagnostics.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- J1939–compliant interface cable

Equipment Condition

None

Test Setup

1. Key-On, Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™ software.

Test Procedure

1. Verify health report was saved. Clear fault codes.
2. Continuous Monitor Test (page 1588) and view voltage signal for suspect sensor.
    - The continuous monitor test will have you watch voltage signals for voltage spikes while wiggling affected harness and connections.
    - A voltage spike while performing continuous monitor wiggle test indicates a damaged harness and/or connector pin.

NOTE: During continuous monitor wiggle test, if a fault code sets (high or low), voltage will latch high or low. To continue performing continuous monitor wiggle test, faults will need to be cleared.

3. If a voltage spike or fault occurs during continuous monitor wiggle test start from the point the voltage spike occurred and inspect harness for rubbing, and inspect nearby connectors for pin damage, corrosion, fretting, etc.

Expected Outcome

The source of the intermittent / inactive fault will be isolated.

Follow-On Procedure

None

Connecting EST with ServiceMaxx Software to Engine

Interface Device Selection

To connect Electronic Service Tool (EST) with ServiceMaxx™ software to engine, the NAVCoM, NAVLink, or generic Interface cable (RP1210B compliant supporting J1939 and J1708) must be connected between EST and vehicle diagnostic connector. The vehicle diagnostic connector is located inside vehicle cab, above clutch pedal.

1. Using Interface cable, connect EST (Electronic Service Tool) to vehicle's diagnostic connector.
2. Start ServiceMaxx™ software.

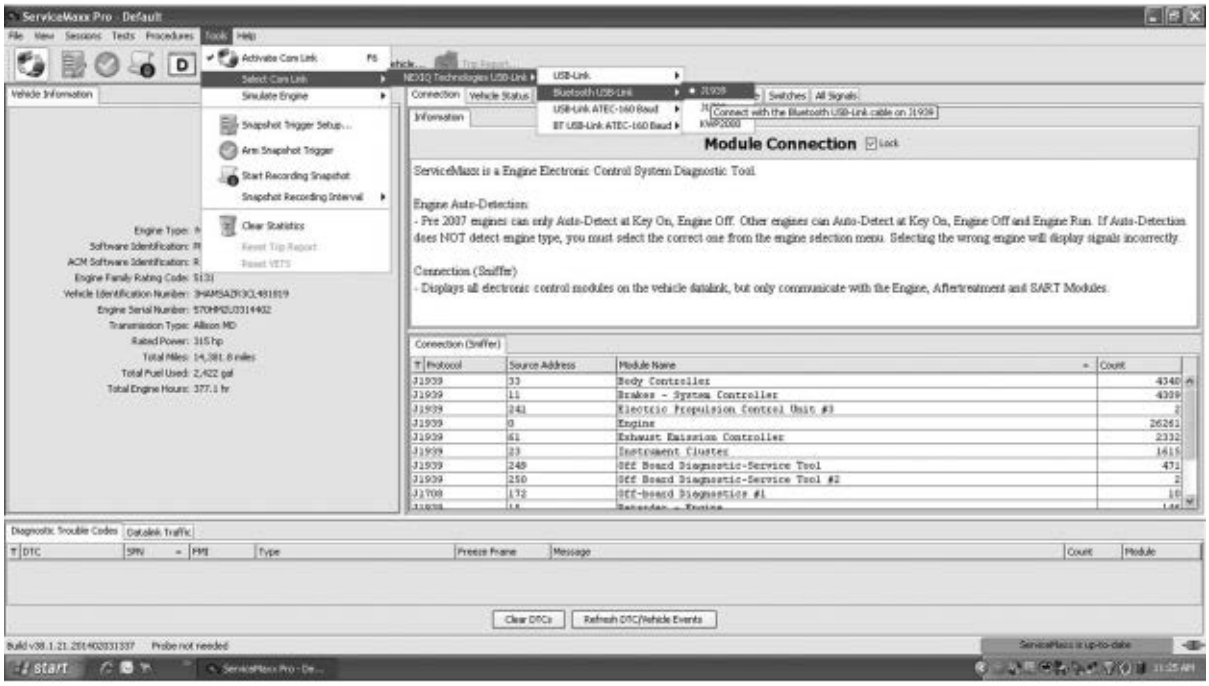


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Figure 640 Com Link Selection Drop Down Menu

3. Select Com Link (Figure 640).

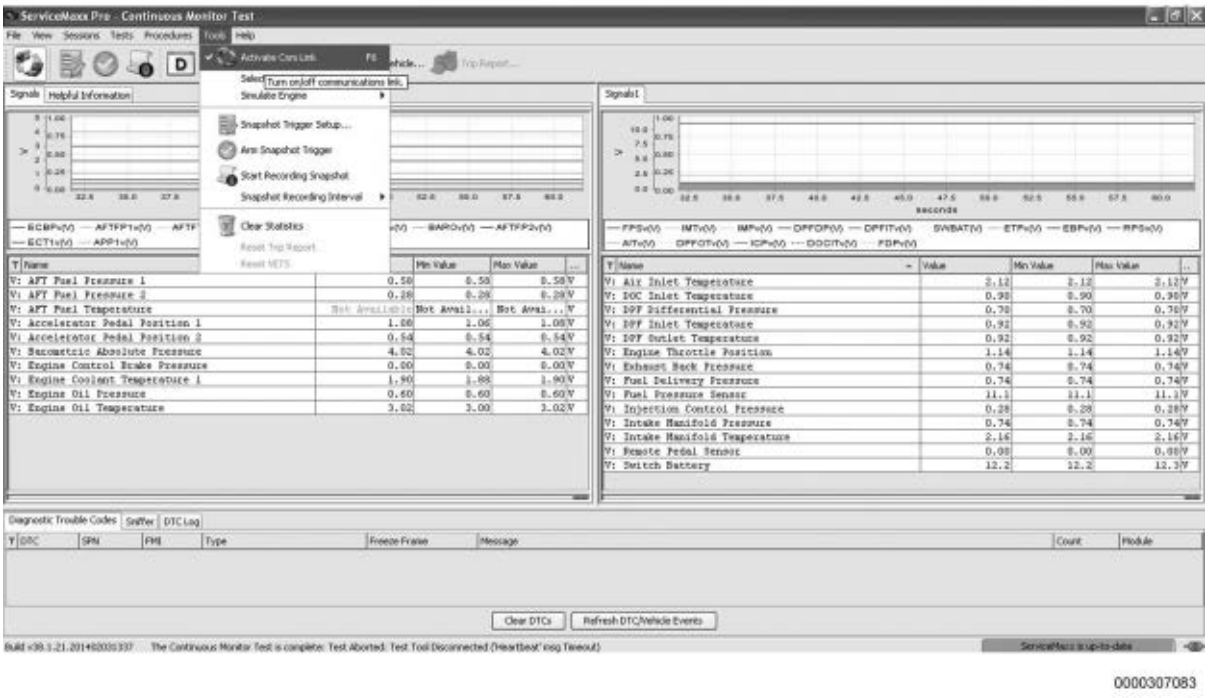

Figure 641 Com Link Activation Drop Down Menu

4. Activate Com Link (Figure 641) for interface cable connection.

If ServiceMaxx™ software fails to autoconnect, use the following procedure:

5. From Tools drop-down menu, go to Select Com Link (Figure 640).

6. Select cable / interface device.
    a. NEXIQ Technologies USB-Link
        — USB-Link
            • J1939
            • J1708
            • KWP2000
        — Bluetooth USB-Link
            • J1939
            • J1708
            • KWP2000
        — USB-Link ATEC 160–Baud
            • J1939
            • J1708
            • KWP2000
        — BT USB-Link ATEC 160–Baud
            • J1939
            • J1708
            • KWP2000

NOTE: If software is still unable to connect, see troubleshooting documentation provided for specific interface cable being used (provided from cable manufacturer).

If cable is not at fault, see J1939 Data Link Error (ECM unable to transmit) in Fault Code Diagnostics section of this manual.

Connecting ServiceMaxx™ Software

1. Turn ignition switch to ON. Do not start engine.
2. Using interface cable, connect EST to vehicle's diagnostic connector.
3. Start ServiceMaxx™ software. After starting ServiceMaxx™ software and selecting appropriate interface device, (Interface Device Selection) (page 1571), a detection process will begin and should connect automatically.

   NOTE: If ServiceMaxx™ software cannot detect Engine Serial Number (ESN), then it may be necessary for user to select engine by clicking on Select Engine from File drop-down menu. Then select engine from pop-up box.

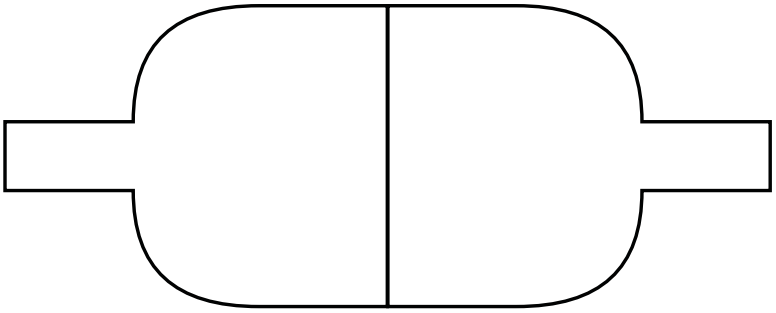

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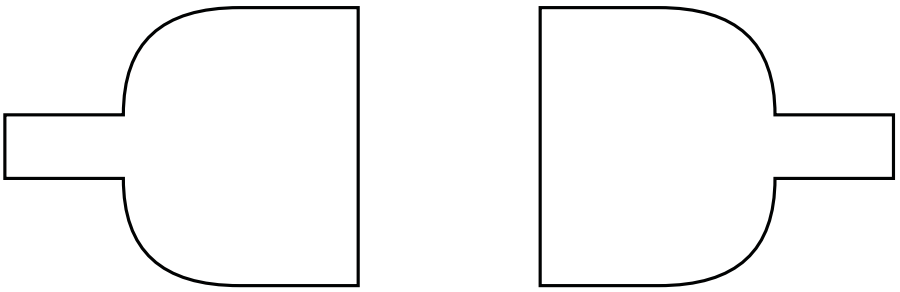
Figure 642 ECM Connected Icon

NOTE: If software has connected to the ECM, active signals will populate startup screen, and ECM connected icon in bottom right corner will show connected.



0000307082

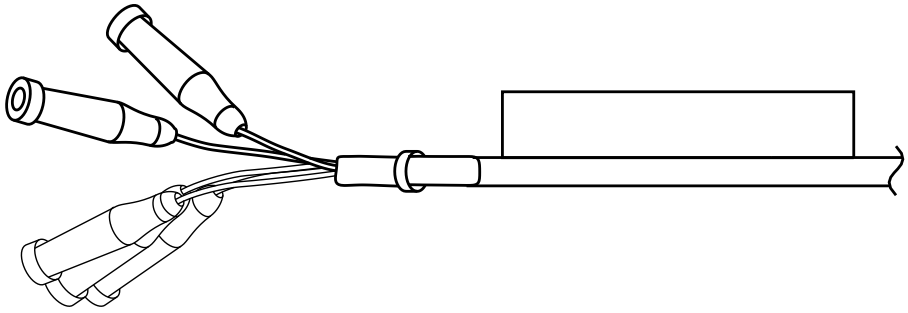
Figure 643 ECM Disconnected Icon

NOTE: When software is unable to connect to ECM, signals and vehicle information will not be displayed, and ECM disconnected icon in bottom right corner will show disconnected.

If software is unable to connect to ECM, go to Interface Device Selection (page 1571) section, above.

Pinpoint Diagnostic Graphic Legend

This defines the graphic depictions of tools required for Pin Point Tests in the Fault Code Diagnostics section of this manual.



0000304602

Figure 644 Breakout Harness

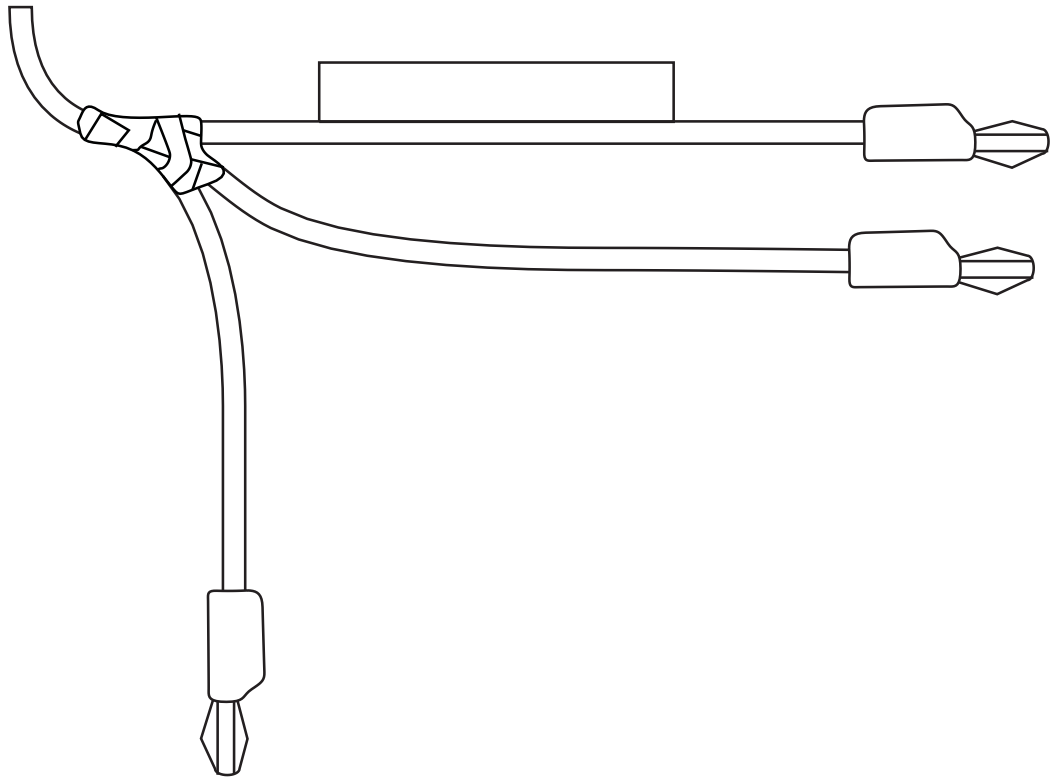


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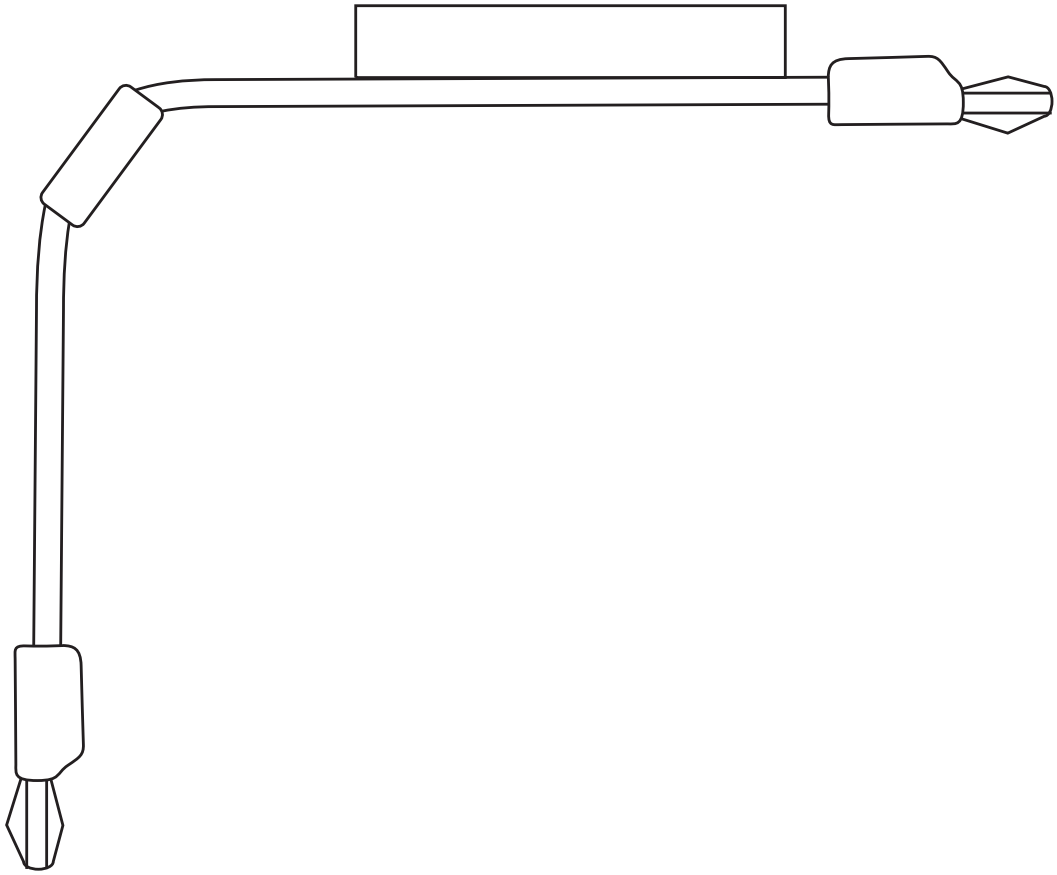
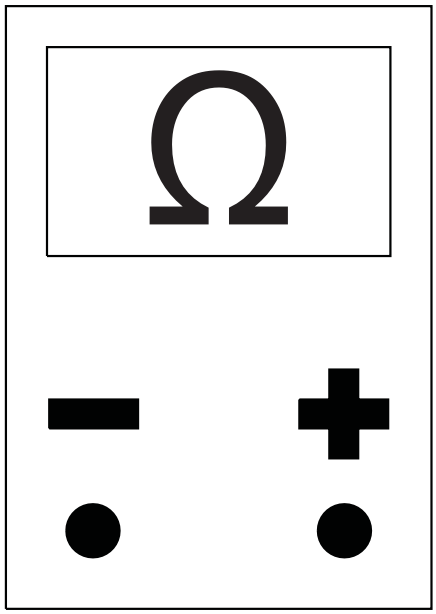
Figure 645 ZTSE4498 – 3–Banana Plug Harness



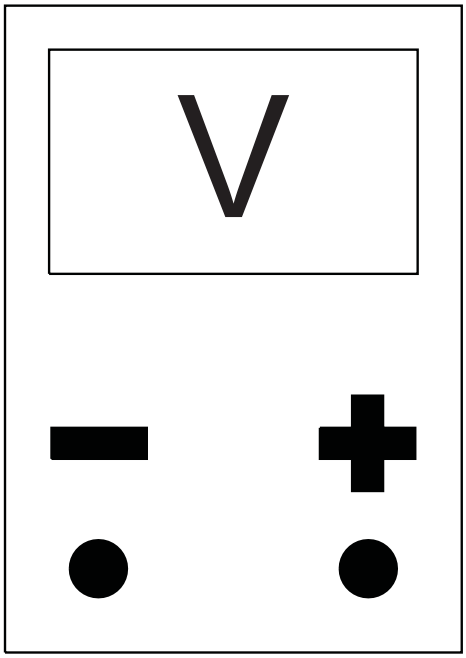
0000319141

Figure 646 ZTSE4497 — 500 Ohm Resistor



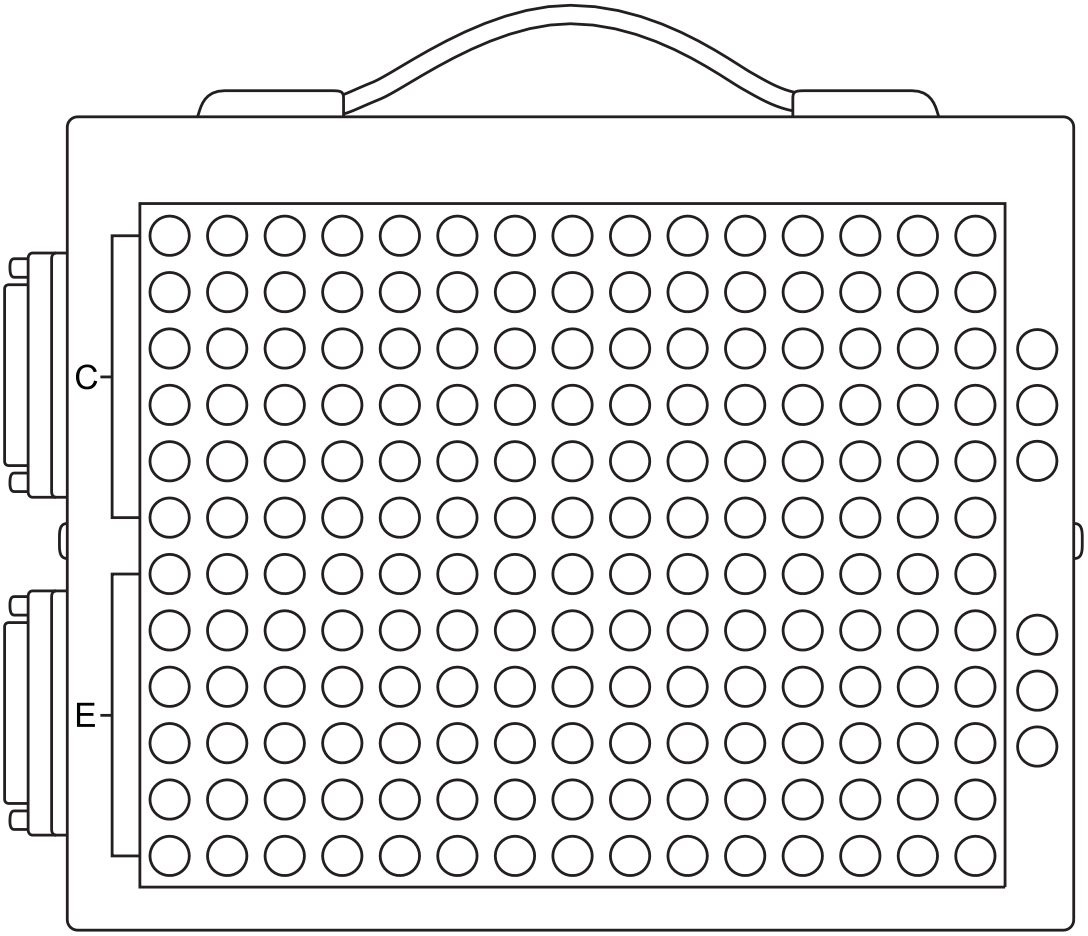
0000304621

Figure 647 Ohm Meter



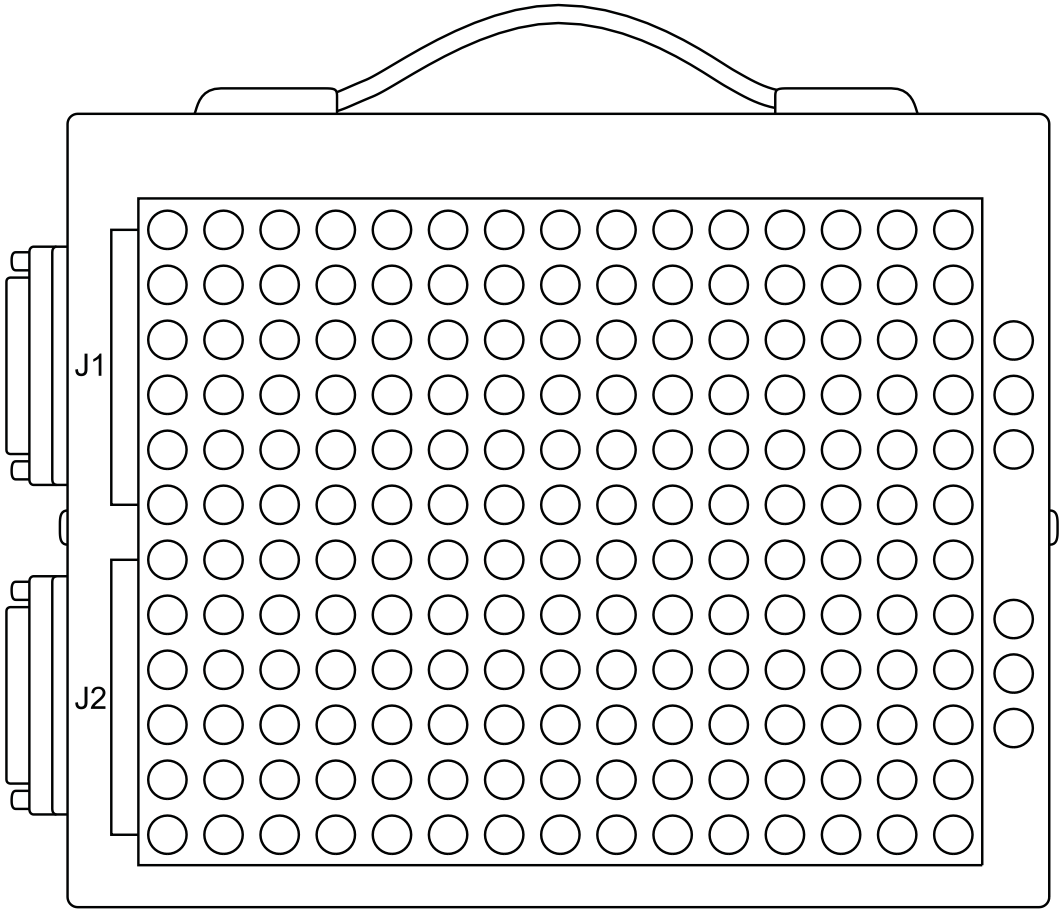
0000304622

Figure 648 Volt Meter



0000304646

Figure 649 ECM (Engine Control Module) 180 Pin Breakout Harness Overlay



0000304645

Figure 650 ACM (Aftertreatment Control Module) 180 Pin Breakout Harness Overlay

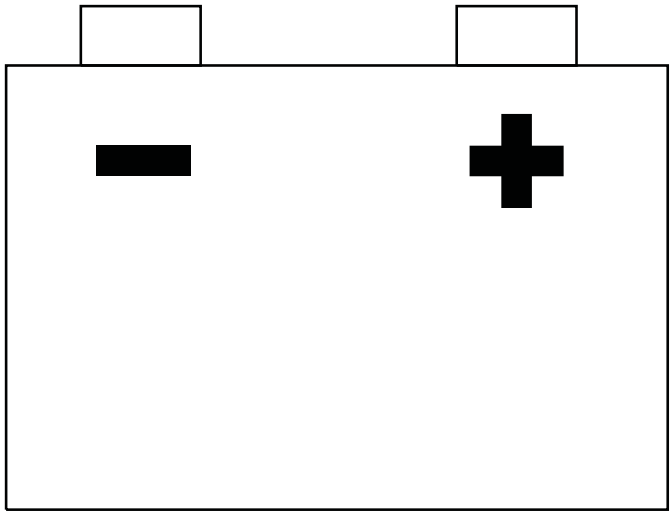


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Figure 651 Battery

Service Bay Tests

Engine Off Tests

Actuator Test

Overview

The Key-On Engine OFF (KOEO) Actuator Test enables technicians to cycle any actuator to high or low states, and some actuators have variable positions. Technicians can use a Digital Multimeter (DMM) to measure changes in voltage or duty cycle, or visually monitor actuator movement while actuator is commanded. This test does not display pass or fail results.

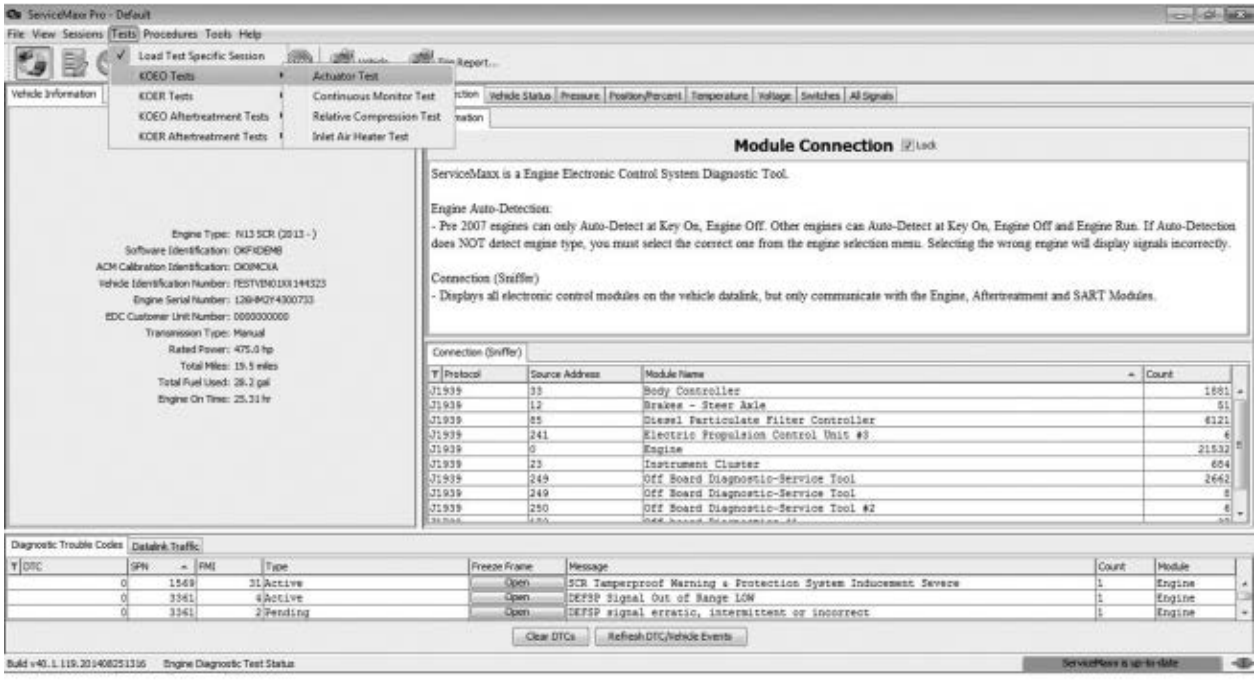
Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software.
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Test Setup

1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Start ServiceMaxx™ software.

Test Procedure



0000341941

Figure 652 Menu – Select Test

1. Select Tests > KOEO Tests > Actuator Test (Figure 652) .

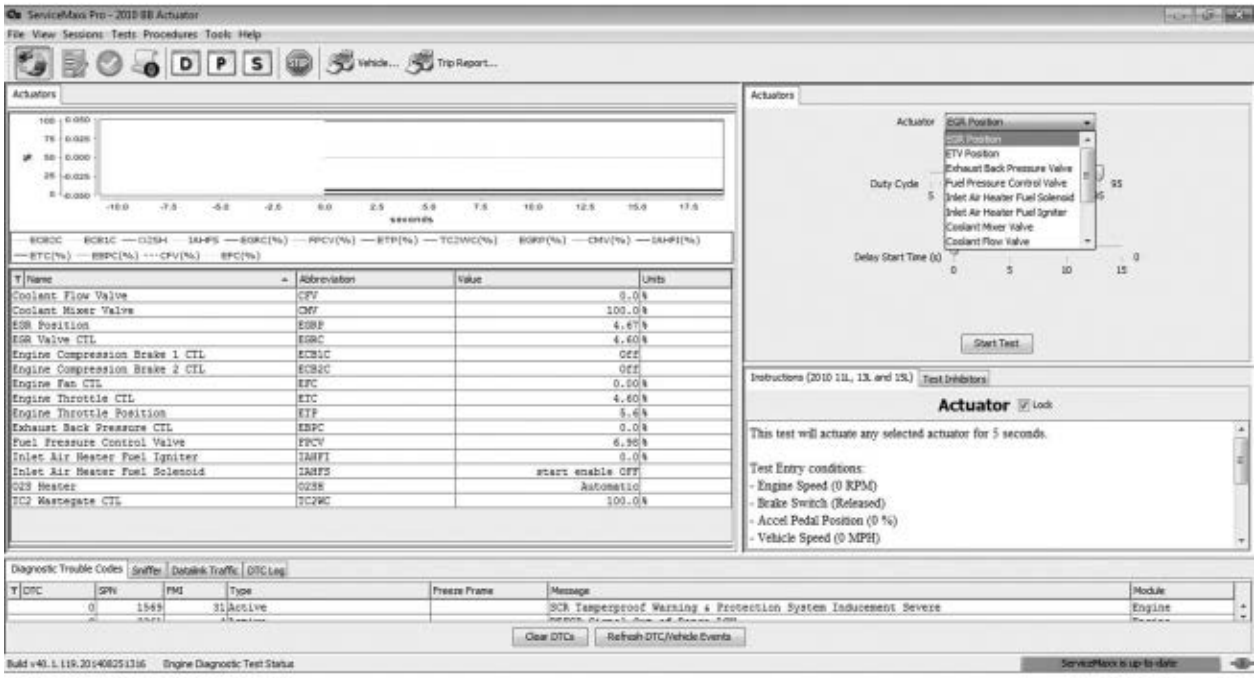


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Figure 653 Actuator Control Panel

2. Select desired actuator from control panel (Figure 653).
3. Adjust amount of duty cycle you wish to control.
4. Adjust delay test start time, if a delay start time is desired.
5. Press the Start Test button to begin the test.
6. Actuator will cycle to commanded position for 5 seconds.

Expected Outcome

The test will complete successfully.

Follow-On Procedure

None

ETV Position Test

Overview

Verify movement of Engine Throttle Valve (ETV).

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- RP1210 Compliant Interface Cable
- Breakout Harness 12-714-01
- Digital Multimeter (DMM)

Equipment Condition

None

Test Setup

1. Key OFF.
2. Connect breakout harness 12-714-01 to both the ETV and engine harness.
3. Key-On Engine-Off (KOEO).
4. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
5. Log in to ServiceMaxx™ software.

Test Procedure

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Figure 654 Menu — Select Test

1. Select Tests > KOEO Tests > Actuator Test
2. Select ETV Position from Actuator Test drop-down menu on the right side.

GRAPHIC
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Figure 655 Start Test Button

3. Select 95% duty cycle and Command actuator movement by clicking the Start Test button.
4. Monitor Engine Throttle Position (ETP) in ServiceMaxx and compare to the commanded duty cycle during the test.
5. Select 5% duty cycle and Command actuator movement by clicking the Start Test button.
6. Monitor Engine Throttle Position (ETP) in ServiceMaxx and compare to the commanded duty cycle during the test.
7. Select 35% duty cycle and Command actuator movement by clicking the Start Test button.
8. Monitor Engine Throttle Position (ETP) in ServiceMaxx and compare to the commanded duty cycle during the test.

Expected Outcome

ETP will meet commanded positions.

Follow-on Procedure

None

Engine Fan Control

Overview

This test will be used to diagnose engine fan control systems and switches.

CONTENT
UNDER
DEVELOPMENT

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Continuous Monitor Test

Overview

The Key-On Engine-Off (KOEO) Continuous Monitor test is used to detect sensor intermittent faults. During this test, sensor voltages are continuously monitored. This test provides a graphical view of all signals and allows the technician to detect intermittent spiking or momentary loss of signal. Perform this test while wiggling connectors, wiring, and harnesses of the suspected faulty component.

NOTE: A sensor fault that goes out of range high or low will cause the voltage signal to display too high or too low. The Continuous Monitor Test will force all sensor voltage to display actual voltages. Signals that display N / A are not available or not enabled on selected engine.

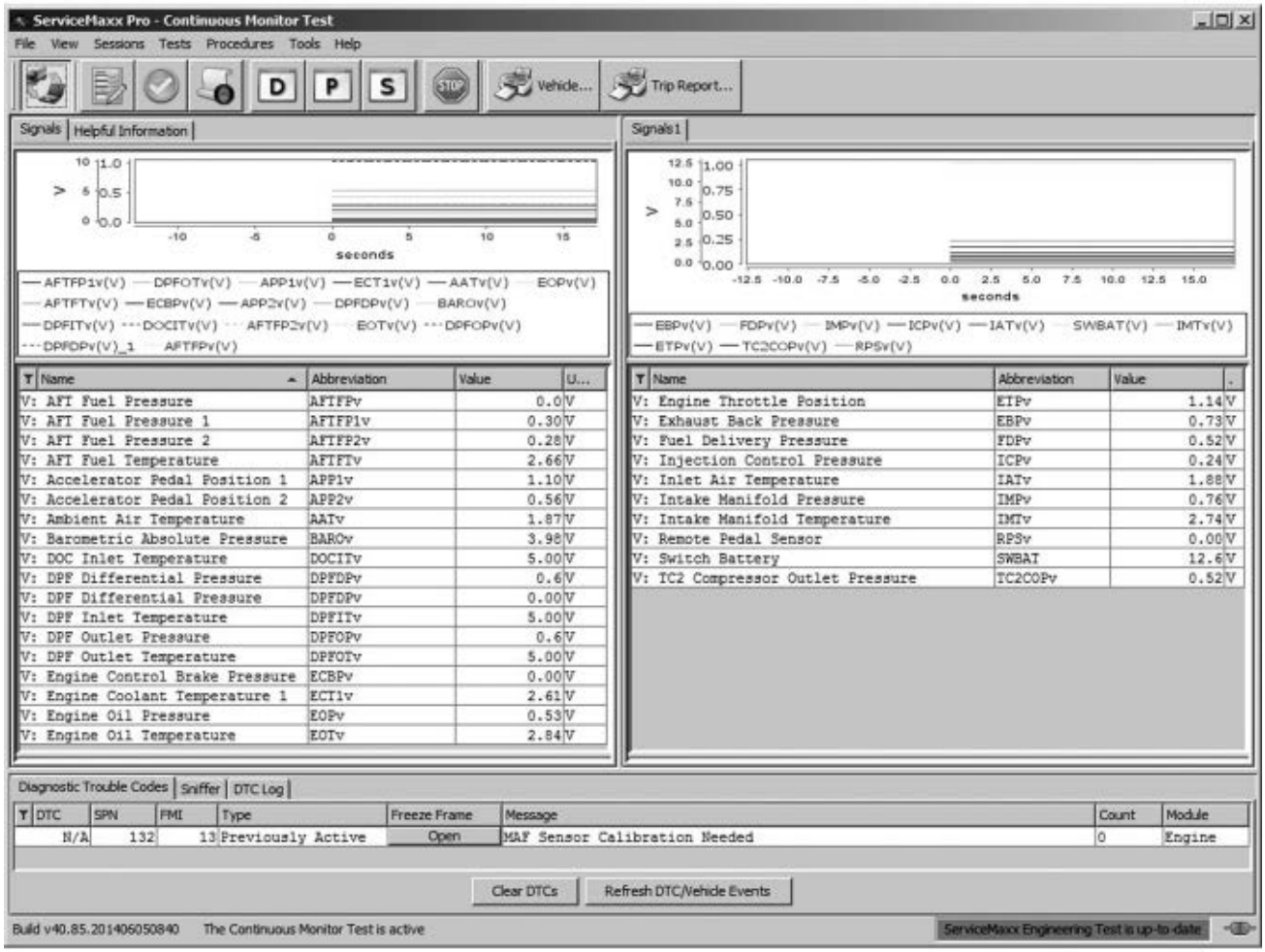

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Figure 657 KOEO Continuous Monitor Test Home Screen

Position Sensor Voltages are Monitored:

- Accelerator Pedal Position 1

- Accelerator Pedal Position 2
- Remote Pedal Sensor (If equipped)
- Urea Tank Level

Pressure Sensor Voltages are Monitored:

- Aftertreatment (AFT) Fuel Pressure
- Barometric Absolute Pressure
- Diesel Fuel Particulate (DPF) Differential Pressure
- DPF Outlet Pressure
- Engine Oil Pressure
- Fuel Delivery Pressure
- Fuel Rail Pressure
- Intake Manifold Pressure
- Turbocharger 1 (TC1) Turbine Outlet Pressure
- TC2 Compressor Inlet Pressure

Temperature Sensor Voltages are Monitored:

- Ambient Air Temperature
- CAC Outlet Temperature
- Engine Coolant Temperature 1
- Engine Coolant Temperature 2
- Engine Oil Temperature
- Exhaust Gas Recirculation GasTemperature
- Intake Air Temperature
- TC2 Compressor Intake Temperature

Other Voltage Signals Monitored:

- Switched Battery
- O2 Sensor INT
- O2 Sensor

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to Vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™.

Test Procedure

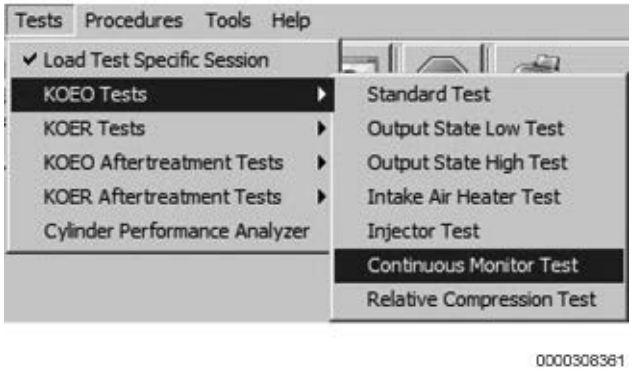

Figure 658 Menu – Select Test

1. Select Continuous Monitor (Figure 658) from drop down menu.

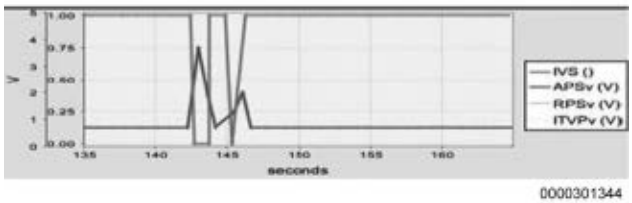

Figure 659 Voltage Spike

2. Monitor suspect voltage signal while wiggling the wiring harness and connectors. If the circuit is interrupted, the signal will spike.

Figure 660 Stop Test Button

3. Test will run until cancelled by pressing the Stop test button (Figure 660).

Follow-on Procedure

None

Relative Compression Test

Overview

The KOEO Relative Compression Test measures cylinder balance in order to determine cylinder integrity. The test results are presented in graphical or numerical displays. The graphs or numbers should be approximately the same, indicating well balanced and equal cylinders.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

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Test Setup

1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™ software.
4. Batteries must be charged (Use Battery charger if necessary).

Test Procedure

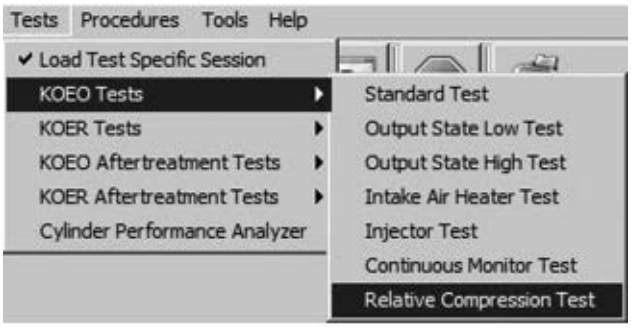


Figure 662 Menu — Select Test

1. Select Relative Compression Test (Figure 662) from the KOEO Tests drop-down menu.

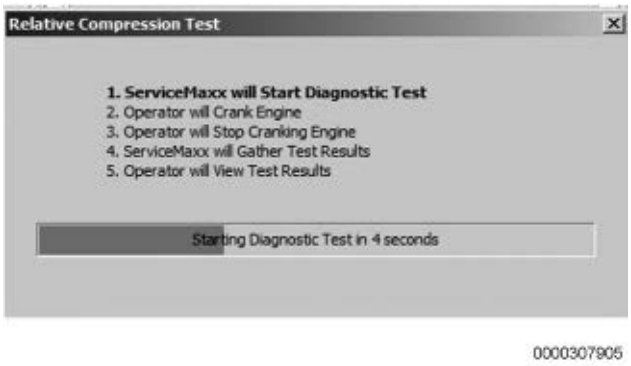


Figure 663 Test Instructions Popup Panel

2. Follow the instructions on the popup test panel (Figure 663) .

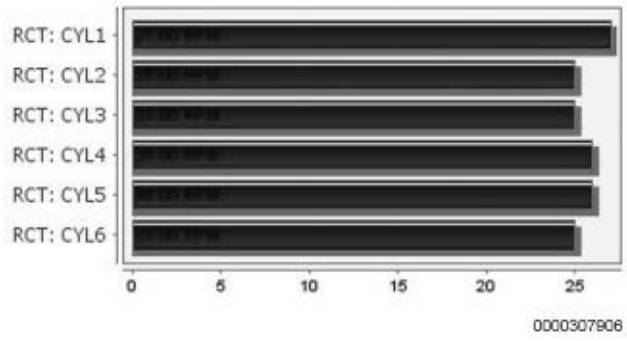


Figure 664 Test Results

3. Results are measured on the down travel of each cylinder's power stroke (Figure 664). A cylinder with low compression will be significantly lower then the others.

Figure 665 Test Complete

4. When test is complete (Figure 665), review test results.

Expected Outcome

Test will complete successfully

Follow-On Procedure

None

Intake Air Heater Test

Overview

The Intake Air Heater (IAH) Test is used to activate the system when engine temperatures are above normal IAH operating range. A technician can use this test to diagnose a problem with this system.

The Intake Air Heater (IAH) System does not assist in starting a cold engine, this system is used to help eliminate white smoke after a cold engine start up. The normal operating range of this is below 50 degrees F.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface Cable (RP1210B-compliant, supporting J1939 and J1708)

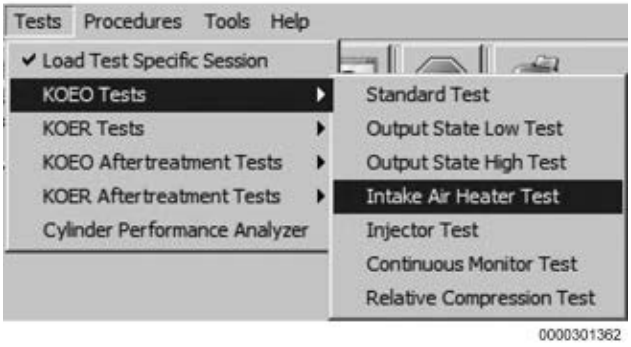
Equipment Condition

None

Test Setup

1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™.

Test Procedure



1. Select Tests > KOEO Tests > Intake Air Heater Test (Figure 666). This will load session and start test..
2. Start engine once WTSL begins to flash.
3. After engine has started, IAH Fuel Solenoid will open allowing fuel to feed the igniter.

Expected Outcome

On a cold engine, Intake Manifold Temperature should raise at least 10 degrees F before the test completes.

Follow-on Procedure

None

Actuator Test - Aftertreatment

DEF Reverting Valve

Overview

The Key-ON Engine-OFF (KOEO) Diesel Exhaust Fluid (DEF) Reverting Control Valve Test is used to command the DEF reverting valve on, allowing a service technician to measure the voltage output to the valve, which confirms the system is working correctly.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

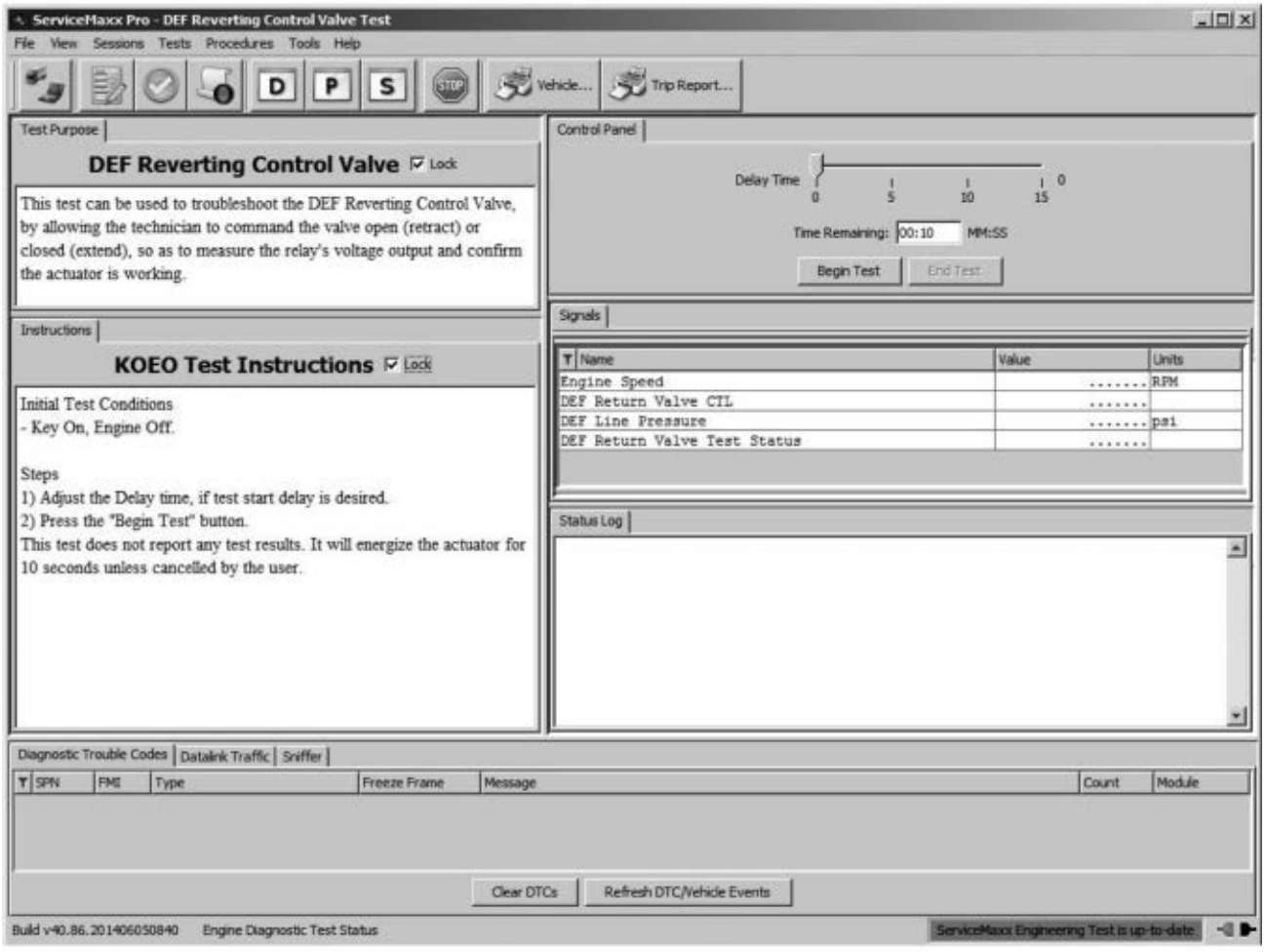


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Figure 667 DEF Reverting Control Valve Test

Test Setup

1. Key-ON Engine-OFF (KOEO).

2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Key ON. Log in to ServiceMaxx™ software.

Test Procedure

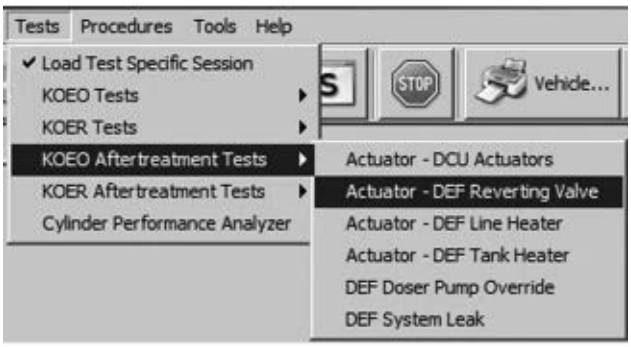

Figure 668 Select Test

1. Select KOEO Aftertreatment Test, Actuator – DEF Reverting Valve (Figure 668) from the drop-down menu.
2. The DEF Reverting Valve test session will load on the screen.

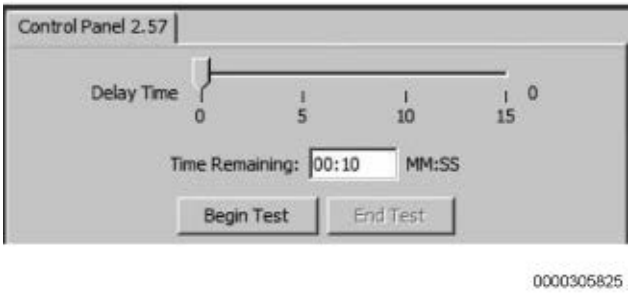

Figure 669 Begin Test Button

3. Adjust the desired test delay (Figure 669) amount, if any delay is needed.
4. Press the Begin Test button (Figure 669) to begin the test.
5. This test does not display pass or fail results.

Expected Outcome

The test will complete successfully.

Follow-On Procedure

None

DEF Line Heater

Overview

The Key-On Engine-Off (KOEO) Diesel Exhaust Fluid (DEF) Line Heater Test is used to command DEF Line Heaters ON, allowing a service technician to measure voltage output to DEF Line heaters while confirming system is working correctly.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Start and log in to ServiceMaxx™ software.

Test Procedure

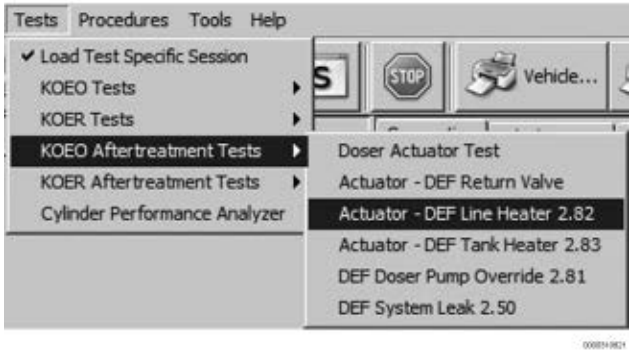

Figure 670 Menu – Select Test

1. Select KOEO Aftertreatment Test > Actuator – DEF Line Heater (Figure 670) from drop-down menu.
2. DEF Line Heater session will load on the screen.

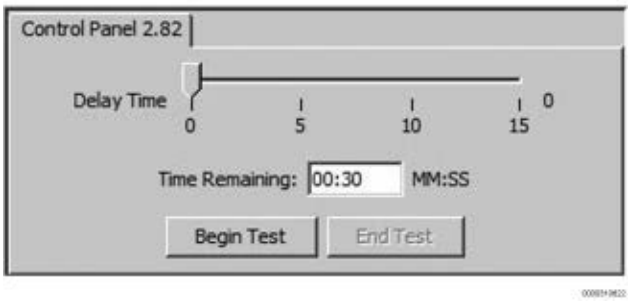

Figure 671 Menu – Begin Test button

3. Adjust desired test delay amount, if any delay is needed (Figure 671).
4. Press Begin Test button to begin test (Figure 671).
5. This test does not display pass or fail results.

Expected Outcome

None

Follow-On Procedure

None

DEF Tank Heater Test

Overview

The Key-ON Engine-OFF (KOEO) Diesel Exhaust Fluid (DEF) Tank Heater Test is used to command the DEF tank heater on, allowing a service technician to measure the voltage output to the DEF tank heater control valve confirming the system is working correctly.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- J1939-compliant Interface Cable

Equipment Condition

None

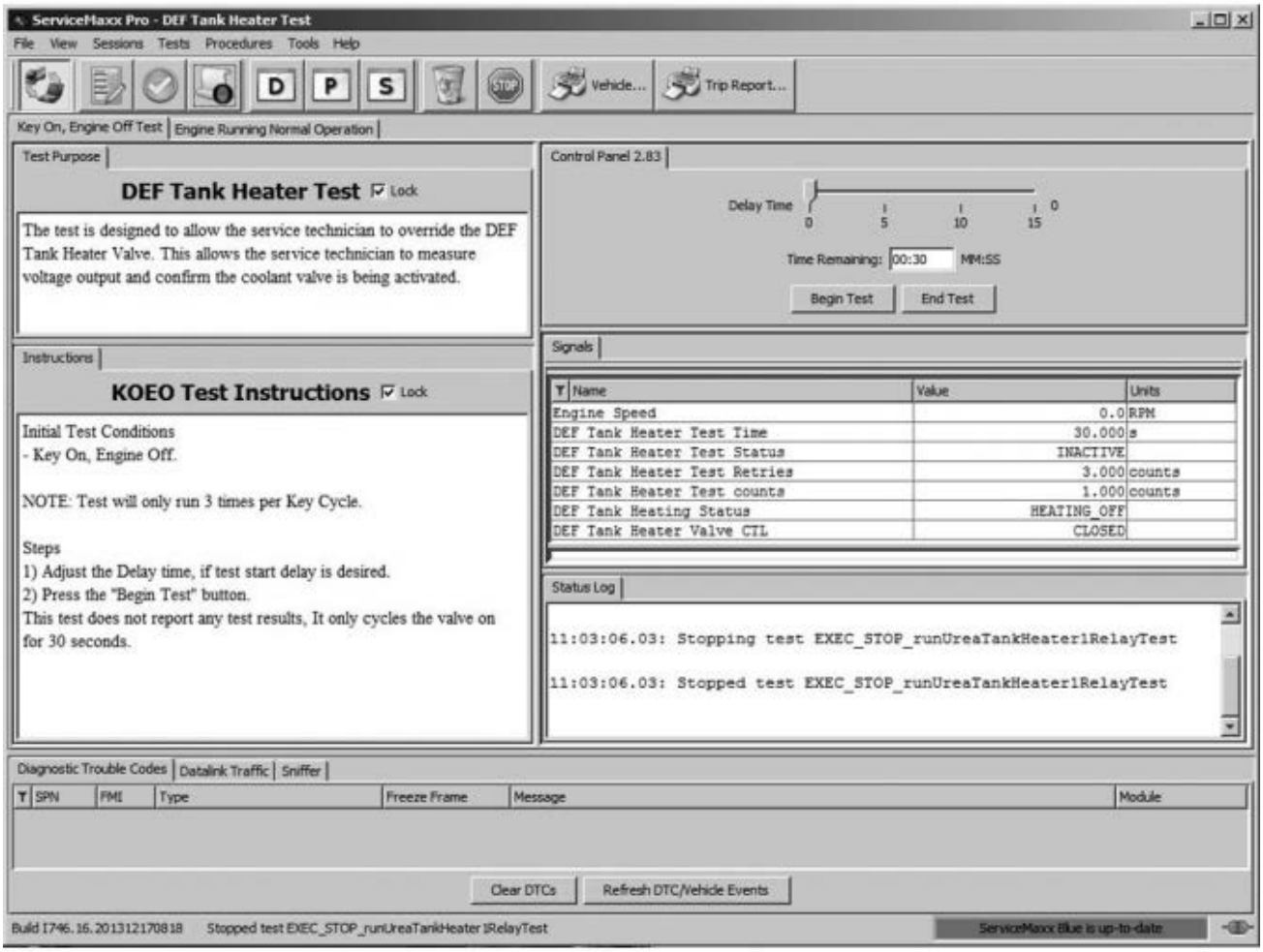

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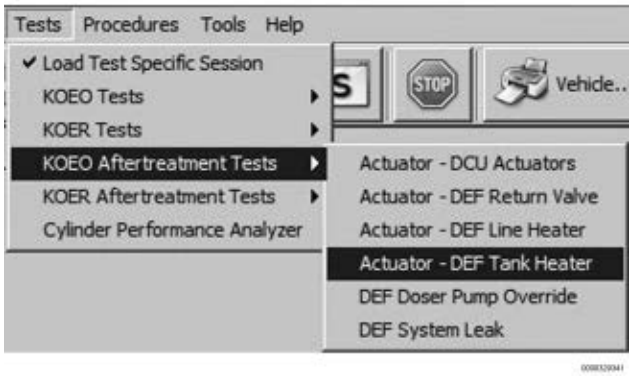
Figure 672 DEF Tank Heater Test

Test Setup

1. Key-ON Engine-OFF (KOEO).
2. Connect Electronic Service Tool (EST) to Vehicle Diagnostic Connector (page 1571).
3. Start ServiceMaxx™ software.

Test Procedure



1. Select KOEO Aftertreatment Tests, Actuator – Diesel Exhaust Fluid (DEF) Tank Heater (Figure 673) from the drop down menu.
2. The DEF tank heater session will load on the screen.

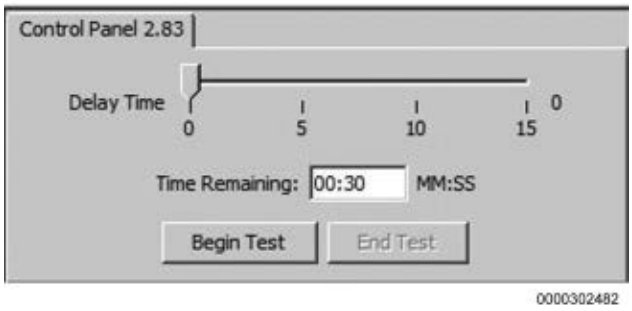


Figure 674 Begin Test button

3. Adjust the desired test delay amount (Figure 674), if any delay is needed.
4. Press the Begin Test button (Figure 674) to begin the test.
5. This test does not display pass or fail results.

Expected Outcome

Test will complete successfully.

Follow-On Procedure

None

DEF Supply Pump Override

Overview

Validates performance of the Diesel Exhaust Fluid (DEF) dosing system, based on the amount of DEF flow for a fixed amount of time. This test will inject 100 ml of DEF in 6 minutes.

Tools Required

- Coolant Management Tool KL5007NAV
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Diesel Exhaust Fluid Doser (DEFD) Spray Test Kit 18-559-01
- Graduated cylinder
- Plastic container
- Air and Fuel Cap and Plug Kit ZTSE4891

Equipment Condition

None

Test Setup

DEF Supply Pump Override Test Initial Checks

1. Check Diesel Exhaust Fluid (DEF) tank, DEF supply module, and DEF Doser (DEFD) lines and connections for: cracks and pitting; loose, leaking, or damaged connections; and restrictions.

   If the DEF tank, DEF supply module, or DEFD valve lines and connections are damaged or restricted, repair or replace the failed component, line, or connection.

2. Check DEF quality. Obtain a sample of DEF. Visually inspect for contamination, and use DEF Refractometer 5025 to test urea concentration of DEF.

   If DEF is contaminated or urea concentration is not between 30 – 34 percent, drain the DEF tank, flush with distilled water, and fill with new and / or known good DEF.

DEF Supply Module Removal and Preparatory Steps

WARNING: To prevent personal injury or death, allow engine to cool before removing components.

WARNING: To prevent personal injury or death, avoid contact with Diesel Exhaust Fluid (DEF) / urea. Do not get DEF in eyes. In case of eye contact, immediately flush eyes with large amounts of water for a minimum of 15 minutes. Do not swallow. If DEF is ingested, contact a physician immediately.

WARNING: To prevent personal injury or death, do the following when removing radiator or deaeration cap:

- **Allow engine to cool for 15 minutes or more.**
- **Wrap a thick cloth around radiator cap or deaeration cap.**
- **Loosen cap slowly a quarter to half turn counterclockwise to vent pressure.**
- **Continue to turn cap counterclockwise to remove.**

3. Low battery voltage can cause dosing volume to be low. Verify batteries are fully charged before beginning this test.

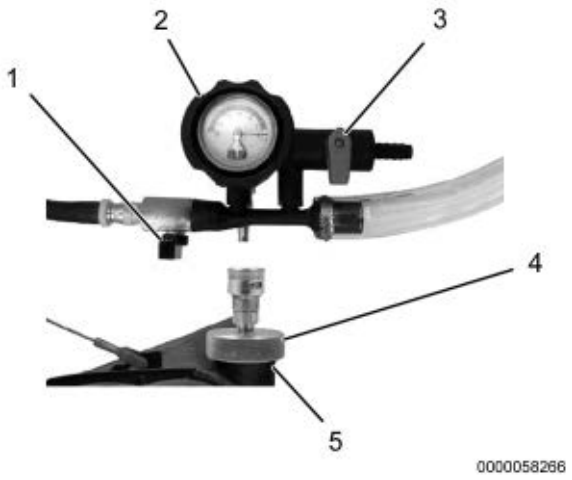


Figure 675 Coolant Management Tool Connections

1. Air valve (closed)
2. Vacuum Module
3. BLUE vent valve
4. Cap Adapter
5. Deaeration tank

4. Remove deaeration tank cap and install Cap Adapter KL5004NAV (Figure 675) (Item 4) onto the deaeration tank (Figure 675) (Item 5).
5. Connect Vacuum Module KL5005NAV (Figure 675) (Item 2) to Cap Adapter.
6. Verify both valves on the vacuum module are in the closed position, and attach clean dry shop air.

Figure 676 Air Valve (Open)

1. Air valve (open)

7. Open air valve (Figure 676) (Item 1) on Vacuum Module, and allow 5 to 10 in. Hg to be drawn on the cooling system.

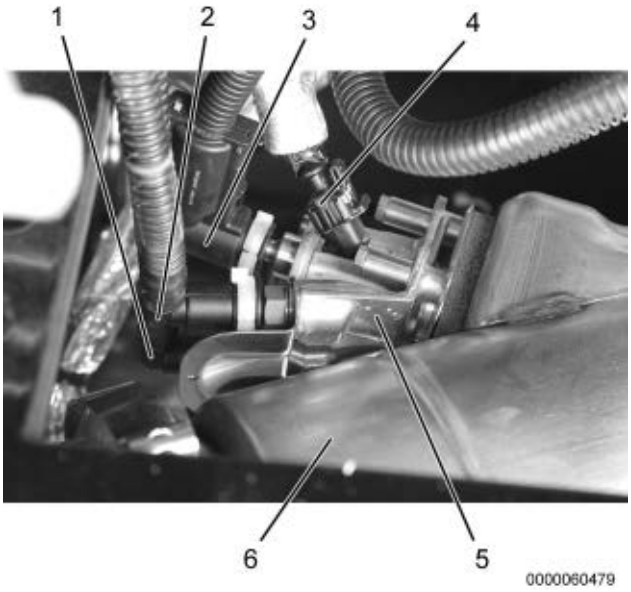


Figure 677 DEFD Valve Connection Locations

1. Coolant return line
2. Coolant supply line
3. Diesel Exhaust Fluid Doser (DEFD) valve pressure line
4. DEFD valve connector
5. DEFD valve
6. Decomposition reactor tube

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

8. Use compressed air to remove any debris trapped in the gaps between the Diesel Exhaust Fluid Doser (DEFD) valve (Figure 677) (Item 5) and the decomposition reactor tube (Figure 677) (Item 6).
9. Clean any white deposits from DEF on the DEFD valve pressure line (Figure 677) (Item 3) connection with a shop towel soaked in warm water.
10. Disconnect DEFD valve coolant supply line (Figure 677) (Item 2) and coolant return line (Figure 677) (Item 1) at DEFD valve.

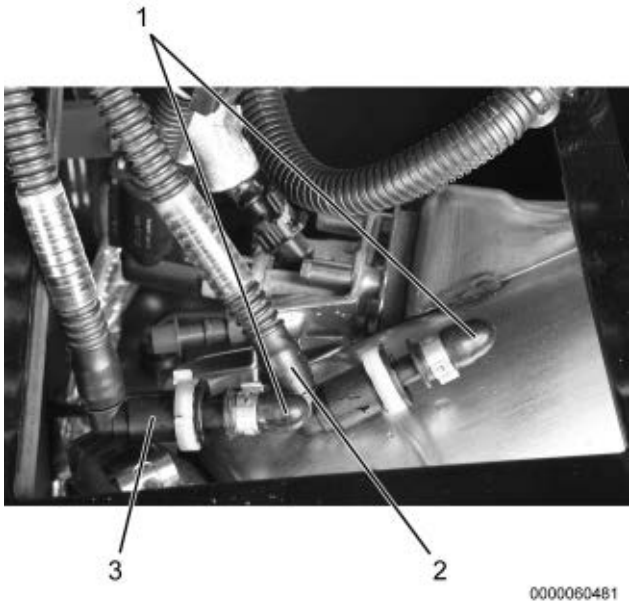


Figure 678 DEFD Valve Coolant Line Plugs Installed

1. DEFD valve Coolant Line Plugs (2)
2. Coolant supply line
3. Coolant return line

11. Install two DEFD valve Coolant Line Plugs 18-559-01-02 (Figure 678) (Item 1) onto DEFD valve coolant supply and return line.
12. Open BLUE vent valve on the Vacuum Module (Figure 675) (Item 2) to release vacuum on the cooling system.

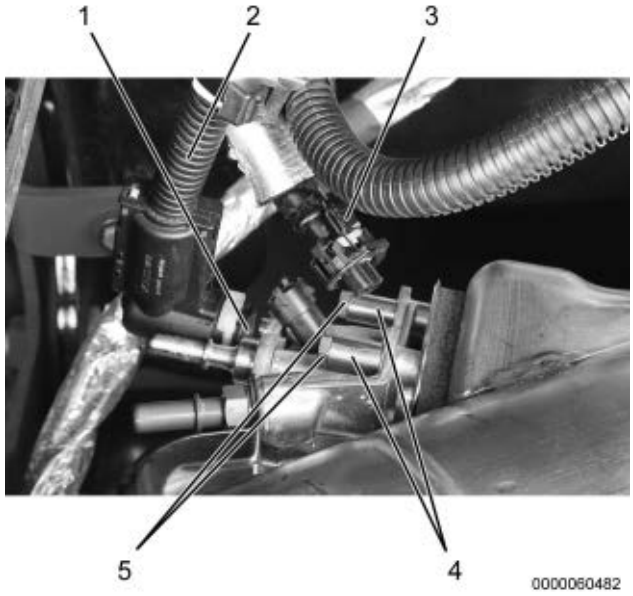


Figure 679 DEFD Valve Pressure Line Plugged and Connector Disconnected

1. DEFD Valve pressure line plug
2. DEFD Valve pressure line
3. DEFD Valve connector
4. DEFD Valve spacers
5. DEFD Valve mounting bolts (3)

13. Place a plastic container under the DEFD Valve to catch Diesel Exhaust Fluid (DEF).

CAUTION: Do Not disconnect vehicle batteries, DEF supply module 12–way connector, or any DEF lines until the DEF dosing system has completed the purge cycle. Wait at least five minutes after Key OFF for the DEF dosing system to complete the purge cycle.

14. Disconnect DEFD Valve pressure line (Figure 679) (Item 2) and install DEFD Valve pressure line plug to prevent debris from entering system using Air and Fuel Cap and Plug Kit ZTSE4891.
15. Disconnect DEFD Valve connector (Figure 679) (Item 3).
16. Remove three DEFD Valve mounting bolts (Figure 679) (Item 5) and spacers (Figure 679) (Item 4).
17. Remove DEFD Valve and gasket from decomposition reactor tube. Discard gasket.

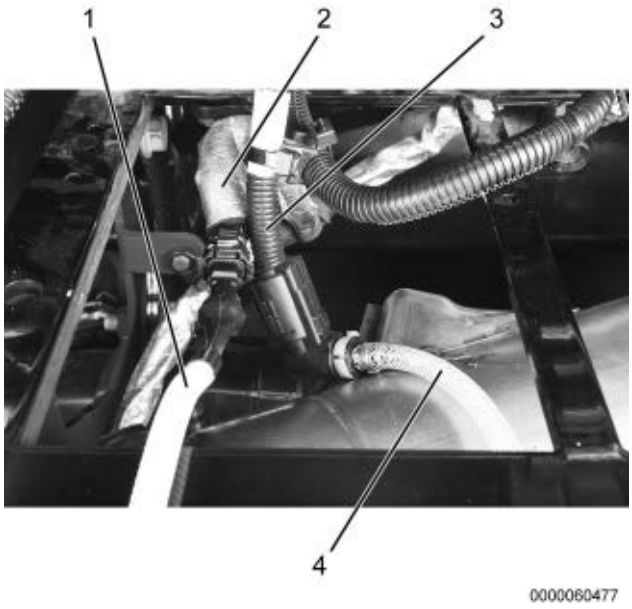


Figure 680 DEFD Valve Pressure Line and Harness Extensions Connected

1. DEFD Valve Harness Extension
2. Vehicle harness
3. DEFD Valve pressure line
4. DEFD Valve Pressure Line Extension

18. Connect DEFD Valve Pressure Line Extension 18-559-01-03 (Figure 680) (Item 4) between DEFD Valve pressure line and DEFD Valve.
19. Connect DEFD Valve Harness Extension 18-559-01-01 (Figure 680) (Item 1) between vehicle harness and DEFD Valve connector.
20. Place DEFD Valve into a clear graduated cylinder, large enough to contain the DEFD Valve, and marked in milliliters (ml) or ounces (oz).
21. Cover the DEFD Valve and graduated cylinder so DEF spray is contained.

Test Procedure

DEF Supply Pump Override Test

1. Verify DEF tank is full before beginning procedure.
2. Key-On, Engine-OFF.
3. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
4. Start ServiceMaxx™.
5. Go to Tests > KOEO Aftertreatment Tests > DEF Doser Pump Override Test.

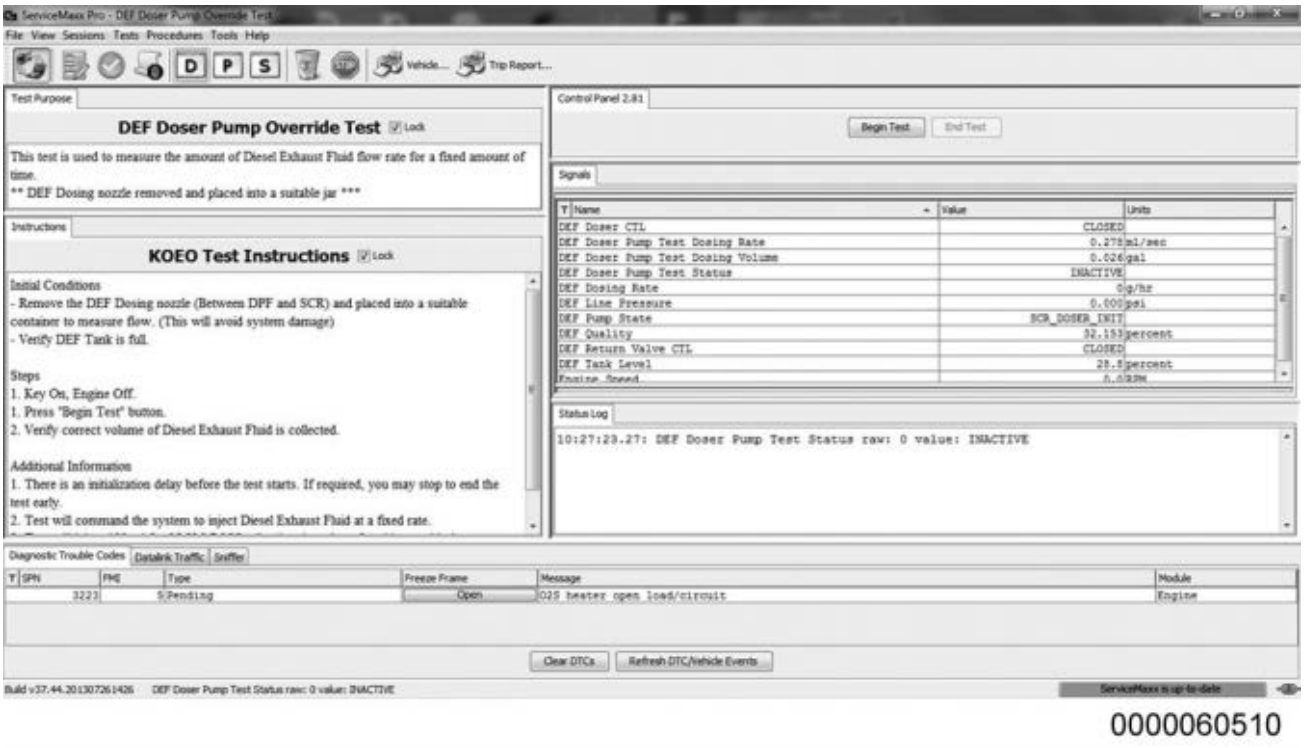


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Figure 681 DEF Doser Pump Override Test

6. Select Begin Test. When test starts, the DEF dosing system will first prime the Diesel Exhaust Fluid Doser Valve (DEFD Valve). The DEFD Valve will open intermittently to purge air from the system. This will cause some DEF to be sprayed from the DEFD Valve (normal operation).
7. While test is running, monitor DEFD Valve spray pattern. DEFD Valve spray pattern should be a fine mist. If larger drops, dripping, or a non-symmetrical spray pattern is present, stop the test and clean the DEFD Valve tip (see Exhaust System Service Manual). After cleaning is completed, restart DEF Doser Pump Override test (page 1610).
8. After test is complete, measure DEF in graduated cylinder. DEF collected should be between 85 ml and 115 ml.
9. Perform steps 1 through 4 three times. If results are not within specification, inspect DEF supply module filter for contamination and debris.
   - If one or more of the test results is below 85 ml, clean the DEFD Valve (see Exhaust System Service Manual).
   - If one or more of the test results is above 115 ml, replace the DEFD Valve.
   - If test results vary above and below specification, replace the DEFD Valve.

   NOTE: Inspect collected sample for contamination or debris.

Expected Outcome

Technician will successfully validate performance of DEF Dosing system.

Follow-on Procedure

1. Remove Diesel Exhaust Fluid Doser Valve (DEFD Valve) from graduated cylinder and dispose of DEF according to local regulations.
2. Clean any components coated with DEF with a shop towel soaked in warm water.
3. Disconnect DEFD Valve Harness Extension 18-559-01-01 from DEFD Valve.
4. Disconnect DEFD Valve Pressure Line Extension 18-559-01-03 from DEFD Valve.
5. Install new DEFD Valve gasket onto bottom of DEFD Valve with metallic side facing DEFD Valve.

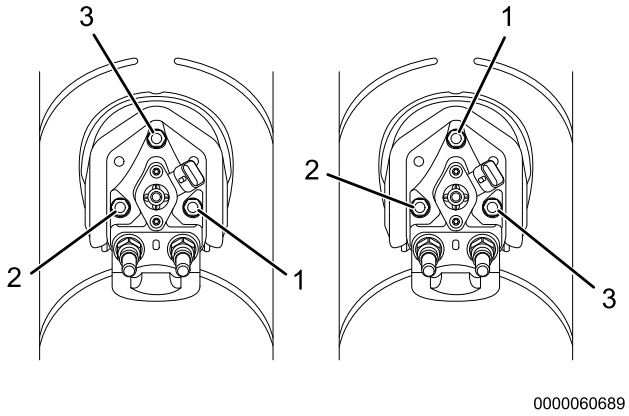

Figure 682 DEFD Valve Mounting Bolts Tightening Sequence

6. Install DEFD Valve, three DEFD Valve mounting bolts, and spacers onto decomposition reactor tube. Tighten three DEFD Valve mounting bolts by hand first using DEFD Valve Mounting Bolts Tightening Sequence (Figure 682) shown on the left. Then tighten to 80 lb·in (9 N·m) in the DEFD Valve Mounting Bolts Tightening Sequence (Figure 682) shown on the right.
7. With Vacuum Module KL5005NAV installed, open air valve on Vacuum Module, and allow 5 to 10 in. Hg to be drawn on the cooling system.
8. Remove DEFD Valve Coolant Line Plugs 18-559-01-02 from coolant supply and return line. Reconnect Coolant supply and return line to DEFD valve.
9. Connect DEFD Valve coolant supply and return line at the DEFD Valve.
10. Connect DEFD Valve pressure line to DEFD Valve.
11. Connect vehicle wiring harness lead to DEFD Valve connector.

KOEO DEF System Leak Test

Overview

Diesel Exhaust Fluid (DEF) System Leak Test is used to prime DEF system and hold pressure so the system can be checked for leaks. This test does not display pass or fail results.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Start and log in to ServiceMaxx™ software.

Test Procedure

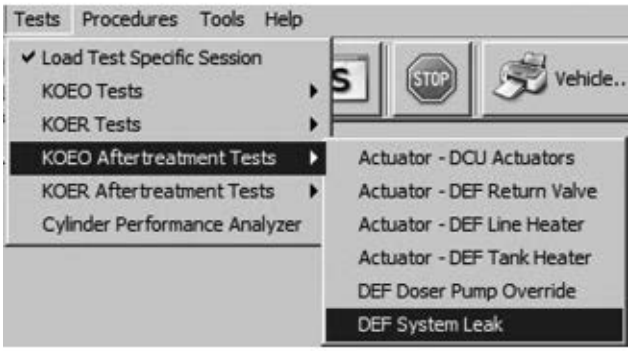

Figure 683 Menu – Select Test

1. Tests > KOEO Aftertreatment Tests > DEF System Leak (Figure 683).

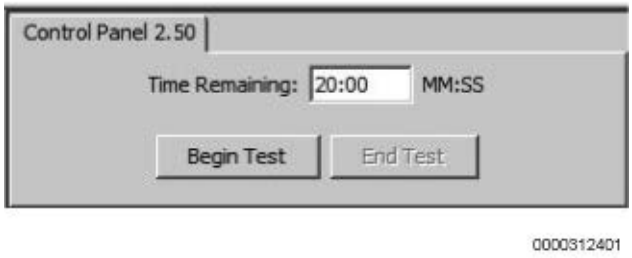

Figure 684 Menu – Begin Test button

2. Select Begin Test button (Figure 684) to start testing.
3. Test will run for 20 minutes, but can be cancelled at any time.

Expected Outcome

DEF System Leak Test will prime and hold pressure on the system allowing for leaks to be detected visually.

Follow-On Procedure

None

SCR Fault Reset Request

Overview

After diagnosing and repairing Selective Catalytic Reduction (SCR) faults, SCR Faults Reset Parameter will have to be reprogrammed.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- J1939-compliant interface cable

Equipment Condition

None

Test Setup

1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Start and log in to ServiceMaxx™ software.

Test Procedure

1. Clear Diagnostic Trouble Code (DTCs) if any are displayed.

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Figure 685 Sessions Menu

2. Sessions > Programming (Figure 685).

3. Click on Service Interval tab.

GRAPHIC
PLACE
HOLDER

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4. Change value on 77880 SCR Faults Reset Request from No to Yes .

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5. Click Program Engine Button .
6. When programming is successful, turn Key OFF for minimum of 15 seconds.
7. Turn Key ON.
8. Clear any Diagnostic Trouble Codes (DTCs).

Expected Outcome

Engine will program successfully and SCR faults will be reset.

Follow-On Procedure

None

Low Coolant Level Reset Request

Overview

After diagnosing and repairing Low Coolant Level Repeat Occurrences faults, Low Engine Coolant Level and Timer Parameters have to be reprogrammed.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-On Engine-Off (KOEO)
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ to Vehicle Diagnostic Connector (page 1571)
3. Log into ServiceMaxx™
4. Clear Diagnostic Trouble Codes (DTC)

Test Procedure

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1. Select Sessions > Programming (Figure 688)
2. Click on Service Interval Tab
3. Change value 4116 Trip Engine Coolant Low Time parameter to zero (0)

4. Click Program Engine Button
5. When programming is successful, turn Key-Off for minimum of 15 seconds
6. Turn Key-On
7. Clear any DTC

Expected Outcome

Engine will program successfully and Coolant Level Faults will be reset.

Follow-On Procedure

None

FRP Relief Valve Reset Procedure

Overview

After diagnosing and repairing Fuel Rail Pressure (FRP) Relief Valve, FRP Relief Valve opening timer and counter parameters have to be reprogrammed.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-On Engine-Off (KOEO)
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™
4. Clear Diagnostic Trouble Codes (DTC)

Test Procedure

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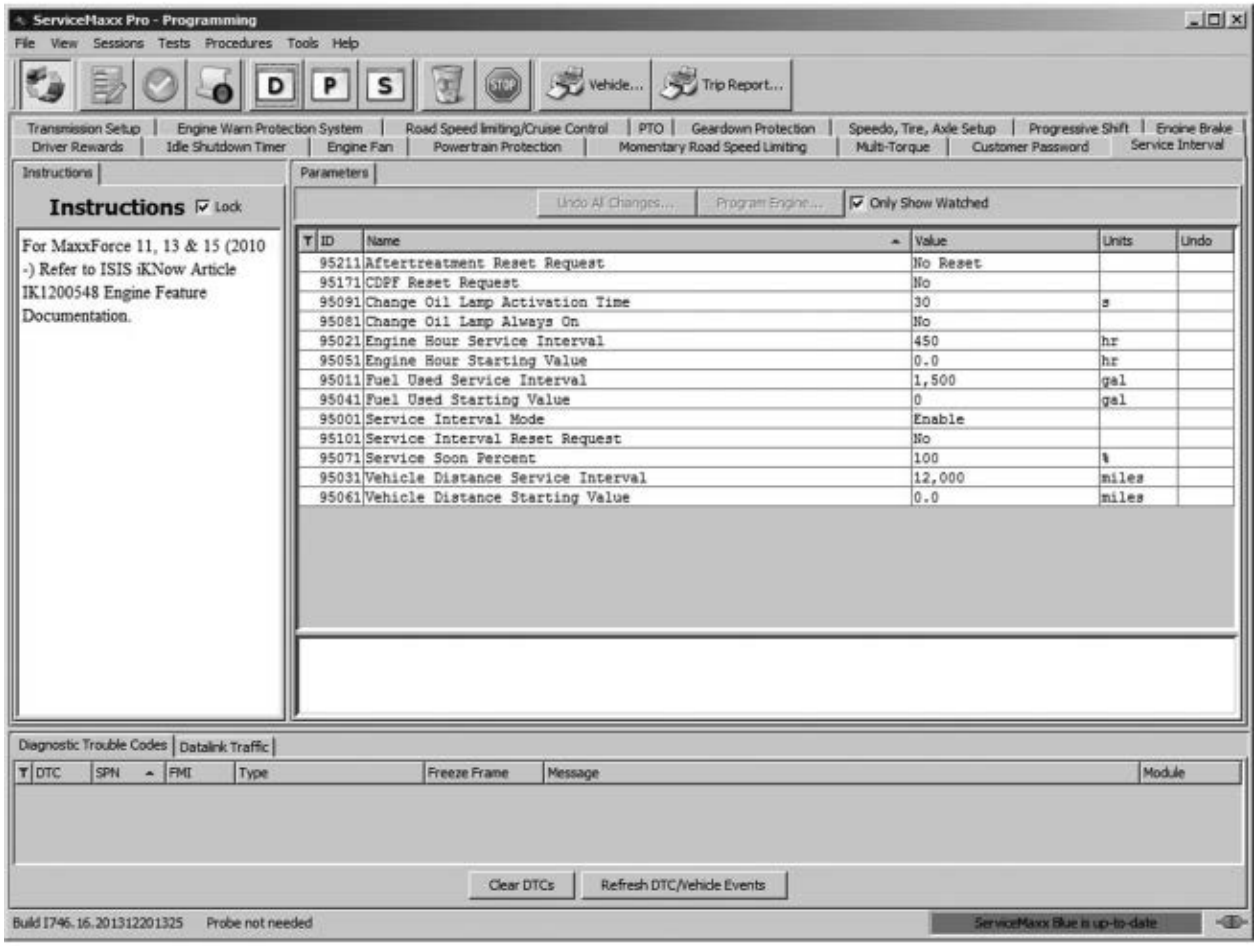
1. Select Sessions > Programming (Figure 689)



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2. Click on Service Interval Tab (Figure 690)

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PLACE
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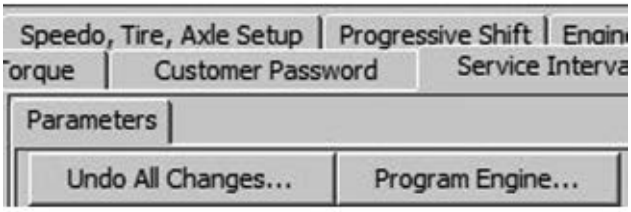
3. Change Value on 95212 FRP Relief Valve Timer parameter (Figure 691)to zero (0)
4. Change Value on 95222 FRP Relief Valve Timer parameter (Figure 691)to zero (0)



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5. Click Program Engine (Figure 692) Button
6. When programming is successful, turn Key-Off for minimum of 15 seconds
7. Turn Key-On
8. Clear any DTCs

Expected Outcome

Engine will program successfully and FRP faults will be reset.

Follow-On Procedure

None

Aftertreatment Purge Air Valve Test

Overview

This test will provide a procedure for testing the Aftertreatment Purge Air Valve.

CONTENT
UNDER
DEVELOPMENT

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Engine Running Tests

Air Management Test

Overview

This test is used to validate the Air Management System by monitoring effects of actuators on Intake Manifold Pressure (IMP). Pressure drops by varying amounts each time an actuator is commanded open. This test does not give Pass or Fail results.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Conditions

- Engine Speed (Low Idle - below 750 RPM)
- Engine Coolant Temperature (Above 100 F)
- Parameter: 77532 Maximum Standstill Engine Speed (Above 1650 RPM)
- Accelerator Pedal Position (0%)
- Brake Switch (Released)
- Parking Brake (Set)

Test Setup

1. Key-On Engine-Off (KOEO)
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ to Vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™
4. Start engine and warm engine coolant temperature above 100° F (38° C)

Test Procedure

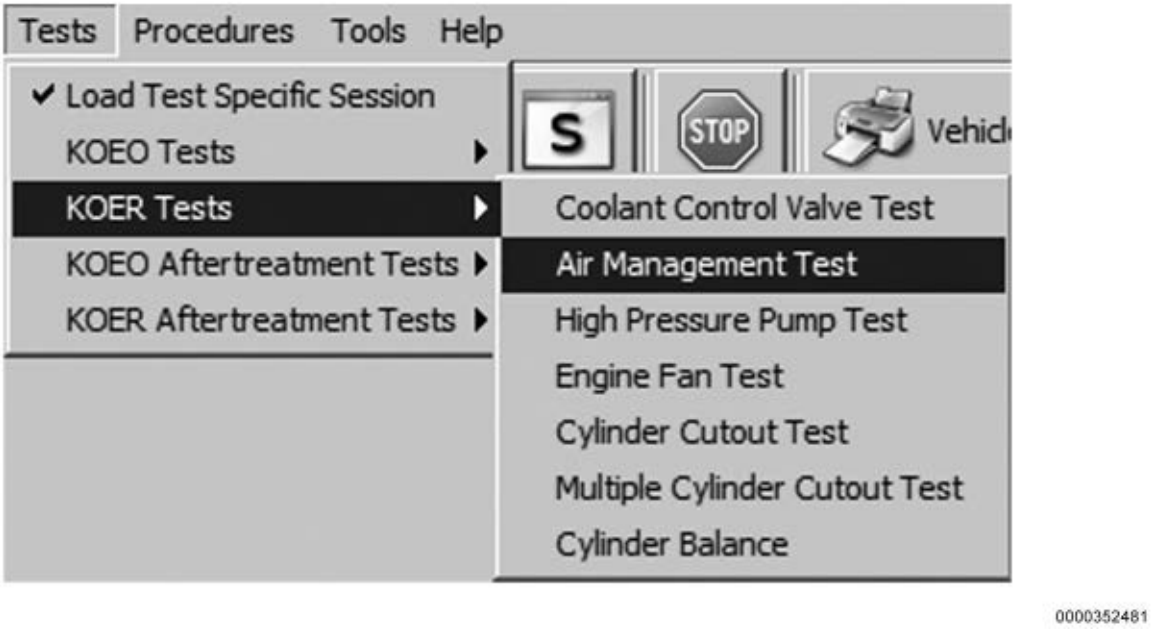

Figure 694 ServiceMaxx™ Tests Menu

1. Select Tests > KOER Tests > Air Management Test (Figure 694)
2. Engine will operate through a series of RPM ramp-ups commanding a different actuator to cycle for each one

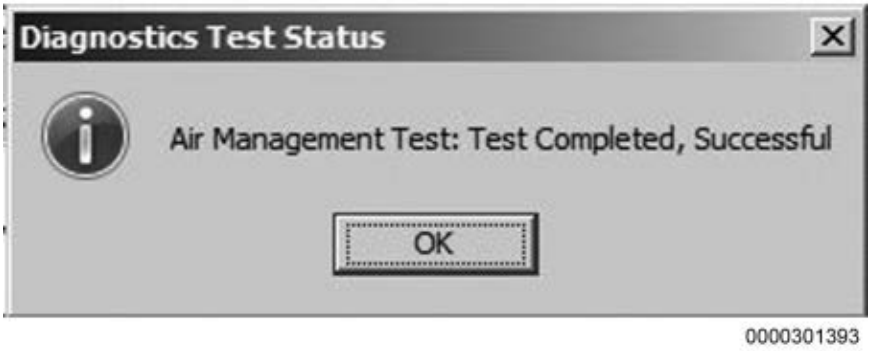

Figure 695 Test Complete Message

3. When test is complete, Air Management Test: Test Completed, Successful (Figure 695) pop-up will appear

Expected Outcome

Test will complete successfully allowing the technician to validate actuator commands and compare them to IMP sensor values.

Follow-On Procedure

None

High Pressure Pump Test

Overview

The High Pressure Pump Test validates performance of the high-pressure fuel system. This test accelerates the engine in four steps while commanding higher fuel rail pressure on each step. When the test is complete, the Engine Control Module (ECM) sends the test results to the Electronic Service Tool (EST).

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Condition

- Engine coolant Temperature 1 (above 100 degrees F)
- Engine Speed (below 700 RPM)
- AFT Regen Status (Not Active)
- Vehicle Speed (Not Moving)
- Accelerator Pedal Position (0%)
- Brake Pedal (Release)
- Clutch Pedal (Release)

Test Setup

1. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
2. Key ON. Log into ServiceMaxx™ software.
3. Start Engine and warm engine coolant temperature above 100 degrees F.

Test Procedure

0000341741

1. Go to Tests > KOER Tests > High Pressure Pump Test (Figure 696).

Figure 697 Pre Test Information Message

2. High Pressure Pump Test Session will auto-load and Pre-Test setup condition warning message will display.
3. After satisfying pre-test conditions, click OK button to begin test.
4. Engine will ramp up and Fuel Pressure Control system will test performance at 4 different test points.

Test Results

Save Print

Name	Value	Units
Pressure increase 1 status	Normal	
Pressure increase 2 status	Normal	
Pressure increase 3 status	Normal	
Pressure increase 4 status	Normal	
Pressure increase 1 time	0.25	s
Pressure increase 2 time	0.24	s
Pressure increase 3 time	0.25	s
Pressure increase 4 time	0.22	s
Pressure decrease 1 time	1.73	s
Pressure decrease 2 time	1.17	s
Pressure decrease 3 time	1.07	s
Pressure decrease 4 time	0.73	s

0000341721

Figure 698 Test Results

5. Test is complete when results are displayed.

Expected Outcome

Test will complete successfully.

Follow-on Procedure

None

Engine Fan Test

Overview

The KOER Engine Fan Test is used to validate performance of Engine Fan.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- J1939 Compliant Interface Cable

Equipment Conditions

- Engine Coolant Temperature 1 (above 160 degrees F)
- Engine Speed (below 700 RPM)
- Vehicle Not Moving
- Accelerator Pedal Position (0%)
- Brake Pedal (Release)
- Clutch Pedal (Release)

Test Setup

1. Key-ON, Engine-OFF.
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
3. Start ServiceMaxx™ Software.
4. Start engine and warm engine coolant temperature above 100 degrees F.

Test Procedure

GRAPHIC
PLACE
HOLDER

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Figure 699 Menu – Select Test

1. Select Engine Fan Test from drop down menu.

GRAPHIC
PLACE
HOLDER

0000300422

Figure 700 Engine Fan Test Home Screen

2. Engine Fan Test session will auto-load, but will not start test until desired test is selected from control panel.

GRAPHIC
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HOLDER

0000300422

Figure 701 Variable Fan Control

GRAPHIC
PLACE
HOLDER

0000300422

Figure 702 Single Speed Control

3. Select desired fan control. Engine can have a Variable Fan or a single speed fan. The Fan Control Panel will auto load the correct controls.
4. Engine speed will ramp up to 1700 rpm before the fan is controlled.

GRAPHIC
PLACE
HOLDER

0000300422

Figure 703 Variable Engine Fan Result Recording

5. Engine Fan speed should be within 250 rpm of Engine Fan Speed Desired. Engine Fan Speed Desired signal is not available on single speed fans.

Expected Outcome

Proper operation of Engine Fan will be verified.

Follow-On Procedure

None

Cylinder Cutout Test

Overview

The KOER Cylinder Cutout Test is used to help diagnose rough idle or misfire symptoms.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- J1939 Compliant Interface Cable

Equipment Conditions

- Engine Coolant Temperature 1 (above 160 degrees F)
- Engine Speed (below 700 RPM)
- Vehicle Not Moving
- Accelerator Pedal Position (0%)
- Brake Pedal (Release)
- Clutch Pedal (Release)

Test Setup

1. Key-ON, Engine-OFF.
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
3. Start ServiceMaxx™ Software.
4. Start engine and warm engine coolant temperature above 100 degrees F.

Test Procedure

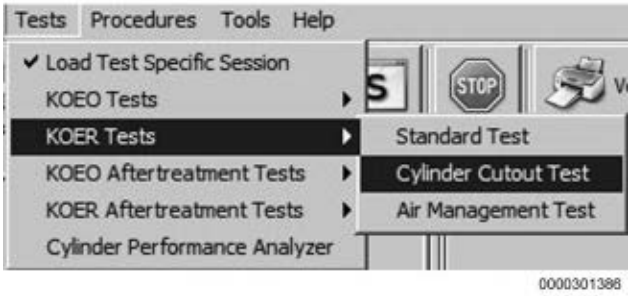

Figure 704 Menu – Select Test

1. Select Tests > KOER Tests > Cylinder Cutout Test (Figure 704).

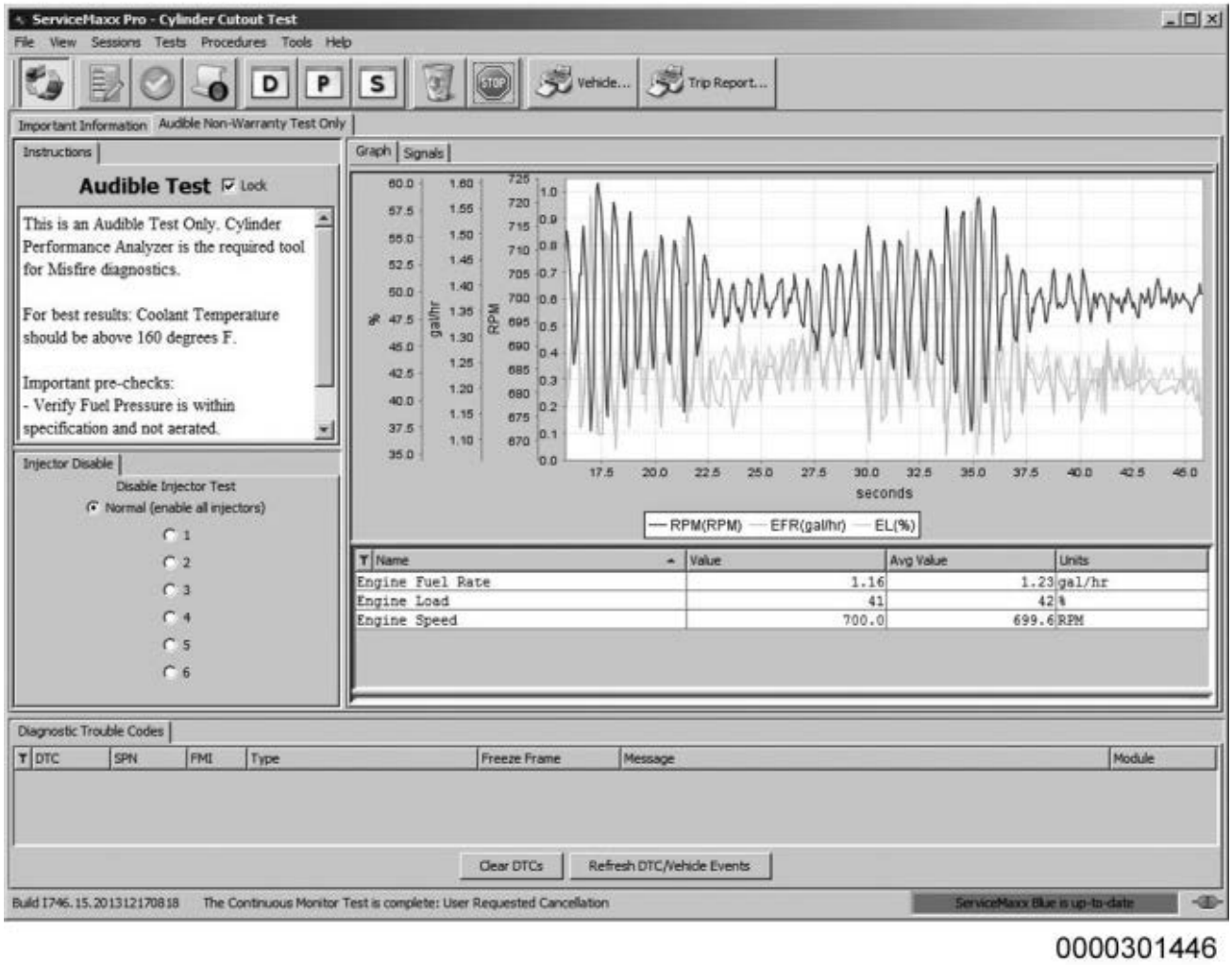

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Figure 705 Cylinder Cutout Test Home Screen

2. The Cylinder Cutout Test (Figure 705) Session will load.

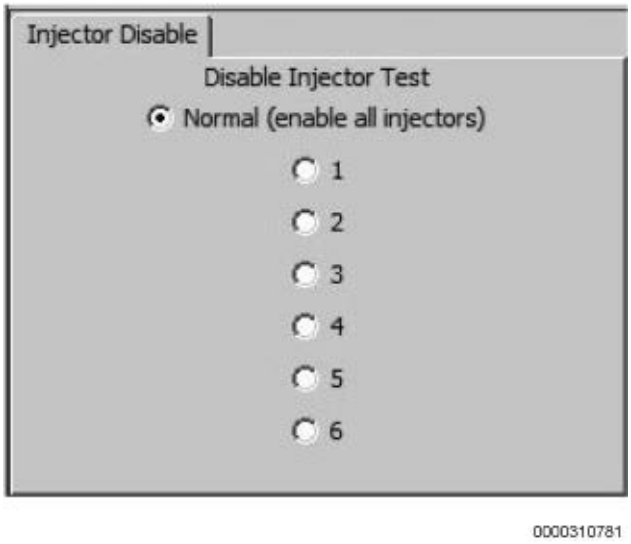

Figure 706 Test Control Panel

3. Click on desired injector (Figure 706) to disable fueling to that cylinder.
4. This test is an audible test only, no results are displayed at end of test.

Expected Outcome

Test will complete successfully.

Follow-On Procedure

None

Multiple Cylinder Cutout Test

Overview

The KOER Multiple Cylinder Cutout test is use to help diagnose rough idle or misfire symptoms. The test will monitor engine load while disabling 3 cylinders at a time in a pre-determined sequence. Engine Load averages are collected from each combination and used to calculating test results.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- J1939 Compliant Interface Cable

Equipment Conditions

- Engine Coolant Temperature 1 (above 160 degrees F)
- Engine Speed (below 700 RPM)
- Vehicle Not Moving
- Accelerator Pedal Position (0%)
- Brake Pedal (Release)
- Clutch Pedal (Release)

Test Setup

1. Key-ON, Engine-OFF.
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
3. Start ServiceMaxx™ Software.
4. Start engine and warm engine coolant temperature above 100 degrees F.

Test Procedure

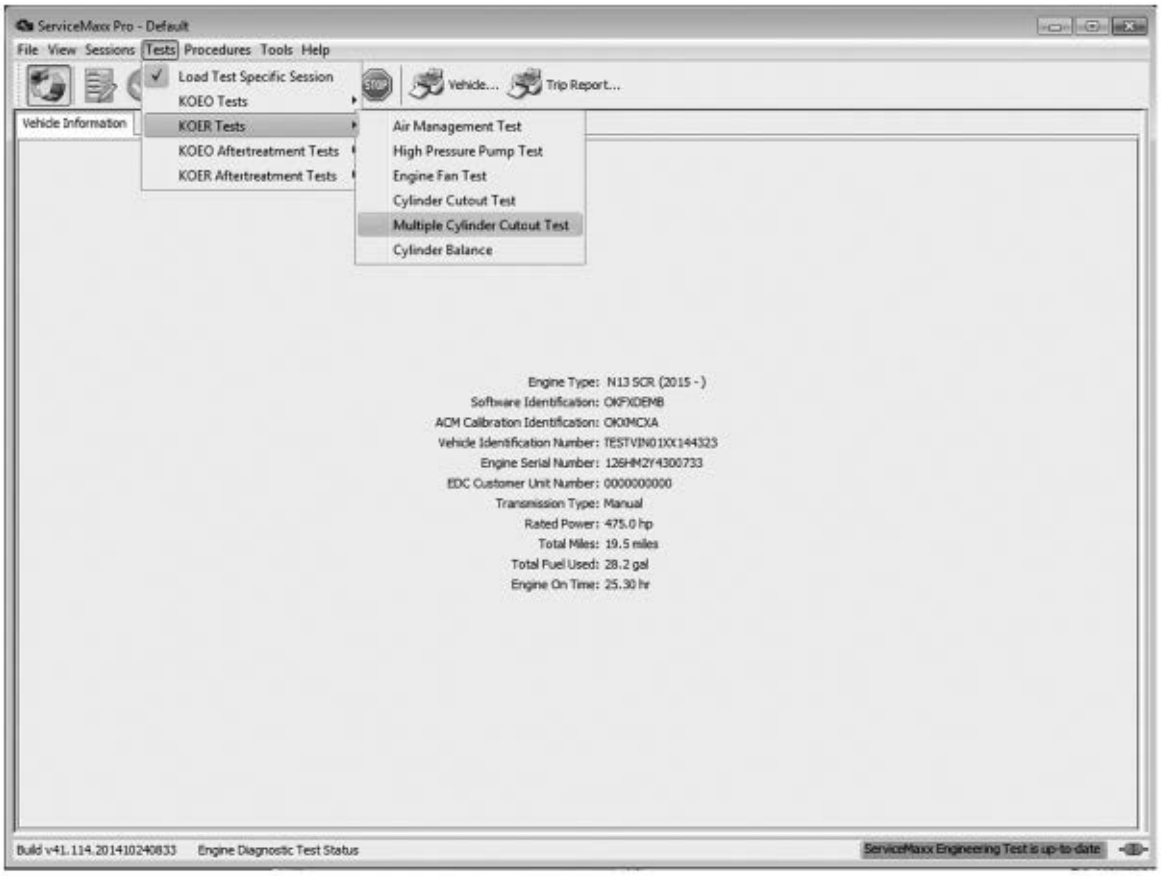

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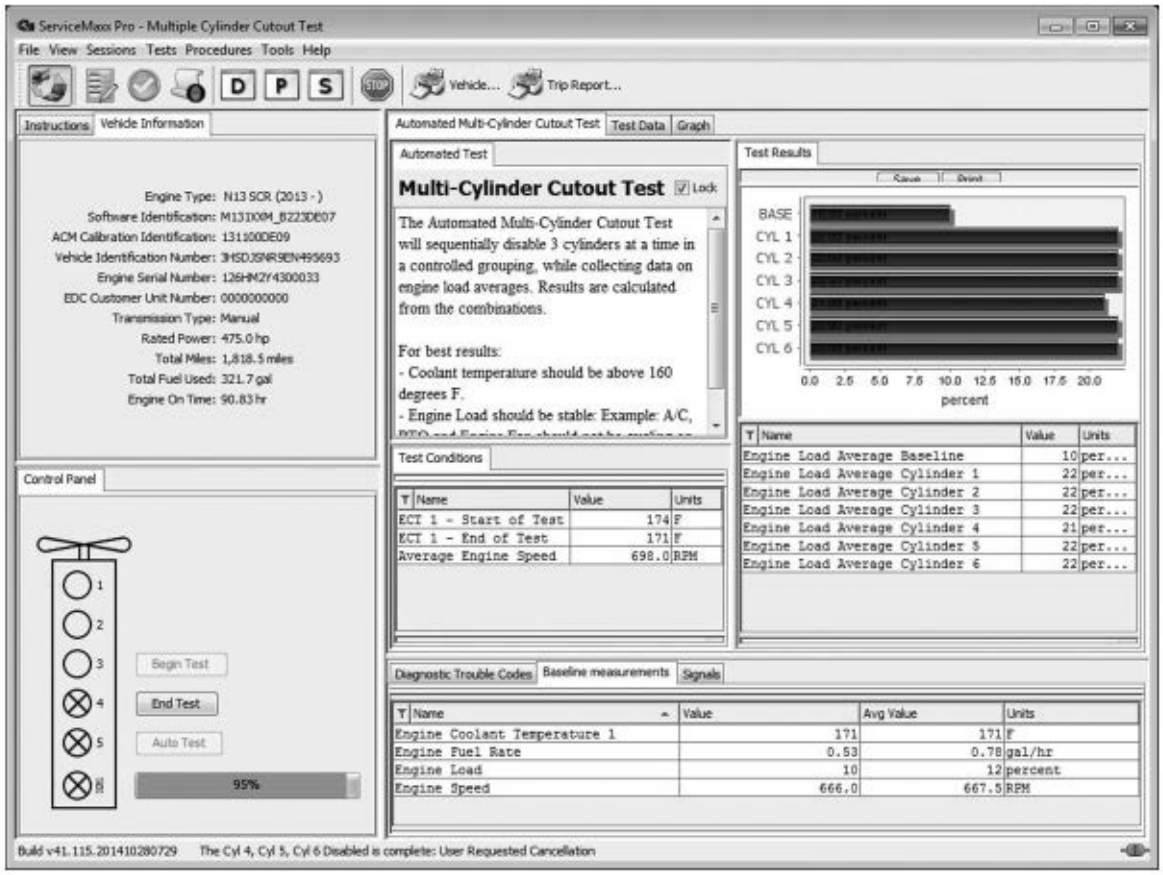
Figure 707 Menu – Select Test

1. Select Tests > KOER Tests > Multiple Cylinder Cutout Test (Figure 704).



0000341641

Figure 708 Multiple Cylinder Cutout Test Home Screen

2. The Multiple Cylinder Cutout Test (Figure 708) Session will load.

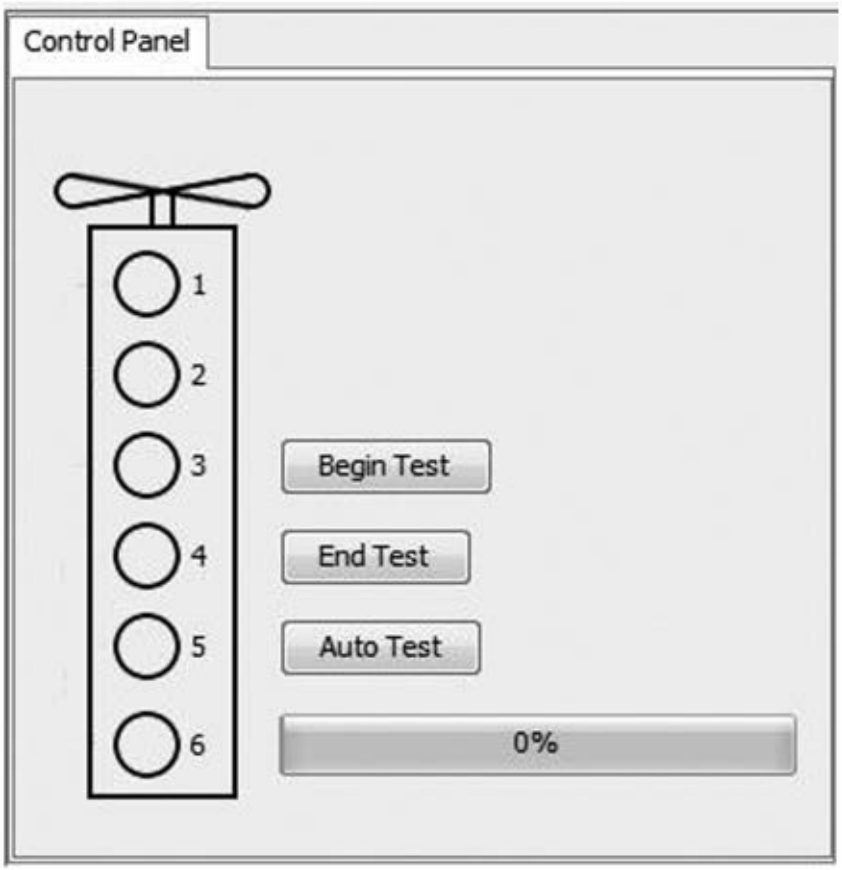


Figure 709 Control Panel

3. This test has the following 2 options:
   - Option 1 – Manual cylinder cutout test. User can select an injector (s) by clicking an X in the cylinder location. Press Begin Test button will disable selected injector (s). To end test, press End Test button. This is an audible test only, does not display test results.
   - Option 2 – Automated Multiple Cylinder Cutout Test (MCCT). Click on Auto Test button to begin the automated test. This test will run for about 8 minutes before displaying Test results.
4. Click on Auto Test button for Automated MCCT. Test will begin an 8 minute sequence disabling cylinder combination while collecting data.
5. Test is complete when the results are displayed.

Expected Outcome

Test will complete successfully.

Follow-On Procedure

None

Cylinder Balance

Overview

This test will be used to measure cylinder balance/imbalance as part of a greater diagnostic picture

CONTENT
UNDER
DEVELOPMENT

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Aftertreatment Fuel Dosing Test

Overview

Validates performance of the Aftertreatment (AFT) fuel dosing system by measuring how much fuel comes out of the Aftertreatment Fuel Injector (AFTFI) in approximately 2 minutes 30 seconds while the AFI and Aftertreatment Fuel Shutoff Valve (AFTFSV) are commanded Open. The AFT Fuel Dosing Test has three different modes:

- AFT Dosing System Test
- AFT Fuel Injector Leak Test
- AFT Fuel Shutoff Valve Leak Test

Tools Required

- Coolant Management Tool KL5007NAV
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Aftertreatment Injector Test Kit 12-559-01
- Graduated Cylinder
- Air and Fuel Cap and Plug Kit ZTSE4891

Test Setup

WARNING: To prevent personal injury or death, allow engine to cool before removing components.

WARNING: To prevent personal injury or death, do the following when removing the radiator cap or deaeration cap:

- Allow engine to cool for 15 minutes or more.
- Wrap a thick cloth around radiator cap or deaeration cap.
- Loosen cap slowly a quarter to half turn counterclockwise to vent pressure.
- Pause for a moment to avoid being scalded by steam.
- Continue to turn the cap counterclockwise to remove.

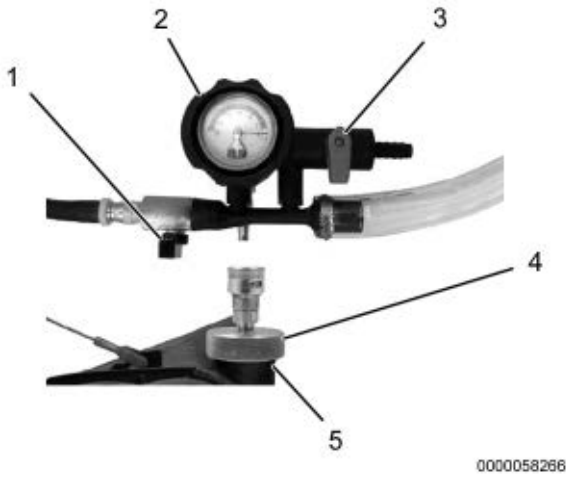


Figure 711 Coolant Management Tool Connections

1. Air valve (closed)
2. Vacuum Module
3. BLUE vent valve
4. Cap Adapter
5. Deaeration tank

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

1. Remove deaeration tank cap and install Cap Adapter KL5004NAV (Figure 711) (Item 4) onto the deaeration tank (Figure 711) (Item 5).
2. Connect Vacuum Module KL5005NAV (Figure 711) (Item 2) to Cap Adapter.
3. Verify both valves on the Vacuum Module are in the closed position, and attach clean dry shop air.

Figure 712 Air Valve (Open)

1. Air valve (open)

Test Procedure

1. Open air valve (Figure 712) (Item 1) on Vacuum Module, and allow 5 to 10 in. Hg to be drawn on the cooling system.

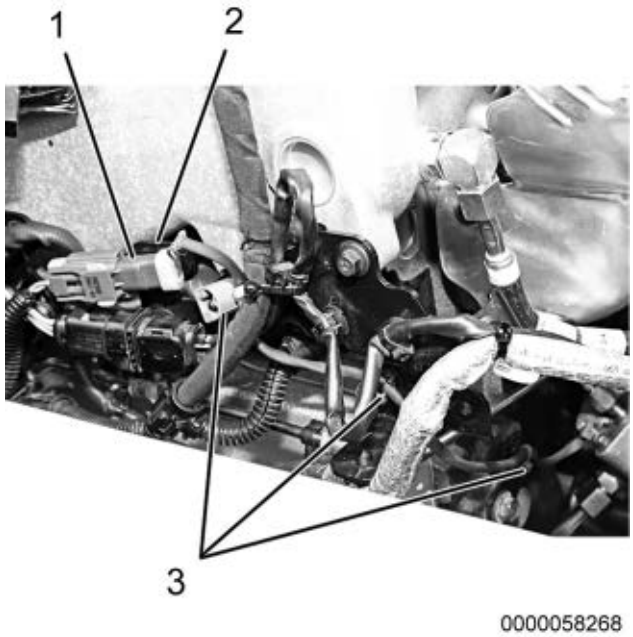


Figure 713 AFTFI Harness and Connections

1. Aftertreatment Fuel Injector (AFI) connector
2. AFI connector mounting bracket
3. AFI harness fasteners (3)

2. Press release tab to disconnect wiring harness lead from AFTFI connector (Figure 713) (Item 1).
3. Disconnect AFTFI connector from AFTFI connector mounting bracket (Figure 713) (Item 2).
4. Disconnect three AFTFI harness fasteners (Figure 713) (Item 3).

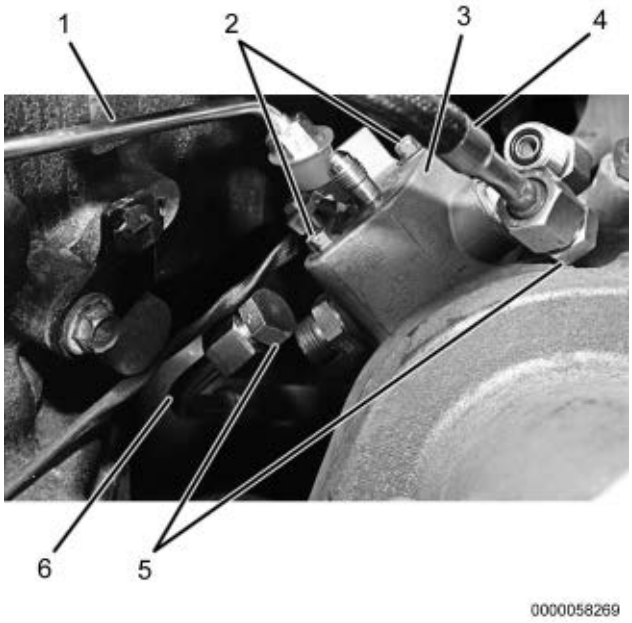


Figure 714 AFTFI Connections (Disconnected)

1. Fuel supply line
2. AFI M6 mounting bolts (2)
3. Aftertreatment Fuel Injector (AFI)
4. Coolant supply line
5. AFI Coolant Line Plugs (2)
6. Coolant return line

5. Disconnect AFTFI fuel supply line (Figure 714) (Item 1) from AFTFI, and use Air and Fuel Cap and Plug Kit ZTSE4891 to cap line. Discard O-rings.
6. Disconnect AFTFI coolant supply line (Figure 714) (Item 4) and coolant return line (Figure 714) (Item 6) at the AFTFI. Discard O-rings.
7. Install two AFTFI Coolant Line Plugs (Figure 714) (Item 5) onto coolant supply and return line.
8. Open the BLUE vent valve (Figure 675) (Item 3) on the Vacuum Module to release vacuum on the cooling system.
9. Remove two AFTFI M6 mounting bolts (Figure 714) (Item 2).
10. Remove AFTFI as an assembly from turbocharger exhaust outlet pipe. Discard metal gasket and fibrous insulator.

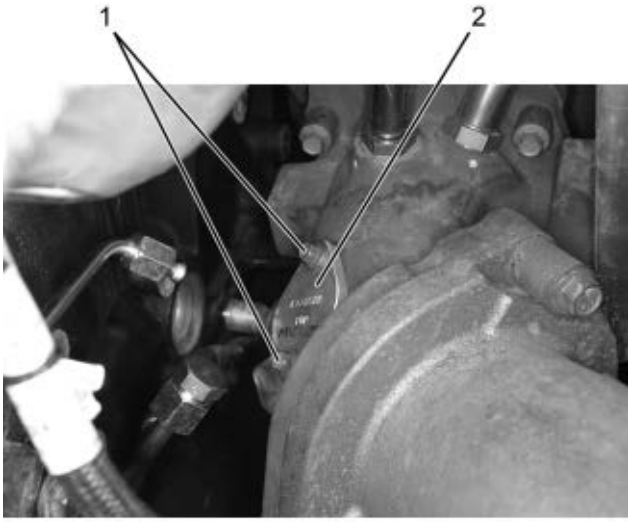


Figure 715 AFTFI Block Off Plate and Bolts

1. AFTFI Block Off Plate Bolt (2)
2. AFTFI Block Off Plate

11. Install AFTFI Block Off Plate 12-559-01-05 (Figure 715) (Item 2) onto turbocharger exhaust outlet pipe using two AFTFI Block Off Plate Bolts 12-55-01-04 (Figure 715) (Item 1).

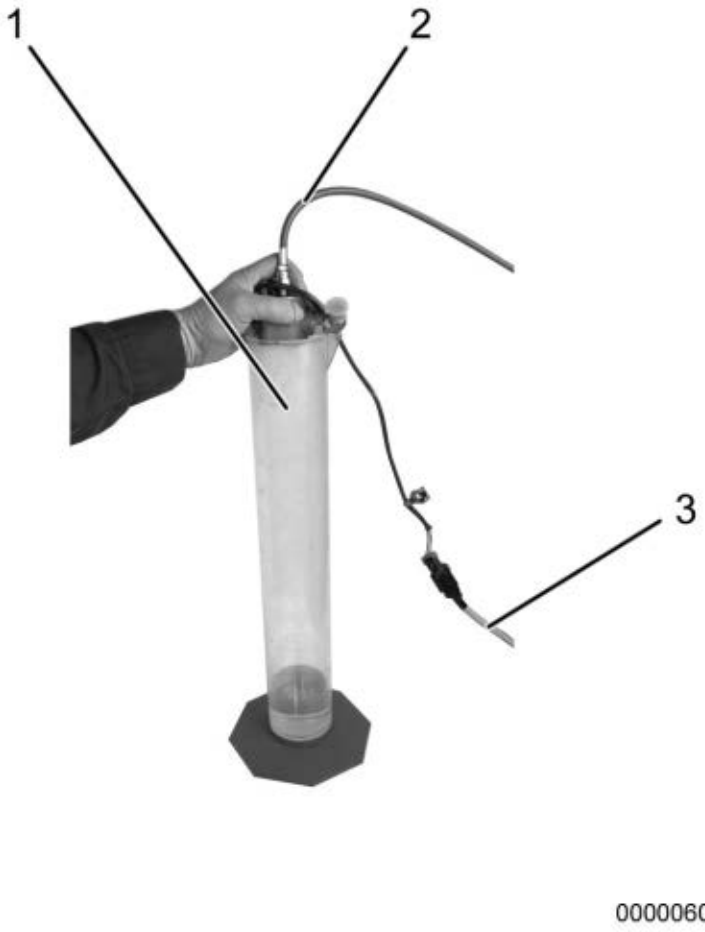


Figure 716 AFTFI In Graduated Cylinder

1. Graduated cylinder
2. AFTFI Fuel Supply Extension Line 12-559-01
3. AFTFI Harness Extension 12-559-01-06

12. Connect AFTFI Fuel Supply Extension Line 12-559-01 (Figure 716) (Item 2) between AFTFI fuel supply line and AFTFI.
13. Connect AFTFI Harness Extension 12-559-01-06 (Figure 716) (Item 3) between vehicle harness and AFTFI connector.
14. Place AFTFI into a clear graduated cylinder (Figure 716) (Item 1), large enough to contain the AFTFI, and marked in milliliters.
15. Cover the AFTFI and graduated cylinder so fuel spray is contained.

Expected Outcome

Technician has setup truck to perform AFT Dosing System Test, AFT Fuel Injector Leak Test, and AFT Fuel Shutoff Valve Leak Test.

Follow-On Procedure

None

Aftertreatment Dosing System

Overview

Determines the amount of fuel dispensed from the Aftertreatment Fuel Injector (AFTFI). The test will open the AFTFI and Aftertreatment Fuel Shutoff Valve (AFTFSV), and inject 225 to 500 ml of fuel within 2 minutes 30 seconds.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Do Aftertreatment Fuel Dosing Test Preparatory steps (page 1641).
2. Start the engine and allow it to reach operating temperature.
3. Connect Electronic Service Tool with ServiceMaxx™ software to Vehicle Diagnostic Connector.
4. Start ServiceMaxx™ software.
5. Go to > KOER Aftertreatment Tests > AFT Fuel Dosing Test.

Test Procedure

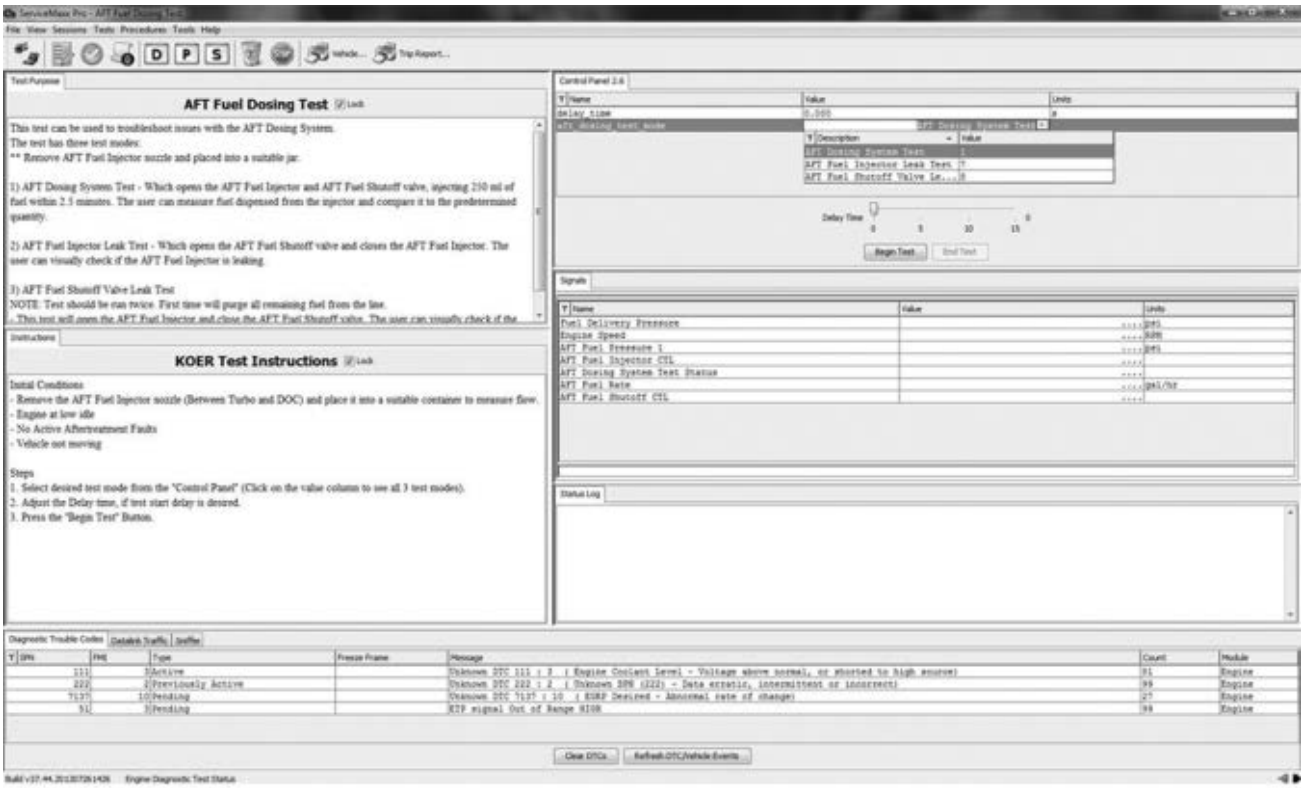


Figure 717 AFT Dosing System Test

1. Under Value heading, select AFT Dosing System Test.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

2. Set the desired Delay Time and select Begin Test.
3. Do steps 3 thru 5 three times, and average the test results. Average amount of fuel collected per test should be between 225 and 500 ml. If fuel collected is within specification, clean and install AFTFI. If fuel collected is not within specification, clean AFTFI and perform AFT Dosing System Test a second time. If average amount of fuel collected is still below specifications, replace AFTFI.

Expected Outcome

Tech will verify amount of fuel dispensed from Aftertreatment Fuel Injector (AFTFI).

Follow-On Procedure

None

Aftertreatment Fuel Shutoff Valve Leak

Overview

Helps determine if the Aftertreatment Fuel Shutoff Valve (AFTFSV) is leaking. This test should be run twice consecutively. The first time to purge all remaining fuel from the Aftertreatment Fuel Injector (AFTFI) supply line. This test will open the AFTFI and close the AFTFSV.

Tools Required.

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Test Setup

1. Do Aftertreatment Fuel Dosing Test Preparatory steps (page 1641).
2. Start the engine and allow it to reach operating temperature.
3. Connect Electronic Service Tool with ServiceMaxx™ software to Vehicle Diagnostic Connector.
4. Start ServiceMaxx™ software.
5. Go to Test > KOER Aftertreatment Tests > AFT Fuel Dosing Test.

Test Procedure

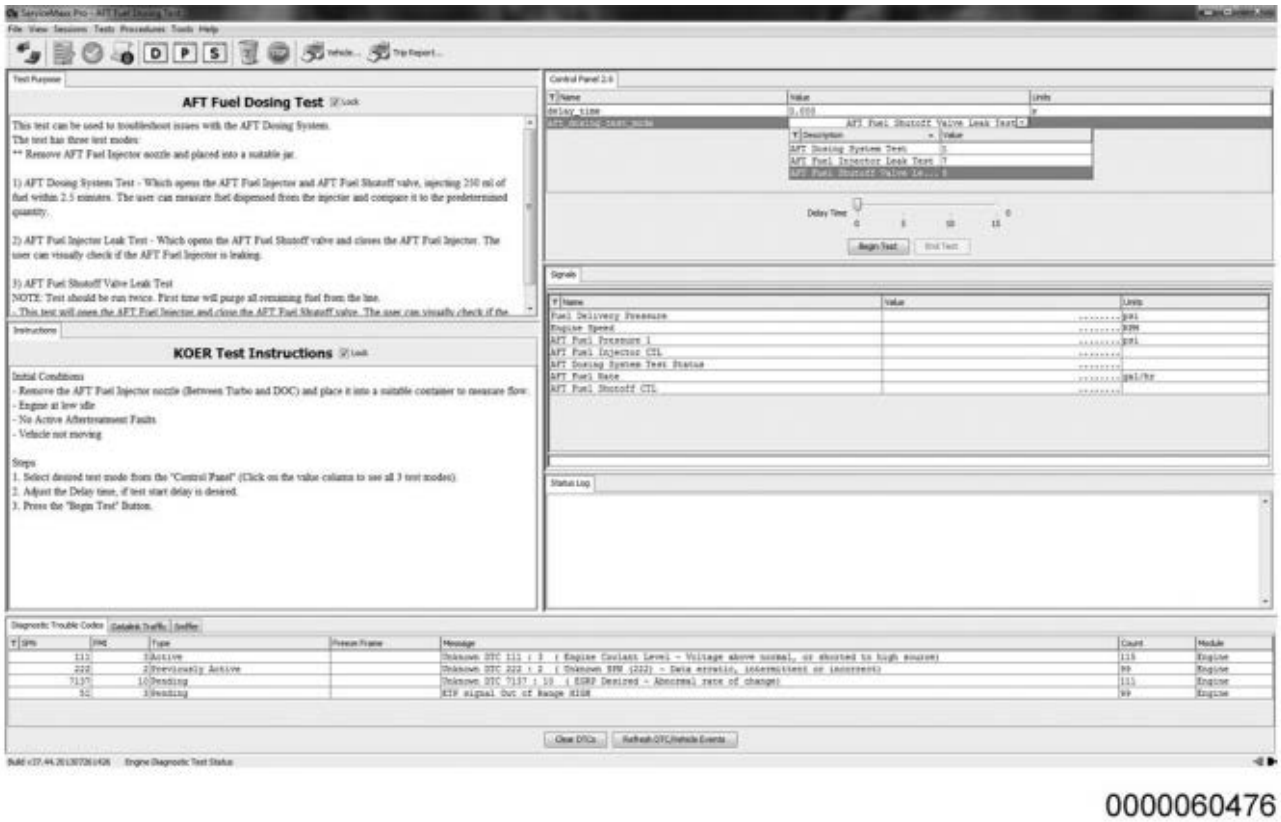


Figure 718 AFT Fuel Shutoff Valve Leak Test

1. Under Value heading, select AFT Fuel Shutoff Valve Leak Test (Figure 718).

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

2. Set the desired Delay Time and select Begin Test.
3. After test is completed, record results. If more than 5 ml of fuel is collected, replace the AFTFSV.

Expected Outcome

Technician will find out if Aftertreatment Fuel Shutoff Valve is leaking.

Follow-On Procedure

None

Aftertreatment Fuel Injector Leak

Overview

Helps to determine if the Aftertreatment Fuel Injector (AFTFI) is leaking. This test will open the Aftertreatment Fuel Shutoff Valve (AFTFSV), and close the AFTFI.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Do Aftertreatment Fuel Dosing Test Preparatory steps (page 1641).
2. Start the engine and allow it to reach operating temperature.
3. Connect Electronic Service Tool with ServiceMaxx™ software to Vehicle Diagnostic Connector.
4. Start ServiceMaxx™ software.

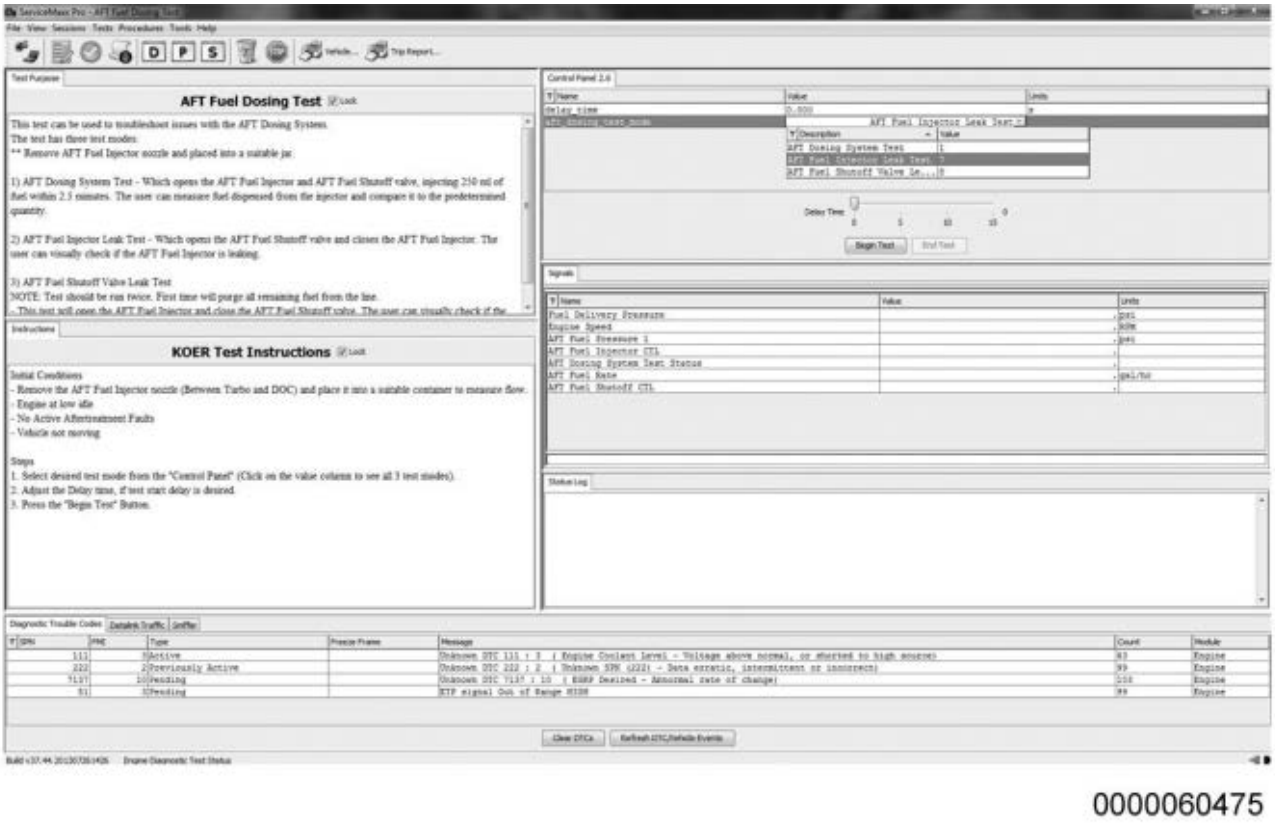


Figure 719 AFT Fuel Injector Leak Test

5. Go to Test > KOER Aftertreatment Tests > AFT Fuel Dosing Test (Figure 719).

Test Procedure

1. Under Value heading, select AFT Fuel Injector Leak Test.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

2. Set the desired Delay Time and select Begin Test.
3. After test is completed, record results. If more than 5 ml of fuel is collected, replace AFTFI.

Expected Outcome

Technician will determine if Aftertreatment Fuel Injector is leaking.

Follow-On Procedure

1. Remove Aftertreatment Fuel Injector (AFTFI) from graduated cylinder and dispose of collected fuel properly.
2. Disconnect AFTFI Harness Extension 12-559-01-06 from AFTFI.
3. Disconnect AFTFI Fuel Supply Extension Line 12-559-01 to AFTFI.
4. Remove AFTFI Block Off Plate 12-559-01-05 from turbocharger exhaust outlet pipe by removing two AFTFI Block Off Plate Bolts 12-559-01-04.
5. Install new fibrous insulator and metal gasket onto AFTFI.
6. Install AFTFI and two AFTFI M6 mounting bolts onto turbocharger exhaust outlet pipe. Tighten two AFTFI M6 mounting bolts to 80 lb·in (9 N·m).
7. With Vacuum Module KL5005NAV installed, open air valve on vacuum module, and allow 20 to 25 in. Hg to be drawn on the cooling system.
8. Remove AFTFI Coolant Line Plugs from coolant supply and return line.
9. Install new O-rings, and connect AFTFI coolant supply and return line at the AFTFI.
10. Install new O-rings, connect AFTFI fuel supply line to AFTFI.
11. Connect three AFTFI harness fasteners.
12. Connect AFTFI connector to AFTFI connector mounting bracket.
13. Connect wiring harness lead to Aftertreatment Fuel Injector (AFTFI) connector.

Low Idle to High Idle Test

Overview

Validate engine performance throughout rpm range.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-ON, Engine-OFF.
2. Connect Electronic Service Tool (EST) to vehicle's Diagnostic Connector (page 1571).
3. Start ServiceMaxx™ software.

Test Procedure

1. Select Performance session.
2. Monitor Accel Pedal Position 1 (APP1) signal and depress accelerator pedal to floor. Record results on Diagnostics Form.
   - If APP1 signal does not go from 0% to 99.6%, see APP Sensor (page 252) in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS.”
   - If APP1 signal does go from 0% to 99.6%, continue to next step.

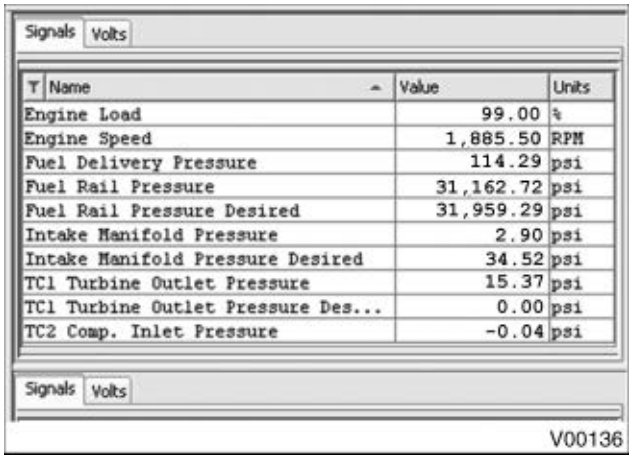


Figure 720 Performance session signals

3. Monitor the following signals:

NOTE: ServiceMaxx™ software displays Fuel Delivery Pressure (FDP) signal 15 psi below actual gauge pressure. When monitoring FDP with ServiceMaxx™ software, the specification listed below is correct.

- Fuel Delivery Pressure (FDP)
- Fuel Rail Pressure (FRP)
- Fuel Rail Pressure Desired (FRPD)
- Engine Speed
- Intake Manifold Pressure (IMP)
- TC1 Turbine Outlet Pressure (TC1TOP)

4. Press the record button and start engine.
5. Allow engine to idle for 5 seconds. Depress accelerator pedal to floor and hold for 20 seconds, then return to low idle.
6. Review results with accelerator pedal at 99.6% and record on Diagnostics Form.
    - If FDP is below specification, go to Fuel Delivery Pressure Test in the Low-pressure Fuel System section.
    - If FDP is above specification, go to High-pressure Pump Inlet Pressure Test .
    - If engine does not accelerate smoothly, or feels unbalanced, (not running on all cylinders), perform Cylinder Performance Test and Fuel Pressure Control Valve (FPCV) Test .
    - If TC1TOP is above specification, verify Exhaust Back Pressure Valve (EBPV) is not the cause of the performance loss. See Exhaust Back Pressure Valve (EBPV) . If EBPV is operating correctly, inspect Diesel Oxidation Catalyst (DOC) for face plugging.
    - If IMP is below specifications, visually inspect for:
        - Charge Air Cooler (CAC) and tubing leaks
        - Intake restriction
        - Turbocharger damage
    - Remove and inspect IMP sensor for soot build up. clean sensor, reinstall, and continue.

Expected Outcome

Technician will validate performance of engine throughout RPM range.

Follow-on Procedure

None.

Road Tests

Lug Down Test

Overview

This procedure alone is not a diagnostic tool, but allows the technician to recreate a problem and record signals for later analysis while operating the vehicle.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

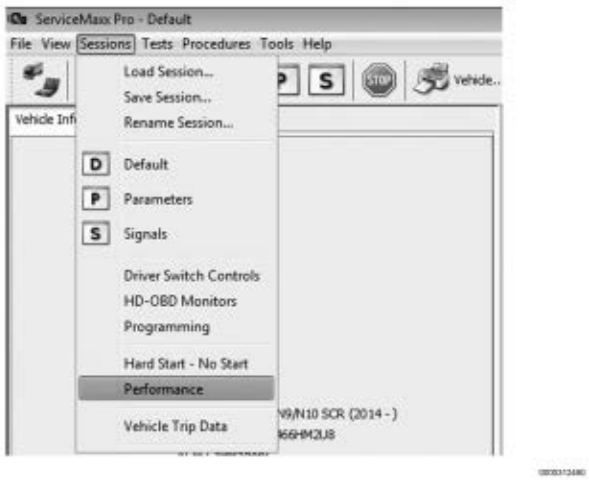
Equipment Condition

None

WARNING: To prevent personal injury or death, do not exceed local speed limit laws or drive too fast for conditions when performing Lug Down Test.

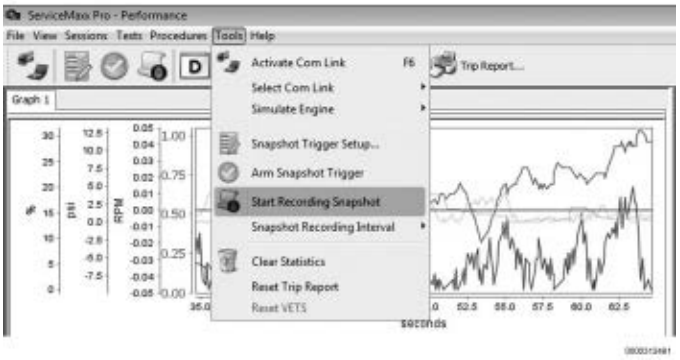
Test Setup

1. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
2. Log in to ServiceMaxx™

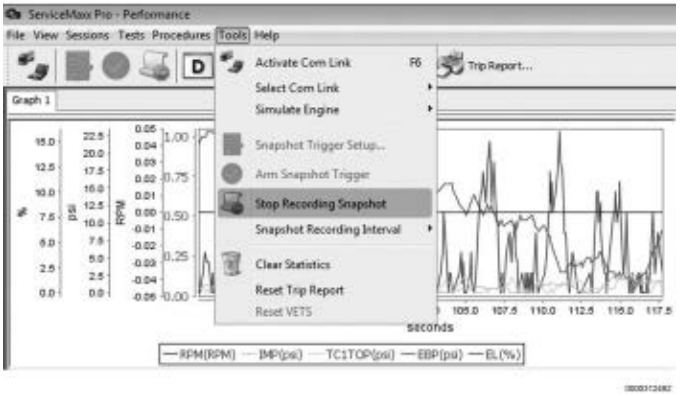


3. Select Sessions > Performance (Figure 721) to load session
4. Find a suitable location to perform Lug Down Test and pull over to the side of the road
5. Ensure engine temperature is above 158° F (70° C)

Test Procedure



1. When it safe to do so, select Tools > Start Recording Snapshot (Figure 722) and drive vehicle up to road speed
2. Select a suitable high range gear (Example: In a 10 Speed gearbox, select 8th gear)
3. Allow engine speed to drop to 1000 RPM
4. Press accelerator fully to the floor and accelerate to rated engine speed
5. Try to reproduce fault while recording



6. After Lug Down Test is complete select Tools > Stop Recording Snapshot (Figure 723)

Expected Outcome

Signals values will be recorded for diagnostic analysis.

Follow-On Procedure

Use recorded signals to analyze graphs and make diagnosis.

Lug Down Test (RPM, FRP, and FRP Desired) Graph

Overview

This graph is to be used as an example only, no two graphs will ever be alike. Use information recorded and this graph to diagnose faults. Only analyze Lug Down Test Signals during engine acceleration.

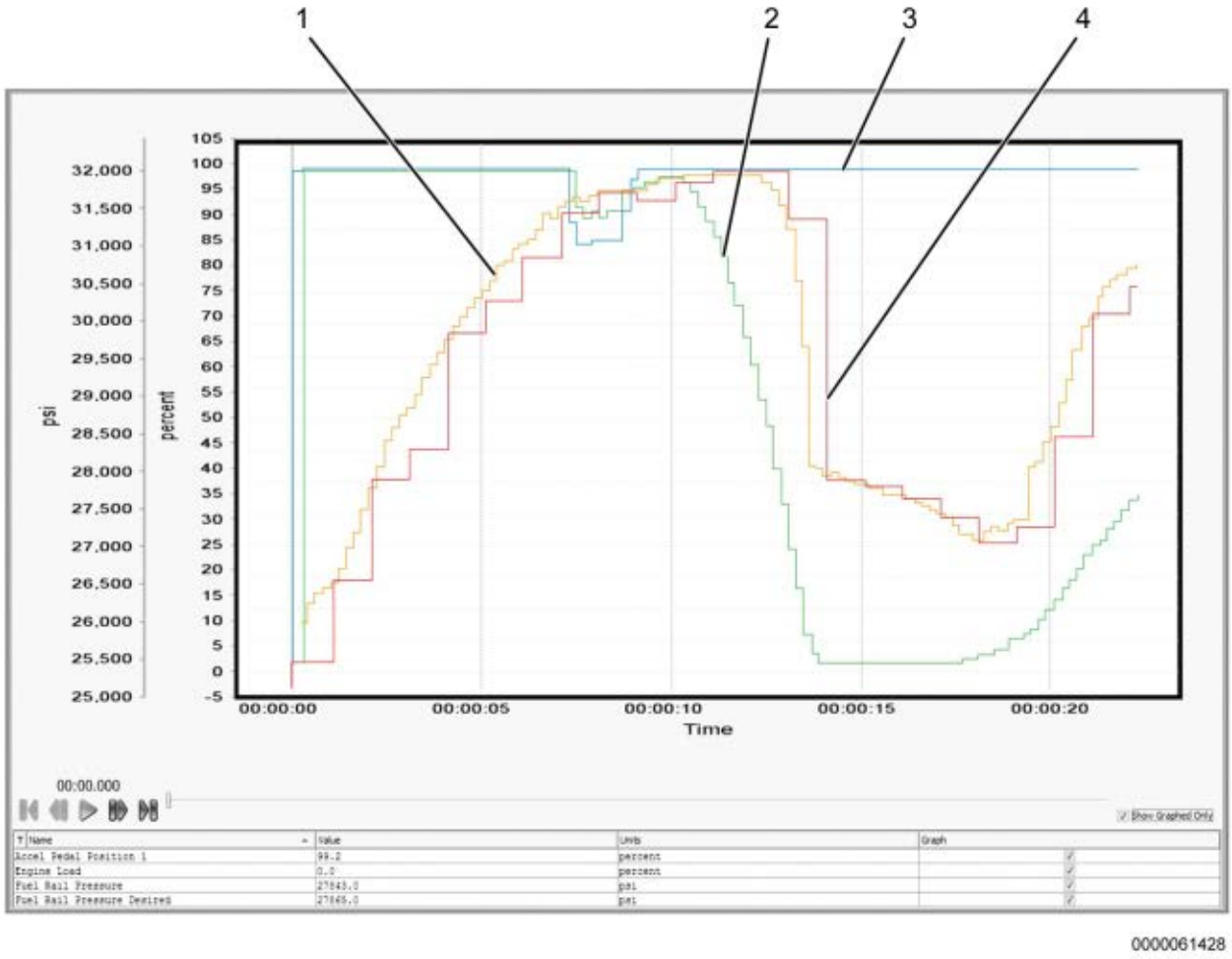


Figure 724 Lug Down Test (Engine Speed, FRP, and FRPD)

1. Fuel Rail Pressure Desired (FRPD) (psi) [Orange]
2. Engine load (percent) [Green]
3. Accelerator Pedal Position 1 (APP1) (percent) [Blue]
4. Fuel Rail Pressure (FRP) (psi) [Red]

Graph Analysis:

This graph shows a fuel management system operating as designed. This test does not give pass or fail results. It only allows the user to validate Fuel Rail Pressure (FRP) and Fuel Rail Pressure Desired (FRPD) signal values

under load. As engine rpm increases, Fuel Rail Pressure (FRP) should steadily increase. Low FRP will cause low Intake Manifold Pressure (IMP). Diagnose low FRP concerns before diagnosing low IMP concerns

Actions:

1. Verify FRP signal value reaches 31,900 psi (219,943 kPa) at full load.
2. Verify FRP signal value is within a 1000 psi (6,895 kPa) range of FRPD signal value during acceleration.

Lug Down Test (RPM, APP1, Vehicle Speed, and IMP) Graph

Overview

This graph is to be used as an example only, no two graphs will ever be alike. Use information recorded and this graph to diagnose faults. Only analyze Lug Down Test Signals during engine acceleration.

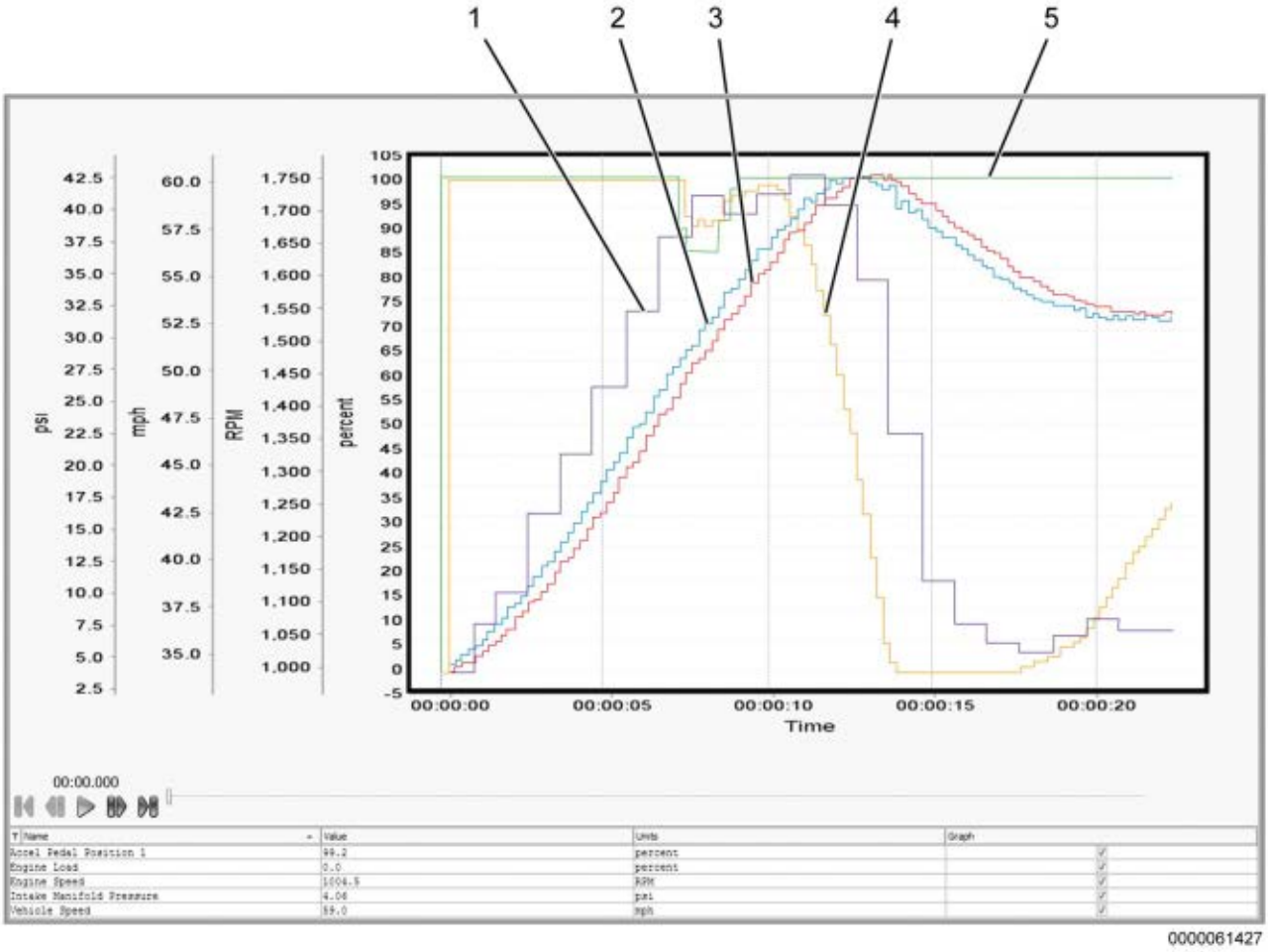


Figure 725 Lug Down Test (Engine Speed, APP1, Vehicle Speed, and IMP)

1. Intake Manifold Pressure (IMP) (psi) [Purple]
2. Engine speed (rpm) [Blue]
3. Vehicle speed (mph) [Red]
4. Engine load (percent) [Orange]
5. Accelerator Pedal Position 1 (APP1) (percent) [Green]

Graph Analysis:

This graph shows the Intake Manifold Pressure (IMP) signal value responding as designed. This test does not give pass or fail results. It only allows the user to validate IMP signal value under load. Engine power band is typically between 1300 to 1700 rpm with peak power occurring around 1600 rpm. Anything outside of this power band drops boost and power significantly. Accelerator Pedal Position 1 (APP1) signal value must be 99.6% to successfully reach peak boost during this test. Low IMP can be the result of low Fuel Rail Pressure (FRP),

or high Turbocharger 1 Turbine Outlet Pressure (TC1TOP). Diagnose low FRP concerns first, high TC1TOP concerns second, and low IMP concerns third.

Action:

1. Verify IMP signal value is between 40 psi (276 kPa) to 43 psi (296 kPa), with Accelerator Pedal Position 1 (APP1) signal value at 99.6%, and engine speed between 1300 rpm to 1700 rpm.

Lug Down Test (RPM and TC1TOP) Graph

Overview

This graph is to be used as an example only, no two graphs will ever be alike. Use information recorded and this graph to diagnose faults. Only analyze Lug Down Test Signals during engine acceleration.

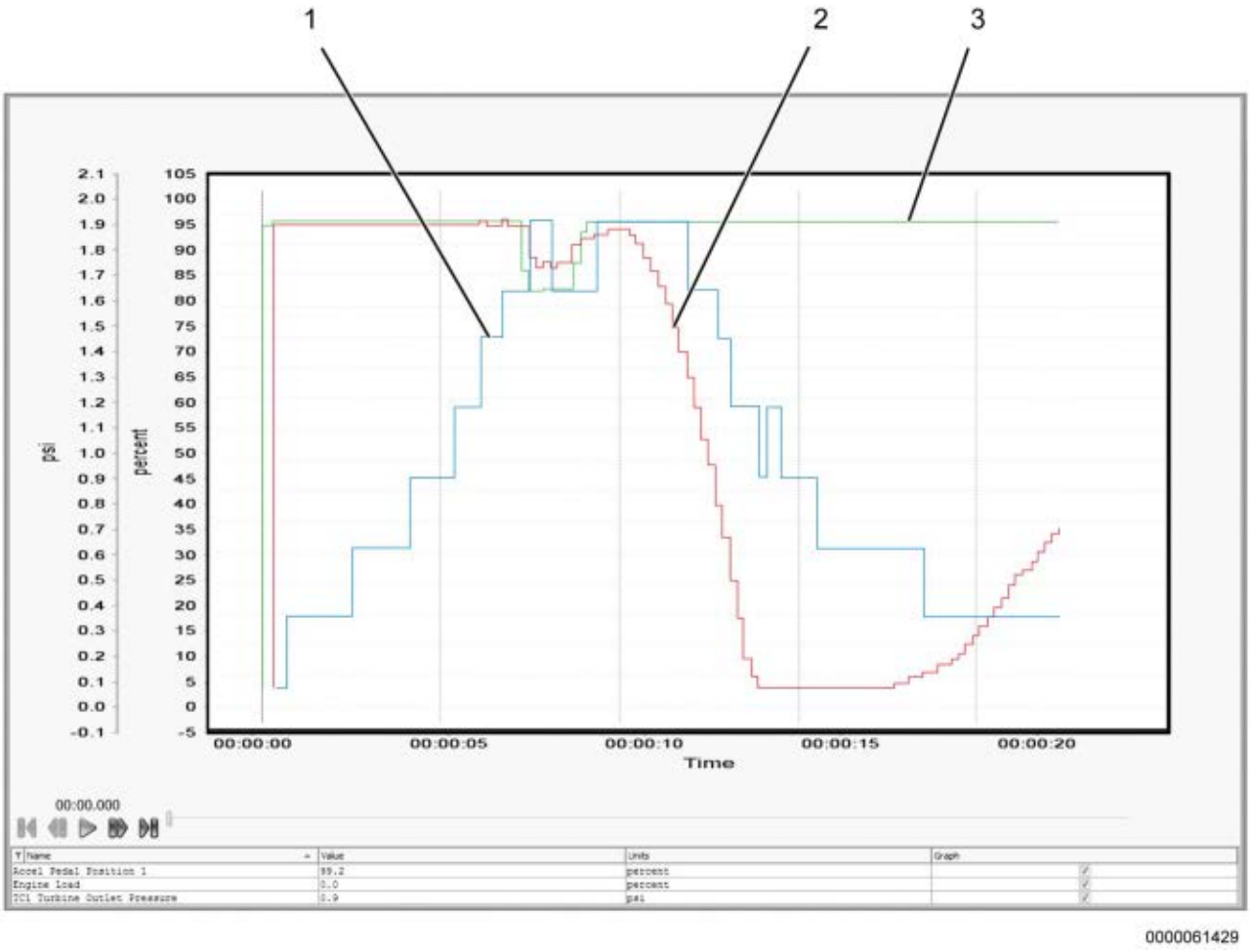


Figure 726 Lug Down Test (Engine Speed and TC1TOP)

1. Turbocharger 1 Turbine Outlet Pressure (TC1TOP) (psi) [Blue]
2. Engine Load (Percent) [Red]
3. Accelerator Pedal Position 1 (APP1) (Percent) [Green]

Graph Analysis:

This graph shows an exhaust aftertreatment system operating as designed (unrestricted). This test does not give pass or fail results. It only allows the user to validate Turbocharger 1 Turbine Outlet Pressure (TC1TOP) signal value under load. High TC1TOP will cause low Intake Manifold Pressure (IMP). Diagnose high TC1TOP concerns before diagnosing low IMP concerns.

Actions:

- Verify TC1TOP signal value is less than 5 psi (34 kPa) during Lug Down Test.

Normal Exhaust Gas Temp Graph

Overview

This graph shows an aftertreatment system operating as designed. This test does not give pass or fail results. It only allows the user to validate operation of the aftertreatment system by monitoring exhaust gas temperatures.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-ON, Engine-Running.
2. Connect Electronic Service Tool (EST) to Vehicle Diagnostic Connector.
3. Start ServiceMaxx™.

Test Procedure

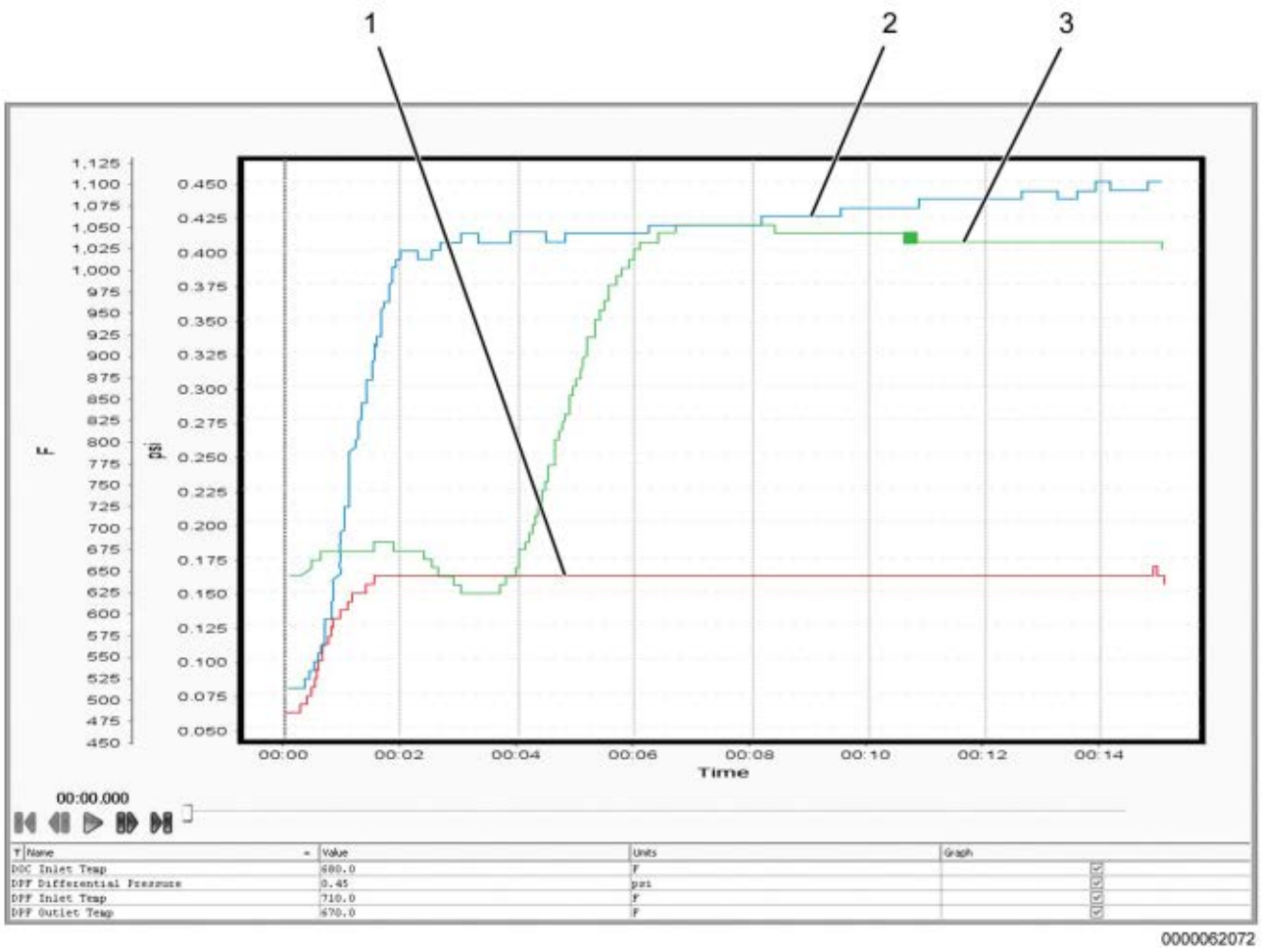


Figure 727 Graph 5: Normal Exhaust Gas Temperatures (Efficient DOC AND Unrestricted AFI) DPF Soot Load Level 5

1. 1. Diesel Oxidation Catalyst Inlet Temperature (DOCIT) (degrees Fahrenheit) [Red]
2. 2. Diesel Particulate Filter Inlet Temperature (DPFIT) (degrees Fahrenheit) [Blue]
3. 3. Diesel Particulate Filter Outlet Temperature (DPFOT) (degrees Fahrenheit) [Green]

1. After Diesel Oxidation Catalyst (DOC) reaches operating temperature and stabilizes, verify Diesel Particulate Filter Inlet Temperature (DPFIT) signal value is at approximate target temperature for current soot load level .
2. Verify Diesel Oxidation Catalyst Inlet Temperature (DOCIT) signal value is between 550°F (287°C) to 800°F (427°C). It is normal to see DOCIT, DPFIT, and DPFOT signal values fluctuate at the beginning and end of the OBFCT.

Expected Outcome

Technician will validate operation of aftertreatment system by monitoring exhaust gas temperatures.

Follow-On Procedure

None

Inverted Exhaust Gas Temp Graph

Overview

This graph shows inverted exhaust gas temperatures indicating an inefficient Diesel Oxidation Catalyst (DOC). Inverted temperatures in the exhaust stream occur when the Diesel Particulate Filter Outlet Temperature (DPFOT) is higher than Diesel Oxidation Catalyst Outlet Temperature (DOCOT) after the DOC has reached operating temperature and stabilized (see callout 3, graph 7). This is caused by unburned fuel reacting with the DPF, instead of the DOC, causing an increase in DPFOT. This test does not give pass or fail results. It only allows the user to validate operation of the aftertreatment system by monitoring exhaust gas temperatures. SPN 4766 FMI 10 (DOC Efficiency) may be active when exhaust gas temperatures are inverted.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-ON, Engine-Running.
2. Connect Electronic Service Tool (EST) to Vehicle Diagnostic Connector.
3. Start ServiceMaxx™.

Test Procedure

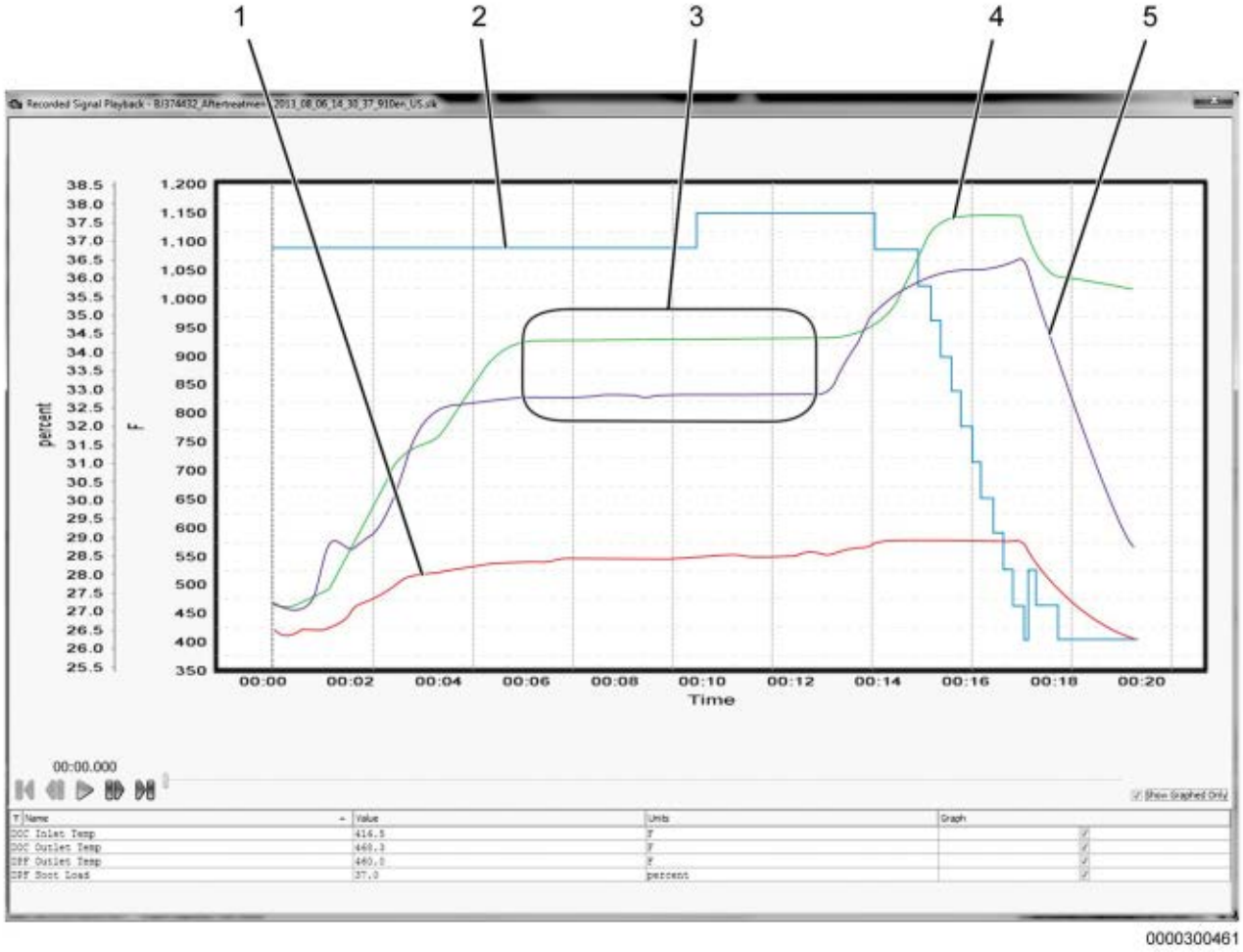


Figure 728 Graph 7: Inverted exhaust Gas Temperatures (Inefficient DOC)

1. 1. Diesel Oxidation Catalyst Inlet Temperature (DOCIT) (degrees Fahrenheit) [Red]
2. 2. Diesel Particulate Filter (DPF) soot load (percent) [Blue]
3. 3. Diesel Oxidation Catalyst (DOC) at operating temperature and stabilized.
4. 4. Diesel Particulate Filter Outlet Temperature (DPFOT) (degrees Fahrenheit) [Green]
5. 5. Diesel Oxidation Catalyst Outlet Temperature (DOCOT) (degrees Fahrenheit) [Purple]

1. After DOC reaches operating temperature and stabilizes (see callout 3, graph 7), verify DPFOT signal value is not 122°F (50°C) higher than DOCOT signal value. In this graph, DPFOT signal value is 122°F (50°C) higher than DOCOT indicating inverted exhaust gas temperatures.
2. Verify Diesel Oxidation Catalyst Inlet Temperature (DOCIT) signal value is between 550°F (287°C) to 800°F (427°C). It is normal to see Diesel Oxidation Catalyst Inlet Temperature DOCIT, DOCOT, and DPFOT signal values to fluctuate at the beginning and end of the OBFCT.

Expected Outcome

Technician will validate operation of aftertreatment system by monitoring exhaust gas temperatures.

Follow-On Procedure

None

Low Exhaust Gas Temp Graph

Overview

This graph shows low exhaust gas temperatures indicating a restricted Aftertreatment Fuel Injector (AFI). Low temperatures in the exhaust stream occur when Diesel Oxidation Catalyst Outlet Temperature (DOCOT) and Diesel Particulate Filter Outlet Temperature (DPFOT) are less than 900°F (482°C) after the DOC has reached operating temperature and stabilized (see callout 2, graph 8). This is caused by restricted fuel flow from the AFI, resulting in less fuel burning in the exhaust stream. This test does not give pass or fail results. It only allows the user to validate operation of the aftertreatment system by monitoring exhaust gas temperatures.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-ON, Engine-Running.
2. Connect Electronic Service Tool (EST) to Vehicle Diagnostic Connector.
3. Start ServiceMaxx™.

Test Procedure

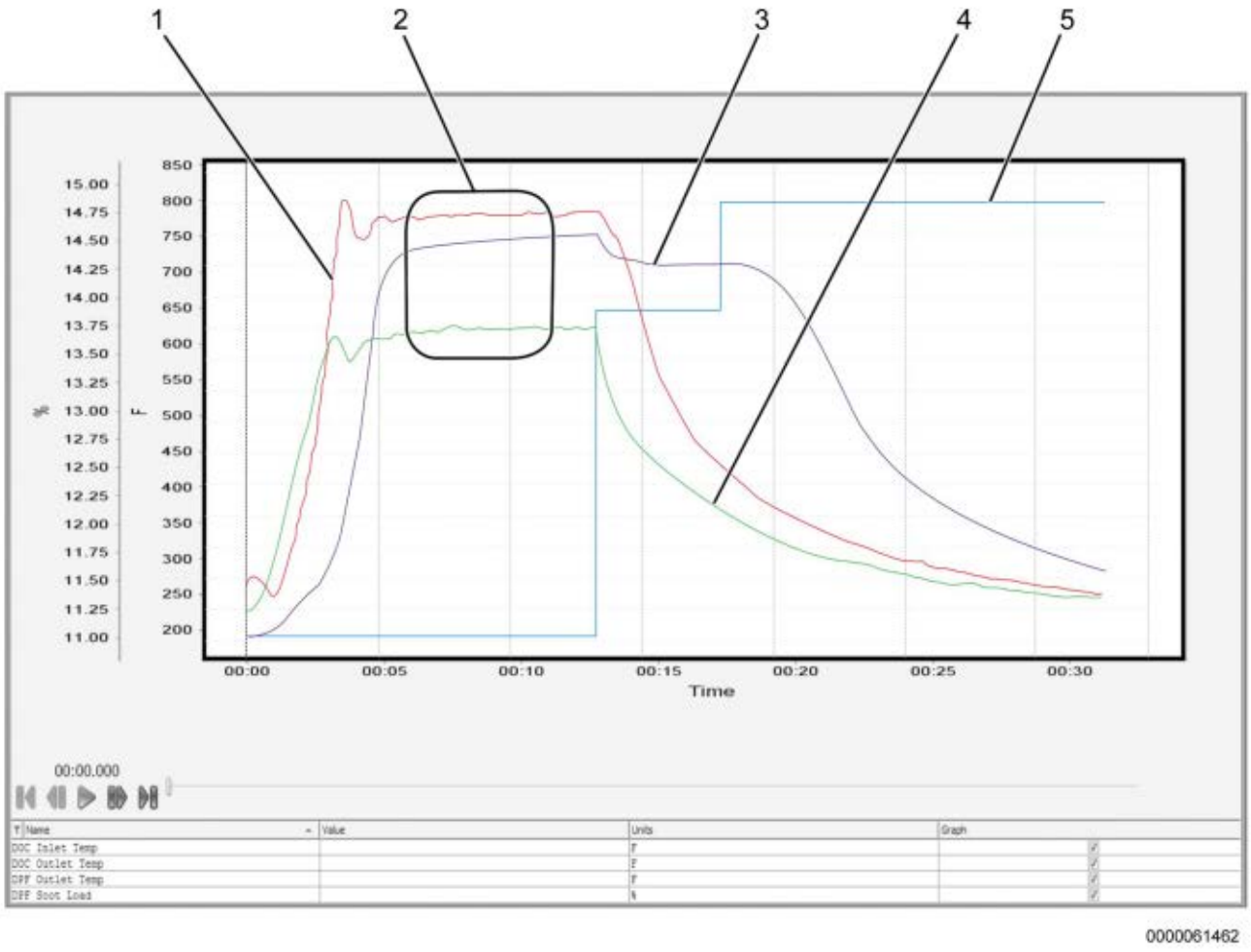


Figure 729 Graph 8: Low Exhaust Gas Temperatures (Restricted AFI)

1. 1. Diesel Oxidation Catalyst Outlet Temperature (DOCOT) (degrees Fahrenheit) [Red]
2. 2. Diesel Oxidation Catalyst (DOC) at operating temperature and stabilized.
3. 3. Diesel Particulate Filter Outlet Temperature (DPFOT) (degrees Fahrenheit) [Purple]
4. 4. Diesel Oxidation Catalyst Inlet Temperature (DOCIT) (degrees Fahrenheit) [Green]
5. 5. Diesel Particulate Filter (DPF) soot load (percent) [Blue]

1. After DOC reaches operating temperature and stabilizes (see callout 2, graph 8), verify DOCOT and DPFOT signal values are greater than 900°F (482°C). In this graph, DOCOT and DPFOT are less than 900°F (482°C).
2. Verify Diesel Oxidation Catalyst Inlet Temperature (DOCIT) signal value is between 550°F (287°C) to 800°F (427°C). It is normal to see Diesel Oxidation Catalyst Inlet Temperature DOCIT, DOCOT, and DPFOT signal values to fluctuate at the beginning and end of the OBFCT.

Expected Outcome

Technician will validate operation of aftertreatment system by monitoring exhaust gas temperatures.

Follow-On Procedure

None

Air Control Valve (ACV) Test

Turbocharger 2 Wastegate (TC2WC) Functional Test

Overview

Verify Turbocharger 2 Wastegate (TC2WC) is working correctly.

Tools Required

- EST with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key-ON, Engine-OFF.
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
3. Start ServiceMaxx™ software.

Test Procedure

1. Select 2010 BB Actuator session. On a cold engine, the TC2 Wastegate Control defaults to open (100.00%) to prevent turbocharger damage.
2. Select TC2 Wastegate Control from Actuator drop-down menu and set to ON (95% Duty Cycle). If TC2 Wastegate CTL displays a value of 100.00% before test is started, duty cycle must be set to Off (5% duty cycle) for actuator rod to move.
3. Test will command actuator ON for 5 seconds, then actuator will return to default position.

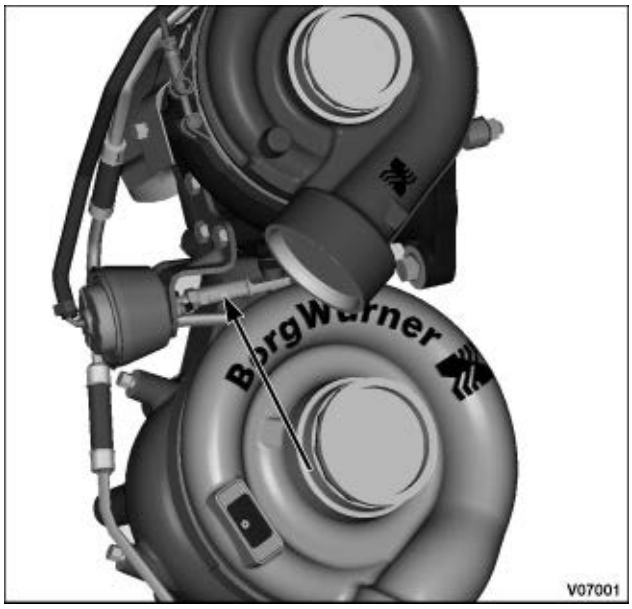


Figure 730 TC2 wastegate valve in closed position

4. Press the Start button and measure actuator rod movement.
   - If actuator rod moves full travel, no action is required.
   - If actuator rod does not move full travel, continue to next step.
5. Remove air supply line from actuator and repeat actuator test.
   - If air cannot be heard leaving the open air supply line when running the test, see TC2WC (page 1447), in “Diagnostic Troubleshooting Procedures.”
   - If air can be heard leaving the open air supply line, continue to next step.
6. Remove actuator rod from valve arm. Check if the valve arm moves freely.
   - If valve arm moves freely, replace wastegate actuator.
   - If valve arm does not move freely, replace high-pressure turbocharger.

Expected Outcome

Technician will verify Turbocharger 2 Wastegate Control is functioning properly.

Follow-On Condition

None

Exhaust Back Pressure Valve- Functional Test

Overview

This test measures the performance of the Exhaust Back Pressure Valve (EBPV). This visual and functional test uses pre-programmed actions of the Engine Control Module (ECM) to cycle the EBPV three times after the key is turned off.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Condition

Remove truck-mounted components as necessary to have a clear view, and to allow access to EBPV.

Test Setup

1. Key-On Engine-Off (KOEO).
2. Ensure air tanks are full.
3. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
4. Start and log in to ServiceMaxx™ software

Test Procedure

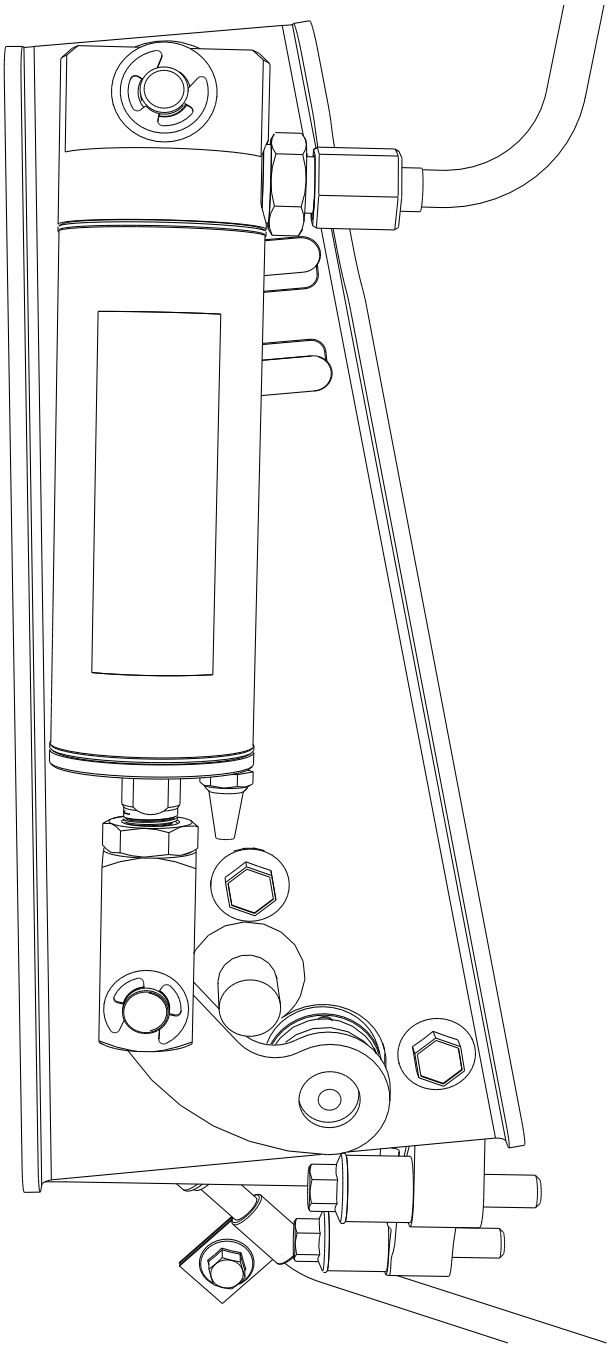


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Figure 731 Exhaust Back Pressure Valve

1. Select Tests > KOEO Tests > Actuator Test.

2. From the drop down menu Select > Exhaust Back Pressure Valve. Set the Duty Cycle to 95% and Select > Start Test.
   - If EBPV cycles fully open and fully closed, it is working.
   - If EBPV does not cycle, go to next step.
3. Disconnect air supply to EBPV.
4. Select Tests > KOEO Tests > Actuator Test.
5. From the drop down menu Select > Exhaust Back Pressure Valve. Set the Duty Cycle to 95% and Select > Start Test.
   - If airflow cannot be heard or felt, go to EBPV control diagnostics.
   - If airflow can be heard or felt go to next step.
6. Check EBPV and linkage for binding and sticking.

Expected Outcome

The EBPV will cycle fully open and closed three times when the key is turned off.

Follow-on Procedure

None

Low-Pressure Fuel System Tests

Fuel System Priming

Overview

Prime the fuel system.

Tools Required

None

Equipment Condition

None

GOVERNMENT REGULATION: Engine fluids (oil, fuel, and coolant) may be a hazard to human health and the environment. Handle all fluids and other contaminated materials (e.g. filters, rags) in accordance with applicable regulations. Recycle or dispose of engine fluids, filters, and other contaminated materials according to applicable regulations.

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

WARNING: To prevent personal injury or death, store diesel fuel properly in an approved container designed for and clearly marked DIESEL FUEL.

Test Setup

None

Test Procedure

1. Verify there is fuel in fuel tank.

Figure 732 Fuel primer pump

2. Pump fuel primer pump until fuel fills the system.
   - If fuel does not pull from fuel tank, go to Fuel Restriction Test (page 1688).

Expected Outcome

Technician will be able to pull from fuel tank, priming the system.

Follow-on Procedure

None

Fuel Delivery Pressure (FDP) Test

Overview

Test Low-pressure Fuel Pump's ability to build and maintain sufficient fuel delivery pressure for a proper performing engine.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

Tools Required

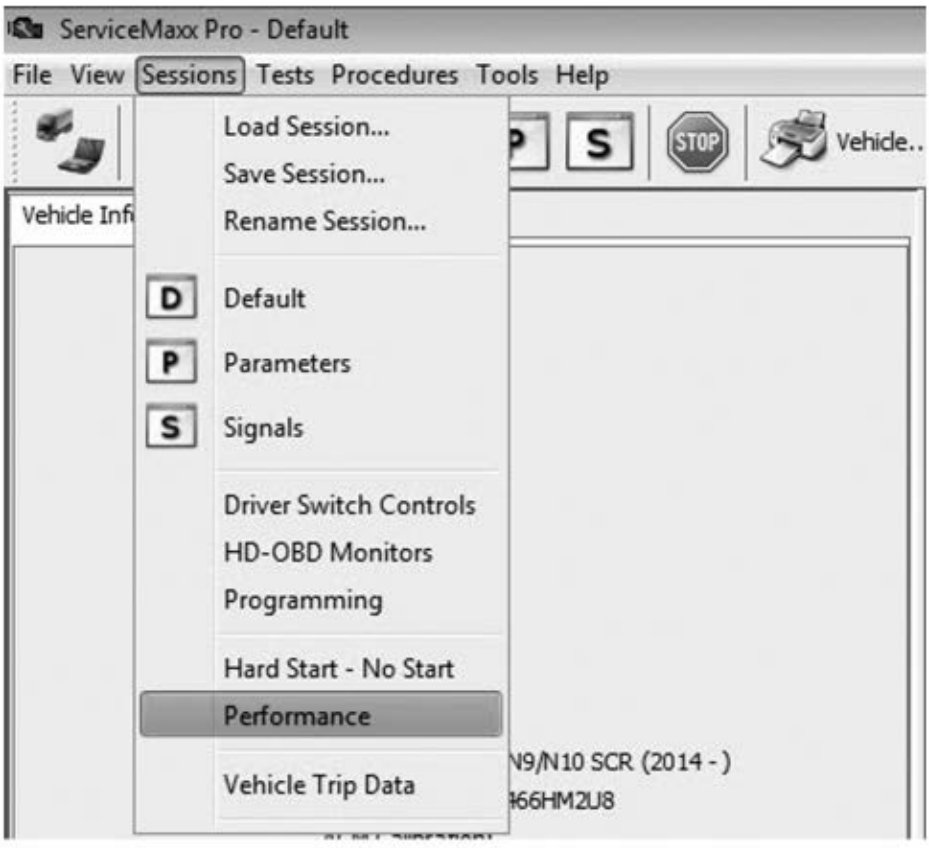
- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)

Equipment Conditions

- None

Test Set-up

1. Connect Electronic Service Tool (EST) to vehicle diagnostic connector



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2. Log in to ServiceMaxx™ and load Performance Session (Figure 733)
   - Select Sessions > Performance
3. Start engine

Test Procedure

1. Monitor Fuel Delivery Pressure (FDP) at low idle
2. Fully press accelerator pedal for 20 seconds, monitor FDP
3. Return engine speed to low idle, shut off engine

Expected Outcome

Fuel Delivery Pressure (FDP) will be within specification.

Follow-on Procedure

None

Start From Clean Fuel Source Test

Overview

Diagnose proper operation of the Low Pressure Fuel Pump by verifying operation of the Low-pressure Fuel system using a known clean, unrestricted and dedicated fuel source.

Tools Required

- Clean Fuel Source Tool – 15–637–01
- Air Cap, Fuel Cap and Plug Kit – ZTSE4891

Equipment Condition

None

CAUTION: Ensure all fuel lines and dry break fittings are clear of dirt and heavy debris before disconnecting any fittings. Failure to comply could cause contaminants to enter the Low-pressure fuel system.

Test Setup

1. With engine Off, disconnect fuel supply line at low-pressure fuel pump inlet fitting
2. Use Air Cap, Fuel Cap and Plug Kit ZTSE4891 to cap disconnected fuel line

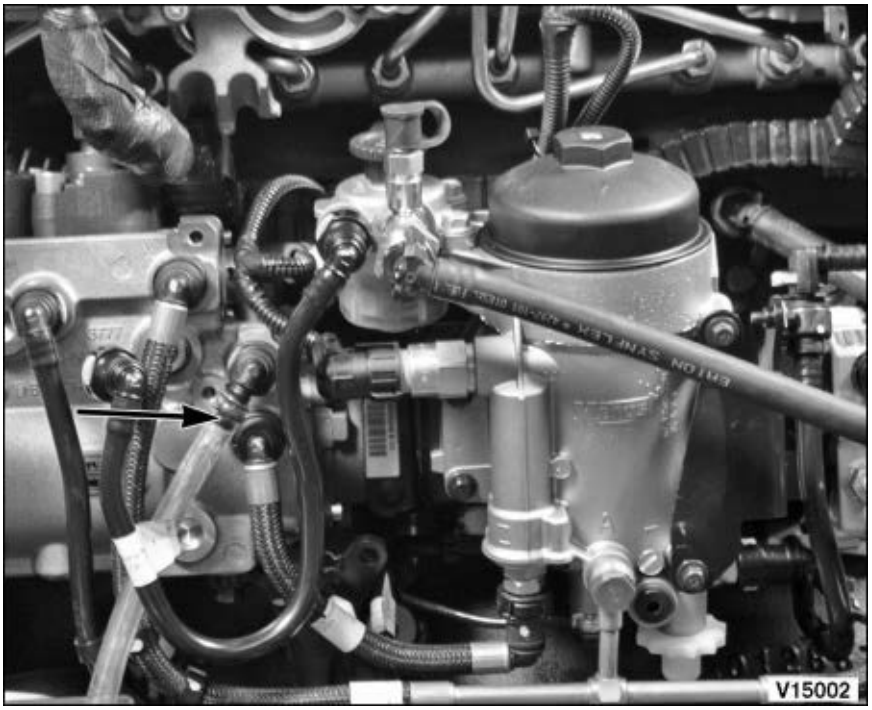

Figure 734 Low-Pressure Fuel Pump with Clean Fuel Source Tool Connected

3. Connect Clean Fuel Source Tool 15-637-01 to low-pressure fuel pump inlet (Figure 734)
4. Prime fuel system by pumping primer bulb

CAUTION: Do not crank engine continuously for longer than 15 seconds. Failure to comply could result in damage to engine starter motor.

Test Procedure

1. Crank the engine
2. If engine starts, idle for 30 seconds before shutting down

Expected Outcome

Engine will start and run with Clean Fuel Source Tool connected.

Follow-on Procedure

None

Fuel Aeration Test

Overview

Check for and diagnose cause of fuel aeration.

Tools Required

- 15-637-01 – Clean Fuel Source Tool
- ZTSE4886 – Fuel Inlet Restriction / Aeration Tool
- ZTSE4905 – Fuel Block Off Tool
- ZTSE4906 – Fuel Line Coupler

Equipment Condition

None

Test Setup 1

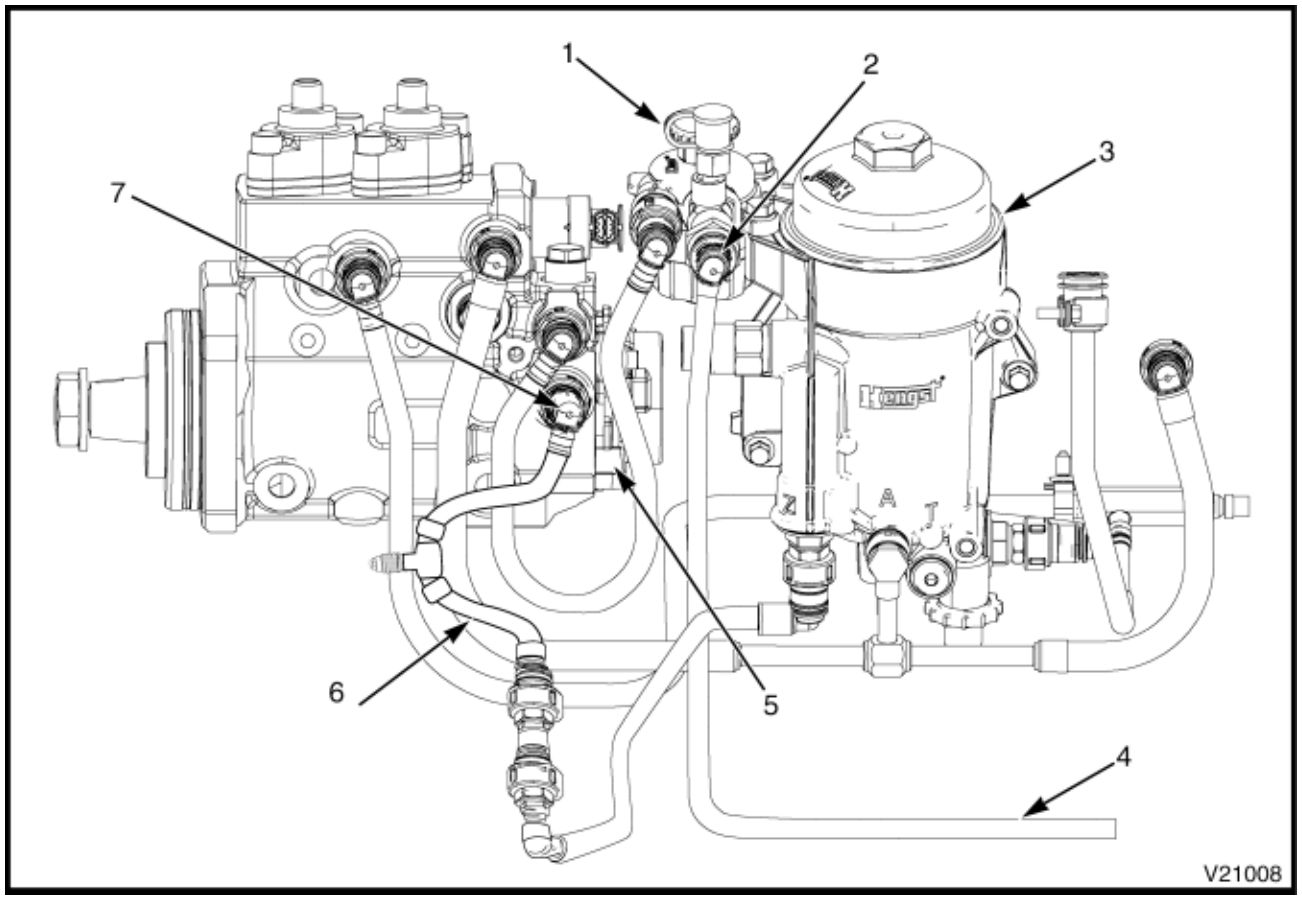

Figure 735 Fuel Aeration Test

1. Strainer / primer pump
2. Fuel Primer Pump inlet fitting
3. Secondary fuel filter
4. Fuel supply line (from tank)
5. Low-pressure Fuel Pump
6. Fuel Inlet Restriction/Aeration Tool
7. Low-pressure Fuel Pump outlet fitting

1. Use Fuel Line Coupler ZTSE4906 to connect Fuel Inlet Restriction/Aeration Tool ZTSE4886 between fuel supply line to secondary fuel filter and low-pressure fuel pump outlet.
2. Prime fuel system by pumping primer pump.

Test Procedure 1

1. Start or crank engine. If possible, raise engine speed to high idle while visually monitoring for fuel aeration (air bubbles passing through the clear line of the Restriction/Aeration Tool).
   - If fuel is not aerated, go to Restriction Test (page 1688).
   - If fuel is aerated, continue to Test 2.

Test Setup 2

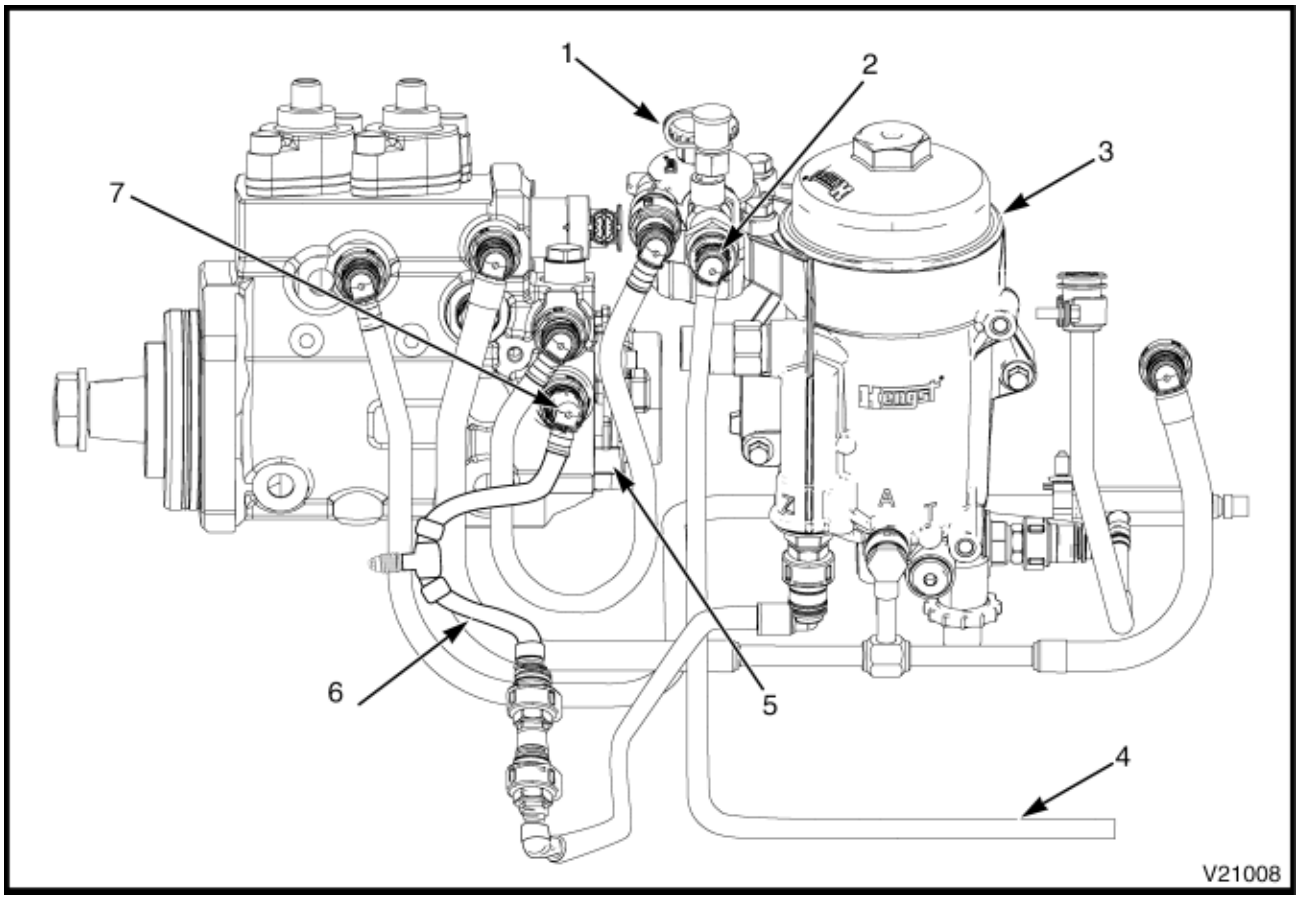

Figure 736 Fuel Aeration Test

1. Strainer / primer pump
2. Fuel Primer Pump inlet fitting
3. Secondary fuel filter
4. Fuel supply line
5. Low-pressure fuel pump
6. Fuel Inlet Restriction/Aeration Tool
7. Low-pressure Fuel Pump outlet fitting

1. Retain Fuel Inlet Restriction/Aeration Tool from previous test.
2. Connect Clean Fuel Source Tool 15-637-01 to primer pump inlet.
3. Prime fuel system by pumping primer pump.

Test Procedure 2

1. Start or crank engine. If possible,raise engine speed to high idle while visually monitoring for fuel aeration (air bubbles passing through the clear line of the Restriction/Aeration Tool).
   - If fuel is not aerated, repair fuel supply line between fuel primer pump and fuel tank.
   - If fuel is aerated, repair low-pressure fuel pump supply line or fuel primer pump.

Expected Outcome

Technician will validate fuel is not aerated or diagnose cause of fuel aeration.

Follow-On Condition

None

Fuel Restriction Test

Overview

Check for and diagnose cause of fuel supply restriction.

Tools Required

- ZTSE4526 – Compucheck fitting
- 15-637-01 – Clean Fuel Source Tool
- ZTSE4409 – Pressure Test Kit
- ZTSE4886 – Fuel Inlet Restriction / Aeration Tool
- ZTSE4906 – Fuel Line Coupler

Equipment Condition

None

Test Setup 1

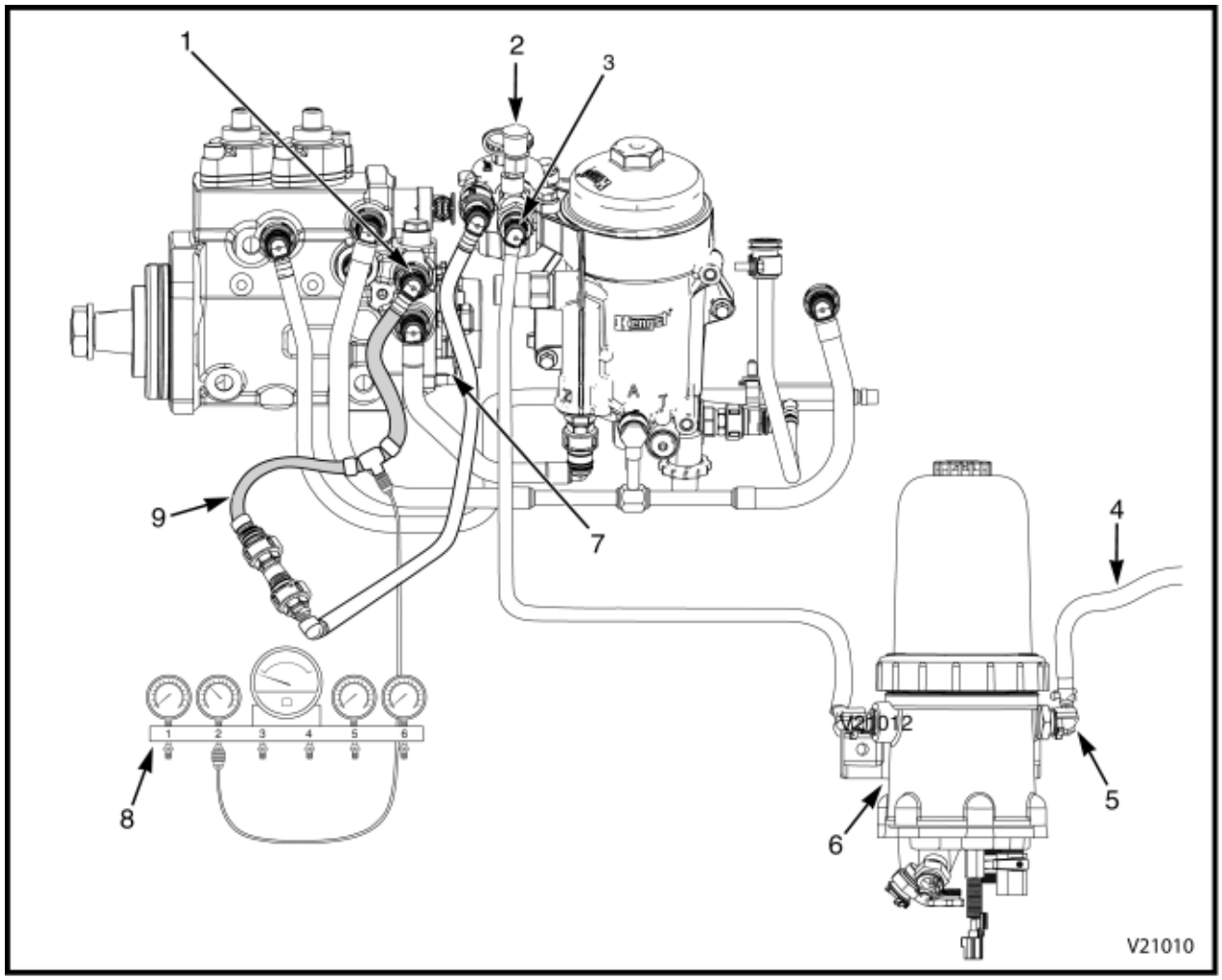

Figure 737 Fuel Restriction Test

1. Low-Pressure Fuel Pump Inlet Fitting
2. Strainer/primer pump
3. Primer Pump Fuel Inlet Fitting
4. Fuel supply line from tank
5. Primary Fuel Filter Inlet Fitting
6. Primary fuel filter
7. Low-pressure fuel pump
8. Pressure Test Kit (vacuum gauge)
9. Fuel Inlet Restriction/Aeration Tool

1. Use Fuel Line Coupler ZTSE4906 to connect Fuel Inlet Restriction / Aeration Tool ZTSE4886 between low-pressure fuel pump supply line and low-pressure fuel pump inlet.
2. Connect Pressure Test Kit ZTSE4409 vacuum gauge to Fuel Inlet Restriction / Aeration Tool ZTSE4886.
3. Prime fuel system by pumping primer pump.

Test Procedure 1

1. Start or crank engine. If possible, raise engine speed to high idle while monitoring Pressure Test Kit vacuum gauge.
   - If restriction is above specification, go to Test 2.
   - If restriction is within specification, retest for original complaint.

Test Setup 2

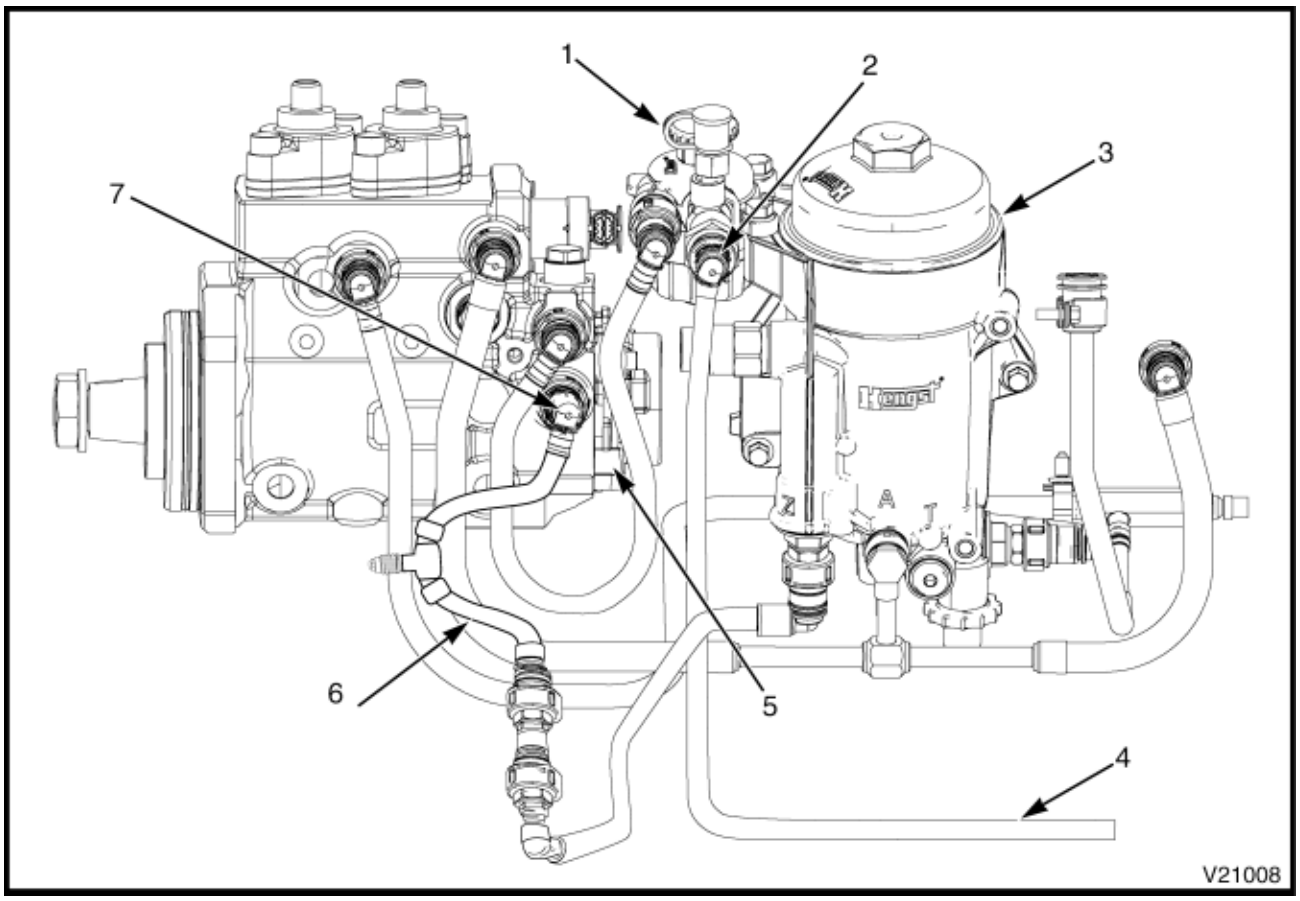

Figure 738 Fuel Aeration Test

1. Strainer / primer pump
2. Fuel Primer Pump inlet fitting
3. Secondary fuel filter
4. Fuel supply line
5. Low-pressure fuel pump
6. Fuel Inlet Restriction/Aeration Tool
7. Low-pressure Fuel Pump outlet fitting

1. Retain setup from previous test
2. Connect Clean Fuel Source Tool 15-637-01 to primer pump inlet.
3. Prime fuel system by pumping primer pump.

Test Procedure 2

1. Start or crank engine. If possible, raise engine speed to high idle while monitoring Pressure Test Kit ZTSE4409 vacuum gauge.
   - If restriction is within specification, go to Test 3
   - If restriction is above specification, repair or replace fuel strainer and primer pump assembly, and check fuel lines. After repairs are complete, retest for original problem.

Test Setup 3

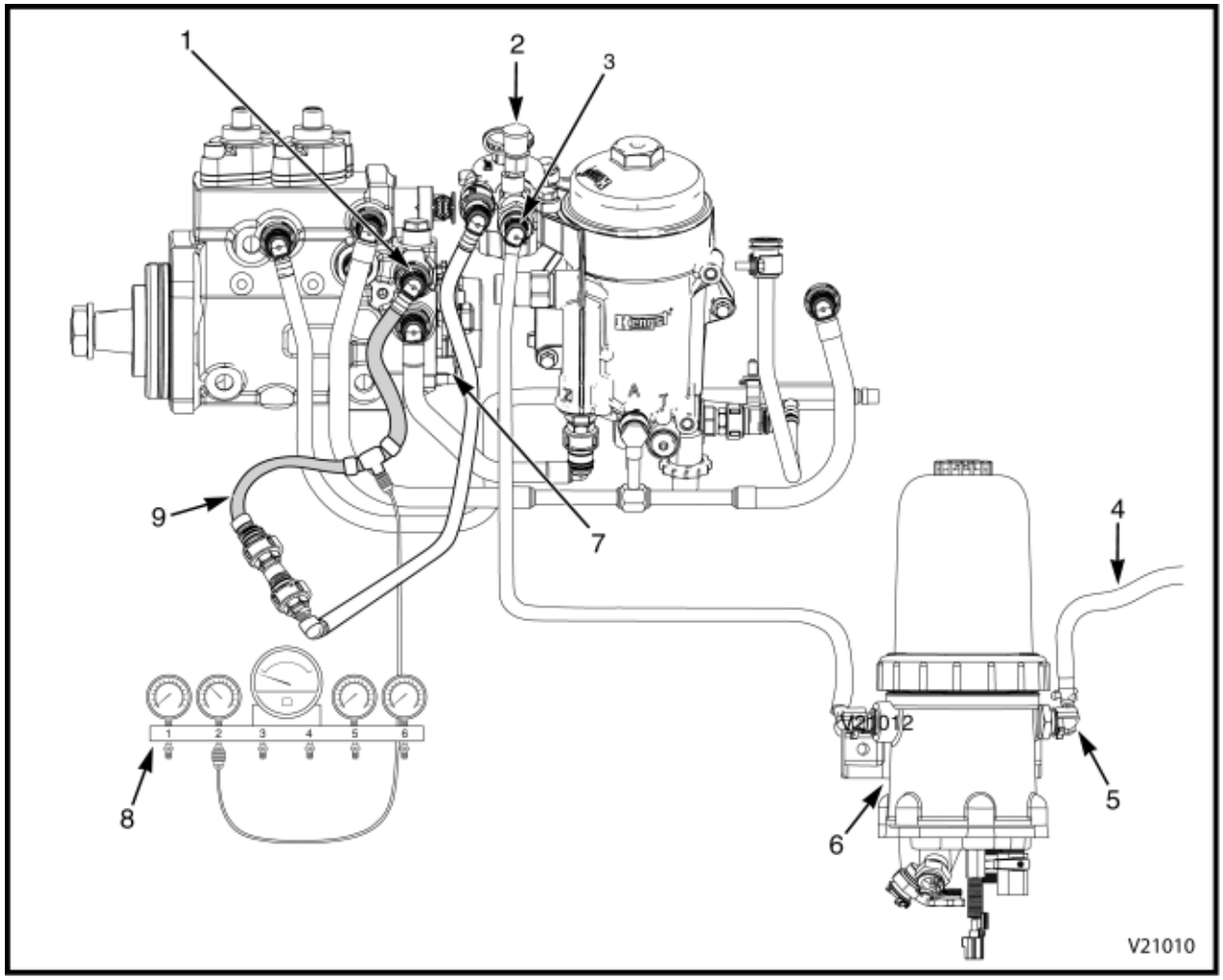

Figure 739 Fuel Restriction Test

1. Low-Pressure Fuel Pump Inlet Fitting
2. Strainer/primer pump
3. Primer Pump Fuel Inlet Fitting
4. Fuel supply line from tank
5. Primary Fuel Filter Inlet Fitting
6. Primary fuel filter
7. Low-pressure fuel pump
8. Pressure Test Kit (vacuum gauge)
9. Fuel Inlet Restriction/Aeration Tool

1. Retain setup from Test 2, but connect Clean Fuel Source Tool 15-637-01 to primary filter inlet

2. Restore any fuel line connections
3. Prime fuel system by pumping primer pump.

Test Procedure 3

1. Start or crank engine. If possible, raise engine speed to high idle while monitoring Pressure Test Kit ZTSE4409 vacuum gauge.
   - If restriction is within specification, repair restriction between primary fuel filter and fuel tank. After repairs are complete, retest for original problem.
   - If restriction is above specification, replace primary fuel filter, clean fuel strainer, and check fuel lines for damage. After repairs are complete, retest for original problem.

Expected Outcome

Technician will verify there is no fuel restriction or diagnose cause of fuel restriction.

Follow-on Procedure

Connect low-pressure fuel lines that were disconnected.

High-Pressure Oil System Tests

HP Pump Inlet Pressure Test

Overview

Verify high-pressure fuel pump is receiving fuel.

Tools Required

- ZTSE4681 – Fuel Pressure Gauge
- ZTSE4886 – Fuel Inlet Restriction / Aeration Tool
- ZTSE4905 – Fuel Block Off Tool
- ZTSE4906 – Fuel Line Coupler

Equipment Condition

None

Test Setup

1. Disconnect fuel supply to AFT fuel doser module.
2. Use Fuel Line Coupler ZTSE4906 to connect Fuel Inlet Restriction / Aeration Tool ZTSE4886 to AFT fuel doser module fuel supply line.

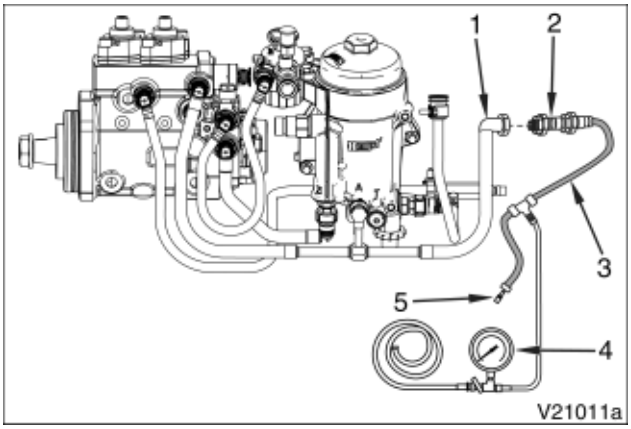

Figure 740 Pressure Test Kit connected to AFT fuel doser module fuel supply line

1. AFT fuel doser module Fuel Supply Line
2. Fuel Line Coupler
3. Fuel Inlet Restriction / Aeration Tool
4. Fuel Pressure Gauge
5. Fuel Block Off Tool

3. Connect Fuel Block Off Tool ZTSE4905 to Fuel Inlet Restriction / Aeration Tool ZTSE4886.
4. Connect ZTSE4681 Fuel Pressure Gauge to Fuel Inlet Restriction / Aeration Tool ZTSE4886.

Test Procedure

1. Start or crank engine. If possible, run at high idle. Monitor Fuel Pressure Gauge ZTSE4681.
   - If gauge pressure is within specification, go to Fuel Rail Pressure (FRP) Return Flow Test .
   - If gauge pressure is below specification, diagnose and repair low-Pressure fuel system.

Expected Outcome

Technician will verify High-Pressure Fuel pump is receiving proper fuel pressure.

Follow-on Procedure

None

Fuel Rail Pressure (FRP) Return Flow Test

Overview

Verify return flow is within specifications.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Diesel fuel container with measuring marks
- ZTSE4887 – High Pressure Return Line Tester

Equipment Condition

Low-pressure fuel system is operating correctly and within specification.

Test Setup 1

1. Disconnect fuel drain tube assembly at rear of cylinder head.

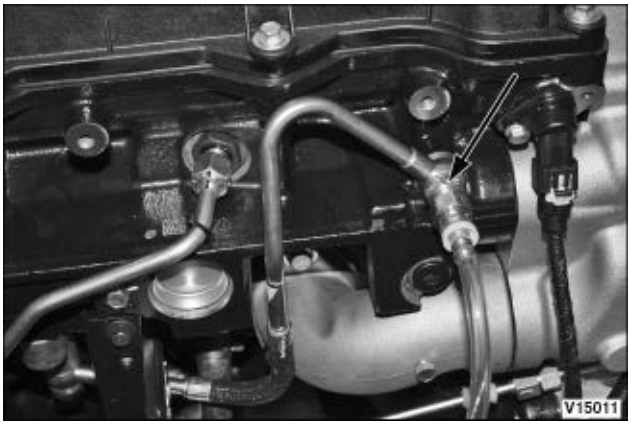

Figure 741 High Pressure Return Line Tester connected to cylinder head

2. Connect High Pressure Return Line Tester ZTSE4887-2 using 2 banjo ring seals to cylinder head fuel drain tube fitting. Thread ZTSE4887-3 to ZTSE4887-2 and route the end into a diesel fuel container.

Test Procedure 1

1. Crank engine for a maximum of 20 seconds or start engine and run at low idle. If engine starts, wait until fuel flow is steady and fuel volume reaches a good starting measurement point, start timer and begin measurement. Measure fuel return volume for 1 minute if the engine starts.
   - If fuel is returning while cranking or volume is out of specification while running, go to Fuel Rail Pressure (FRP) Leak Isolation.
   - If engine starts and fuel volume is within specification, continue to next step.
   - If engine does not start and no fuel is returned, continue to next step.

2. Before running this test, ensure low-pressure fuel system is operating correctly. Reinstall fuel drain tube assembly disconnected in step 1.

Test Setup 2

1. Reconnect the fuel drain tube to the cylinder head.
2. Disconnect fuel rail return line at fuel rail.

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Figure 742 ZTSE4887 - 2 High Pressure Return Line Tester

3. Connect High Pressure Return Line Tester ZTSE4887-2 using 2 banjo ring seals to fuel rail return port. Thread ZTSE4887-3 to ZTSE4887-2 and route the end into a diesel fuel container.

Test Procedure 2

1. Crank engine for a maximum of 20 seconds or start engine and run at low idle. If engine starts, wait until fuel flow is steady and fuel volume reaches a good starting measurement point, start timer and begin measurement. Measure fuel return volume for 1 minute if the engine starts.

- If fuel flows from High Pressure Return Line Tester ZTSE4887, replace fuel rail pressure relief valve.
- If fuel does not flow from High Pressure Return Line Tester ZTSE4887, no further action is required.

Expected Outcome

Technician will verify fuel return flow rate is within specification.

Follow-on Procedure

None

Fuel Rail Pressure (FRP) Leak Isolation

Overview

Isolate pressure loss in high-pressure fuel system. Only run this test if engine fails High Pressure Pump test.

Tools Required

- Diesel fuel container measuring in milliliters
- ZTSE4887 – High Pressure Rail Return Line Tester
- ZTSE6098 – High Pressure Rail Plugs

Equipment Condition

None

Test Setup

WARNING: The high-pressure fuel system may have extremely high pressure. Verify pressure is below 500 psi before cracking a line. Every time the engine is shut down and the key is in the OFF position, the ECM commands a blank shot injection process that drains the high-pressure fuel rail.

1. Connect High Pressure Return Line Tester ZTSE4887 to cylinder head.

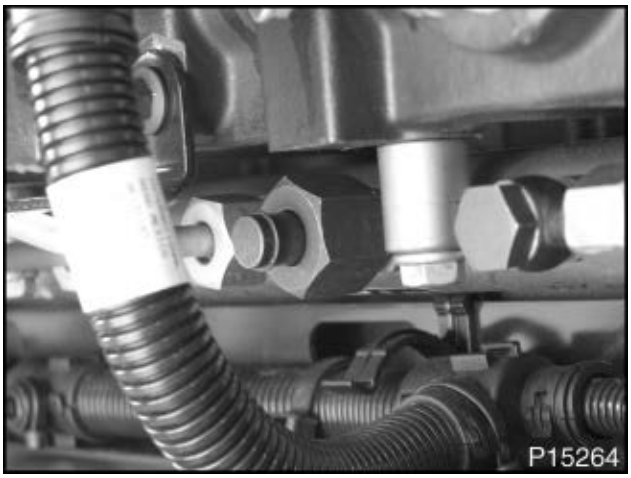

Figure 743 High Pressure Rail Plug installed on injector six

2. Disconnect number six injector fuel line and cap off rail with High Pressure Rail Plug ZTSE6098 (Figure 743).

Test Procedure

Normal fuel return flow with number of connected injectors (Engine running)

All 6 INJs	5 INJs	4 INJs	3 INJs	2 INJs
> 20 - 22 ml	16 - 18 ml	12 – 16 ml	8 - 12 ml	8 - 10 ml

NOTE: This table displays typical fuel return volume specifications for a good running engine. Results much higher than specification indicate an excessive leak.

1. Start or crank engine. If the engine starts, run at low idle. When fuel flow is steady and fuel volume reaches a good starting measurement point, start timer, and begin measurement. Measure fuel return volume for 1 minute and compare to specification. If the engine doesn't start, no fuel should be seen exiting the cylinder head.
   - If fuel volume is above specification, leave High Pressure Rail Plug ZTSE6098 installed and continue to next Step.
   - If fuel volume is within specification, return to step based diagnostics.
2. Disconnect number five injector fuel line and cap off rail with High Pressure Rail Plug ZTSE6098.

3. Start or crank engine. If the engine starts, run at low idle. When fuel flow is steady and fuel volume reaches a good starting measurement point, start timer, and begin measurement. Measure fuel return volume for 1 minute and compare to specification. If the engine doesn't start, no fuel should be seen exiting the cylinder head.
    - If fuel volume is above specification, leave High Pressure Rail Plug ZTSE6098 connected and continue capping off one injector supply port at a time until excessive leak is isolated. Once the excessive leak is isolated, replace the removed injector tubes with new parts.

Expected Outcome

Technician will be able to isolate pressure loss in high-pressure fuel system.

Follow-on Procedure

None

HP Pump Fuel Return Pressure Test

Overview

Verify return flow is within specifications.

Tools Required

- ZTSE4526 – Compucheck fitting
- ZTSE4681 – Fuel Pressure Gauge
- ZTSE4886 – Fuel Inlet Restriction / Aeration Tool
- ZTSE4906 – Fuel Line Coupler

Equipment Condition

None

Test Setup

1. Disconnect high-pressure fuel pump return line.

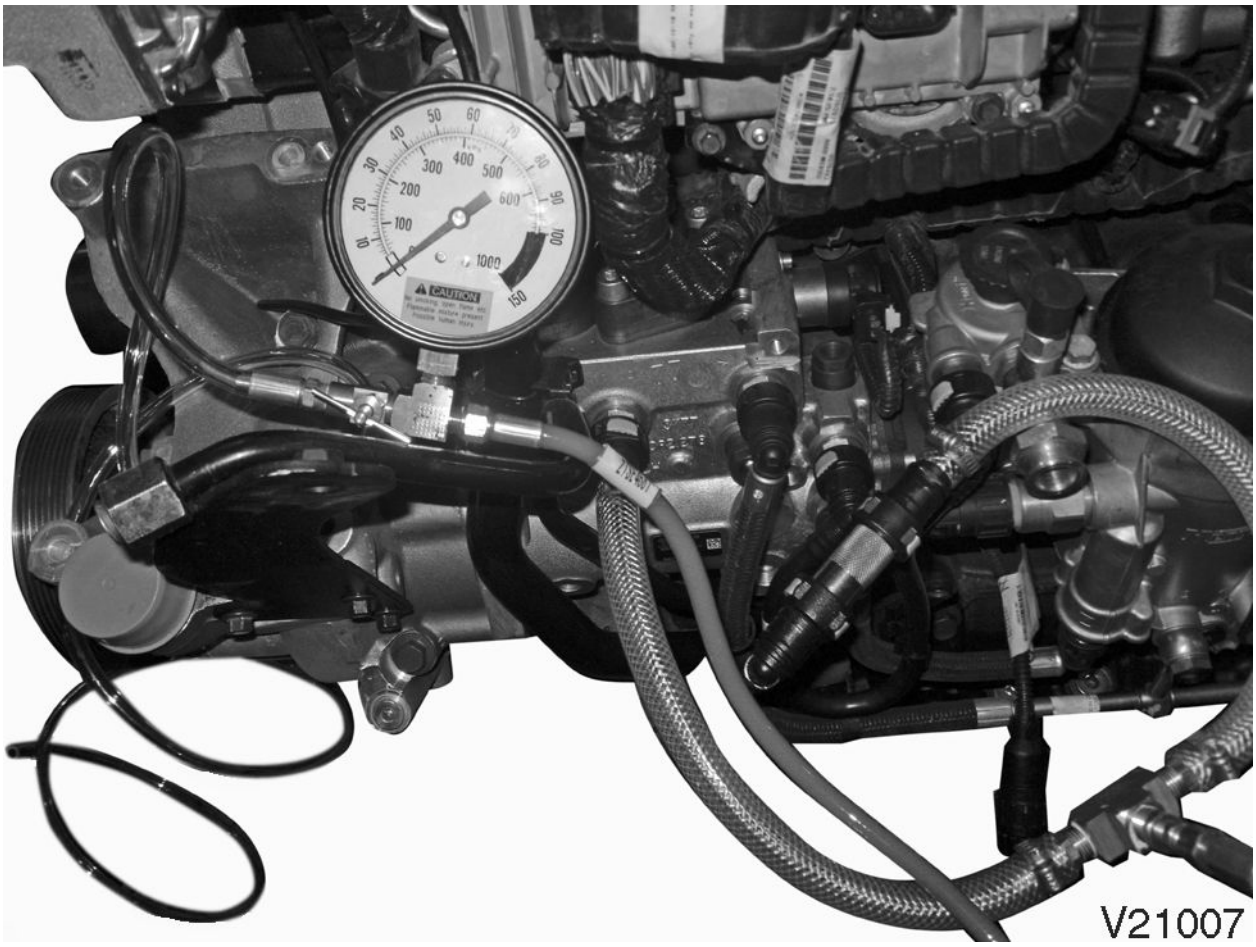

Figure 744 High-pressure fuel pump return line connected to Fuel Pressure Gauge

2. Use Fuel Line Coupler ZTSE4906 to connect Fuel Inlet Restriction/Aeration Tool ZTSE4886 between the high-pressure fuel pump and return line.
3. Use Compucheck fitting ZTSE4526 to connect Fuel Inlet Restriction / Aeration Tool ZTSE4886 to Fuel Pressure Gauge ZTSE4681.

Test Procedure

1. Start or crank engine. If the engine starts run at high idle while monitoring Fuel Pressure Gauge.
2. If the engine does not start, continue cranking for a maximum of 20 seconds while monitoring fuel pressure gauge.

Expected Outcome

Technician will verify fuel return flow is within specification.

Follow-on Procedure

None

HP Pump Fuel Return Flow Test

Overview

Verify return flow is within specifications.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Diesel fuel container with measuring marks
- ZTSE4887 – High Pressure Return Line Tester

Equipment Condition

Before running this test, verify low-pressure fuel system is operating correctly.

Test Setup

1. Disconnect fuel drain tube assembly at rear of cylinder head.

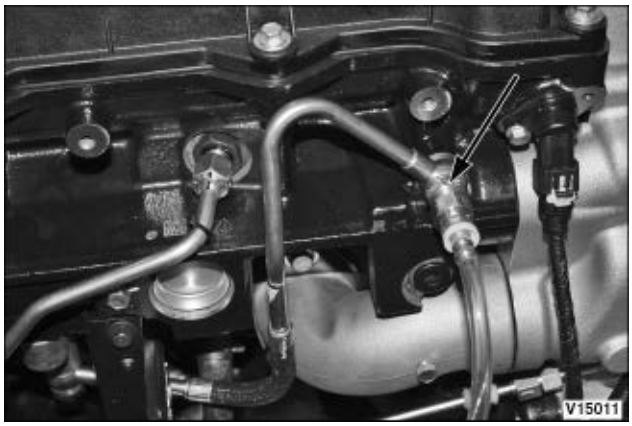

Figure 745 High Pressure Return Line Tester connected to cylinder head

2. Connect High Pressure Return Line Tester ZTSE4887-2 using 2 banjo ring seals to cylinder head fuel drain tube fitting. Thread ZTSE4887-3 to ZTSE4887-2 and route the end into a diesel fuel container.

Test Procedure

Fuel Rail Pressure (FRP) Return Flow Test Part 1

1. Start engine and run at low idle. When fuel flow is steady and fuel volume reaches a good starting measurement point, start timer and begin measurement. Measure fuel return volume for 1 minute.
   - If fuel volume is above specification, go to Fuel Rail Pressure (FRP) Leak Isolation.
   - If fuel volume is within specification, continue to next step.

Fuel Rail Pressure (FRP) Return Flow Test Part 2

2. Reinstall fuel drain tube assembly disconnected in step 1 of Test Setup.
3. Disconnect fuel rail return line at fuel rail.
4. Connect High Pressure Return Line Tester ZTSE4887-2 using 2 banjo ring seals to fuel rail return port. Thread ZTSE4887-3 to ZTSE4887-2 and route the end into a diesel fuel container.
5. Start engine and run at high idle. Monitor fuel return from High Pressure Return Line Tester ZTSE4887.
   - If fuel flows from High Pressure Return Line Tester ZTSE4887, replace fuel rail.
   - If fuel does not flow from High Pressure Return Line Tester ZTSE4887, no further action is required.

Expected Outcome

Technician will verify fuel return flow is within specification.

Follow-on Procedure

None

Inlet Air Heater Tests

Inlet Air Heater Fuel Igniter (IAHFI) Test

Overview

Verify IAHFI is working properly.

Tools Required

- EXP-1000 HD by Midtronics
- ZTSE4575 - EXP-1000 HD by Midtronics or Digital Multimeter with amp clamp
- Electronic Service Tool (EST) with ServiceMaxx™ software
- J1939-compliant Interface Cable

Equipment Condition

None

Test Setup

1. Key-ON, Engine-OFF.
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ to Vehicle Diagnostic Connector (page 1571).
3. Start ServiceMaxx™ software.

Test Procedure

1. In ServiceMaxx select Tests > KOEO Tests > Actuator Test.

Figure 746 Current clamp on IAHFI

2. Connect EXP-1000 HD by Midtronics current clamp or DMM with amp clamp ZTSE4575 around IAHFI power circuit.
3. Select Inlet Air Heater Igniter from Actuator drop-down menu.
4. Press the Start Test button while monitoring current draw. Record results on Diagnostics Form.

Expected Outcome

Technician will verify Intake Air Heater Fuel Igniter (IAHFI) is working.

Equipment Condition

None

Fuel Supply at Inlet Air Heater Fuel Solenoid (IAHFS) Test

Overview

Verify sufficient fuel pressure is being supplied to the IAHFS.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- ZTSE4681 – Fuel Pressure Gauge
- ZTSE6059 – Inlet Air Heater Solenoid Test Adapter Kit

Equipment Condition

None

Test Setup

1. Key-ON, Engine-OFF.
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
3. Start ServiceMaxx™ software.

Test Procedure

1. Select Hard Start - No Start session.
2. Crank engine while monitoring Fuel Delivery Pressure (FDP).
   - If FDP is below specification, go to Fuel Delivery Pressure Test (page 1680).
   - If FDP is within specification, continue to next step.
3. Disconnect fuel supply to IAHFS.

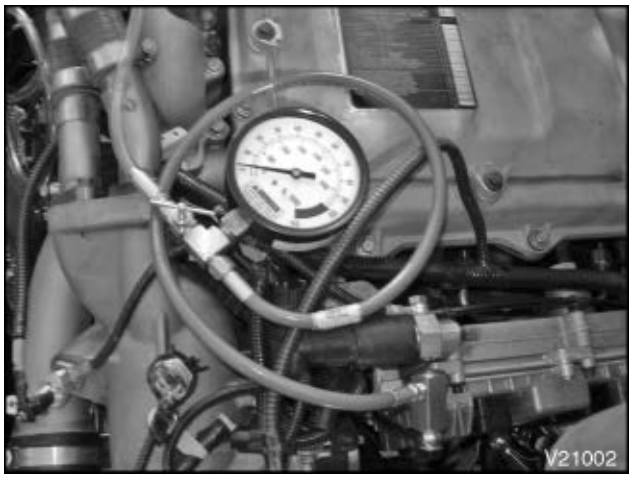

Figure 747 Fuel Pressure Gauge ZTSE4681 connected to IAHFS fuel supply line

4. Use Inlet Air Heater Solenoid Test Adapter Kit ZTSE6059 to connect Fuel Pressure Gauge ZTSE4681 to IAHFS fuel supply line.
5. Crank engine while monitoring Fuel Pressure Gauge ZTSE4681. Record results on Diagnostics Form.
    - If pressure is below specification, inspect IAHFS fuel supply line for restriction. If IAHFS fuel supply line is not restricted, replace fuel regulator in fuel filter housing.
    - If pressure is within specification, go to Fuel Supply at Inlet Air Heater Fuel Igniter (IAHFI) Test.

Expected Outcome

Technician will verify sufficient fuel pressure is being supplied to the IAHFS.

Follow-on Procedure

None

Fuel Supply at Inlet Air Heater Fuel Igniter (IAHFI) Test

Overview

Verify sufficient fuel pressure is being supplied to the IAHFI. This test can only be run if ECT1 is below 10 °C (50 °F) or ServiceMaxx™ software can run the Inlet Air Heater procedure.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- ZTSE4681 – Fuel Pressure Gauge
- ZTSE6059 – Inlet Air Heater Solenoid Test Adapter Kit

Equipment Condition

None

Test Setup

1. Key-ON, Engine-OFF.
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
3. Start ServiceMaxx™.

Test Procedure

1. Select Hard Start - No Start session.
2. Reinstall fuel supply line to Inlet Air Heater Fuel Solenoid (IAHFS) disconnected in previous test.
3. Disconnect fuel supply to IAHFI.

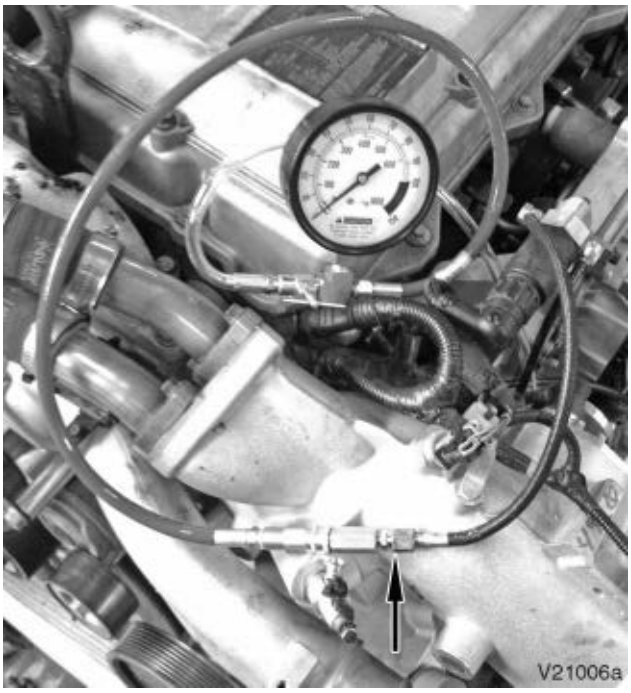

Figure 748 Fuel Pressure Gauge ZTSE4681 connected to IAHFI fuel supply line

4. Use Inlet Air Heater Solenoid Test Adapter Kit ZTSE6059 to connect Fuel Pressure Gauge ZTSE4681 to IAHFI fuel supply line.
5. Monitor Wait to Start lamp in vehicle's dashboard.
6. When Wait to Start lamp begins flashing, crank engine while monitoring Fuel Pressure Gauge ZTSE4681. Record results on Diagnostics Form.
    - If pressure is below specification, inspect IAHFI fuel supply line for restriction. If IAHFI fuel supply line is not restricted, see Inlet Air Heater Fuel Solenoid (page 1027) in “ELECTRONIC CONTROL SYSTEMS DIAGNOSTICS.”
    - If pressure is within specification, replace IAHFI.

Expected Outcome

Technician will verify sufficient fuel pressure is being supplied to the Intake Air Heater Fuel Igniter (IAHFI).

Follow-on Procedure

None

General Test Procedures

Batteries and Electrical System Inspection

Overview

Inspect batteries, electrical system, and connections to help identify corroded connections, voltage drops, verify proper battery voltage, and identify damaged electrical connections and components.

WARNING: To prevent personal injury or death, disconnect the main battery negative terminal before disconnecting or connecting electrical components. Always connect ground cable last.

WARNING: To prevent personal injury or death when working with batteries, always wear face or eye protection, have water supply available, assure good ventilation, and be sure no flames or sparks are present.

Tools Required

- Digital Multi-Meter (DMM)
- Flash light (optional)
- Battery charger

Equipment Condition

None

Inspection Procedure

1. Inspect batteries and battery connections. If connections are corroded, loose, or damaged; clean and reinstall battery connections. If batteries are cracked or damaged replace as necessary.
2. If applicable, check batteries electrolyte level. If electrolyte is below the top of the plates in one or more cells, add distilled water.
3. Inspect electrical system for damaged electrical components or wiring, and loose connections (including engine grounds and starter connections). Repair damaged or loose components or connections.
4. Measure voltage of batteries. If voltage is less than 12.6 volts, charge batteries, and test charging system.

Expected Outcome

Batteries, wiring, electrical connections, and electrical components are clean, connections are tight, and not damaged. Batteries voltage 12.6-15 volts.

Engine Cranking Test

Overview

Monitors engine systems as the engine is cranked to determine if systems are able to meet minimum starting requirements.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- J1939-Compliant Interface Cable

Equipment Condition

None

Test Setup

1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571).
3. Log in to ServiceMaxx™ software.

Test Procedure

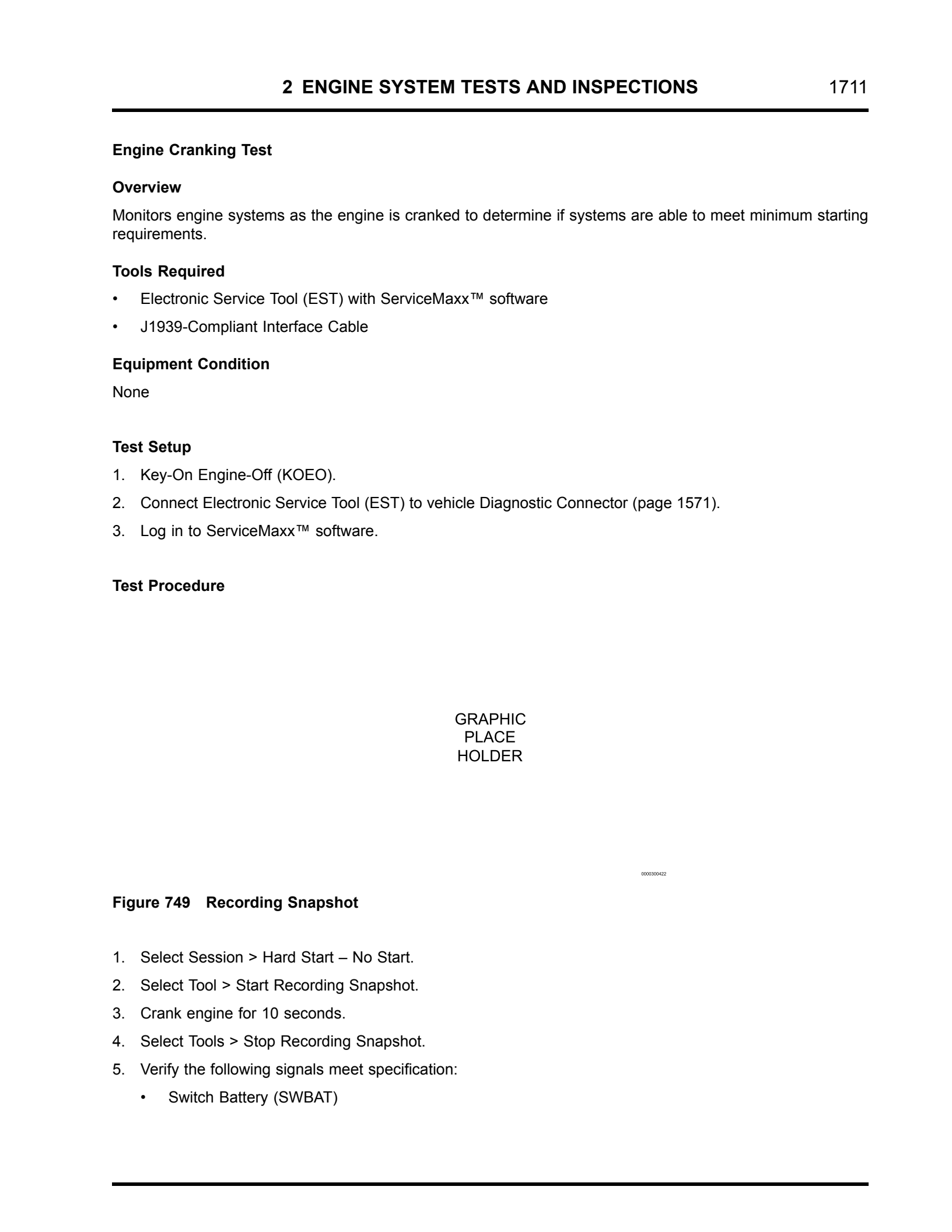

Figure 749 Recording Snapshot

1. Select Session > Hard Start – No Start.
2. Select Tool > Start Recording Snapshot.
3. Crank engine for 10 seconds.
4. Select Tools > Stop Recording Snapshot.
5. Verify the following signals meet specification:
   - Switch Battery (SWBAT)

- Engine Speed (RPM)
- Fuel Rail Pressure (FRP)
- Fuel Delivery Pressure (FDP)
- Turbocharger 1 Turbine Output Pressure (TC1TOP)

Expected Outcome

All signal values meet specification.

Follow-on Procedure

None

Crankcase Oil Breather Separator Test

Overview

Check if centrifuge breather is functioning properly.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- ZTSE4800 – Ultrasonic Leak Detector

Equipment Condition

Before performing this test, ensure engine operating temperature is 82 to 88˚ C (180 to 190˚ F) and oil level and pressure are within specification.

Test Setup

1. Key-ON, Engine-OFF.
2. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
3. Start ServiceMaxx™.

Test Procedure

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, set parking brake, shift transmission to neutral or park, and block wheels starting the engine.

WARNING: To prevent personal injury or death, avoid rotating parts (belts and fan) and hot engine surfaces.

1. Select Performance session.
2. Start engine. Ensure engine operating temperature is 82 to 88˚ C (180 - 190˚ F).

   NOTE: The Crankcase Oil Separator Speed (CCOSS) sensor does not have circuit fault codes. A Diagnostic Trouble Code (DTC) will only be set if the Engine Control Module (ECM) does not see an rpm signal with the engine running.
3. Monitor CC Oil Separator (CCOS) signal with engine at low and high idle. Record results on Diagnostics Form.
   - If CCOS is within specification, crankcase breather system is operating correctly.
   - If CCOS is reading 0 rpm with engine running, continue to next step.
4. With engine running, place Ultrasonic Ear ZTSE4800 near CCOSS sensor.
5. Turn engine OFF and quickly monitor for centrifugal noise. The centrifuge will continue spinning for 15 seconds after engine is shut off.

Expected Outcome

Technician will verify if centrifuge breather is working properly.

Follow-on Condition

None

Charge Air Cooler (CAC) Pressure Test

Overview

Pressure test the Charge Air Cooler.

Tools Required

- ZTSE4351 Charge Air Cooler Test Kit

Equipment Condition

None

Test Setup

WARNING: To prevent personal injury or death, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

Figure 750 CAC Cleaning Adapter Kit (Off Chassis) 09-925-01 With CAC Pressure Test Kit ZTSE4341 Installed

1. CAC Pressure Test Kit ZTSE4341

NOTE: Optional Charge Air Cooler (CAC) Pressure Test Kit ZTSE4341 (Figure 750) (Item 1) shown installed in the CAC Cleaning Adapter Kit 09-925-01 carrying case. CAC Pressure Test Kit is not part of CAC Cleaning Adapter Kit , but allows for storage in the carrying case.

1. Remove Charge Air Cooler (CAC) from vehicle. See appropriate Radiator / Cooling System Service Manual.

2. Place CAC on a flat surface.

Test Procedure

1. Visually inspect CAC for cracks, holes, and other damage. If cracked or damaged, replace CAC.

WARNING: To prevent personal injury or death, clean all hoses and other pressure test components of oil, grease, or other lubricants before connecting.

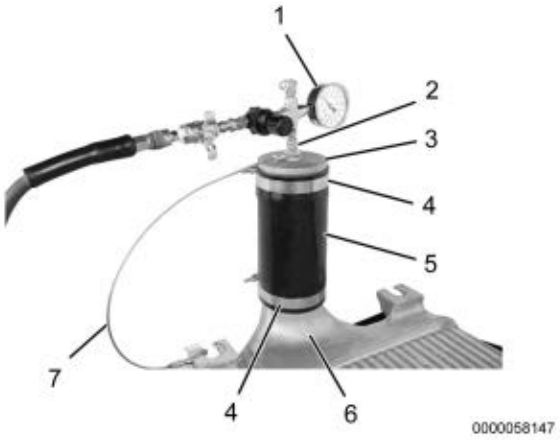

Figure 751 CAC Pressure Test Kit Installed on CAC Outlet

1. Gauge / regulator assembly
2. Quick disconnect fitting
3. Gauge coupler
4. T-clamp (2)
5. Large hose
6. Charge Air Cooler (CAC) outlet
7. Safety cable

2. Install large hose (Figure 751) (item 5) and T-clamp onto CAC outlet (Figure 751) (item 6). Tighten T-clamp (Figure 751) (item 4) securing large hose to CAC outlet to 55 lb·in (6.2 N·m).
3. Install gauge coupler (Figure 751) (item 3) and T-clamp onto large hose. Tighten T-clamp securing gauge coupler to large hose to 55 lb·in (6.2 N·m).
4. Connect safety cable (Figure 751) (item 7) to a known good anchor point.
5. Attach gauge / regulator assembly (Figure 751) (item 1) onto quick disconnect fitting (Figure 751) (item 2).

Figure 752 Bleed-Off Coupler Installed On CAC Intake

1. Safety cable
2. Bleed-off coupler
3. T-clamp (2)
4. Small hose
5. Charge Air Cooler (CAC) Intake

6. Install small hose (Figure 752) (Item 4) and T-clamp (Figure 752) (Item 3) onto CAC Intake (Figure 752) (Item 5). Tighten T-clamp (Figure 752) (Item 3) securing small hose to CAC Intake to 55 lb·in (6.2 N·m).
7. Install bleed-off coupler (Figure 752) (Item 2) and T-clamp onto small hose. Tighten T-clamp securing bleed-off coupler to small hose to 55 lb·in (6.2 N·m).
8. Connect safety cable (Figure 752) (Item 1) to a known good anchor point.

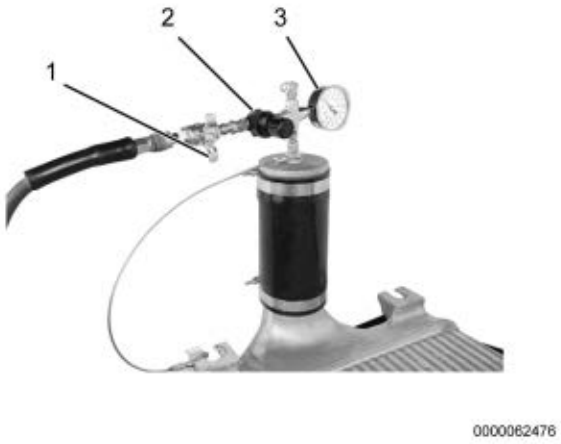

Figure 753 Gauge / Regulator Assembly Connections

1. Air valve
2. Air regulator knob
3. Gauge

WARNING: To prevent personal injury or death, attach safety cables to Charge Air Cooler (CAC) or a known good anchor point.

CAUTION: Adjust air regulator valve to minimum setting before connecting shop air supply. Accidentally applying high-pressure can damage tool components or the Charge Air Cooler (CAC).

9. Connect filtered shop air supply to air valve (Figure 753) (item 1) on gauge / regulator assembly.

WARNING: To prevent personal injury or death, increase air pressure slowly to prevent coupler blowing-out during testing.

10. Open air valve slightly, and slowly increase air pressure until gauge (Figure 753) (Item 3) reads 30 psi (205 kPa). If needed, adjust air regulator knob (Figure 753) (Item 2) as follows until gauge reads 30 psi (205 kPa):
    a. Pull air regulator knob outward to unlock.
    b. Turn air regulator knob to adjust pressure to 30 psi (205 kPa).
    c. Push air regulator knob inward back into locked position.
11. Close air valve and monitor gauge pressure for 15 seconds.
    - If air pressure drops more than 5 psi (34 kPa), replace CAC.
    - If air pressure drops 5 psi (34 kPa) or less, perform cleaning procedure. See Charge Air Cooler (CAC) Cleaning
12. Repeat steps 12 and 13 three times to verify results.

Expected Outcome

Technician will verify Charge Air Cooler (CAC) in not leaking.

Follow-on Procedure

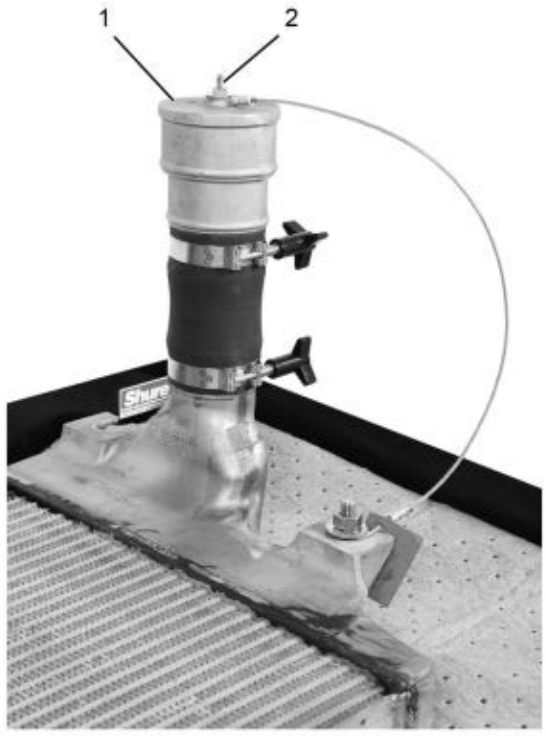

Figure 754 Bleed-Off Coupler Components

1. Bleed-off coupler
2. Bleed-off valve

WARNING: To prevent personal injury or death, relieve air pressure through bleed-off valve slowly before removing test equipment.

1. Slowly turn bleed-off valve (Figure 754) (Item 2) on bleed-off coupler (Figure 754) (Item 1) counterclockwise, and release air from system.
2. Disconnect filtered shop air supply from air valve on gauge / regulator assembly.

Figure 755 Bleed-Off Coupler Installed On CAC Intake

1. Safety cable
2. Bleed-off coupler
3. T-clamp (2)
4. Small hose
5. Charge Air Cooler (CAC) Intake

3. Disconnect safety cable (Figure 755) (Item 1) from anchor point.
4. Remove bleed-off coupler (Figure 755) (Item 2) and T-clamp (Figure 755) (Item 4) from small hose.
5. Remove small hose (Figure 755) (item 4) and T-clamp from CAC Intake (Figure 755) (item 5).

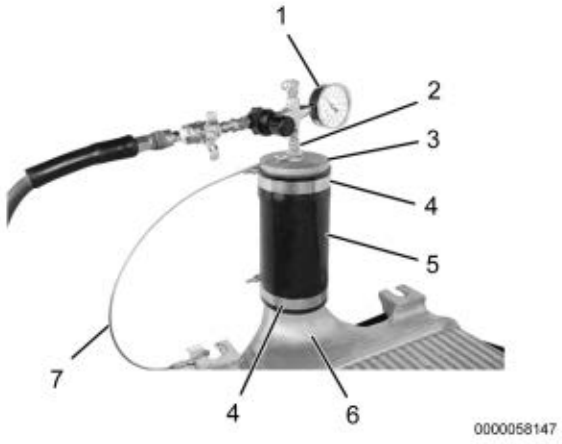

Figure 756 CAC Pressure Test Kit Installed on CAC Outlet

1. Gauge / regulator assembly
2. Quick disconnect fitting
3. Gauge coupler
4. T-clamp (2)
5. Large hose
6. Charge Air Cooler (CAC) outlet
7. Safety cable

6. Remove gauge / regulator assembly (Figure 756) (item 1) from quick disconnect fitting (Figure 756) (item 2).
7. Remove safety cable (Figure 756) (item 7) from anchor point.
8. Remove gauge coupler (Figure 756) (item 3) and T-clamp (Figure 756) (Item 4) from large hose (Figure 756) (Item 5).
9. Remove large hose and T-clamp from CAC outlet (Figure 756) (item 6).
10. Install Charge Air Cooler on engine.

Interstage Cooler (ISC) Pressure test

Overview

Pressure test the Interstage Cooler (ISC).

Tools Required

- Interstage Cooler (ISC) Pressure Test Kit ZTSE6042
- Gauge / Air Regulator Assembly 12–544–01–02

Equipment Condition

None

Test Setup

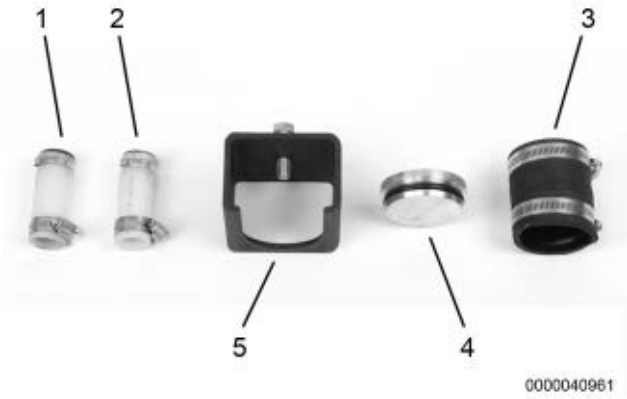

Figure 757 Charge Air Cooler Test Kit ZTSE6042

1. Coolant Port Plug (with 1/4” NPT hole)
2. Coolant Port Plug (solid)
3. Air Inlet Plug (with 1/4” NPT hole)
4. Air Outlet Disc Plug
5. Air Outlet Disc Plug Retaining Bracket

1. Remove ISC from engine.

WARNING: To prevent personal injury or death, ensure ISC Test Kit components are tightened properly; otherwise, they can explode while ISC is under pressure.

WARNING: To prevent personal injury or death, ensure ISC air inlet and outlet, O-rings are removed and that no lubricant is on sealing surface. O-ring and lubricant can cause the ISC Pressure Test Kit components to explode while ISC is under pressure.

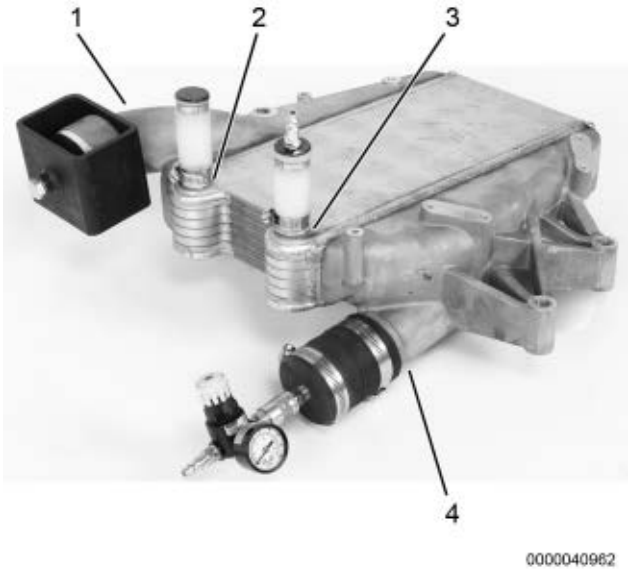

Figure 758 Pressure Test On Air Side Of Interstage Cooler (ISC)

1. ISC air outlet
2. ISC coolant return port
3. ISC coolant supply port
4. ISC air inlet

2. Attach Charge Air Cooler Test Kit to ISC.
   - Obtain 3-inch couplers and clamps locally.
3. Cover ISC air outlet (Figure 758) (Item 1) with Air Outlet Disc Plug.
4. Install Air Outlet Disc Plug Retaining Bracket on top of Air Outlet Disc Plug. Tighten clamping bolt to seal ISC air outlet.
5. Attach Air Inlet Plug (with 1/4″ NPT hole) to ISC air inlet (Figure 758) (Item 4), and tighten clamps.
6. Attach Coolant Port Plug (solid) to ISC coolant return port (Figure 758) (Item 2). Tighten clamp.
7. Attach Coolant Port Plug (with 1/4″ NPT hole) to ISC coolant supply port (Figure 758) (Item 3). Tighten clamp.

Test Procedure

WARNING: To prevent personal injury or death, wear safety glasses with side shields. Limit compressed air pressure to 30 psi (207 kPa).

1. Connect locally obtained regulator with shop air source, and pressurize the air side of ISC to 30 psi (207 kPa).
2. Spray a soapy water solution on ISC. Look for leaks from hose connections, ISC, or test components.
3. If a leak is detected on ISC or test gauge pressure drops, replace ISC.

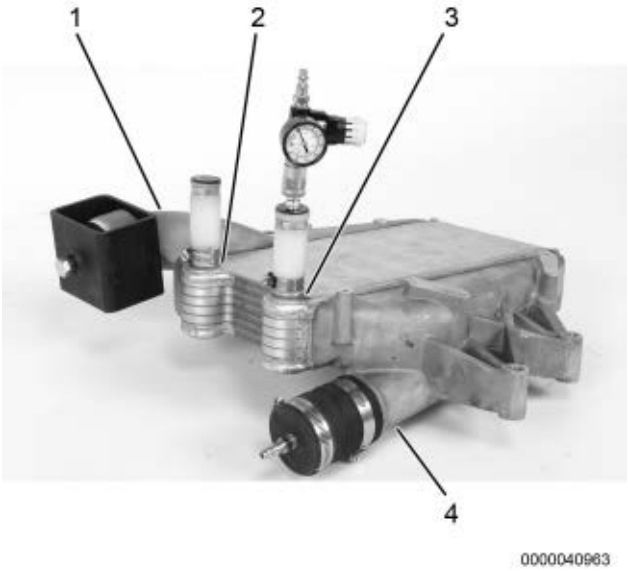

Figure 759 Pressure test on coolant side of Interstage Cooler (ISC)

1. ISC air outlet
2. ISC coolant return port
3. ISC coolant supply port
4. ISC air inlet

4. Connect regulator with shop air source, and pressurize the coolant side of ISC to 30 psi (207 kPa).
5. Spray a soapy water solution on ISC. Look for leaks from hose connections, ISC, or test components.
6. If a leak is detected on ISC or test gauge pressure drops, replace ISC.

Expected Outcome

Technician will verify if Interstage Cooler (ISC) is leaking.

Follow-on Procedure

1. Remove Interstage Cooler (ISC) Pressure Test Kit from ISC.
2. Install ISC on engine.

Crankcase Pressure Test

Overview

Verify if engine is in need for a possible overhaul or repair due to cylinder or valve wear or damage. Verify operation of air compressor or turbochargers for possible worn or damaged parts.

Tools

- Digital manometer or ZTSE2217A – Water Manometer
- ZTSE4039 – Crankcase Pressure Test Tool
- ZTSE4891 – Air Cap, Fuel Cap and Plug Kit

Test Setup

1. Verify crankcase oil breather separator is functioning properly before running this test. See Crankcase Oil Breather Separator Test (page 1713).
2. Disconnect breather outlet tube from 90 degree breather outlet elbow on top of oil separator.
3. Connect Crankcase Pressure Test Tool ZTSE4039 to breather outlet elbow.

Figure 760 Digital manometer connected to Crankcase Pressure Tool

1. Crankcase Pressure Test Tool
2. Digital manometer

4. Connect manometer to Crankcase Pressure Test Tool ZTSE4039.
5. Ensure engine is at normal operating temperature – 158° F (70° C)

Test procedure

1. Start engine and run at high idle. Allow manometer reading to stabilize before recording pressure reading.
2. Record crankcase pressure
   - If pressure is within specification, no repair is required.
   - If pressure is above specification, continue to next step.

3. Shut engine OFF. Drain vehicle air tanks until pressure is removed from air system.
4. Remove air line from remote-mounted centrifugal filter and cap using Air Cap, Fuel Cap and Plug Kit ZTSE4891.
5. Start engine and run at high idle. Allow manometer reading to stabilize before recording pressure reading.
6. Record crankcase pressure
   - If pressure is within specification, repair or replace centrifugal filter assembly.
   - If pressure is above specification, continue to next step.

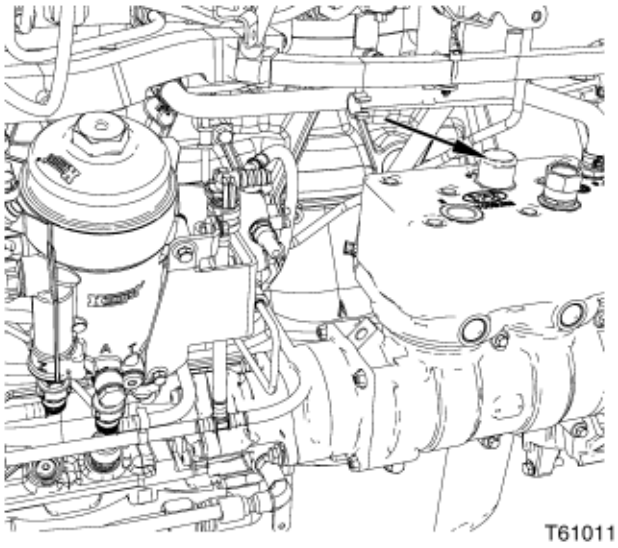

Figure 761 Air compressor discharge port

7. If engine has an air compressor, remove discharge line and test again. Allow manometer reading to stabilize before recording pressure reading.
8. Record crankcase pressure
   - If pressure is above specification, go to Relative Compression Test (page 1592) to pinpoint suspect cylinder.
   - If pressure is at or below specification, compressed air is leaking into crankcase. Repair or replace air compressor.

Expected Outcome

Crankcase pressure will be within specification. Cause of crankcase pressure being out of specification will be diagnosed and determined.

Follow-on Procedure

None

Relay Diagnostics

Overview

This table provides information for relay diagnostics. It lists the different type of relay activation conditions, how to test that type of relay, which relays are utilized in what way, where the relays are mounted and relevant fault code or symptom information for each relay.

Relay Diagnostics Applicability Table

Relay	Location	Relevant Fault Codes	Control Side Test	Relevant Fault Codes	Switch Side Test	Relevant Fault Codes
Starter	Engine	Symptom - Does not crank	SW-85 GND No Code(page 1743)		SW-85 GND	
Sw Ign	AFT	SPN 1761 FMI 19; SPN 3216 FMI 19; SPN 3226 FMI 19; SPN 4377 FMI 19; SPN 5742 FMI 19; SPN 5743 FMI 19	SW-86 PWR No Code		SW-86 PWR (page 1730)	
DEFSM Heater	AFT	None	SW-86 PWR (page 1730)	SPN 5746 FMI 3, 4	SW-86 PWR (page 1730)	SPN 5745 FMI 3, 4
DEF Line Heater	AFT	None	SW-86 PWR (page 1730)	SPN 5491 FMI 3, 4	SW-86 PWR (page 1730)	SPN 4340 FMI 3, 5 SPN 4342 FMI 3, 5 SPN 4344 FMI 3, 5

Relay Test 1 - Switched-86 GND

Overview

This test provides diagnostics for relays that have constant battery voltage at Terminal-85, switched ground (GND) at Terminal-86 and constant battery voltage at Terminal-30.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Digital Multimeter (DMM)
- Relay Breakout Harness

Equipment Conditions

None

Test Setup

1. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
2. Log in to ServiceMaxx™
3. Install appropriate Relay Breakout Harness in place of the relay.

   To find the correct Relay Breakout Harness, see Electrical Tools (page 1849) section of this manual.
4. Install relay into Relay Breakout Harness

Test Procedure

Step 1	Check for battery power at Terminal-30.	Decision
Measure voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V)?		Yes: Go to Step 2 No: Check and repair wiring, connectors and fuses to relay Terminal-30. After repairs are complete, retest for original problem.

Step 2	Verify use of Electronic Service Tool (EST) with ServiceMaxx™ to activate relay.	Decision
Can the relay be activated using ServiceMaxx™?		Yes: Go to Step 3 No: Go to Step 5

Step 3	Activate and test relay input.	Decision
	A. Using EST with ServiceMaxx™, activate the command circuit for the relay B. Measure voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V) when relay is activated?	Yes: Go to Step 4 No: Check and repair connectors and wiring for corrosion, looseness and damaged or broken pins that would cause high resistance. After repairs are complete, retest for original problem.

Step 4	Activate and test relay output.	Decision
	A. Using EST with ServiceMaxx™, activate the command circuit for the relay B. Measure voltage at Terminal-87 Does Terminal-87 have Battery Voltage (+/- 0.5 V) when relay is activated?	Yes: End Diagnostic Steps No: Replace relay. After repairs are complete, retest for original problem.

Step 5	Activate and test relay input.	Decision
	A. Use jumper wire to short Terminal-86 to GND B. Check for battery voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V) when relay is activated?	Yes: Go to Step 6 No: Check and repair connectors and wiring for corrosion, looseness and damaged or broken pins that would cause high resistance. After repairs are complete, retest for original problem.

Step 6	Activate and test relay output.	Decision
	A. Use jumper wire to short Terminal-86 GND B. Check for battery voltage at Terminal-87 Does Terminal-87 have Battery Voltage (+/- 0.5 V) when relay is activated?	Yes: End Diagnostic Steps No: Replace relay. After repairs are complete, retest for original problem.

Expected Outcome

Technician will validate that relay is working properly or diagnose cause of relay not working properly.

Follow-on Procedure

None

Relay Test 2 – Switched-86 PWR

Overview

This test provides diagnostics for relays that have a constant ground (GND) at Terminal-85, switched battery voltage at Terminal-86 and constant battery voltage at Terminal-30.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Digital Multimeter (DMM)
- Relay Breakout Harness

Equipment Conditions

None

Test Setup

1. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
2. Log in to ServiceMaxx™
3. Install appropriate Relay Breakout Harness in place of the relay.

   To find the correct Relay Breakout Harness, see Electrical Tools (page 1849) section of this manual.
4. Install relay into Relay Breakout Harness

Test Procedure

Step 1	Check for battery power at Terminal-30.	Decision
Measure voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V)?		Yes: Go to Step 2
		No: Check and repair wiring, connectors and fuses to relay Terminal-30. After repairs are complete, retest for original problem.

Step 2	Verify use of Electronic Service Tool (EST) with ServiceMaxx™ to activate relay.	Decision
Can the relay be activated using ServiceMaxx™?		Yes: Go to Step 3
		No: Go to Step 5

Step 3	Activate and test relay input.	Decision
A. Using EST with ServiceMaxx™, activate the command circuit for the relay B. Measure voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: Go to Step 4 No: Check and repair connectors and wiring for corrosion, looseness and damaged or broken pins that would cause high resistance. After repairs are complete, retest for original problem.

Step 4	Activate and test relay output.	Decision
A. Using EST with ServiceMaxx™, activate the command circuit for the relay B. Measure voltage at Terminal-87 Does Terminal-87 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: End Diagnostic Steps No: Replace relay. After repairs are complete, retest for original problem.

Step 5	Activate and test relay input.	Decision
A. Use jumper wire to short Terminal-86 to Terminal-30 B. Check for battery voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: Go to Step 6 No: Check and repair connectors and wiring for corrosion, looseness and damaged or broken pins that would cause high resistance. After repairs are complete, retest for original problem.

Step 6	Activate and test relay output.	Decision
A. Use jumper wire to short Terminal-86 to Terminal-30 B. Check for battery voltage at Terminal-87 Does Terminal-87 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: End Diagnostic Steps No: Replace relay. After repairs are complete, retest for original problem.

Expected Outcome

Technician will validate that relay is working properly or diagnose cause of relay not working properly.

Follow-on Procedure

None

Relay Test 3 – Switched-85 GND

Overview

This test provides diagnostics for relays that have switched ground (GND) at Terminal-85, constant battery voltage at Terminal-86 and constant battery voltage at Terminal-30.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Digital Multimeter (DMM)
- Relay Breakout Harness

Equipment Conditions

None

Test setup

1. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
2. Log in to ServiceMaxx™
3. Install appropriate Relay Breakout Harness in place of the relay.

   To find the correct Relay Breakout Harness, see Electrical Tools (page 1849) section of this manual.
4. Install relay into Relay Breakout Harness

CAUTION: Verify that relay is not diode-protected. This can cause a properly working relay coil to fail resistance tests. Failure to comply will result in misdiagnosis and unnecessary repairs.

Test Procedure

Step 1	Check for battery power at Terminal-30.	Decision
Measure voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V)?		Yes: Go to Step 2 No: Check and repair wiring, connectors and fuses to relay Terminal-30. After repairs are complete, retest for original problem.

Step 2	Check for battery power at Terminal-86.	Decision
Measure voltage at Terminal-86 Does Terminal-86 have Battery Voltage (+/- 0.5 V)?		Yes: Go to Step 3
		No: Check and repair wiring, connectors and fuses to relay Terminal-86. After repairs are complete, retest for original problem.

Step 3	Verify use of Electronic Service Tool (EST) with ServiceMaxx™ to activate relay.	Decision
Can the relay be activated using ServiceMaxx™?		Yes: Go to Step 4
		No: Go to Step 6

Step 4	Activate and test relay input.	Decision
A. Using EST with ServiceMaxx™, activate the command circuit for the relay B. Measure voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: Go to Step 5
		No: Check and repair connectors and wiring for corrosion, looseness and damaged or broken pins that would cause high resistance. After repairs are complete, retest for original problem.

Step 5	Activate and test relay output.	Decision
A. Using EST with ServiceMaxx™, activate the command circuit for the relay B. Measure voltage at Terminal-87 Does Terminal-87 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: End Diagnostic Steps
		No: Replace relay. After repairs are complete, retest for original problem.

Step 6	Activate and test relay input.	Decision
A. Use jumper wire to short Terminal-85 to GND B. Check for battery voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: Go to Step 7
		No: Check and repair connectors and wiring for corrosion, looseness and damaged or broken pins that would cause high resistance. After repairs are complete, retest for original problem.

Step 7	Activate and test relay output.	Decision
	A. Use jumper wire to short Terminal-85 to GND	Yes: End Diagnostic Steps
	B. Check for battery voltage at Terminal-87 Does Terminal-87 have Battery Voltage (+/- 0.5 V) when relay is activated?	No: Replace relay. After repairs are complete, retest for original problem.

Expected Outcome

Technician will validate that relay is working properly or diagnose cause of relay not working properly.

Follow-on Procedure

None

Relay Test 4 – Switched-85 Shared 30

Overview

This test provides diagnostics for relays that have switched ground (GND) at Terminal-85, constant battery voltage at Terminal-86 and constant battery voltage at Terminal-30.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Digital Multimeter (DMM)
- Relay Breakout Harness

Equipment Conditions

None

Test setup

1. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
2. Log in to ServiceMaxx™
3. Install appropriate Relay Breakout Harness in place of the relay.

   To find the correct Relay Breakout Harness, see Electrical Tools (page 1849) section of this manual.
4. Install relay into Relay Breakout Harness

CAUTION: Verify that relay is not diode-protected. This can cause a properly working relay coil to fail resistance tests. Failure to comply will result in misdiagnosis and unnecessary repairs.

Test Procedure

Step 1	Check for battery power at Terminal-30.	Decision
Measure voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V)?		Yes: Go to Step 2 No: Check and repair wiring, connectors and fuses to relay Terminal-30. After repairs are complete, retest for original problem.

Step 2	Check for battery power at Terminal-86.	Decision
Measure voltage at Terminal-86 Does Terminal-86 have Battery Voltage (+/- 0.5 V)?		Yes: Go to Step 3 No: Check and repair wiring, connectors and fuses to relay Terminal-86. After repairs are complete, retest for original problem.

Step 3	Verify use of Electronic Service Tool (EST) with ServiceMaxx™ to activate relay.	Decision
Can the relay be activated using ServiceMaxx™?		Yes: Go to Step 4 No: Go to Step 6

Step 4	Activate and test relay input.	Decision
A. Using EST with ServiceMaxx™, activate the command circuit for the relay B. Measure voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: Go to Step 5 No: Check and repair connectors and wiring for corrosion, looseness and damaged or broken pins that would cause high resistance. After repairs are complete, retest for original problem.

Step 5	Activate and test relay output.	Decision
A. Using EST with ServiceMaxx™, activate the command circuit for the relay B. Measure voltage at Terminal-87 Does Terminal-87 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: End Diagnostic Steps No: Replace relay. After repairs are complete, retest for original problem.

Step 6	Activate and test relay input.	Decision
A. Use jumper wire to short Terminal-85 to GND B. Check for battery voltage at Terminal-30 Does Terminal-30 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: Go to Step 7 No: Check and repair connectors and wiring for corrosion, looseness and damaged or broken pins that would cause high resistance. After repairs are complete, retest for original problem.

Step 7	Activate and test relay output.	Decision
	A. Use jumper wire to short Terminal-85 to GND	Yes: End Diagnostic Steps
	B. Check for battery voltage at Terminal-87 Does Terminal-87 have Battery Voltage (+/- 0.5 V) when relay is activated?	No: Replace relay. After repairs are complete, retest for original problem.

Expected Outcome

Technician will validate that relay is working properly or diagnose cause of relay not working properly.

Follow-on Procedure

None

Relay Test 5 – Switched-85 GND, FMI 4

Overview

This test provide diagnostics for relays that set FMI 4 when the control is shorted to ground (GND).

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Digital Multimeter (DMM)
- Relay Breakout Harness

Equipment Conditions

None

Test setup

1. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
2. Log in to ServiceMaxx™
3. Install appropriate Relay Breakout Harness in place of the relay.

   To find the correct Relay Breakout Harness, see Electrical Tools (page 1849) section of this manual.
4. Install relay into Relay Breakout Harness

CAUTION: Verify that relay is not diode-protected. This can cause a properly working relay coil to fail resistance tests. Failure to comply will result in misdiagnosis and unnecessary repairs.

Test Procedure

Step 1	Check for battery power at Terminal-86.	Decision
Measure voltage between Terminal-86 and GND Does Terminal-86 have Battery Voltage (+/- 0.5 V)?		Yes: Go to Step 2 No: Check and repair wiring, connectors and fuses to relay Terminal-86. After repairs are complete, retest for original problem.

Step 2	Check for battery power between Terminal-86 and Terminal-85.	Decision
Measure voltage between Terminal-86 and Terminal-85 Does Terminal-86 have Battery Voltage (+/- 0.5 V)?		Yes: Check and repair wiring and/or connectors to relay Terminal-85 for short to GND. After repairs are complete, retest for original problem.
		No: Go to Step 3

Step 3	Check for a shorted or open coil.	Decision
Measure resistance between Terminal-85 and Terminal-86 Is resistance reading between Terminal-85 and Terminal-86 approximately 100 Ohms?		Yes: Relay is good, End Diagnostic Steps
		No: Replace relay, coil is shorted (if low) or open (if high). After repairs are complete, retest for original problem.

Expected Outcome

Technician will validate that relay is working properly or diagnose cause of relay not working properly.

Follow-on Procedure

None

Relay Test 6 – Switched-86 PWR, No Code

Overview

This test provides diagnostics for relays that have switched ground (GND) at Terminal-85, constant battery voltage at Terminal-86 and constant battery voltage at Terminal-30.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Digital Multimeter (DMM)
- Relay Breakout Harness

Equipment Conditions

None

Test setup

1. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
2. Log in to ServiceMaxx™
3. Install appropriate Relay Breakout Harness in place of the relay.

   To find the correct Relay Breakout Harness, see Electrical Tools (page 1849) section of this manual.
4. Install relay into Relay Breakout Harness

CAUTION: Verify that relay is not diode-protected. This can cause a properly working relay coil to fail resistance tests. Failure to comply will result in misdiagnosis and unnecessary repairs.

Test Procedure

Step 1	Check for a shorted or open coil.	Decision
Measure resistance between Terminal-85 and Terminal-86 Is resistance reading between Terminal-85 and Terminal-86 approximately 100 Ohms?		Yes: Go to Step 2 No: Replace relay, coil is shorted (if low) or open (if high). After repairs are complete, retest for original problem.

Step 2	Check for battery power at Terminal-30.	Decision
Measure voltage between Terminal-30 and GND Does Terminal-30 have Battery Voltage (+/- 0.5 V)?		Yes: Go to Step 3 No: Check and repair wiring, connectors and fuses to relay Terminal-30. After repairs are complete, retest for original problem.

Step 3	Check for battery power between Terminal-86 and Terminal-85.	Decision
Measure voltage between Terminal-30 and Terminal-85 Does Terminal-30 have Battery Voltage (+/- 0.5 V)?		Yes: Go to Step 4 No: Check and repair wiring and connectors between Terminal-85 and GND. After repairs are complete, retest for original problem.

Step 4	Verify use of Electronic Service Tool (EST) with ServiceMaxx™ to activate relay.	Decision
Can the relay be activated using ServiceMaxx™?		Yes: Go to Step 5 No: Go to Step 6

Step 5	Activate and test relay switch circuit.	Decision
A. Using EST with ServiceMaxx™, activate the command circuit for the relay B. Measure voltage between Terminal-85 and Terminal-86 Does Terminal-86 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: End Diagnostic Steps No:Check and repair wiring between Terminal-86 and control unit. After repairs are complete, retest for original problem.

Step 6	Activate and test relay.	Decision
A. Use jumper wire to short Terminal-30 to Terminal-86 B. Check to see if relay activates Does relay activate?		Yes: Check and repair open in wiring between Terminal-86 and control unit. After repairs are complete, retest for original problem. No: Replace relay. After repairs are complete, retest for original problem.

Expected Outcome

Technician will validate that relay is working properly or diagnose cause of relay not working properly.

Follow-on Procedure

None

Relay Test 7 – Switched-85 GND, No Code

Overview

This test provides diagnostics for relays that have switched ground (GND) at Terminal-85, constant battery voltage at Terminal-86 and constant battery voltage at Terminal-30.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)
- Digital Multimeter (DMM)
- Relay Breakout Harness

Equipment Conditions

None

Test setup

1. Connect Electronic Service Tool (EST) with ServiceMaxx™ software to Vehicle Diagnostic Connector (page 1571).
2. Log in to ServiceMaxx™
3. Install appropriate Relay Breakout Harness in place of the relay.

   To find the correct Relay Breakout Harness, see Electrical Tools (page 1849) section of this manual.
4. Install relay into Relay Breakout Harness

CAUTION: Verify that relay is not diode-protected. This can cause a properly working relay coil to fail resistance tests. Failure to comply will result in misdiagnosis and unnecessary repairs.

Test Procedure

Step 1	Check for a shorted or open coil.	Decision
Measure resistance between Terminal-85 and Terminal-86 Is resistance reading between Terminal-85 and Terminal-86 approximately 100 Ohms?		Yes: Go to Step 2 No: Replace relay, coil is shorted (if low) or open (if high). After repairs are complete, retest for original problem.

Step 2	Check for battery power at Terminal-86.	Decision
Measure voltage between Terminal-86 and GND Does Terminal-86 have Battery Voltage (+/- 0.5 V)?		Yes: Go to Step 3 No: Check and repair wiring, connectors and fuses to relay Terminal-86. After repairs are complete, retest for original problem.

Step 3	Verify use of Electronic Service Tool (EST) with ServiceMaxx™ to activate relay.	Decision
Can the relay be activated using ServiceMaxx™?		Yes: Go to Step 4
		No: Go to Step 5

Step 4	Activate and test relay switch circuit.	Decision
A. Using EST with ServiceMaxx™, activate the command circuit for the relay B. Measure voltage between Terminal-85 and Terminal-86 Does Terminal-86 have Battery Voltage (+/- 0.5 V) when relay is activated?		Yes: End Diagnostic Steps
		No:Check and repair wiring between Terminal-85 and control unit. After repairs are complete, retest for original problem.

Step 5	Activate and test relay.	Decision
A. Use jumper wire to short Terminal-85 to GND B. Check to see if relay activates Does relay activate?		Yes: Check and repair open in wiring between Terminal-85 and control unit. After repairs are complete, retest for original problem.
		No: Replace relay. After repairs are complete, retest for original problem.

Expected Outcome

Technician will validate that relay is working properly or diagnose cause of relay not working properly.

Follow-on Procedure

None

J1939 diagnostics

Overview

This test will diagnose problems with the J1939 datalink

CONTENT
UNDER
DEVELOPMENT

0000305681

Coolant Test Procedures

Deaeration Tank Cap Test

Overview

Verify proper operation of the deaeration tank cap.

WARNING: To avoid possible injury or death, use care when working around hot coolant.

WARNING: To prevent personal injury or death, do the following when removing the radiator cap or deaeration cap:

- **Allow engine to cool for 15 minutes.**
- **Wrap a thick cloth around radiator cap or deaeration cap.**
- **Loosen cap slowly a quarter to half turn counterclockwise to vent pressure.**
- **Pause for a moment to avoid being scalded by steam.**
- **Continue to turn the cap counterclockwise to remove.**

Tools Required

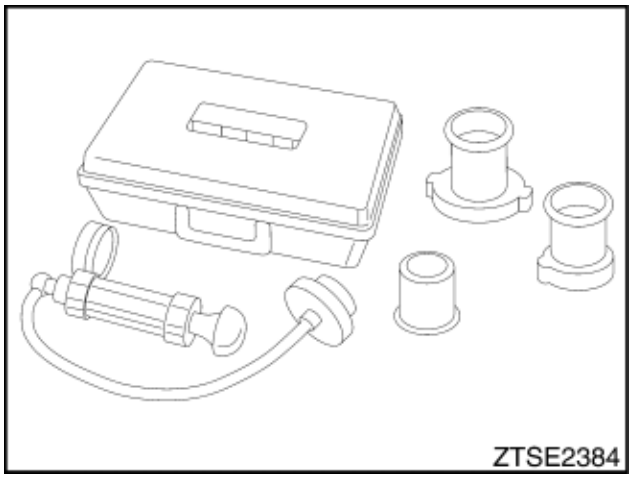

Figure 763 ZTSE2384 Radiator Pressure Testing Kit ZTSE2384

Figure 764 09–040–01 Coolant Cap Pressure Tester

- ZTSE2384 Radiator Pressure Testing Kit or 09-040-01 Coolant Cap Pressure Tester

Equipment Condition

None

Test Setup

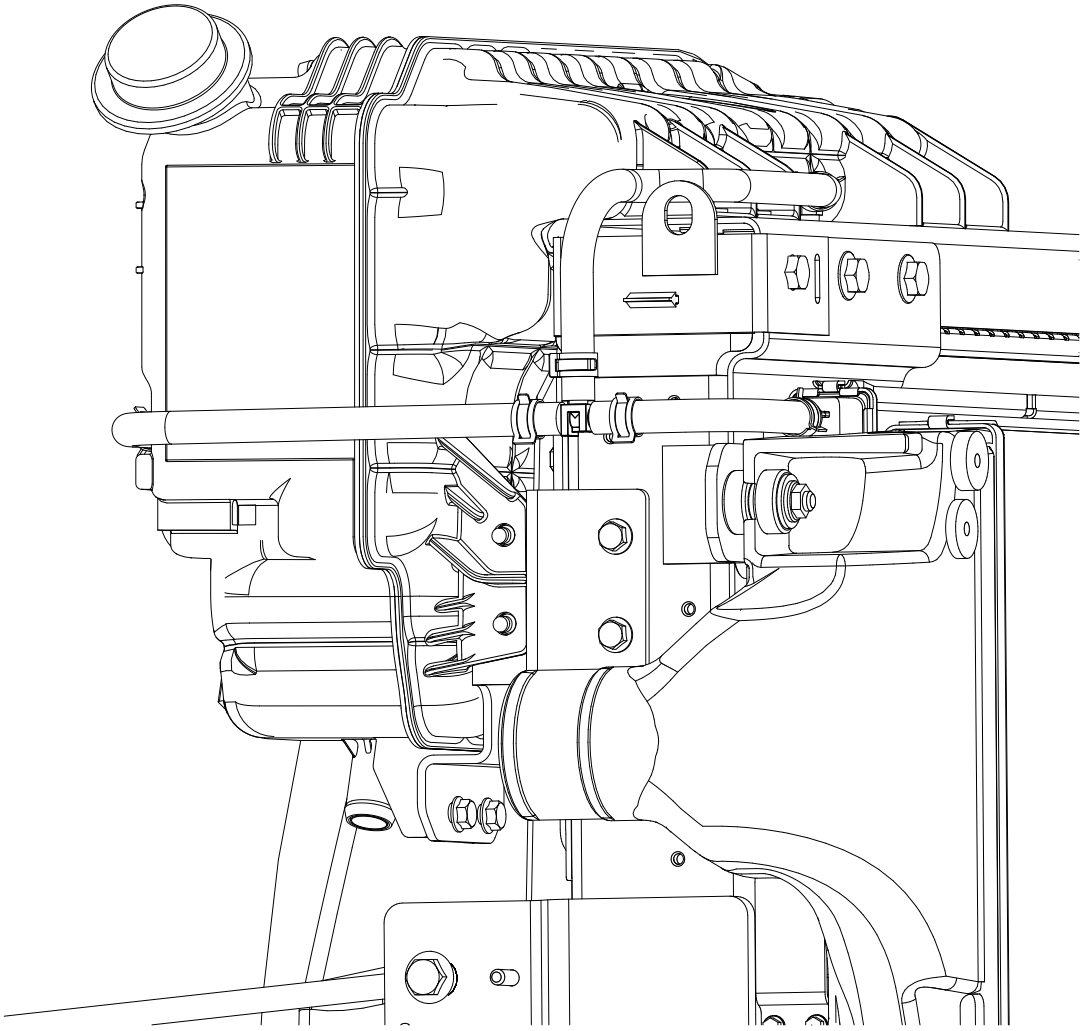

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Figure 765 Coolant Deaeration Tank and Cap

1. Remove cap from deaeration tank (Figure 765).
2. Check deaeration tank (Figure 765) neck for cracks or warping.

Test Procedure

1. Determine rated pressure of deaeration tank cap.
2. Test dearation cap following the tool instructions for the tester being used.
3. Replace cap if not within specification.

Expected Outcome

Cap will hold rated pressure.

Follow-on Procedure

None

Cooling System Pressure Test

Overview

The following test is used to verify integrity of cooling system by using air pressure. Applying air pressure ensures system has no leaks. The system should hold pressure indicating there are no leaks in the system.

WARNING: To prevent personal injury or death, wear safety glasses with side shields.

WARNING: To prevent personal injury or death, do following when removing radiator cap or deaeration cap:

- **Allow engine to cool for 15 minutes or more.**
- **Wrap a thick cloth around the radiator cap or deaeration cap.**
- **Loosen cap slowly a quarter to half turn to vent pressure.**
- **Pause for a moment to avoid being scalded by steam.**
- **Continue to turn cap counter-clockwise to remove.**

WARNING: To prevent personal injury or death, ensure shop-air pressure is properly regulated.

Tools Required

- Coolant Management Tool KL5007NAV.

Equipment Condition

1. Remove splash guards (as necessary).
2. Cooling system full.

Test Setup

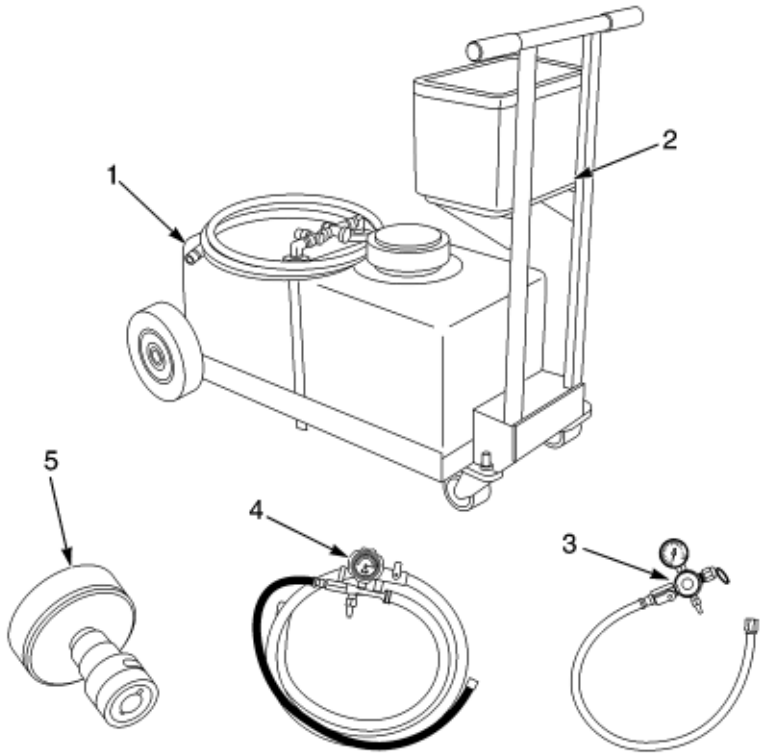

Figure 766 Coolant Management Tool (KL5007NAV)

1. Coolant Supply Tank
2. Cart
3. Pressure Module
4. Vacuum Module
5. Cap Adapter

1. Replace deaeration cap with cap adapter (Figure 766) (Item 5) from Coolant Management Tool.
2. Connect Pressure Module (Figure 766) (Item 3) to cap adapter (Figure 766) (Item 5).
3. Apply shop air to Pressure Module (Figure 766) (Item 3).

Test Procedure

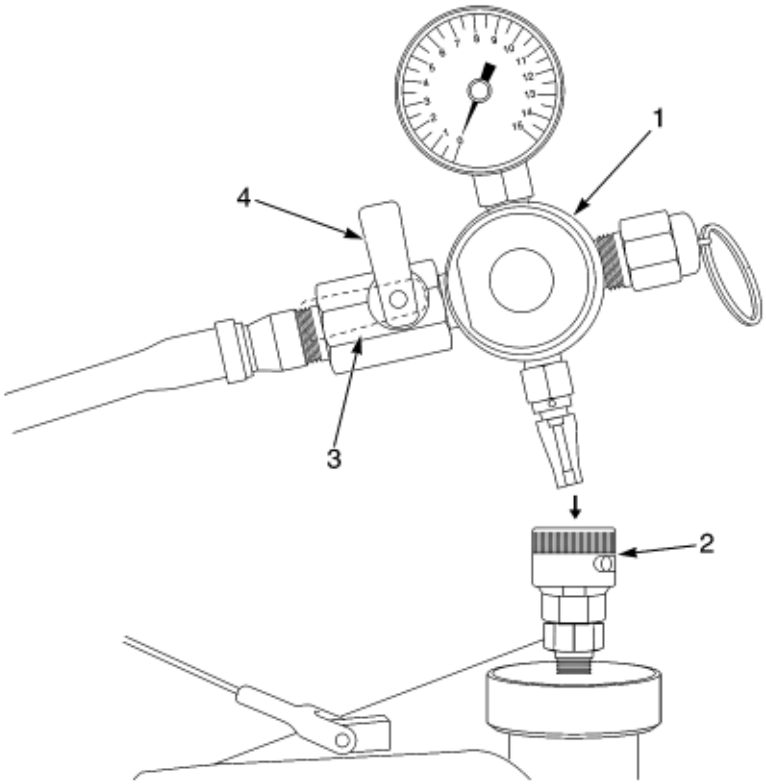

Figure 767 Cap Adapter and Pressure Module

1. Pressure Module
2. Cap Adapter (KL5004NAV)
3. Air Valve (Open)
4. Air Valve (Closed)

1. Turn Coolant Supply Tank valve to CLOSED position.
2. Open air valve (Figure 767) (Item 3) on Pressure Module (Figure 767) (Item 1) making sure not to exceed cap pressure on system.
3. Close air valve (Figure 767) (Item 4). System is now pressurized with air.
4. Take note of gauge reading and check for pressure decay. If no decay is detected, there are no leaks, go to Step 7.
5. If decay is evident, check cooling system for leak(s).
6. Repeat steps 1 to 3 to re-pressurize system as necessary to find source of pressure loss.
7. Disconnect compressed air, and remove Pressure Module (Figure 767) (Item 1).
8. Slowly open air valve (Figure 767) (Item 3) on Pressure Module (Figure 767) (Item 1) to vent the pressure in the cooling system.

Expected Outcome

Engine cooling system holds steady air pressure.

Follow-on Procedure

Replace splash guards (if removed).

Air Compressor Leaking Coolant to Oil Test

Overview

This test is used to verify that the air compressor is not leaking engine coolant into the engine lube oil.

Tools Required

- Radiator Pressure Test Kit – ZTSE2384

Equipment Condition

None

Test Setup

1. Drain engine lube oil and remove oil pan
2. Install Radiator Pressure Test Kit - ZTSE2384 on Deaeration Tank
3. Maintain 15 psi (103 kPa) of cooling system pressure throughout this test
4. Perform Coolant Leak - Visual Inspection (page 1789)

Test Procedure

1. With cooling system under 15 psi (103 kPa) of pressure, visually inspect engine lube oil return port from air compressor inside crankcase

Expected Outcome

No engine coolant will be found leaking from engine lube oil return port from air compressor.

Follow-On Procedure

None

Air Compressor Leaking Air to Coolant Test

Overview

Verify that the Air compressor is not aerating the coolant. Perform this test when there is a coolant overflow condition.

Tools Required

None

Equipment Condition

None

Test Setup

1. Key,On, Engine-Running.
2. When Overflow condition is present perform next step.

Test Procedure

1. Pull and prop open the drain valves on the air tanks.
2. Monitor deaeration tank for overflow.

Expected Outcome

Technician will verify if Air Compressor is aerating engine coolant.

Follow-on Procedure

1. Close drain valves on air tanks.

Cylinder Head Leak Test

Overview

This test will provide diagnostic information on how to test the cylinder head for coolant leaks

CONTENT
UNDER
DEVELOPMENT

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Fan Engagement Temperature Test

Overview

This test provides diagnostics for ensuring the fan activates and deactivates at the appropriate temperatures.

CONTENT
UNDER
DEVELOPMENT

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Thermostat Operational Test

Overview

This test is used to determine if engine thermostat opens when engine reaches operating temperature by monitoring upper radiator hose temperature.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)
- Infrared Thermometer ZTSE4799

Equipment Condition

1. Allow engine to cold soak.
2. Perform Coolant Level Inspection (page 1786)

Test Setup

1. Key-On Engine-Off (KOEO)
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector (page 1571)
3. Log in to ServiceMaxx™
4. Check for active or inactive fault codes related to coolant temperature. If present, diagnose and repair these faults first
5. Block off radiator, if necessary

Test Procedure

1. Select the Temperature tab in ServiceMaxx™
2. Verify the following sensor values are approximately equal:
   - Engine Coolant Temperature 1 (ECT1)
   - Engine Oil Temperature (EOT)
   - Exhaust Gas Temperature (EGT)
   - Intake Manifold Temperature (IMT)
3. Start engine
4. Monitor upper radiator hose temperature using Infrared Thermometer ZTSE4799
5. Run engine to operating temperature. Upper radiator hose temperature should be less than ECT1 while thermostat is closed.

   As ECT1 reaches approximately 190°F (88°C), a working thermostat will begin to open, and the upper radiator hose should heat up to match ECT1 (± 5° F).

- If ECT1 continues to rise and upper radiator hose remains cooler, replace thermostat and retest.

- If ECT1 never reaches 190° F (88° C), replace thermostat and retest.
- If upper hose matches ECT1 (± 5° F) after engine coolant temperature reaches approximately 190°F (88°C), thermostat is working properly.

Expected Outcome

Upper radiator hose temperature will increase to within ± 5° F of ECT1 after engine warms up past thermostat opening temperature.

Follow-On Procedure

None

Aftertreatment Fuel Injector (AFTFI) Coolant Leak Test

Overview

Inspect inside of exhaust pipe at Aftertreatment Fuel Injector (AFI) nozzle for presence of coolant.

Tools Required

- ZTSE2384 – Radiator Pressure Testing Kit

Equipment Condition

WARNING: To prevent personal injury or death, do the following when removing the radiator cap or deaeration cap:

- Allow engine to cool for 15 minutes or more.
- Wrap a thick cloth around radiator cap or deaeration cap.
- Loosen cap slowly a quarter to half turn counterclockwise to vent pressure.
- Pause for a moment to avoid being scalded by steam.
- Continue to turn cap counterclockwise to remove.

Test Setup

1. Remove deaeration tank cap.
2. Connect Radiator Pressure Testing Kit ZTSE2384 with Surge Tank Cap Adaptor to deaeration tank.

WARNING: To prevent personal injury or death, allow engine to cool before removing components.

WARNING: To prevent personal injury or death, do not let engine fluids stay on your skin. Clean skin and nails using hand cleaner and wash with soap and water. Wash or discard clothing and rags contaminated with engine fluids.

Test Procedure

1. Disconnect exhaust pipe at the turbocharger outlet pipe after the AFTFI.
2. Pressurize cooling system to 117 kPa (17 psi) for 15 minutes.

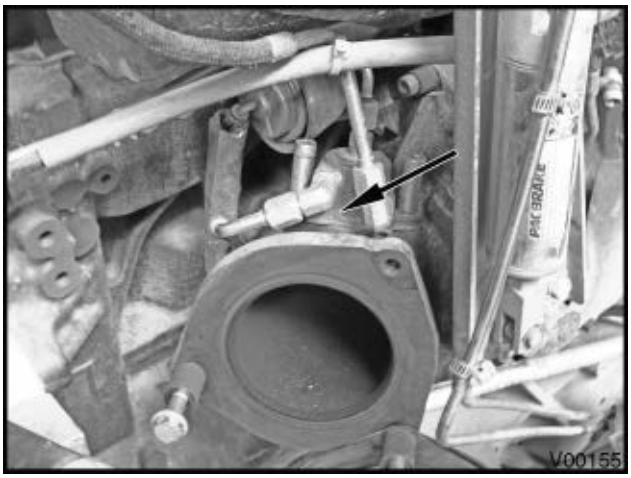

Figure 770 Aftertreatment Fuel Injector (AFI) nozzle

3. Inspect inside of exhaust pipe at AFI nozzle for coolant leaks.

Expected Outcome

Technician will verify if coolant is present in exhaust pipe at AFI nozzle.

Follow-on Procedure

None

On-Engine EGR Cooler Leak Test

Overview

This test will provide direction for the use of new tools on the new style EGR Cooler

Thermostat Operational Test

CONTENT
UNDER
DEVELOPMENT

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Engine Oil Tests

Oil Pressure Verification Test

Overview

Oil Pressure Verification Test verifies electronic signal from Engine Oil Pressure (EOP) sensor. This test utilizes a mechanical gauge to compare sensor output to actual EOP.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B-compliant supporting J1939 and J1708)
- Pressure Test Kit ZTSE4409
- Oil Pressure Test Fitting (Tool Under Development)

Equipment Condition

None

Test Setup Part 1

1. Key-On Engine-Off (KOEO).
2. Connect Electronic Service Tool (EST) to vehicle Diagnostic Connector. (page 1571)
3. Log in to ServiceMaxx™ software.

Test Procedure Part 1

1. Start engine.

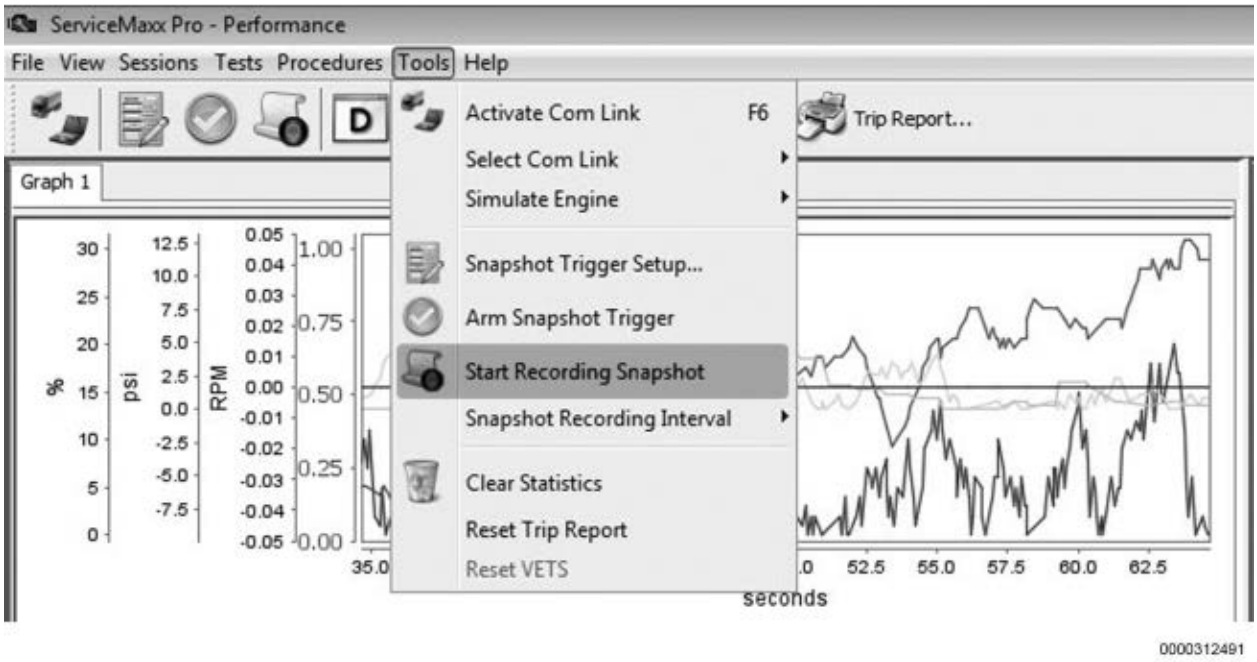

Figure 772 ServiceMaxx™ Tools Menu – Start Recording

2. Start recording by selecting Tools > Start Recording Snapshot. Monitor instrument panel gauge during test.
3. Allow engine to idle for 5 – 10 seconds or until oil pressure reading is stabilized.
4. Increase engine speed to high idle.
5. Wait until oil pressure reading stabilizes and then return engine to low idle.

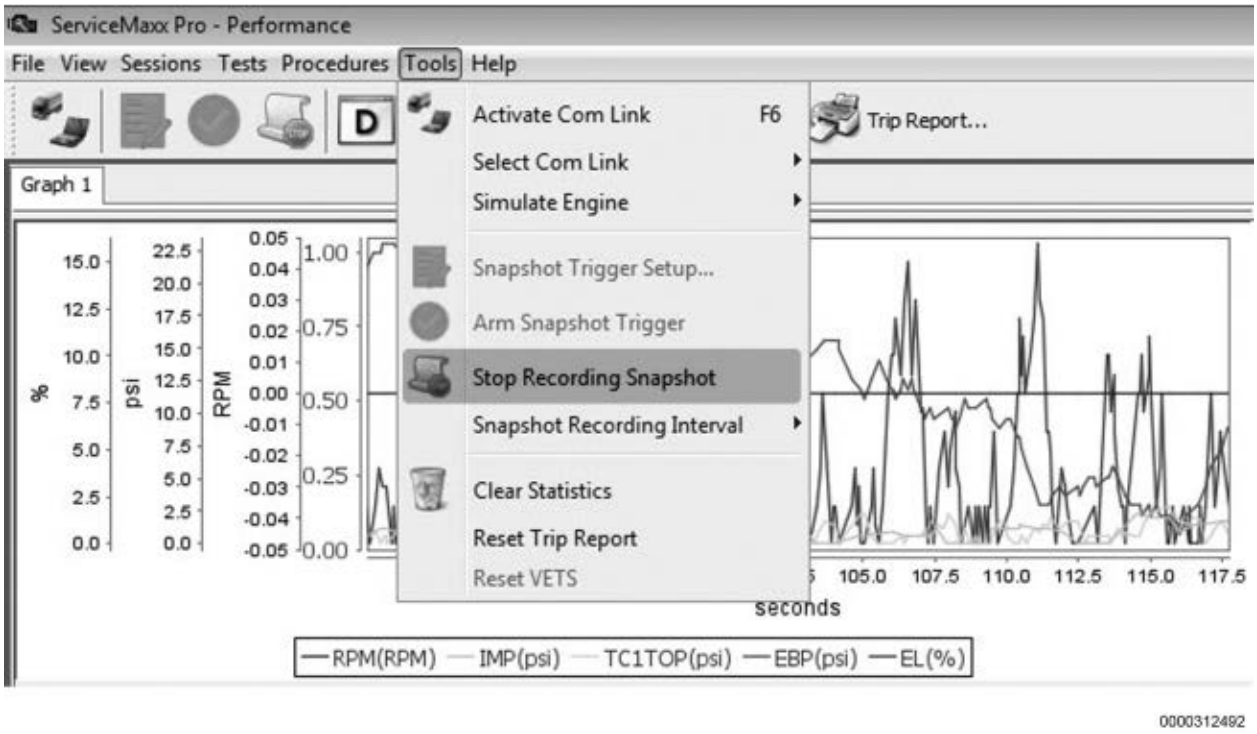

Figure 773 ServiceMaxx™ Tools Menu – Stop Recording

6. Stop the signal recording by selecting Tools > Stop Recording Snapshot.
7. Compare Instrument panel gauge and ServiceMaxx™ Oil Pressure readings.

Expected Outcome

Engine Oil Pressure reading in ServiceMaxx™ software and on instrument panel gauge are within specifications and approximately the same.

Follow-on Procedure

Proceed to Test Procedure Part 2.

Test Setup Part 2

1. Remove EOP sensor from tee fitting on oil filter module (see Engine Service Manual).
2. Install Oil Pressure Test Fitting (tool under development) into tee fitting.

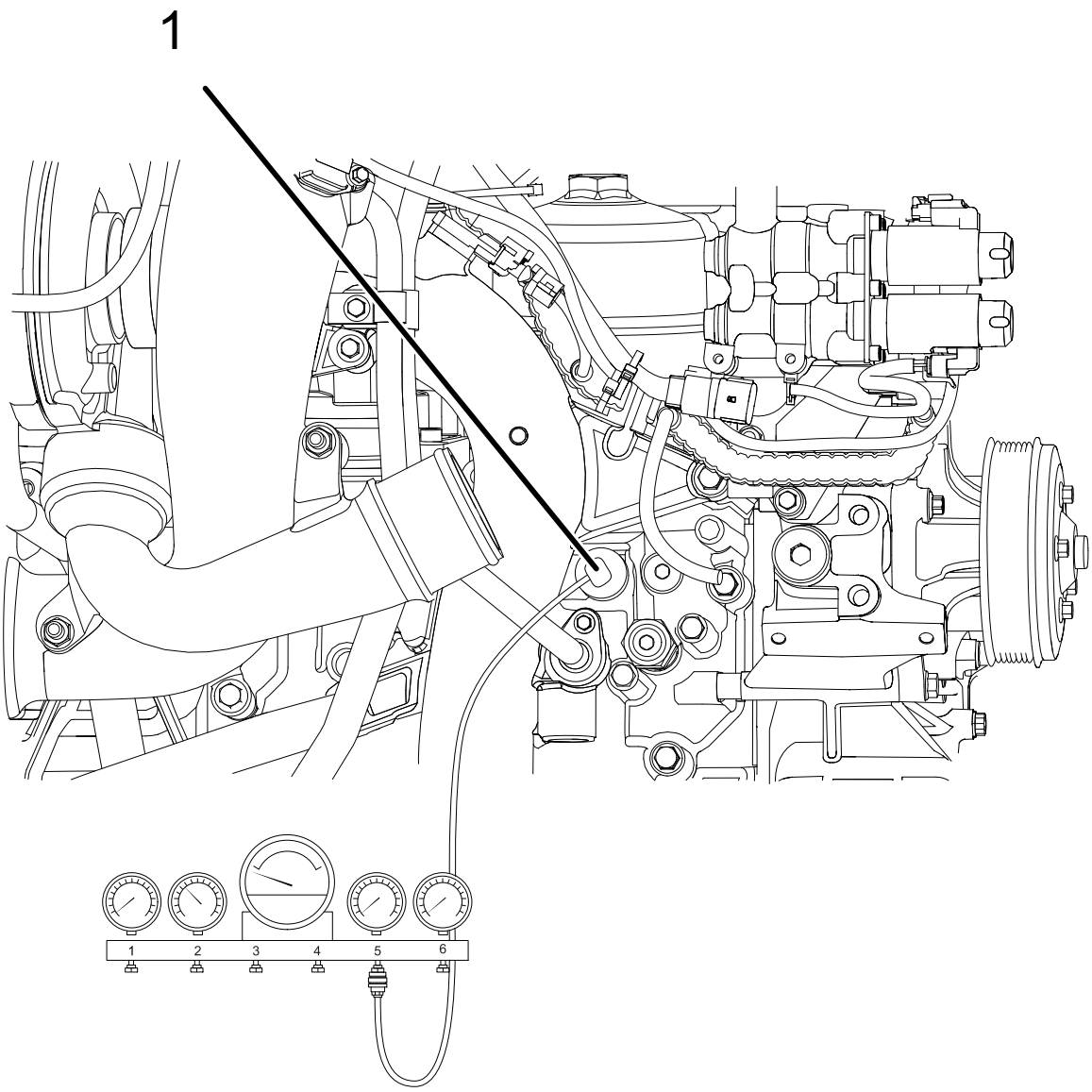

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Figure 774 Oil Pressure Verification Test Connection

1. Oil Pressure Test Coupler (Tool Under Development)

3. Connect Pressure Test Kit ZTSE4409 to oil pressure test fitting (Figure 774) (tool under development).

Test Procedure Part 2

1. Start engine.
2. At low idle, monitor mechanical gauge for engine oil pressure reading; compare this value to snapshot recorded in Test Procedure Part 1.

3. Increase engine speed to high idle.
4. At high idle, monitor mechanical gauge for engine oil pressure reading; compare this value to snapshot recorded in Test Procedure Part 1.

Expected Outcome

Engine Oil Pressure (EOP) reading on mechanical gauge and EOP sensor signal value in ServiceMaxx™ will be within specification and approximately the same.

Follow-on Procedure

None

Power Steering Fluid Leak to Engine Oil Test

Overview

Verify Power Steering Fluid is not leaking to Engine Lube Oil.

Tools Required

None

Equipment Condition

None

Test Setup

1. Adjust engine lube oil level to full operating range.
2. Adjust power steering fluid level to full operating range.

Test Procedure

1. Start engine, run for a minimum of 10 minutes.
2. Stop engine, inspect engine lube oil and power steering fluid levels.
   - If power steering fluid level is decreasing and engine lube oil level is increasing, install a new power steering pump (see *Engine Service Manual*).
   - If power steering fluid level is not decreasing and engine lube oil level is not increasing, power steering fluid is not leaking into engine lube oil.

Expected Outcome

Technician will verify Power Steering Fluid is not leaking to Engine Lube Oil.

Follow-on Procedure

None

Oil Aeration

Overview

This test will be used to determine if the engine lube oil is being aerated.

CONTENT
UNDER
DEVELOPMENT

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Engine Brake

Engine Brake ECM Input Check

CONTENT
UNDER
DEVELOPMENT

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Engine Brake Inspection

CONTENT
UNDER
DEVELOPMENT

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Engine Brake Slave Piston Clearance Adjustment

CONTENT
UNDER
DEVELOPMENT

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Engine System Inspections

Initial Key On Check

Determine if Engine Control Module (ECM) is powered up and if water is in fuel supply.

Tools Required

None

Equipment Condition

None

Test Setup

1. Key-ON, Engine-OFF.

Test Procedure

1. Observe the following:
   - Wait to Start lamp
   - WATER IN FUEL indicator (Integral Digital Display)
2. Record results on Diagnostics Form.

- If WATER IN FUEL indicator stays ON, go to Fuel Quality Check .

Expected Outcome

Technician will verify ECM is powered up and if water is in fuel supply.

Follow-on Procedure

None

Fuel System Inspection

Overview

Verify the fuel system is clean and free of damage.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

Tools Required

None

Inspection Procedure

1. Visually inspect the condition and routing of fuel lines and connections.
2. Remove fuel strainer. Inspect fuel strainer for cleanliness and to ensure it is free of damage.
3. Remove fuel filter and inspect for: damage, sediments, gasoline, kerosene, waxing, or icing.

Expected Outcome

Fuel lines, fuel filter, fuel strainer, and fuel connections are clean and not damaged.

Fuel Level Inspection

Overview

This inspection is to verify that the instrument panel fuel gauge indicates the correct fuel level in the fuel tanks.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

Tools Required

None

Equipment Condition

None

Inspection Procedure

1. Inspect interior of fuel tanks and ensure fuel level is equal in both tanks.
2. Check instrument panel fuel gauge and verify that indicated fuel level is consistent with actual fuel level.

Expected Outcome

Fuel gauge should function properly and indicate correct fuel level in fuel tanks.

Primary Fuel Filter Inspection

Overview

Check for poor fuel quality or contaminants.

Tools Required

- Clear diesel fuel container
- Clear plastic hose

NOTE: Ultra Low Sulfur Diesel (ULSD) fuel is required for Navistar® N13 Diesel Engines used with advanced aftertreatment systems.

Figure 779 Fuel requirements label

NOTE: WATER IN FUEL indicator illuminates ON, then OFF, on the Integral Digital Display if there is no water in the system. If WATER IN FUEL indicator stays ON, water is detected.

Equipment Condition

None

Test Setup

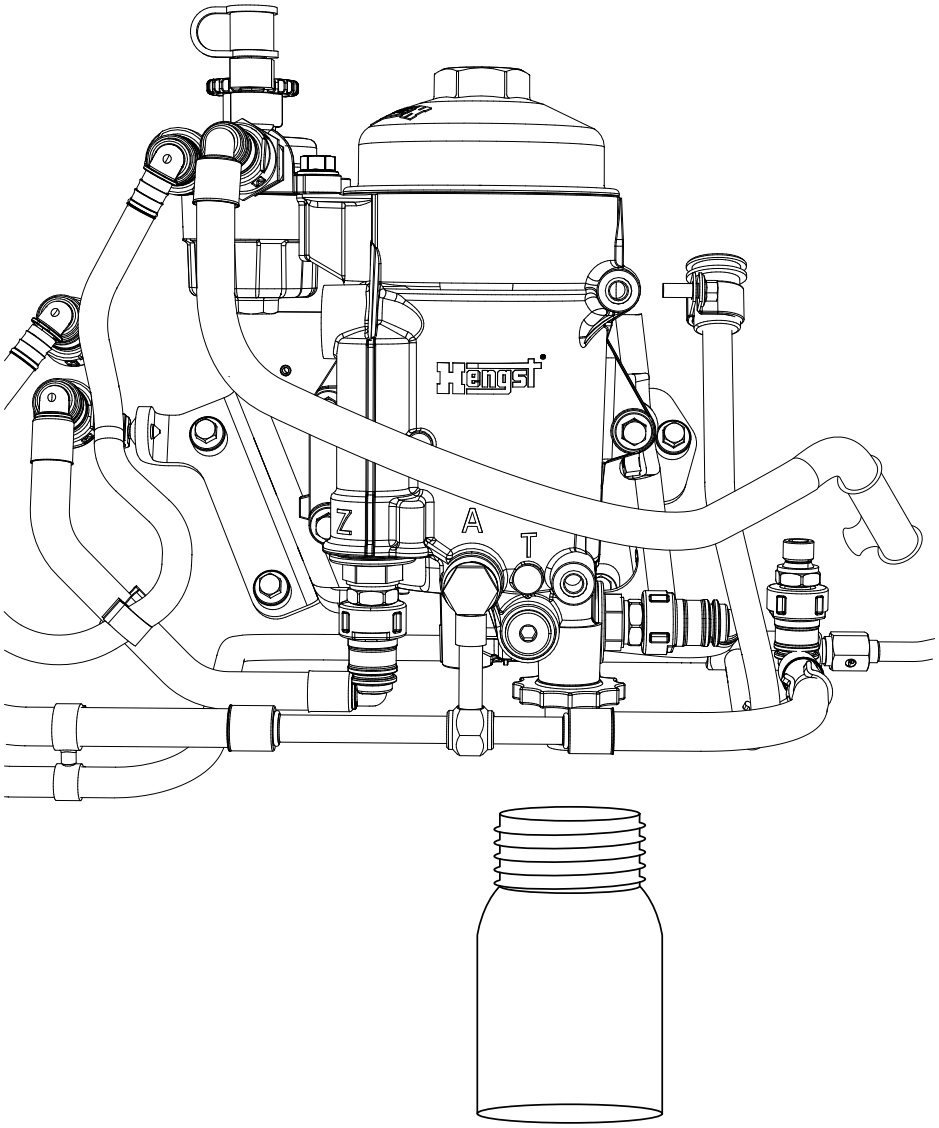

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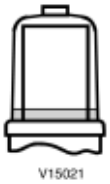
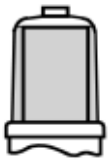
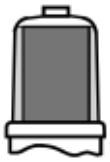
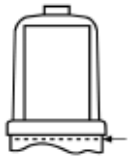
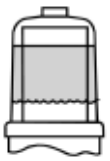
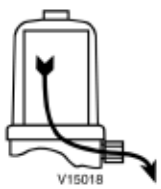
Figure 780 Fuel Sample

1. Install clear plastic hose on fuel drain valve.
2. Route clear plastic hose into clear diesel fuel container.

Test Procedure

1. Open fuel drain valve to fill container. If fuel does not flow, crank engine.

2. Check for water, waxing, icing, sediment, gasoline, Diesel Exhaust Fluid (DEF) or kerosene by shaking fuel sample container and letting contents settle. Record results on Diagnostics Form.
   - Sediments will fall to bottom of fuel sample container.
   - Gasoline and kerosene will separate from diesel fuel.
   - Waxing or icing will prevent diesel fuel from flowing out of fuel drain valve.
   - If fuel quality is questionable, repair as necessary. Take another sample to verify fuel quality is satisfactory.
   - If fuel quality is satisfactory, continue diagnostics.

Fuel Level	Visual Indication	Possible Solution
 V15021	Fuel level below top of fuel filter.	Normal - no repair necessary.
 V15013	Fuel level above top of fuel filter. May cause loss of power complaint.	Change primary fuel filter element.
 V15014	Fuel level is to top of fuel filter and looks to be full of wax.	1. Change primary fuel filter element 2. Run engine for a minimum of 25 minutes at idle. Do not run at high idle.
V15015	Bubbles are seen flowing within fuel.	1. Check all fittings and lines from between fuel tank and chassis fuel filter assembly. 2. Check upper and lower connector O-rings.
 V15016	Loss of power complaint. Fuel level is below fuel filter housing collar.	1. Check for missing grommet at lower end of filter. 2. Check for missing or broken spring at top of primary fuel filter element.
 V15017	Water is seen (noticeable separation) in fuel filter assembly.	1. Inspect fuel tank(s) for water contamination. 2. Drain a full cup of fuel from chassis fuel filter assembly. **NOTE:** Do not drain with engine running. 3. Restart engine. Shut off engine and drain chassis fuel filter assembly. 4. Repeat step 3 until ALL water is removed.
 V15018	Fuel drains back to fuel tank when changing fuel filter or draining water separator.	1. Remove and inspect check valve assembly. 2. Repair (clean) or replace as necessary, and retest.

CAUTION: Do not continue diagnostics if fuel is contaminated.

Expected outcome

Technician will verify fuel is free of contamination.

Follow-on Procedure

None

Fuel Quality Inspection

Overview

Drain fuel filter assembly and check fuel quality.

WARNING: To prevent personal injury or death, do not smoke and keep fuel away from flames and sparks.

NOTE: Ultra Low Sulfur Diesel (ULSD) fuel is required for Navistar® Diesel Engines used with advanced aftertreatment systems.

NOTE: Do not continue diagnostic procedures if fuel is contaminated.

Tools Required

- Clear diesel fuel container
- Clear plastic hose

Equipment Condition

None

Inspection Procedure

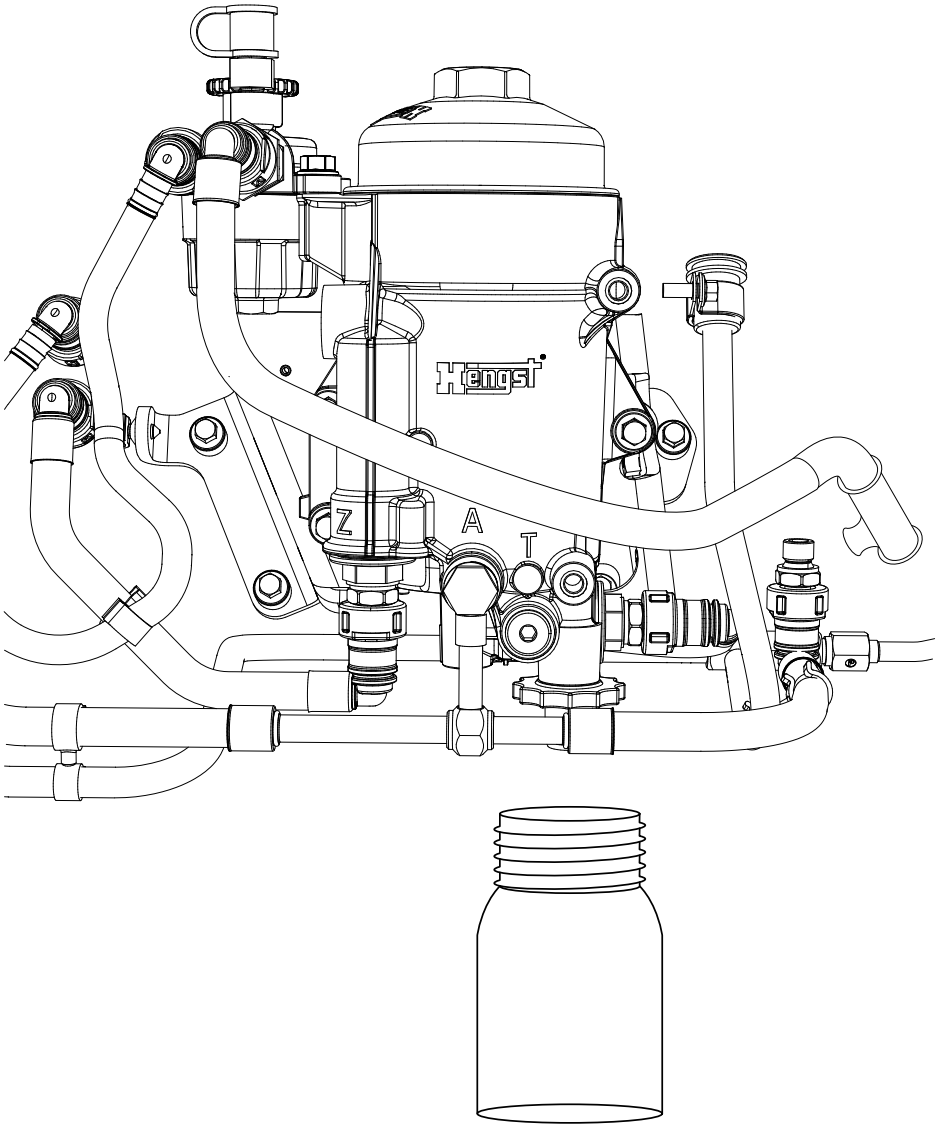


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Figure 781 Fuel Sample

1. Place clear diesel fuel container under fuel-filter housing (Figure 781).
2. Install clear plastic hose on fuel drain valve.
3. Route clear plastic hose into clear diesel fuel container.
4. Open drain valve and fill container.
5. Check for water, waxing, icing, sediment, gasoline, kerosene, or Diesel Exhaust Fluid (DEF) by shaking fuel sample container and letting contents settle.
    - Sediments will fall to bottom of fuel sample container.

- Gasoline and kerosene will separate from diesel fuel.
- Waxing or icing will prevent diesel fuel flowing from fuel-drain valve.

Expected Outcome

Fuel is free of water, waxing, icing, sediment, gasoline, kerosene, or Diesel Exhaust Fluid (DEF).

Engine Oil Level and Quality Inspection

Overview

The following procedure is for the inspection of engine oil level and engine oil quality.

NOTE: API CJ-4 oils are recommended for use in high-speed diesel engines with advanced-exhaust aftertreatment systems that meet on-highway exhaust emissions standards for year 2007 and beyond.

Figure 782 API CJ-4 Oil Label

NOTE: If inspection indicated that engine oil is contaminated or diluted, engine oil and filter must be replaced.

Tools Required

None

Equipment Condition

None

Inspection Procedure

GRAPHIC
PLACE
HOLDER

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1. Use oil level gauge (dipstick) (Item A) to check engine oil level.
   - If engine oil level is below specification, inspect engine for leaks, oil consumption, or improper servicing. Repair cause of low engine oil prior to filling to proper level.
   - If engine oil level is above specification, inspect for fuel dilution, coolant contamination, or improper servicing. If engine oil level is above specification, drain to proper level and diagnose cause of dilution, contamination, or improper servicing.

Expected Outcome

Oil level should be within specification and free of dilution, coolant contamination, and improper servicing.

Coolant Level Inspection

Overview

The following procedure is to inspect that coolant in the deaeration tank is at appropriate level and free of contamination.

Tools Required

None

Equipment Condition

None

Inspection Procedure

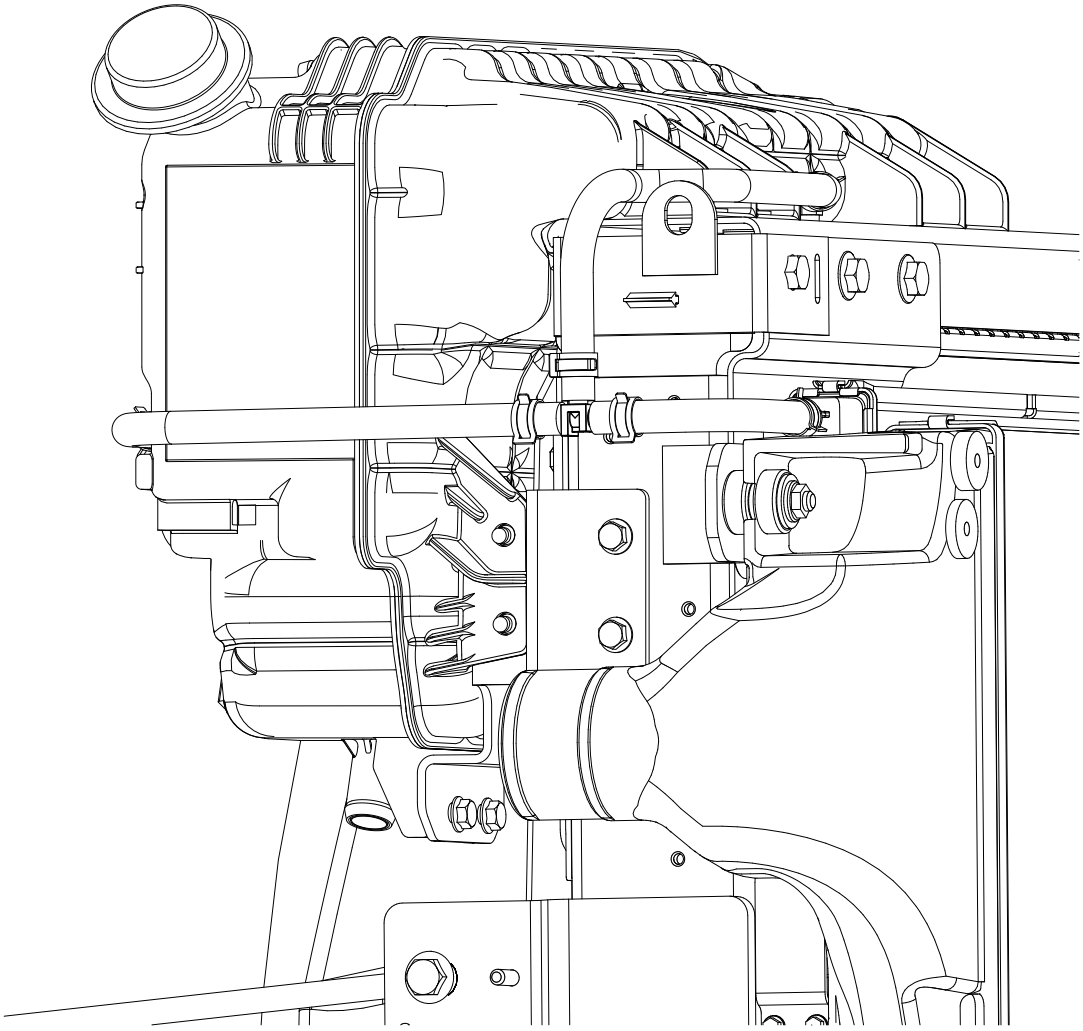

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Figure 784 Coolant Deaeration Tank

1. Inspect coolant level in deaeration tank.

Expected Outcome

Coolant level should be within specification and free of contaminants.

Coolant Quality Inspection

Overview

Check coolant for proper freeze point, and for contamination.

Tools Required

- Coolant and Battery Refractometer ZTSE4796

Equipment Condition

- Park the vehicle on level ground
- If engine was running, allow engine to cool for 15 minutes or more.

Inspection Procedure

1. Wrap a thick cloth around the deaeration cap.
2. Loosen cap slowly a quarter to half turn to vent pressure.
3. After pressure has been released, remove the cap.
4. Check coolant appearance for signs of contamination.
5. Take a sample from the deaeration tank.
6. Examine sample for lube oil and Diesel Exhaust Fluid (DEF).
    - Oil contamination will result in a dark sludge.
    - DEF contamination will give the coolant a dark yellow/brown color with a strong ammonia smell.
7. If coolant is not contaminated, check freeze point.

Expected Outcome

Coolant should be free of contamination, and at the correct freeze point.

Coolant Leak - Visual

Overview

Check engine cooling system for proper level and leaks.

Tools Required

- Radiator Pressure Test Kit ZTSE2384

Equipment Condition

None

Inspection Procedure

1. Park vehicle on level ground. If engine was running, allow engine to cool for 15 minutes or more.
2. Wrap a thick cloth around the deaeration cap. Loosen cap slowly a quarter to half turn to vent pressure. After pressure has been released, remove the cap.
3. Check coolant level. Compare coolant level to level indicators on the deaeration tank. If coolant level is low, add coolant.
4. Install Radiator Pressure Test Kit ZTSE2384.
5. Pressurize cooling system.
6. Check both sides of vehicle for coolant, leaks, and coolant on the ground.
7. If coolant is leaking, determine what component is leaking.

Expected Outcome

Coolant should be at the correct level. There should be no visible coolant leaks.

Coolant in Exhaust Inspection

Symptoms

Coolant leaks to the exhaust may be detected externally or internally. See the following list of symptoms for identification of coolant leaks to the exhaust.

- Coolant residue at exhaust manifold flanges
- Observation of coolant loss without engine overheating
- Coolant smell in exhaust
- Coolant leaking from exhaust
- Severe case - engine hydraulic lock
- Failed Aftertreatment Fuel Injector (AFTFI)
- Restricted Diesel Particulate Filter (DPF) or Diesel Oxidation Catalyst (DOC).

Possible Causes

- Failed EGR cooler
- Failed AFTFI
- Cracked cylinder head
- Cracked cylinder liner

CAUTION: If a coolant leak to exhaust is determined from one of the listed possible causes, the Oxygen Sensor (O_2S) must be replaced. See the *Engine Service Manual* for O_2S replacement procedures. Perform O_2S Calibration Procedure anytime O_2S is replaced.

Coolant to Oil Inspection

Overview

Check for a source of cooling system leak to lubrication system.

Tools Required

- ZTSE2384 – Radiator Pressure Testing Kit

Equipment Condition

None

Test Setup

- EGR Cooler is operating properly and passes a pressure test.
- Remove oil sump following procedures in the *Engine Service Manual*.

Test Procedure

WARNING: To prevent personal injury or death, do the following when removing the radiator cap or deaeration cap:

- Allow engine to cool for 15 minutes or more.
- Wrap a thick cloth around radiator cap or deaeration cap.
- Loosen cap slowly a quarter to half turn counterclockwise to vent pressure.
- Pause for a moment to avoid being scalded by steam.
- Continue to turn cap counterclockwise to remove.

1. Remove deaeration tank cap.
2. Install Radiator Pressure Testing Kit ZTSE2384 with Surge Tank Cap Adaptor on deaeration tank.
3. Pressurize cooling system to 117 kPa (17 psi) for a minimum of 15 minutes.
4. Inspect the inside of the crankcase for coolant leakage.
    - If coolant leak is at the air compressor drain, install a new air compressor following procedures in the *Engine Service Manual*.
    - If coolant leak is from oil cooler, install a new oil cooler following procedures in the *Engine Service Manual*.
    - If coolant is evident at the front cover area, continue to next step.
    - If coolant is evident at the rear gear train area, inspect freeze plug on rear of cylinder head and repair as necessary.
    - If coolant is evident on the bottom edge of a cylinder liner(s), skip to step 8.
    - If coolant leak is from cracks in the crankcase, replace crankcase following procedures in the *Engine Service Manual*.
5. Remove water distributor housing following procedures in the *Engine Service Manual*.

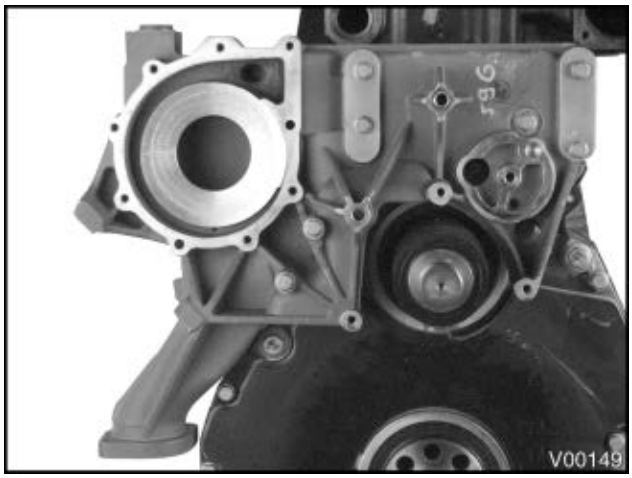

Figure 785 Water distributor housing

6. Inspect gear train area for coolant leaks.
   - If coolant is leaking into gear train area, inspect distributor housing for leak sources. Repair as necessary.
   - If no coolant is leaking into the gear train area, inspect water distributor housing and gasket for leak sources. Repair as necessary.
   - If no coolant is leaking from water distributor housing or gasket, continue to next step.
7. Inspect lower edges of cylinder liners for coolant leaks. Note cylinder number(s) where coolant leakage is identified.
   - If coolant is leaking on the outside of a cylinder liner, install new cylinder liner O-rings following procedures in the *Engine Service Manual*.
   - If coolant is leaking inside of cylinder liner, continue to next step.
8. Remove front and rear tubes from EGR cooler and pressure test EGR cooler, in vehicle, following procedures in the *Engine Service Manual*.
   - If a leak is detected, install a new EGR cooler following procedures in the *Engine Service Manual*.
   - If no leak is found, continue to next step.
9. Test cylinder head for coolant leaks. Go to Cylinder Head Leak Test.
10. Test cooling system again to validate repair.

Expected Outcome

Technician will verify if there is coolant contamination in lube oil.

Follow-on Procedure

None

Cylinder Sleeve Cavitation and Crack Inspection

Overview

Inspect cylinder sleeves for holes or cracks caused by cavitation (gas-filled bubbles formed in the coolant).

Tools Required

None

Equipment Condition

Remove cylinder head. See *Engine Service Manual*.

Inspection Procedure

1. Inspect piston crowns for signs of coolant leaks. Lack of carbon indicates possible coolant leak into the cylinder.
2. Bar engine over until pistons 1 and 6 are at Bottom Dead Center (BDC). Visually inspect cylinder sleeve for cracks or holes.
3. Inspect cylinder sleeves 1 and 6 for possible cavitation leaks and/or cracks.
4. Repeat for cylinders pairs 2-5 and 3-4.
5. Repair as needed.

Expected Outcome

Carbon deposits should be present on piston crowns, indicating cylinder sleeves are free of holes and cracks.

Interstage Cooler Inspection

Overview

Visual inspection of the Interstage Cooler (ISC) and the High-Pressure (HP) Turbocharger Intake Elbow for coolant or evidence of coolant residue.

WARNING: To prevent personal injury or death, allow engine to cool before removing components.

WARNING: To prevent personal injury or death, ensure Interstage Cooler Test Kit components are tightened properly; otherwise, they can explode while ISC is under pressure.

WARNING: To prevent personal injury or death, ensure ISC air inlet and outlet O-rings are removed and that not lubricant is on sealing surface. O-ring and lubricant can cause the ISC Pressure Test Kit components to explode while ISC is under pressure.

Tools Required

- Interstage Cooler Test Kit ZTSE6042

Equipment Condition

None

Inspection Procedure

1. Inspect for coolant or white coolant residue in High Pressure (HP) turbocharger air inlet duct and Interstage Cooler (ISC).
   - Remove HP turbocharger center section with HP turbocharger air inlet duct. See Engine Service Manual for procedure.
2. Pressure test ISC. See Engine Service Manual for procedure.

Expected Outcome

No evidence of coolant or coolant residue will be found in the Interstage Cooler or the HP-Turbocharger Intake Piping.

Charge Air Cooler Inspection

Overview

Inspect the High-Pressure Charge Air Cooler (CAC), Interstage Cooler (ISC), and CAC piping for leaking, worn, or damaged parts.

Tools Required

None

Equipment Condition

None

Inspection Procedure

GRAPHIC
PLACE
HOLDER

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GRAPHIC
PLACE
HOLDER

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1. Inspect High-Pressure Charge Air Cooler (HPCAC) (Item D), Interstage Cooler (ISC) (Item A), associated hoses (Item B), clamps (Item C) and connections (Item E) for leaks and worn or damaged parts.

Expected Outcome

HPCAC, ISC, hoses, clamps and connections are free of leaks, wear, or damage.

Intake Air Inspection

Overview

Inspect the air filter and air intake assembly for blockages and / or damage.

Tools Required

None

Equipment Condition

None

Inspection Procedure

1. Inspect for a dirty, damaged, or incorrectly installed air filter.
   - If air filter is clean, undamaged, and correctly installed, go to next step.
   - If air filter is dirty or damaged, replace air filter, go to next step.
2. Inspect for air flow restrictions in air intake tubing, tubing connections, and filter housing.
   - If air flow is restricted repair air flow restrictions, go to next step.
   - If no air flow restriction is found, no action is required, go to next step.
3. Inspect for loose or damaged intake and CAC hoses and pipes.
   - If loose or damaged air hoses and pipes are found, repair Intake or CAC.
   - If no loose or damaged air hoses and pipes are found, no action is required.

Expected Outcome

Air filter, air intake tubing, and air filter housing are free of damage and restrictions. Intake air restriction should be less than 25 in Hg (84.7 kPa) at full load and at rated speed.

Exhaust and Aftertreatment System Inspection

Overview

Inspect exhaust and aftertreatment system for leaks and damage.

Black staining in exhaust tailpipe can occur. This is normal and the Diesel Particulate Filter (DPF) should not be replaced.

Tools Required

None

Equipment Condition

None

Inspection Procedure

1. Inspect exhaust system (engine and vehicle) for restrictions, leaks, and damage.

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HOLDER

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Figure 788 Exhaust and Aftertreatment System

A. Aftertreatment Doser Injector (AFT: DI)
B. AFT: DI Fuel Supply lines
C. AFT: DI gasket
D. AFT: DI bore
E. Coolant Supply and Return line
F. Coolant Supply and Return line

2. Visually inspect Aftertreatment Doser Injector (AFT: DI) fuel supply lines (Figure 788) (Item B) and coolant supply and return lines (Figure 788) (Items E and F) for leaks, kinks, bends, or other damage.
3. Remove AFT: DI (see *Engine Service Manual)* and perform visual check for the following:
   - The correct AFT: DI gasket (Figure 788) (Item C) is installed.
   - AFT: DI (Figure 788) (Item A) and bore (Figure 788) (Item D) are unrestricted and free of carbon buildup.
   - AFT: DI tip (Figure 788) (Item A) is free of cracks and other visible damage.

Expected Outcome

Exhaust system (engine and vehicle) will be free of restrictions, leaks, and/or damage. AFT: DI fuel supply and coolant supply return lines will be free of leaks, kinks, bends, and/or other damage.

Oil and Crankcase Inspection

Overview

The goal of this inspection is to inspect for internal components leaking larger than normal amounts of oil or damaged internal parts.

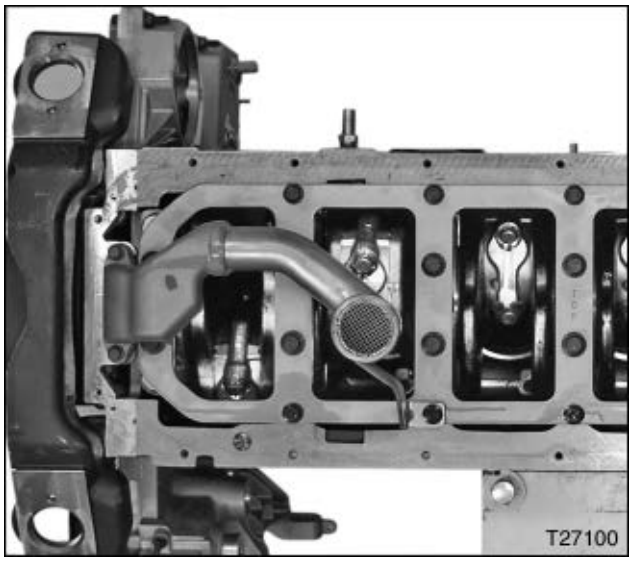
Tools Required

- Regulator assembly

Equipment Condition

1. Oil drained.
2. Oil pan removed (see *Engine Service Manual*).

Inspection Procedure



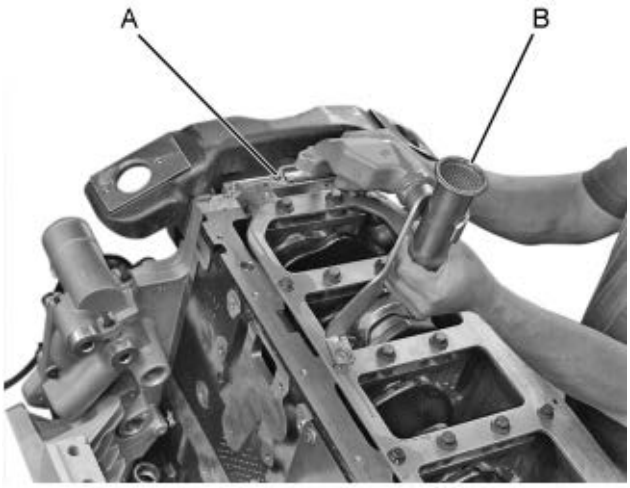


Figure 790 Oil Pump Pick-up Tube

A. Oil Pump Pick-up Tube Gasket
B. Oil Pump Pick-up Tube

1. Remove oil pump pick-up tube (Figure 790) (Item B).
2. Check tube and gasket (Figure 790) (Item A).

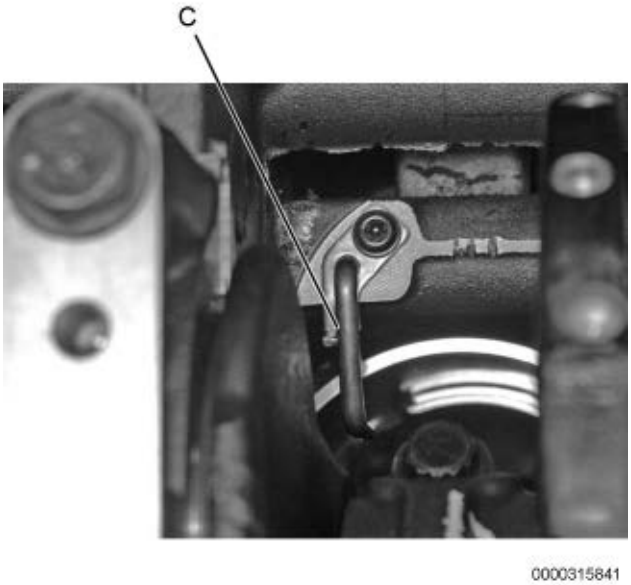


Figure 791 Piston

3. Check for missing or broken piston cooling jets (Figure 791) (Item C).
4. Use regulated shop air to check for loose bearings, cam bushings, or excessive flow from regulator valve return port.

Expected Outcome

No internal engine damage or excessive engine lube oil leaking will be found.

Engine Brake Solenoid Inspection

CONTENT
UNDER
DEVELOPMENT

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Engine Brake Control Valve Inspection

CONTENT
UNDER
DEVELOPMENT

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Air Tanks Inspection

CONTENT
UNDER
DEVELOPMENT

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HP-Turbocharger Radial Play Inspection

Overview

Check High-Pressure (HP) Turbocharger for excessive radial play.

Tools Required

None

Equipment Condition

Remove compressor housing from High Pressure (HP) Turbocharger.

Inspection Procedure

1. Inspect high pressure turbocharger compressor housing and compressor wheel for signs of contact including damage to the compressor wheel and/or scaring to the compressor housing.

Expected Outcome

High-Pressure (HP) Turbocharger compressor wheel does not have excessive play, and does not contact the inside of the compressor wheel housing, and is free from damage.

Aftertreatment

Snap Acceleration Test

Overview

This test is used to check the Diesel Particulate Filter (DPF) for cracks or internal damage without removing it from vehicle. The test checks for basic functionality of the DPF and should be done prior to removing it.

Tools Required

None

Equipment Condition

None

Test Setup

None

Test Procedure

1. The transmission must be in neutral and the parking brake applied.
2. Start and idle the engine.
3. Rapidly snap the accelerator to full throttle (this can be done multiple times).
4. During the engine accelerations, visually monitor the exhaust pipe for heavy black smoke. Use assistant if necessary.

Expected Outcome

There will not be heavy clouds of black smoke exiting the exhaust pipe. Black smoke is an indication of a failure in the Aftertreatment (AFT) system, specifically the DPF.

Follow-On Procedure

None

Hot Run Sensor Comparison Test

Overview

Check for failed aftertreatment system temperature sensor.

Tools Required

- Electronic Service Tool (EST) with ServiceMaxx™ software
- Interface cable (RP1210B compliant supporting J1939 and J1708)

Equipment Condition

None

Test Setup

1. Key Off
2. Disconnect Exhaust Gas Recirculation (EGR) Valve connector
3. Key-ON, Engine-OFF (KOEO)
4. Connect Electronic Service Tool (EST) with ServiceMaxx™ to vehicle diagnostic connector (page 1571).
5. Log into ServiceMaxx™.

Test Procedure

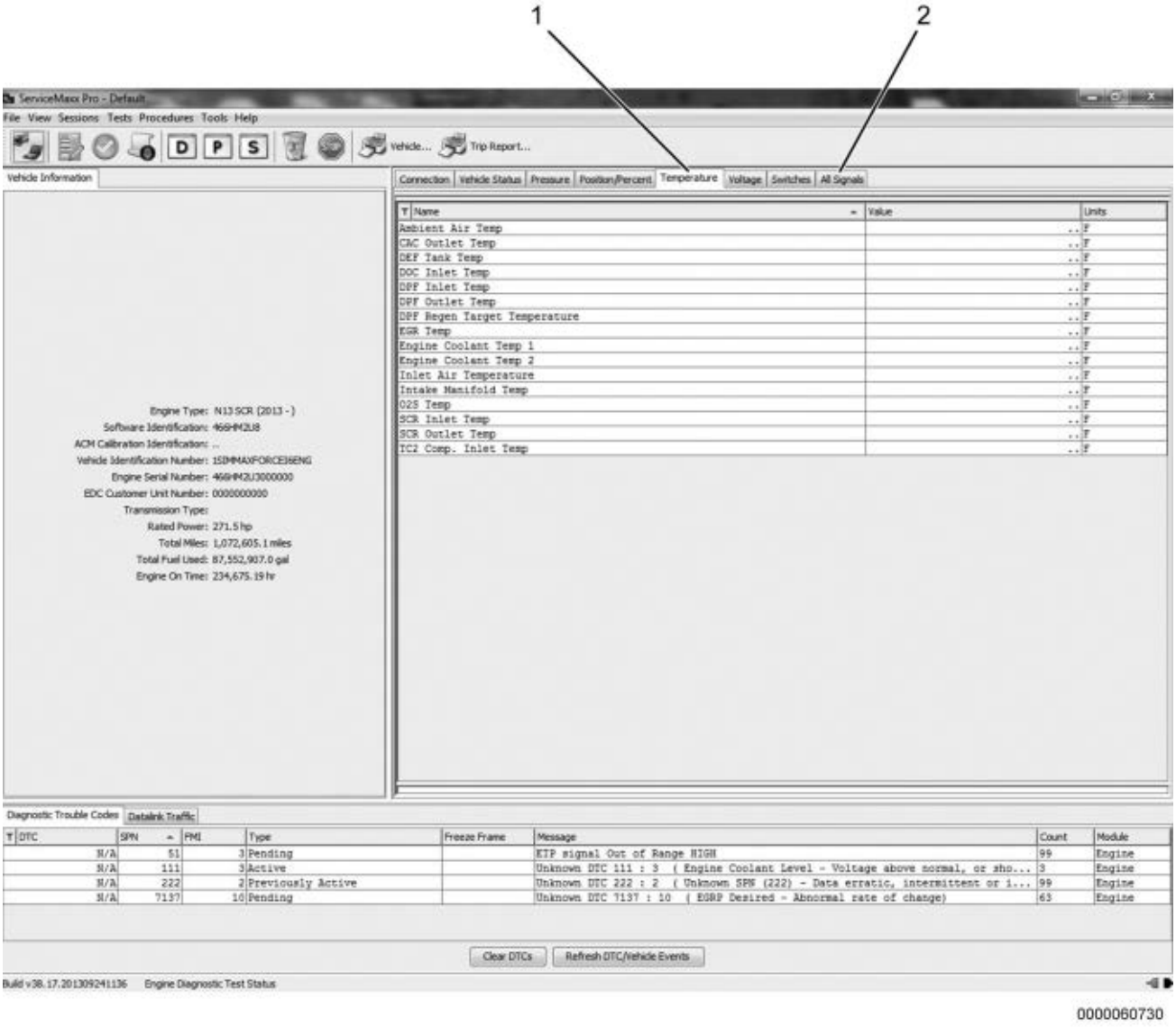

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Figure 795 Default Session

1. Temperature tab
2. All Signals tab

1. Select Temperature tab (Figure 795).

WARNING: To prevent personal injury or death, shift transmission to park or neutral, set parking brake, and block wheels before doing diagnostic or service procedures.

2. Start and run engine at 1400 - 1500 rpm for 5 minutes.
3. Monitor the following signals in the Temperature tab:

Compare the following three signals:

- DOC Intake Temp
- DPF Intake Temp
- DPF Outlet Temp

After 5 minutes, if any of these three aftertreatment temperature sensors are not within 77°F (25°C) of each other, diagnose appropriate sensor and / or circuit (see Diagnostic Troubleshooting Procedures).

Compare the following two signals:

- SCR Intake Temp
- SCR Outlet Temp

After 5 minutes, if either of the two SCR temperature sensors are not within 77°F (25°C) of each other, diagnose appropriate sensor and / or circuit (see Diagnostic Troubleshooting Procedures).

Expected Outcome

Technician will validate performance of aftertreatment temperature sensors.

Follow-on Procedure

1. Reconnect the EGR Valve connector
2. Use EST with ServiceMaxx™ to clear Fault Codes that set during test

Aftertreatment Purge Air Valve Test

CONTENT
UNDER
DEVELOPMENT

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Diesel Exhaust Fluid Dosing Valve (DEFD) Inspection

Overview

Inspect Diesel Exhaust Fluid Dosing Valve (DEFD).

Tools Required

None

Equipment Condition

1. Remove DEFD for inspection. Follow procedures in *Exhaust Aftertreatment System with DPF and SCR Service Manual.*

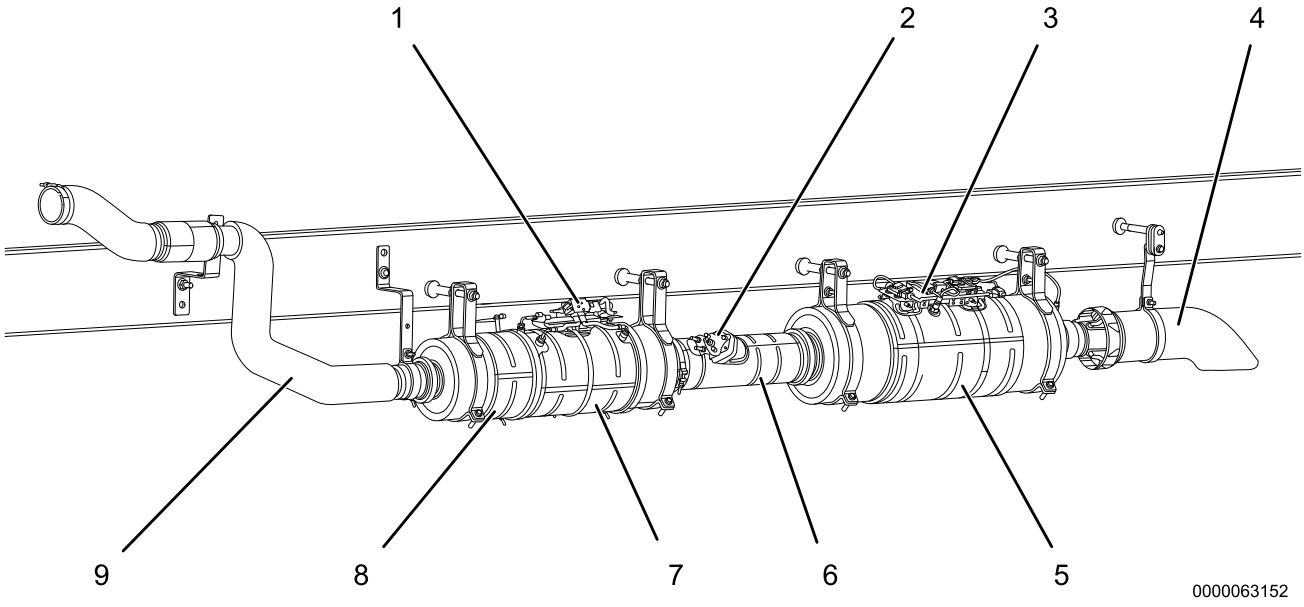

Figure 797 In-Line Exhaust System

1. Diesel Particulate Filter (DPF) sensors
2. Diesel Exhaust Fluid Dosing Valve (DEFD)
3. Selective Catalyst Reduction (SCR) sensors
4. Tailpipe
5. Selective Catalyst Reduction (SCR) canister
6. Decomposition reactor tube
7. Diesel Particulate Filter (DPF)
8. Diesel Oxidation Catalyst (DOC)
9. Turbo pipe

Inspection Procedure

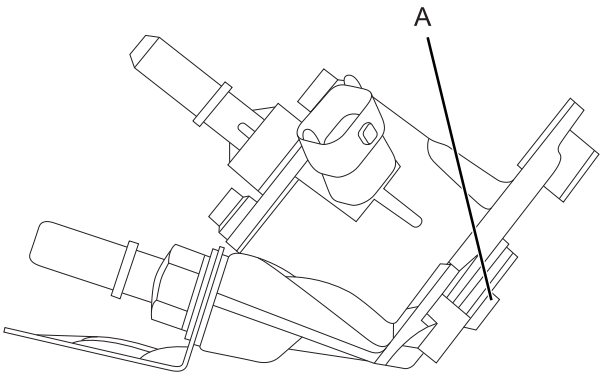

Figure 798 Diesel Exhaust Fluid Dosing Valve (DEFD) Tip

A. DEF Dosing Valve tip

1. Inspect Diesel Exhaust Fluid Dosing Valve (DEFD) (Figure 798) (Item A) tip for DEF deposits.

- If DEF deposits are found, the DEFD must be cleaned. Follow cleaning procedure in the *Exhaust Aftertreatment System with DPF and SCR Service Manual.*
- If DEFD tip is free of DEF deposits, go to next step.

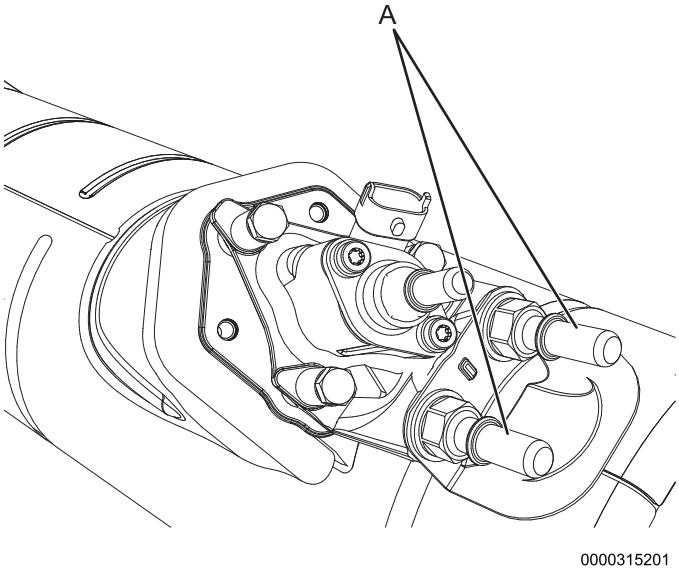

Figure 799 DEFD Coolant Passages

A. DEFD coolant passages

2. Check that DEFD coolant passages (Figure 799) (Item A) are clean.

- If DEFD coolant passages need to be cleaned, follow cleaning procedure in *Exhaust Aftertreatment System with DPF and SCR Service Manual.*
- If DEFD coolant passages are clean, go to Decomposition Reactor Tube Inspection .

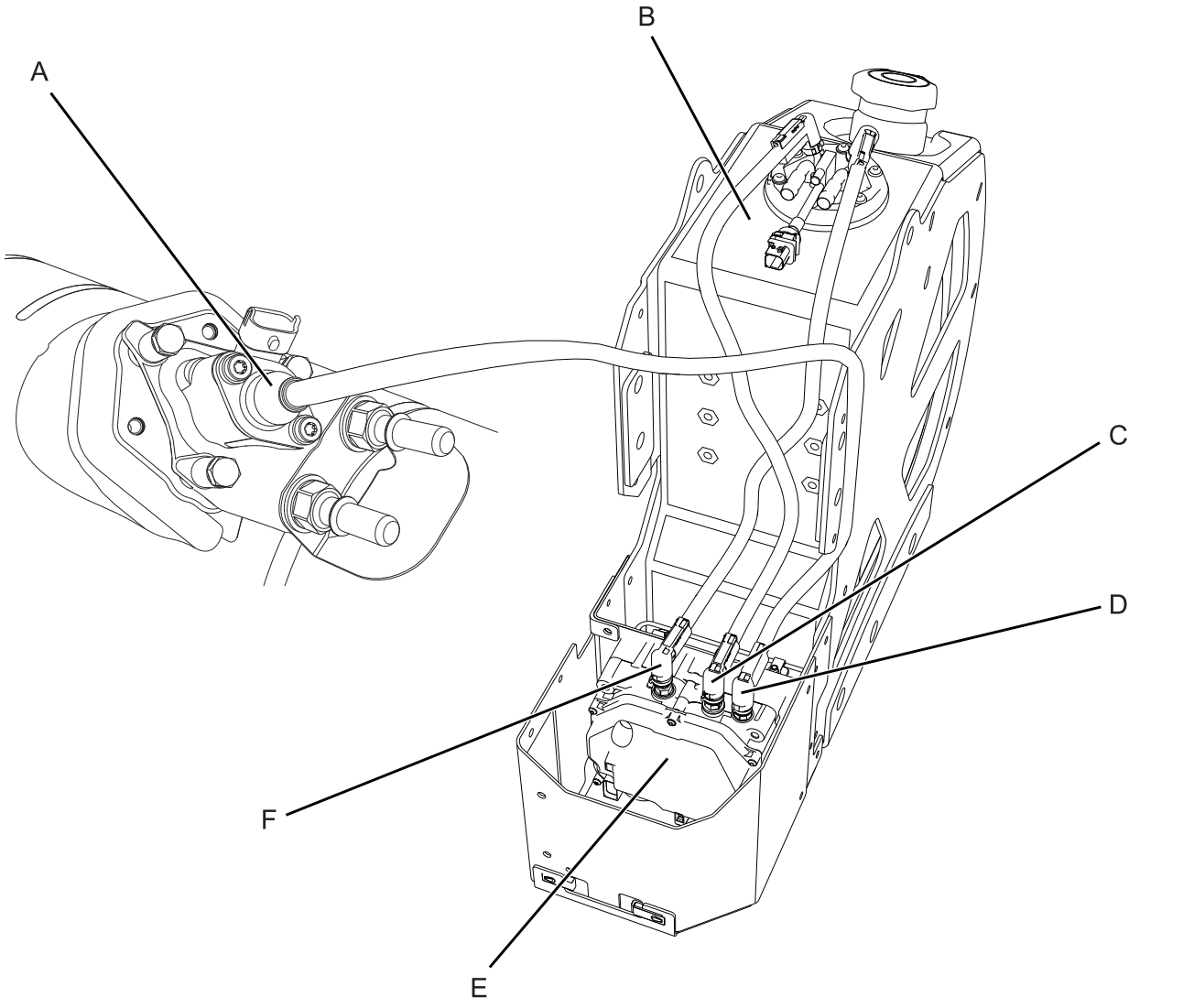

Figure 800 Diesel Exhaust Fluid Dosing Valve (DEFD)

A. DEFD
B. DEF Tank
C. DEF Return Line
D. DEF Pressure Line
E. DEF Supply Module
F. DEF Supply Line

3. Visually inspect Diesel Exhaust Fluid (DEF) pressure, suction, and return lines (Figure 800) for leaks, kinks, bends, or other damage.

Expected Outcome

DEFD tip should be free of DEF deposits and coolant passages should be clean.

DEF Quality (refractometer & contamination) Test

Overview

Inspect Diesel Exhaust Fluid (DEF) for contamination and proper urea concentration.

WARNING: To prevent personal injury or death, avoid contact with Diesel Exhaust Fluid (DEF) / urea. Do not get DEF in eyes. In case of eye contact, immediately flush eyes with large amounts of water for a minimum of 15 minutes. Do not swallow. If DEF is ingested, contact a physician immediately.

Tools Required

- Diesel Exhaust Fluid (DEF) Refractometer 5025

Equipment Condition

None

Inspection Procedure

1. Obtain sample of Diesel Exhaust Fluid (DEF).
2. Visually inspect for contamination.
3. Use DEF Refractometer 5025 to test urea concentration of DEF.

Expected Outcome

Diesel Exhaust Fluid (DEF) should be free of contamination and urea concentration should be 32.5% +/- 1.5%.

DEF Level Inspection

Overview

Determine the approximate level of Diesel Exhaust Fluid (DEF) in the DEF tank and operation of the DEF level gauge.

Tools Required

None

Equipment Condition

- Park vehicle on level ground.
- Key-On Engine-Off (KOEO).

Inspection Procedure

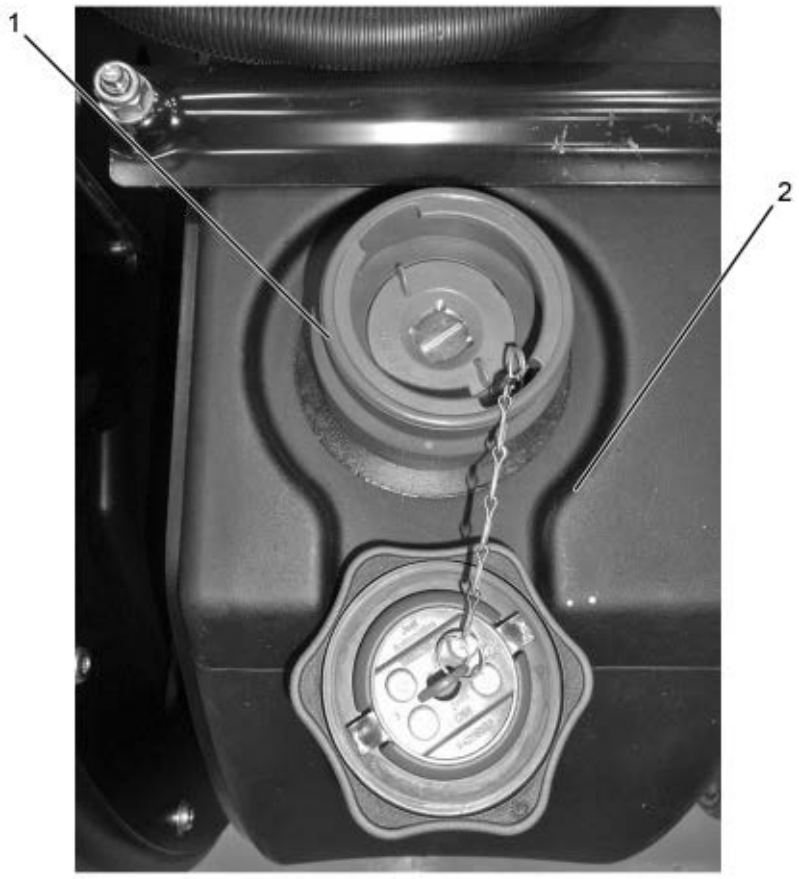

Figure 801 Diesel Exhaust Fluid Filler Neck and Cap

1. Filler neck
2. Cap

1. Remove Diesel Exhaust Fluid (DEF) cap (Figure 801).

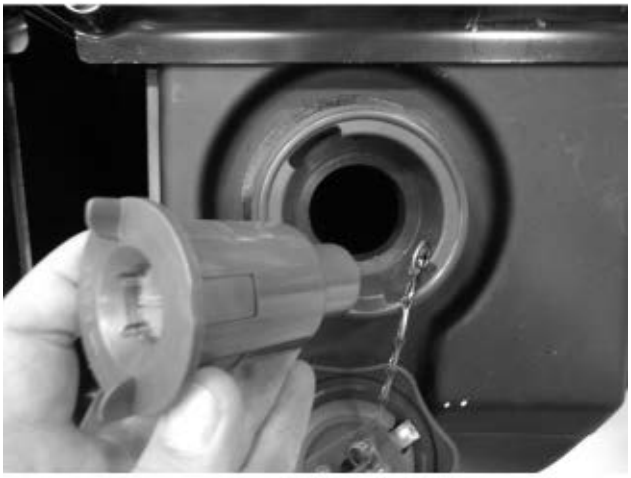

Figure 802 Diesel Exhaust Fluid (DEF) Filler Neck Removed

2. Remove DEF fill neck (Figure 802) by turning fill neck counter clockwise until it stops, roughly 45°, and lifting out.
3. Use shop light or flashlight to view DEF level in tank related to tank volume. Example: 1/4 full, 1/2 full.
4. Compare DEF tank level to gauge reading.
5. DEF level should be roughly equivalent to amount shown on DEF level Gauge.
6. Reinstall DEF filler neck and DEF cap.

Expected Outcome

There should be Diesel Exhaust Fluid (DEF) in the DEF tank close to the level indicated on the DEF level gauge.

DPF Inspection

Overview

Inspect Diesel Particulate Filter (DPF) channels for restriction, contamination, soot leakage, and filter damage. Inspect exterior for container damage.

Tools Required

None

Equipment Condition

Index and mark components to show direction of exhaust flow. Mark Diesel Particulate Filter (DPF) to ensure proper installation after filter has been cleaned or replaced.

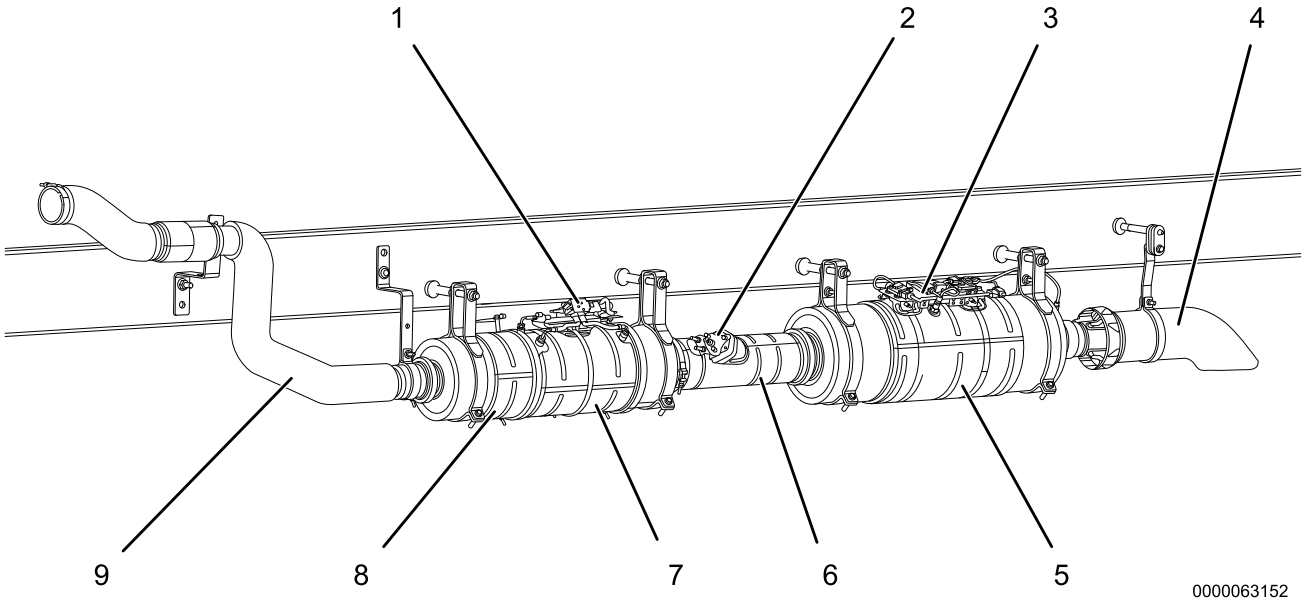

Figure 803 In-Line Exhaust System

1. Diesel Particulate Filter (DPF) interface module
2. Diesel Exhaust Fluid Dosing Unit (DEF: DU)
3. Selective Catalyst Reduction (SCR) interface module
4. Tailpipe
5. Selective Catalyst Reduction (SCR) canister
6. Decomposition reactor tube
7. Diesel Particulate Filter (DPF)
8. Diesel Oxidation Catalyst (DOC)
9. Turbo pipe

1. DPF (Figure 803) (Item 7) may need to be removed for inspection. There are several variations of exhaust systems depending on the specific truck series. All variations have the same components and removal/installation procedures are similar for the different variations. Follow procedures in the *Exhaust Aftertreatment System with DPF and SCR Service Manual.*

Inspection Procedure

Figure 804 New Diesel Particulate Filter (DPF) - face is clear and all channels are visible

1. Inspect the exterior of the Diesel Particulate Filter (DPF) (Figure 803) (Item 7).
2. If the DPF shows signs of exterior damage such as dents or cracks, replace DPF.
3. Inspect the DPF intake and outlet.
4. If all channels are visible (Figure 804) and the light soot coating over the whole face is easily wiped away with a finger, system is working correctly. No action is required.
5. If the DPF is plugged with ash, remove DPF and clean or replace.
6. If filter is cracked or melted, the source of the excessive soot that caused the cracking or melting must be investigated and the filter must be replaced.
7. Follow Diesel Oxidation Catalyst (DOC) and DPF Reuse Guidelines in the *Exhaust Aftertreatment System with DPF and SCR Service Manual.*

Expected Outcome

Diesel Particulate Filter (DPF) should be free of contamination, soot leakage, and filter damage. DPF channels should be free of restrictions.

DOC Inspection

Overview

Inspect Diesel Oxidation Catalyst (DOC) for restriction, contamination, soot leakage, and melted or deformed cells.

Tools Required

None

Equipment Condition

Before removal, mark the DOC to show the direction of exhaust flow. Marking the DOC ensures proper installation after the DOC has been cleaned or replaced.

Inspection Procedure

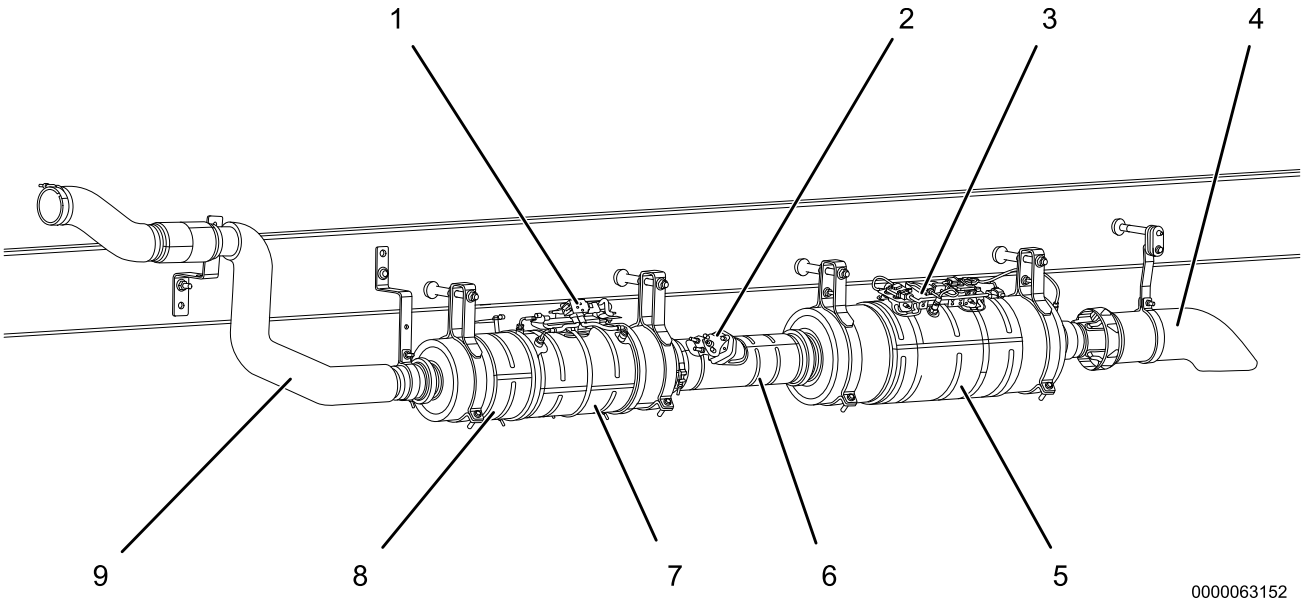

Figure 805 In – Line Exhaust System

1. Diesel Particulate Filter (DPF) interface module
2. Diesel Exhaust Fluid Dosing Unit (DEF: DU)
3. Selective Catalyst Reduction (SCR) interface module
4. Tailpipe
5. Selective Catalyst Reduction (SCR) canister
6. Decomposition reactor tube
7. Diesel Particulate Filter (DPF)
8. Diesel Oxidation Catalyst (DOC)
9. Turbo pipe

1. The Diesel Oxidation Catalyst (DOC) may need to be removed to be inspected. There are several variations of exhaust systems depending on the specific truck series. All of the variations have the same components and the removal/installation procedures are similar for the different variations. Follow procedures in the *Exhaust Aftertreatment System with DPF and SCR Service Manual.*

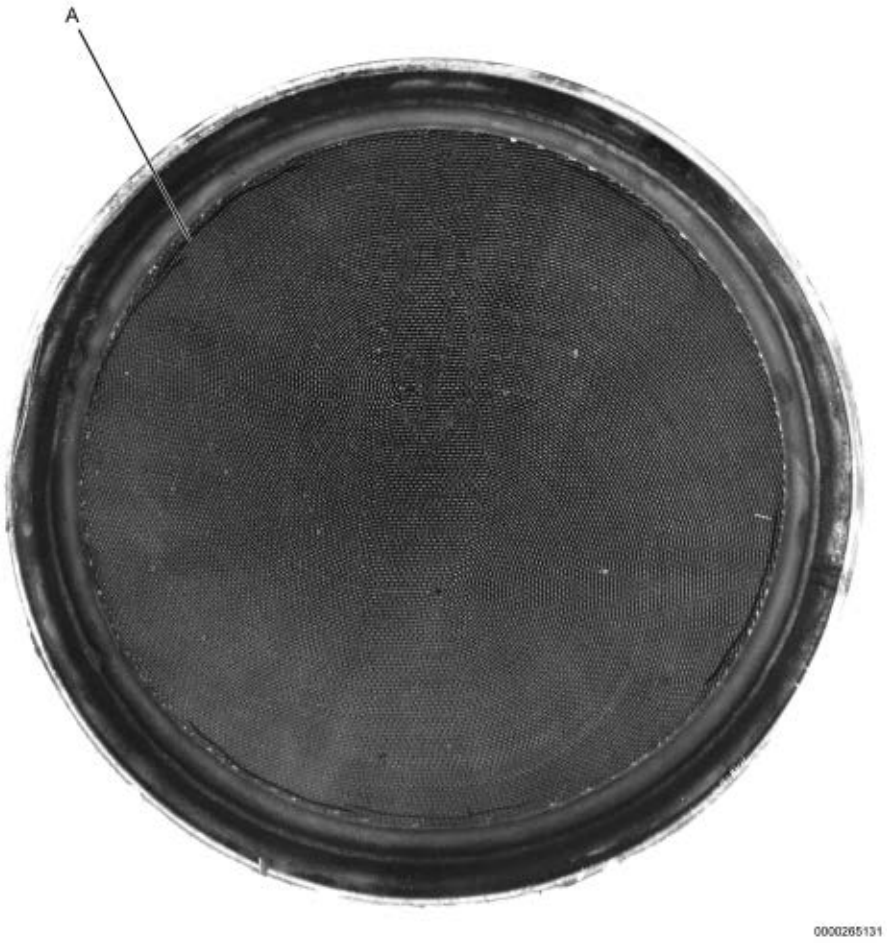

Figure 806 Diesel Oxidation Catalyst (DOC) Outlet

A. DOC separation between the substrate and housing

2. Inspect DOC.
3. If black soot or gray ash is visible on the face of the DOC, the system is working properly. The DOC can be reused.
4. If inspection shows separation between the substrate and housing(Item A)(Figure 806), the DOC can be reused.
5. If DOC cells are melted or deformed, determine the cause of excessive exhaust gas temperatures.
6. Repair cause of excessive exhaust gas temperatures. Replace the DOC. Follow procedure in the *Exhaust Aftertreatment System with DPF and SCR Service Manual.*

Expected Outcome

DOC should be free of restriction, contamination, soot leakage, and melted or deformed cells.

SCR Inspection

Overview

Inspect Selective Catalyst Reduction (SCR) canister.

Tools Required

None

Equipment Condition

None

Inspection Procedure

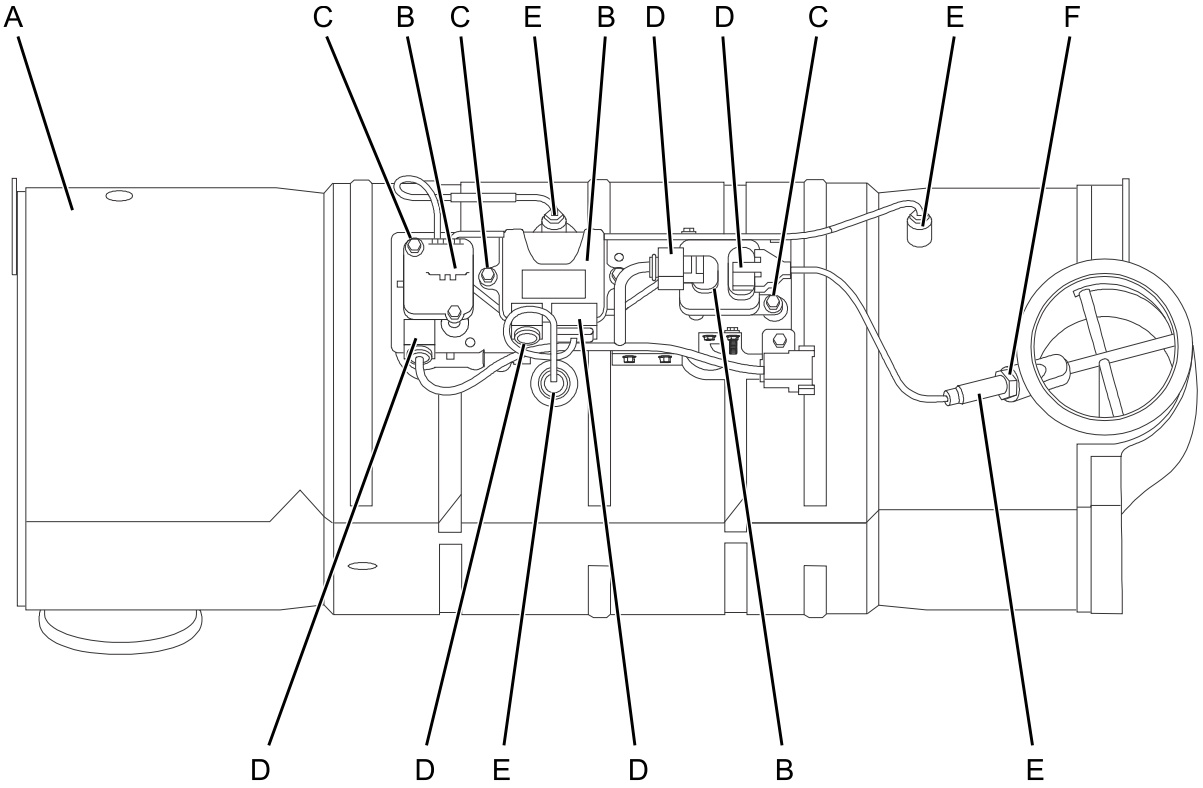

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Figure 807 Selective Catalyst Reduction (SCR) Assembly

A. SCR canister
B. Sensor module (3)
C. Mounting bolt (6)
D. Electrical connector (5)
E. Sensor (4)
F. Mounting nut (1)

1. Check SCR canister (Figure 807) (Item A) for exterior damage such as dents or cracks.
2. Check sensors (Figure 807) (Item E) and sensor modules (Figure 807) (Item B) for visual damage.
3. Check for loose, damaged, brittle, or cracked wiring or electrical connectors (Figure 807) (Item D).

4. Check for loose or damaged mounting bolts (Figure 807) (Item C) or nut (Figure 807) (Item F).
5. Correct items that fail visual check(s).

Expected Outcome

Selective Catalyst Reduction (SCR) canister should be free of dents of cracks. Sensors and sensor modules should be free of visual damage. Wiring and electrical connectors should pass visual inspection and be in good working order.

Follow-On Procedure

None

Decomp Tube Inspection

Overview

Inspect decomposition reactor tube for blockage caused by Diesel Exhaust Fluid (DEF) deposits.

Tools Required

None

Equipment Condition

Decomposition Reactor Tube removed from exhaust.

Inspection Procedure

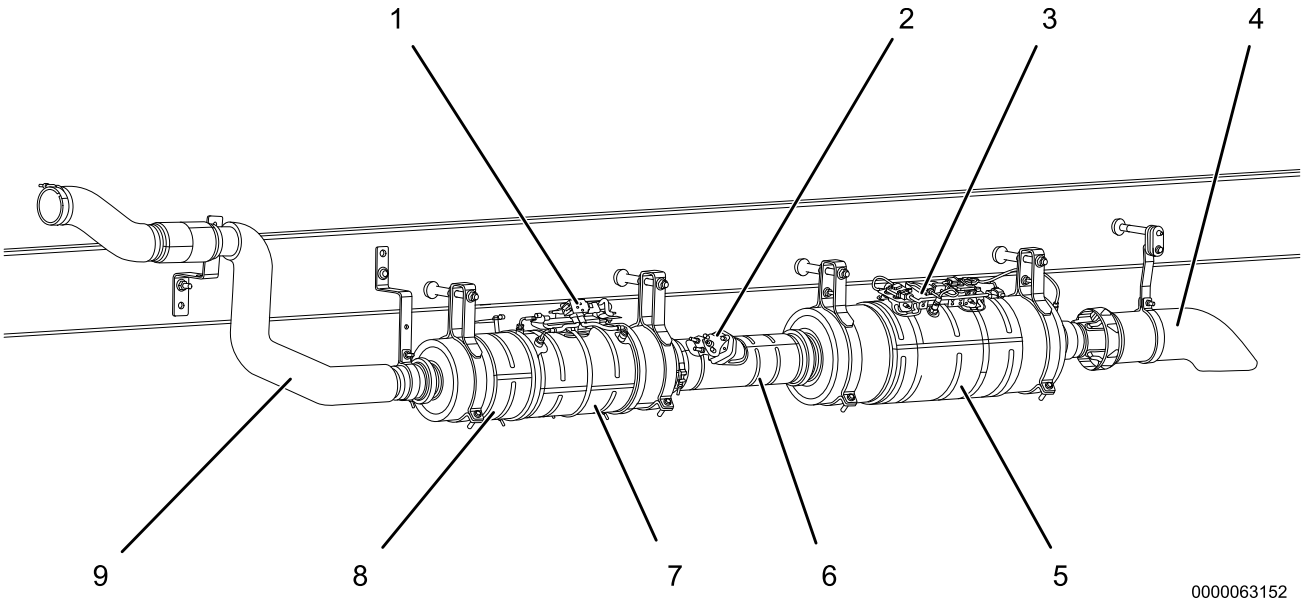

Figure 808 In-Line Exhaust System

1. Diesel Particulate Filter (DPF) interface module
2. DEF Dosing Unit
3. Selective Catalyst Reduction (SCR) interface module
4. Tailpipe
5. Selective Catalyst Reduction (SCR) canister
6. Decomposition reactor tube
7. Diesel Particulate Filter (DPF)
8. Diesel Oxidation Catalyst (DOC)
9. Turbo pipe

1. Inspect decomposition reactor tube for blockage caused by Diesel Exhaust Fluid (DEF) deposits.
   - If the DEF deposits in the mixer area are blocking more than 50% of the decomposition reactor tube, the decomposition reactor tube must be cleaned.
2. Inspect the exhaust flanges for corrosion or other damage.
3. Follow cleaning procedure in the *Exhaust Aftertreatment System with DPF and SCR Service Manual.*

Expected Outcome

Decomposition reactor tube should be free from blockage caused by Diesel Exhaust Fluid (DEF) deposits.

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All Ratings

Key On Engine Off Specifications

Barometric pressure (500 ft. above sea level)	99.01 kPa (14.36 psi) / 3.91 V
Fuel rail pressure	0 kPa (0 psi) / 0.5 V
Turbocharger 1 turbine outlet pressure	0 kPa (0 psi) / 0.84 V
Fuel delivery pressure	0 kPa (0 psi) / 0.5 V
Intake manifold pressure	0 kPa (0 psi) / 1.06 V
Diesel particulate filter differential pressure	0 kPa (0 psi) / 0.5 V
Exhaust gas recirculation valve position	4.5 to 5.5 %
Engine throttle valve position	4.5 to 5.5 %
Accelerator pedal position sensor (at idle)	0.7 V / 0 %
Accelerator pedal position sensor (depressed to floor)	3.75 V / 99.6 %
Engine oil pressure	0 kPa (0 psi) / 0.5 V

Engine Cranking Specifications

Battery voltage (min. based on ECM drop out)	10.5 V
Cranking rpm (min.)	130 rpm
20 seconds maximum crank time per attempt. Wait 2 to 3 minutes before repeating.	
Fuel delivery pressure (min.)	With Gauge: 207 kPa (30 psi) / 1.15 V With EST: 103 kPa (15 psi) / 1.15 V
Fuel rail pressure	20 MPa (3000 psi) / 1 V
Turbocharger 1 turbine outlet pressure	< 34 kPa (< 5 psi) / 0.84 V
Fuel Intake restriction	203 - 305 mmHg (8 - 12 inHg)
High-pressure pump Intake pressure	> 207 kPa (> 30 psi)
Intake air heater fuel solenoid fuel supply pressure	55 - 82 kPa (8 - 12 psi)
Intake air heater fuel igniter fuel supply pressure	55 - 82 kPa (8 - 12 psi)
Diesel particulate filter differential pressure	0 kPa (0 psi) / 0.66 V
Exhaust gas recirculation valve	0 %

Low Idle No Load

Fuel delivery pressure (min.)	413 kPa (60 psi) / 1.8 V
Fuel delivery pressure (max.)	827 kPa (120 psi) / 3.2 V
Fuel rail pressure	80,250 kPa (11,639 psi)
Engine speed	600 - 650 rpm
Intake manifold pressure	< 21 kPa (< 3 psi) / 1.026 V
Turbocharger 1 turbine outlet pressure	< 34 kPa (< 5 psi) / 0.84 V
Fuel Intake restriction	330 - 432 mmHg (13 - 17 inHg)
High-pressure pump Intake pressure	482 - 896 kPa (70 - 130 psi)
High-pressure fuel return flow	< 60 ml
Crankcase oil separator speed	7000 to 8500 rpm
Engine coolant temperature 1 (at thermostat opening)	86° C (186° F) / 0.571 V
Engine coolant temperature 1 (max. before DTC is set)	120 °C (248 °F) / 0.64 V
Engine coolant temperature 2 (at thermostat opening)	55 °C (131 °F) / 1.26 V
Engine coolant temperature 2 (max. before DTC is set)	120 °C (248 °F) / 0.64 V
Engine oil pressure (min. with gauge)	68 kPa (10 psi) / 1.5 V
Engine oil temperature	98 °C (208 °F) / 0.405 V
Intake air temperature 2 (boost)	48 °C (118 °F) / 1.06 V
Intake air temperature 2 (boost) (max. before DTC is set)	95 °C (203 °F) / 1.11 V
Intake manifold air temperature	53 °C (127 °F) / 1.329 V
Intake manifold air temperature (max. before DTC is set)	135 °C (275 °F) / 0.47 V
Actuator supply pressure (min.)	620 kPa (90 psi)
Turbocharger wastegate control supply pressure (min.)	358 kPa (52 psi)

High Idle No Load

Air cleaner restriction (max.)	3.7 kPa (15 in H_2O)
Fuel delivery pressure (min.)	413 kPa (60 psi) / 1.8 V
Fuel delivery pressure (max.)	827 kPa (120 psi) / 3.2 V
Fuel rail pressure	165 to 200 MPa (24,000 to 29,000 psi) / 4.01 V
Engine speed	1550 - 2200 rpm
Intake manifold pressure	90 - 110 kPa (13 - 16 psi)
Turbocharger 1 turbine outlet pressure	< 34 kPa (< 5 psi) / 0.84 V
High-pressure pump fuel return pressure	90 kPa (13 psi)
Diesel particulate filter differential pressure (max. before DTC is set)	35 kPa (5 psi) / 1.9 V
Engine oil pressure (min. with gauge)	275 - 482 kPa (40 - 70 psi) / 4.7 V

Full Load

Air cleaner restriction (max.)	6.2 kPa 25 in H_2O)
Fuel rail pressure	220 MPa (31900 psi) / 4.1 V
Fuel delivery pressure (min.)	413 kPa (60 psi) / 1.3 V
Fuel delivery pressure (max.)	827 kPa (120 psi) / 3.2 V
Engine speed	1550 - 2200 rpm
Intake manifold pressure	> 206 kPa (30 psi) / 2.18 V
Turbocharger 1 turbine outlet pressure	< 34 kPa (< 5 psi) / 0.84 V
Engine oil pressure (min. with gauge)	500 kPa (72 psi) / 3.9 V
Engine oil temperature (max.)	98 °C (208 °F) / 0.41 V
Diesel particulate filter differential pressure (max. before DTC is set)	35 kPa (5 psi) / 1.9 V
Exhaust back pressure (max.)	35 kPa (5 psi)
Water temperature differential across radiator (top and bottom)	9 °C (16 °F)

Engine Coolant Temperatures

Temperature Sensors (Engine Coolant Temperature 1 [ECT1], Engine Coolant Temperature 2 [ECT2], Engine Oil Temperature [EOT], Intake Manifold Air Temperature [IMAT])	
Temperature at -18 °C (0 °F)	4.2 V / 14030 Ω
Temperature at 0 °C (32 °F)	3.6 V / 5876 Ω
Temperature at 21 °C (70 °F)	2.6 V / 2404 Ω
Temperature at 65 °C (150 °F)	0.94 V / 507 Ω
Temperature at 93 °C (200 °F)	0.47 V / 224 Ω
Temperature Sensors (Intake Air Temperature [IAT])	
Temperature at -18 °C (0 °F)	4.21 V / 13866 Ω
Temperature at 0 °C (32 °F)	3.59 V / 5988 Ω
Temperature at 21 °C (70 °F)	2.67 V / 2561 Ω
Temperature at 65 °C (150 °F)	1.05 V / 576 Ω
Other Components	
Camshaft Position (CMP) sensor	860 Ω ± 10% @ 20 °C
Crankshaft Position (CKP) sensor	860 Ω ± 10% @ 20 °C
Coolant Mixer Valve (CMV)	5.45 - 6.00 Ω @ 24 °C
Coolant Flow Valve (CFV)	5.45 - 6.00 Ω @ 24 °C
Intake Air Heater Fuel Solenoid (IAHFS)	8 Ω ± 1 Ω @ room temperature
Turbocharger Wastegate Control (TC2WC) solenoid	9.5 Ω ± 10%, -5% @ 20 °C

Intake Air Temperatures

Intake air heater fuel igniter current draw	15 A

Diesel Oxidation Catalyst Intake Temperatures

Temperature Sensors (Engine Coolant Temperature 1 [ECT1], Engine Coolant Temperature 2 [ECT2], Engine Oil Temperature [EOT], Intake Manifold Air Temperature [IMAT])	
Temperature Sensors (Diesel Oxidation Catalyst Intake Temperature [DOCIT], Diesel Oxidation Catalyst Outlet Temperature [DOCOT], Diesel Particulate Filter Outlet Temperature [DPFOT])	
Temperature at 21 °C (70 °F)	4.5 V / 19.4 Ω
Temperature at 65 °C (150 °F)	3.9 V / 7.1 Ω
Temperature at 93 °C (200 °F)	3.4 V / 4.3 Ω
Temperature at 204 °C (400 °F)	1.6 V / 0.96 Ω
Temperature at 482 °C (900 °F)	0.34 V / 0.146 Ω

Soot Load Level versus Exhaust Gas Target Temperature Chart

Soot Load (%)	Target Temperature (Degrees Celsius)
0.0	0.0
11.1	560.0
22.2	560.0
33.3	560.0
44.4	550.0
55.6	550.0
66.7	550.0
77.8	550.0
88.9	525.0
100.0	525.0
111.1	525.0
122.2	525.0
133.3	500.0
144.4	500.0
155.6	500.0
166.7	500.0
177.8	500.0

Other Component Specifications

Actuator Output State

Exhaust Gas Recirculation (EGR) valve control	Output state low – 5 % Output state high – 95 %
Exhaust Gas Recirculation Position (EGRP)	Output state low – 5 % Output state high – 95 %
Exhaust Back Pressure (EBP) valve	Output state low – 0 % Output state high – 95%
Engine Throttle Valve (ETV) control	Output state low – 5 % Output state high – 95 %
Engine Throttle Valve (ETV) position	Output state low – 5 % Output state high – 95 %
Turbocharger Wastegate Control (TC2WC) solenoid	Output state low – 5 % Output state high – 95 %
Fuel Pressure Control Valve (FPCV)	Output state low – 5 % Output state high – 95 %
Coolant Flow Valve (CFV)	Output state low – 5 % Output state high – 95 %
Coolant Mixer Valve (CMV)	Output state low – 5 % Output state high – 95 %
Aftertreatment Fuel Doser Control (AFTFD)	Output state low – 5 % Output state high – 95 %
Inlet Air Heater Fuel Igniter (IAHFI)	Output state low – 5 % Output state high – 95 %
Engine Fan Control (EFC)	Output state low – 5 % Output state high – 95 %

Crankcase Pressure

High idle no load - crankcase blow by flow	< 8 in H_2O

EBPV Rod Extension

Full travel	42 mm

TC2WC Rod Extension

Full travel	13 mm

Navistar® N13 (12.4 L)

410 HP @ 1700 rpm

International®Navistar® N13 410 hp @ 1700 rpm / 1450 ft•lb @ 1000 rpm	
50 state 2010 Model Year (MY)	
Engine model	GDT410
Engine Family Rating Code (EFRC)	2231 and 1131
Injection timing	Nonadjustable
High idle speed - manual transmission	2200 rpm
High idle speed - automatic transmission	2200 rpm
Low idle speed	600 rpm
Full load on chassis dynamometer or highway, stabilized engine operating temperature	
Intake manifold pressure (gauge)	Peak torque – 196 kPa (29 psi) / 2.17 V
	Rated speed – 295 kPa (43 psi) / 3.30 V

430 HP @ 1700 rpm (Allison)

International® Navistar® 13 430 hp @ 1700 rpm / 1550 ft•lb @ 1000 rpm	
50 state 2010 Model Year (MY)	
Engine model	GDT430
Engine Family Rating Code (EFRC)	2221 and 1121
Injection timing	Nonadjustable
High idle speed - manual transmission	2200 rpm
High idle speed - automatic transmission	2200 rpm
Low idle speed	600 rpm
Full load on chassis dynamometer or highway, stabilized engine operating temperature	
Intake manifold pressure (gauge)	Peak torque – 213 kPa (31 psi) / 2.36 V
	Rated speed – 298 kPa (43 psi) / 3.33 V

450 hp @ 1700 rpm (Manual)

International® Navistar® 13 450 hp @ 1700 rpm / 1700 ft•lb @ 1000 rpm	
50 state 2010 Model Year (MY)	
Engine model	GDT450
Engine Family Rating Code (EFRC)	2211 and 1111
Injection timing	Nonadjustable
High idle speed - manual transmission	2200 rpm
Low idle speed	600 rpm
Full load on chassis dynamometer or highway, stabilized engine operating temperature	
Intake manifold pressure (gauge)	Peak torque – 214 kPa (31 psi) / 2.73 V
	Rated speed – 285 kPa (41 psi) / 3.33 V

475 hp @ 1700 rpm

International® Navistar® 13 475 hp @ 1700 rpm / 1700 ft•lb @ 1000 rpm	
50 state 2010 Model Year (MY)	
Engine model	GDT475
Engine Family Rating Code (EFRC)	2211 and 1111
Injection timing	Nonadjustable
High idle speed - manual transmission	2200 rpm
High idle speed - automatic transmission	2200 rpm
Low idle speed	600 rpm
Full load on chassis dynamometer or highway, stabilized engine operating temperature	
Intake manifold pressure (gauge)	Peak torque – 214 kPa (31 psi) / 2.73 V
	Rated speed – 285 kPa (41 psi) / 3.33 V

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Electrical Tools

180-Pin Breakout Box

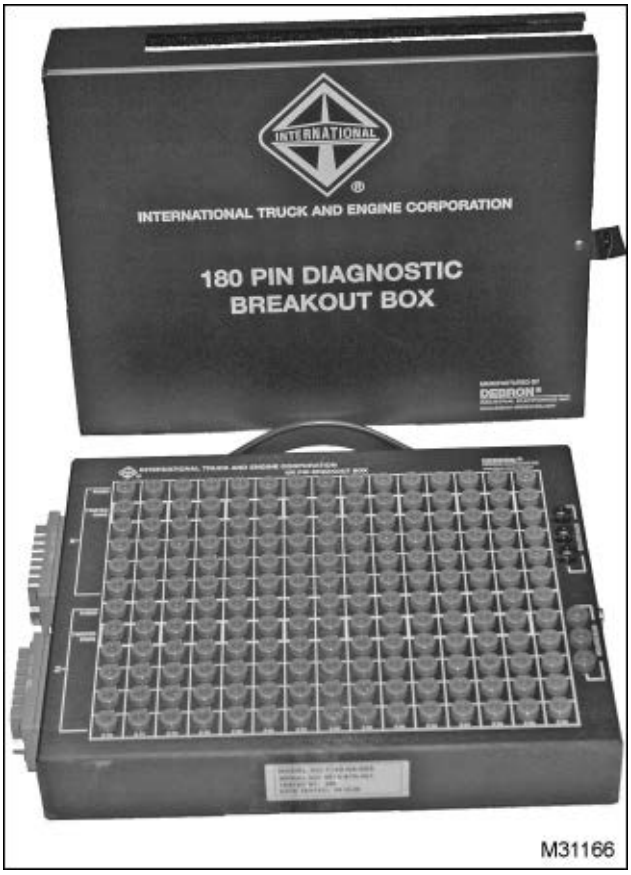

Figure 810 00-00956-08

The 180-Pin Breakout Box allows testing of electronic control system components without disturbing connections or piercing wire insulation to access various signal voltages in the electronic control system.

CAUTION: To prevent damage to the 180-Pin Breakout Box, the 180-Pin Breakout Box is used for measurement only, not to activate or control circuits. High current levels passing through the 180-Pin Breakout Box will burn out the internal circuitry.

This box is universal and can adapt to any control system by means of a unique jumper harness. Each jumper harness is a separate part, complete with a 180-Pin Breakout Box overlay (pin identifier) sheet.

The standard box layout is as follows:

- Two 90-pin connectors which feed 90 banana plug probing points.
- Each 90-pin section of the box is basically a stand-alone box.
- The top row is all fuse protected circuits, the second row is all twisted pair circuits.

2010 MaxxForce 11 & 13 Harness Kit

The 00-01462-00 2010 MaxxForce 11 & 13 Harness Kit with breakout box overlay (pin identifier) sheet is used with the 180-pin Breakout Box. These cables are used to test the circuits going to the engine and chassis connectors on the Engine Control Module (ECM).

3-Banana Plug Harness ZTSE4498

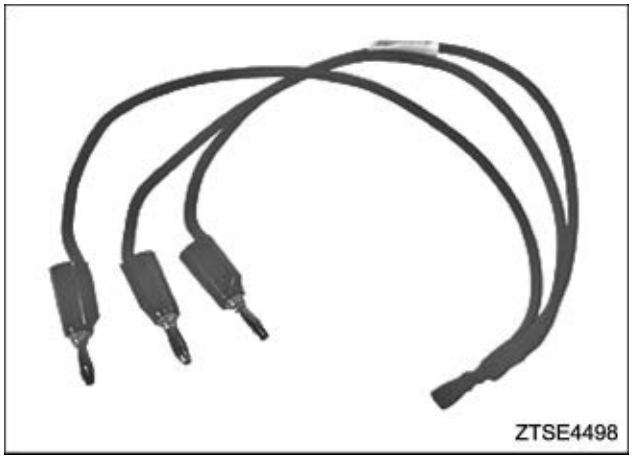

Figure 811 ZTSE4498

The 3-Banana Plug Harness ZTSE4498 is used for sensor-end diagnostics of sensor circuits.

500-Ohm Resistor Harness ZTSE4497

Figure 812 ZTSE4497

The 500-Ohm Resistor Harness ZTSE4497 is used for sensor-end diagnostics of sensor circuits, and for performing loaded circuit tests.

International® Electronic Engine Terminal Test Kit

Figure 813 ZTSE4435C

The International® Electronic Engine Terminal Test Kit is used to access circuits in the connector harness and allows for the use of a DMM without damaging the harness connectors. The probes may also be used as a guide to determine whether the harness connector is retaining correct tension on the mating terminal.

Big Bore Terminal Test Probe Kit

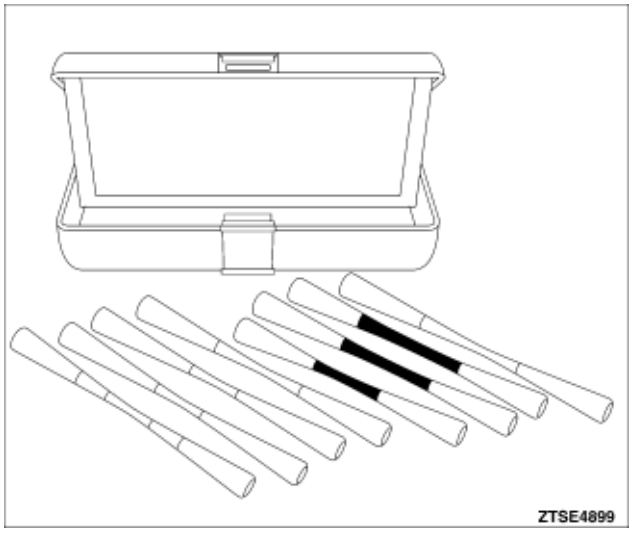

Figure 814 ZTSE4899

The terminal test probe kit is used to access circuit in the connector harness and allows for the use of a DMM without damaging the harness connectors.

Digital Multimeter (DMM) ZTSE4357

Figure 815 ZTSE4357

The DMM ZTSE4357 is used to troubleshoot electrical components, sensors, injector solenoids, relays, and wiring harnesses. The DMM has a high input impedance that allows testing of sensors while the engine is running without loading the circuit being tested. This ensures the signal voltage measurement will not be affected by the voltmeter.

Amp Clamp

Figure 816 ZTSE4575

The Amp Clamp is used to measure amperage draw for the inlet air heater.

EXP-1000 HD by Midtronics

Figure 817 EXP-1000 HD INTL

The EXP-1000 HD by Midtronics is used to measure current draw for the inlet air heater system.

EZ-Tech® Electronic Service Tool (EST)

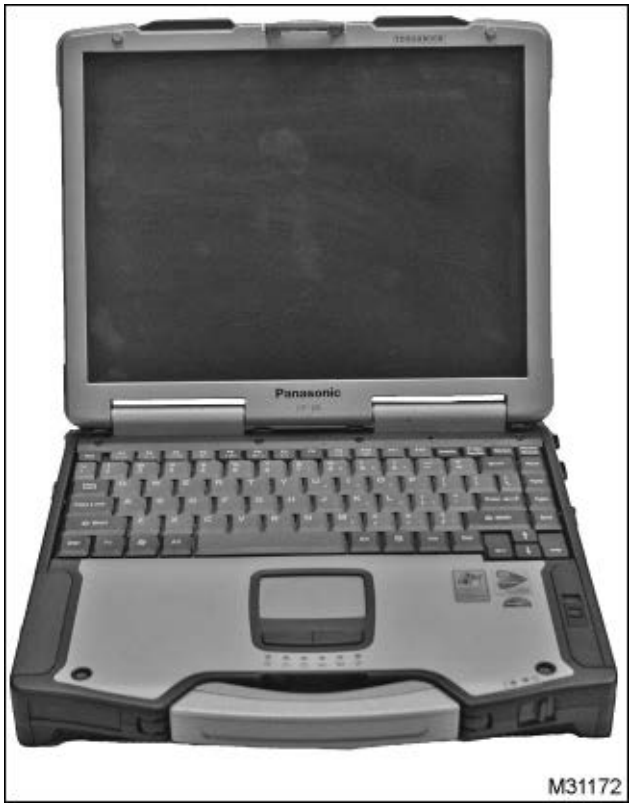

Figure 818 Electronic Service Tool (EST) (typical)

The EST is used to run ServiceMaxx™ software for diagnosing and troubleshooting engine and vehicle problems.

ServiceMaxx™ Software

ServiceMaxx™ software, loaded to an EST or laptop computer, is used to check performance of engine systems, diagnose engine problems, and store troubleshooting history for an engine.

Interface cable (RP1210B compliant supporting J1939 and J1708)

The Interface cable (RP1210B compliant supporting J1939 and J1708) is used to connect the EST to the vehicle. It is available from various suppliers.

Breakout Harness 4485A (APP)

Figure 819 ZTSE4485A

Breakout Harness 4485A is used to measure voltage and resistance on circuits that go to the Accelerator Pedal Position (APP) sensor.

Breakout Harness 4602 (ECT1, ECT2 and EOT)

Figure 820 ZTSE4602

Breakout Harness 4602 is used to measure voltage and resistance on circuits that go to: Engine Coolant Temperature 1 (ECT1), Engine Coolant Temperature 2 (ECT2) or Engine Oil Temperature (EOT) sensors.

Breakout Harness 4735A (O_2S)

Figure 821 ZTSE4735A

Breakout Harness 4735A is used to measure voltage and resistance on circuits connected to the Oxygen Sensor (O_2S).

Breakout Harness 4760A (AFTFSV, AFTPAV, AFTFI and EGRGT)

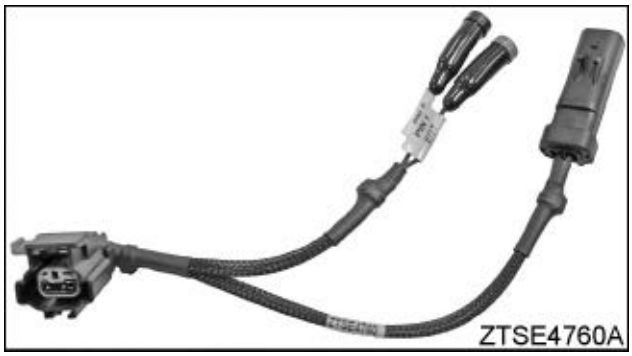

Figure 822 ZTSE4760A

Breakout Harness 4760A is used to measure voltage and resistance on circuits that go to the Aftertreatment Fuel Shutoff Valve (AFTFSV), Aftertreatment Purge Air Valve (AFTPAV), Aftertreatment Fuel Injector (AFTFI), and Exhaust Gas Recirculation Temperature (EGRGT) sensors.

Breakout Harness 4782 (IMT and CACOT)

Figure 823 ZTSE4782

Breakout Harness 4782 is used to measure voltage and resistance on circuits connected to: Intake Manifold Temperature (IMT) and Charge Air Cooler Temperature (CACOT) sensors.

Breakout Harness 4827 (DEFTHC, IAHFS, and EOL)

Figure 824 ZTSE4827

Breakout Harness 4827 is used to measure voltage and resistance on circuits connected to the Diesel Exhaust Fluid Tank Heater Control Valve (DEFTHC), Inlet Air Heater Fuel Solenoid (IAHFS) and Engine Oil Level (EOL).

Breakout Harness 4828 (FPCV and DEFDV)

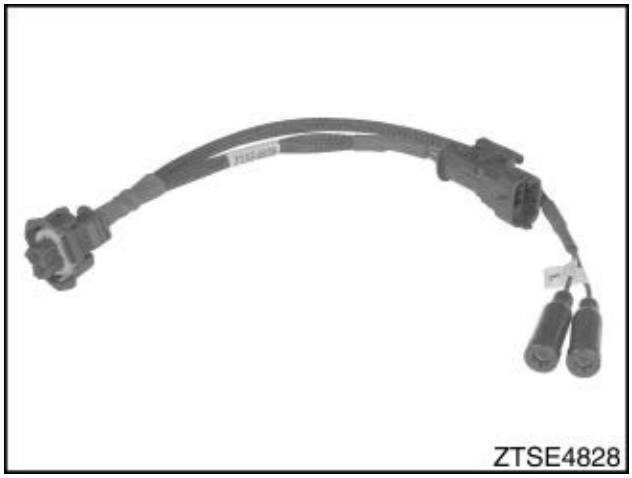

Figure 825 ZTSE4828

Breakout Harness 4828 is used to measure voltage and resistance on circuits connected to the Fuel Pressure Control Valve (FPCV) and Diesel Exhaust Fluid Doser Valve (DEFDV).

Breakout Harness 4829 (FRP)

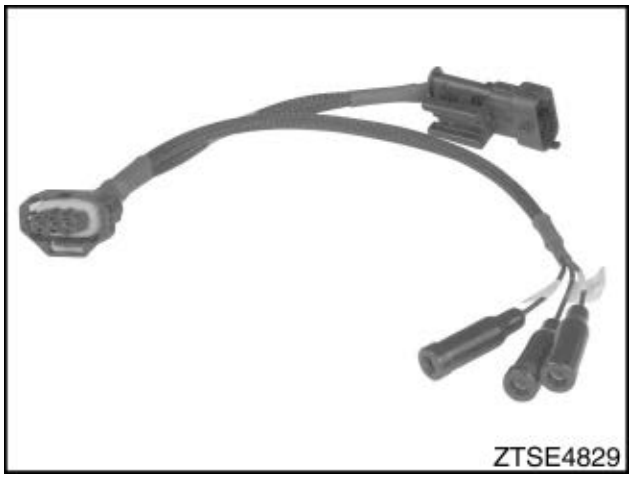

Figure 826 ZTSE4829

Breakout Harness 4829 is used to measure voltage and resistance on circuits connected to the Fuel Rail Pressure (FRP) sensor.

Breakout Harness 4830 (TC2CIS)

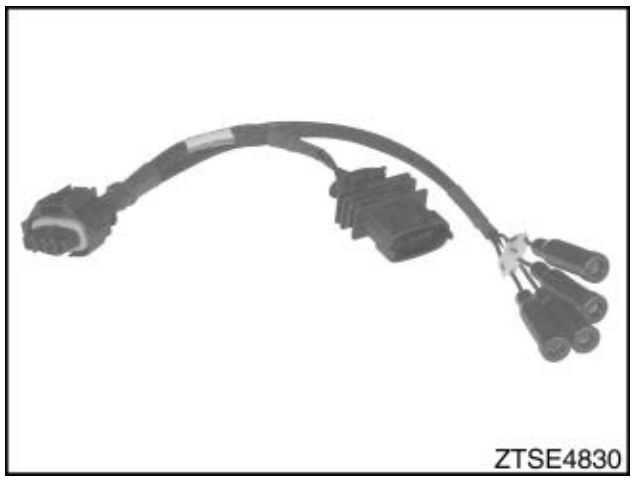

Figure 827 ZTSE4830

Breakout Harness 4830 is used to measure voltage and resistance on circuits connected to Turbocharger 2 Compressor Inlet Sensor (TC2CIS).

Breakout Harness 4844 (EFAN)

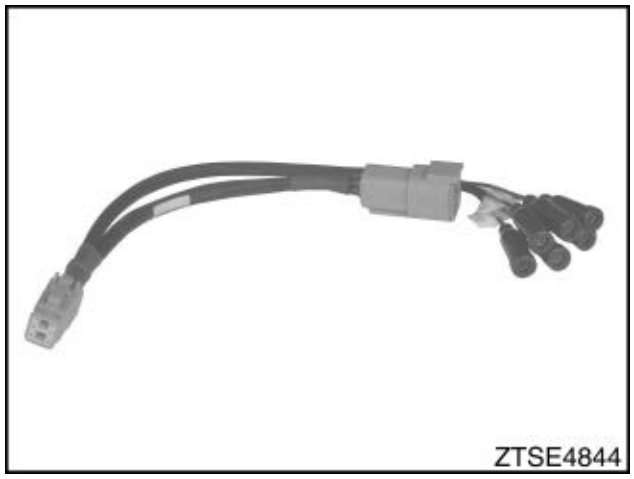

Figure 828 ZTSE4844

Breakout Harness 4844 is used to measure voltage and resistance on circuits connected to the variable Electronic Fan (EFAN) control .

Breakout Harness 4845

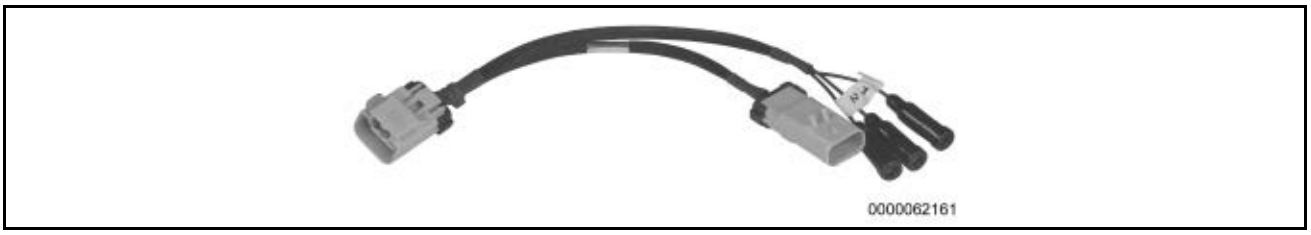

Figure 829 ZTSE4845

Breakout Harness 4845 is used to measure voltage and resistance on circuits connected to the Aftertreatment Fuel Pressure sensor 1 (AFTFP1) sensor.

Breakout Harness 4850 (IMP, TC1TOP, EOP and FDP)

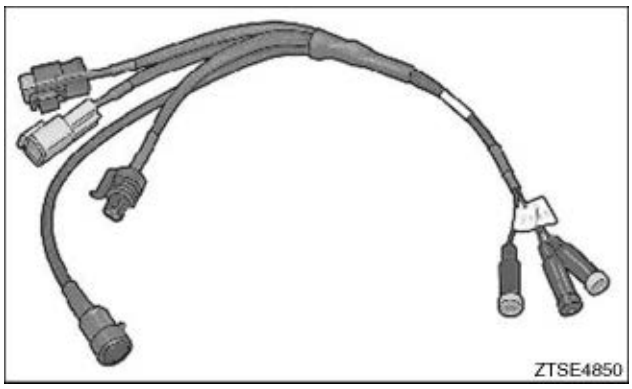

Figure 830 ZTSE4850

Breakout Harness 4850 is used to measure voltage and resistance on circuits connected to: Intake Manifold Pressure (IMP), Turbocharger 1 Turbine Outlet Pressure (TC1TOP), Engine Oil Pressure (EOP) and Fuel Delivery Pressure (FDP) sensors.

Breakout Harness 4871 (AAT and EFC)

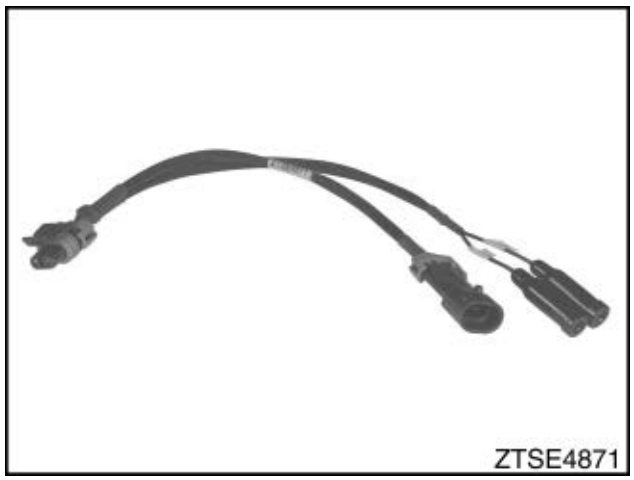

Figure 831 ZTSE4871

Breakout Harness 4871 is used to measure voltage and resistance on circuits connected to: Ambient Air Temperature (AAT) sensor and Engine Fan Control (EFC).

Breakout Harness 4885 (IAHR)

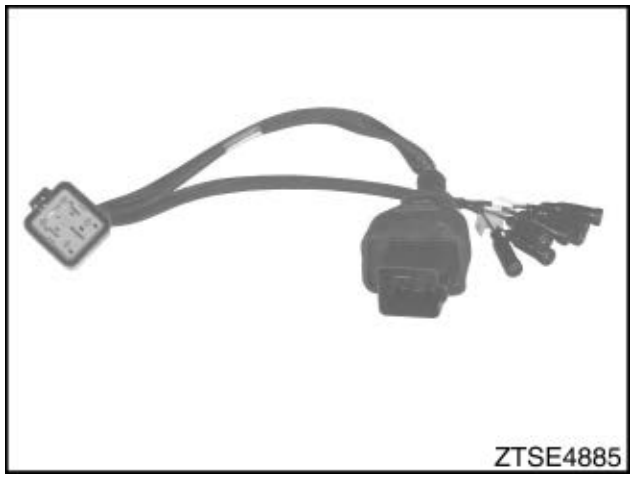

Figure 832 ZTSE4885

Breakout Harness 4885 is used to measure voltage and resistance on circuits connected to the Inlet Air Heater Relay (IAHR).

Breakout Harness 4908

Figure 833 ZTSE4908

Breakout Harness 4908 is used to measure voltage and resistance on various relay circuits.

Breakout Harness 4951 (CCOSS)

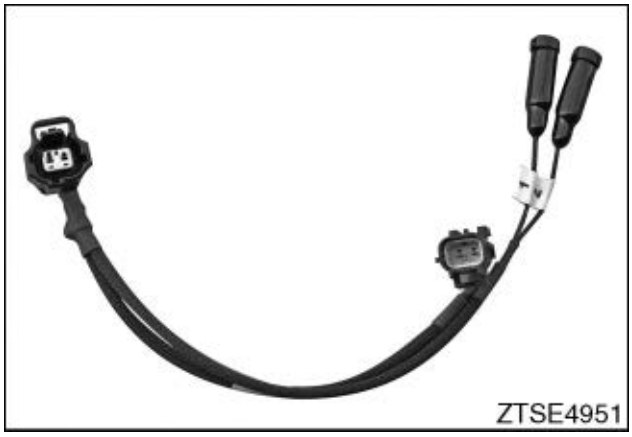

Figure 834 ZTSE4951

Breakout Harness 4951 is used to measure voltage and resistance on circuits connected to the Crankcase Oil Separator Speed (CCOSS) sensor.

Breakout Harness 6002 (WIF)

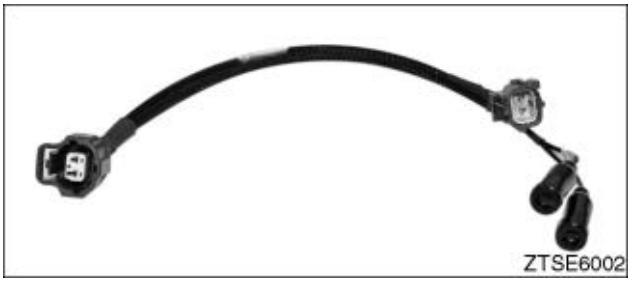

Figure 835 ZTSE6002

Breakout Harness 6002 is used to measure voltage and resistance on circuits that go to the Water In Fuel (WIF) sensor.

Breakout Harness 6004 (ECB)

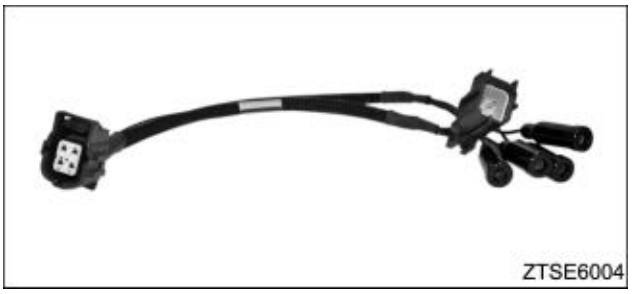

Figure 836 ZTSE6004

Breakout Harness 6004 is used to measure voltage and resistance on circuits that go to the Engine Compression Brake (ECB).

Breakout Harness 6021 (CKP and CMP)

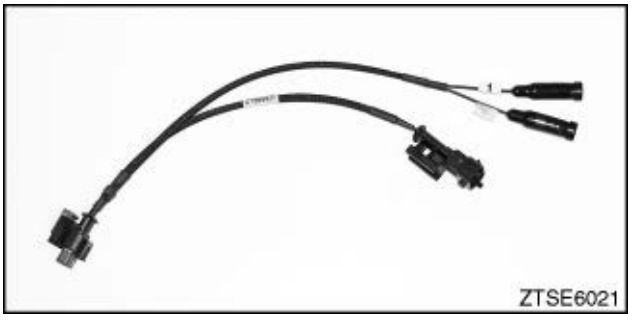

Figure 837 ZTSE6021

Breakout Harness 6021 is used to measure voltage and resistance on circuits that go to the Crankshaft Position (CKP) and Camshaft Position (CMP) sensors.

Breakout Harness 12-574-01 (8-way DPF Jumper)

Figure 838 12-574-01

Breakout Harness 12-574-01 is used to measure voltage and resistance on circuits that pass through the 8-way DPF Jumper.

Breakout Harness 12-575-01 (DPF Differential Pressure / Outlet Pressure Sensor)

Figure 839 12-575-01

Breakout Harness 12-575-01 is used to measure voltage and resistance on circuits that go to the DPF Differential Pressure / Outlet Pressure Sensor.

Breakout Harness 18-045-01 (DEF Suction Line Heater)

Figure 840 18-045-01

Breakout Harness 18-045-01 is used to measure voltage and resistance on circuits that go to the Diesel Exhaust Fluid (DEF) Suction Line Heater.

Breakout Harness 18-046-01 (DEF Return Line Heater)

Figure 841 18-046-01

Breakout Harness 18-046-01 is used to measure voltage and resistance on circuits that go to the Diesel Exhaust Fluid (DEF) Return Line Heater.

Breakout Harness 18-047-01 (DEF Pressure Line Heater)

Figure 842 18-047-01

Breakout Harness 18-047-01 is used to measure voltage and resistance on circuits that go to the DEF Pressure Line Heater.

Breakout Harness 18-050-01 (20-way DEF Harness Interconnect)

Figure 843 18-050-01

Breakout Harness 18-050-01 is used to measure voltage and resistance on circuits that pass through the 20-way DEF Harness Interconnect.

Breakout Harness 18-124-01 (DEF Tank Level and Temperature Sensor)

Figure 844 18-124-01

Breakout Harness 18-124-01 is used to measure voltage and resistance on circuits that go to the Diesel Exhaust Fluid (DEF) Tank Level and Temperature Sensor.

Breakout Harness 18-250-01 (12-way SCR Jumper Harness)

0000053773

Figure 845 18-250-01

Breakout Harness 18-250-01 is used to measure voltage and resistance on circuits that pass through the 12-way Selective Catalyst Reduction (SCR) Jumper Harness.

Breakout Harness 18-500-01 (12-way AFT Interconnect)

0000053774

Figure 846 18-500-01

Breakout Harness 18-500-01 is used to measure voltage and resistance on circuits that pass through the 12-way Aftertreatment (AFT) interconnect.

Breakout Harness 18-648-01 (NOx In Sensor Module and SCR Temperature Sensor Module)

0000053775

Figure 847 18-648-01

Breakout Harness 18-648-01 is used to measure voltage and resistance on circuits that go to the Carbon Monoxide (NOx) In sensor module and Selective Catalyst Reduction (SCR) temperature sensor module.

Breakout Harness 18-649-01 (NOx Out and DOC / DPF Temperature Sensor Module)

0000053776

Figure 848 18-649-01

Breakout Harness 18-649-01 is used to measure voltage and resistance on circuits that go to the Carbon Monoxide (NOx) Out and Diesel Oxidation Catalyst / Diesel Particulate Filter (DOC / DPF) temperature sensor module.

Breakout Harness 18-909-01 (DEF Supply Module)

Figure 849 18-909-01

Breakout Harness 18-909-01 is used to measure voltage and resistance on circuits that go to the Diesel Exhaust Fluid (DEF) Supply Module.

Mechanical Tools

Air Cap, Fuel Cap and Plug Kit

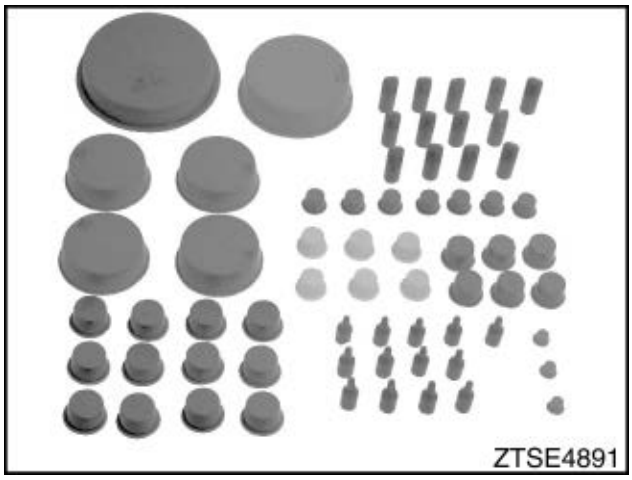

Figure 850 ZTSE4891

The Disposable Air and Fuel Caps are used to cap the fuel system lines and fittings when the fuel system is disconnected for diagnostics. The Disposable Air and Fuel Caps prevent dirt and foreign particles from entering and contaminating the fuel system.

Air Compressor Coolant Line Release Tool

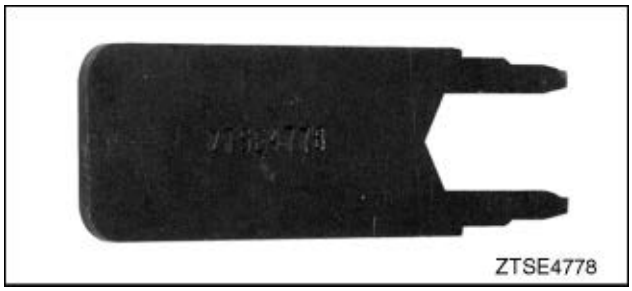

Figure 851 ZTSE4778

Air Compressor Coolant Line Release Tool releases the locking mechanism to allow the removal of the coolant line on the air compressor.

Air Intake Guard

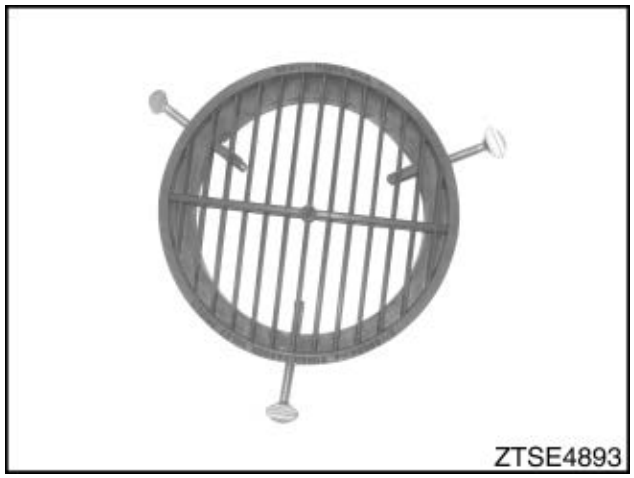

Figure 852 ZTSE4893

The Air Intake Guard is used to protect the turbochargers while performing diagnostics with the air cleaner disconnected.

Blow-by Test Tool

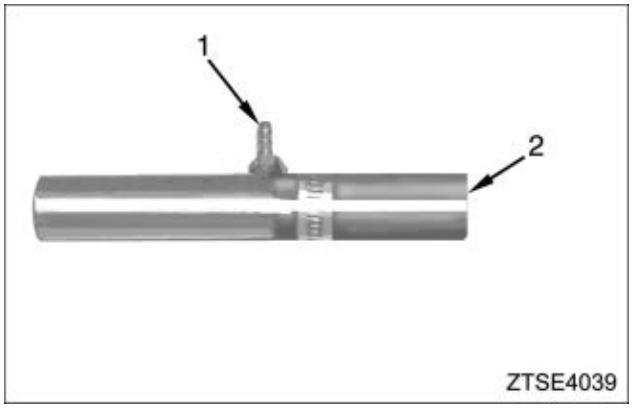

Figure 853 ZTSE4039 (0.406 in. diameter)

1. To magnehelic gauge or manometer
2. To valve cover

The Blow-by Test Tool is used to measure combustion gas flow from the crankcase oil separator and may be used with the digital or Slack Tube® manometer.

Use the pressure readings obtained with this adapter as the main source of engine condition. Use oil consumption trend data if the pressure readings are over the specified limits. Neither changes in oil consumption trends nor crankcase diagnostic pressure trends can establish a specific problem. These changes only indicate that a problem exists.

Clean Fuel Source Tool

Figure 854 15-637-01

The Clean Fuel Source Tool is used to provide a clean, alternative fuel source to aid in the diagnosis of the fuel system.

Coolant Cap Pressure Tester

Figure 855 09–040–01

Inlet Air Heater Solenoid Test Adapter Kit

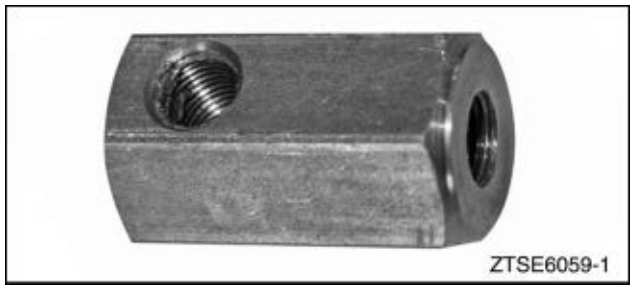

Figure 856 ZTSE6059-1

Figure 857 ZTSE6059-2

The Inlet Air Heater Solenoid Test Adapter Kit is used with the Fuel Pressure Gauge to test fuel pressure at the Inlet Air Heater Fuel Igniter (IAHFI) and Inlet Air Heater Fuel Solenoid (IAHFS).

Digital Manometer

Figure 858 Obtain locally

The Digital Manometer is used to measure low vacuum due to intake restriction or low crankcase pressure. A variety of digital manometers are available for purchase locally. The Water Manometer kit (ZTSE2217A) is an alternative to the Digital Manometer.

EGR Cooler Leak Detection Test Kit

CONTENT
UNDER
DEVELOPMENT

000030568I

New kit is being developed. The EGR Cooler Leak Detection Test Kit is used to pressure test the EGR cooler to check for leaks.

Charge Air Cooler Test Kit

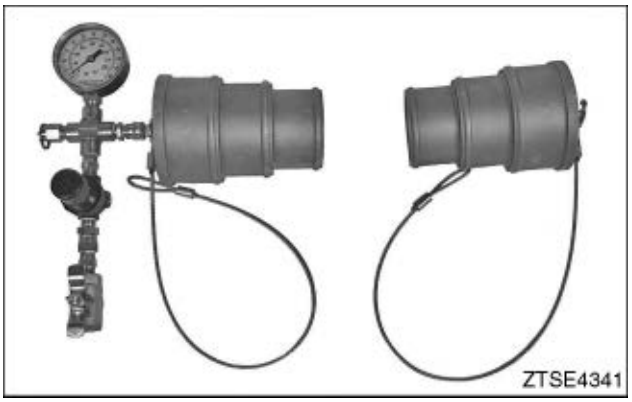

Figure 860 ZTSE4341

The Charge Air Cooler Test Kit is used to pressurize the charge air cooler and piping to check for leaks.

Digital IR Thermometer

Figure 861 ZTSE4799

The Digital Infrared (IR) Thermometer is used to take temperature readings when Electronic Service Tool (EST) and dash gauge readings need to be verified.

Lash Gauge (0.50mm)

Figure 862 ZTSE6076-5A

This tool is used to measure intake valve lash.

Lash Gauge (0.80mm)

Figure 863 ZTSE6076-7A

This tool is used to measure exhaust valve lash.

Fuel Block Off Tool

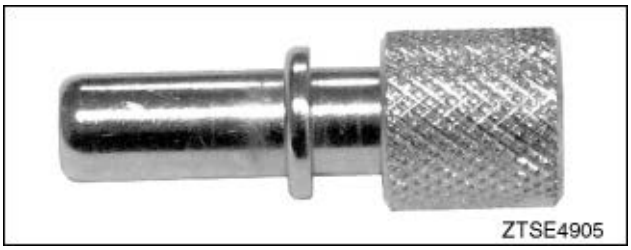

Figure 864 ZTSE4905

The Fuel Block Off Tool is used to block the T-connector fuel line at the high pressure pump in order to measure the low pressure pump output pressure.

Fuel Injector Cups

Figure 865 ZTSE4892

Fuel Injector Cups protects and prevents dirt and debris from damaging the injectors while out of the engine.

Fuel Inlet Restriction and Aeration Tool

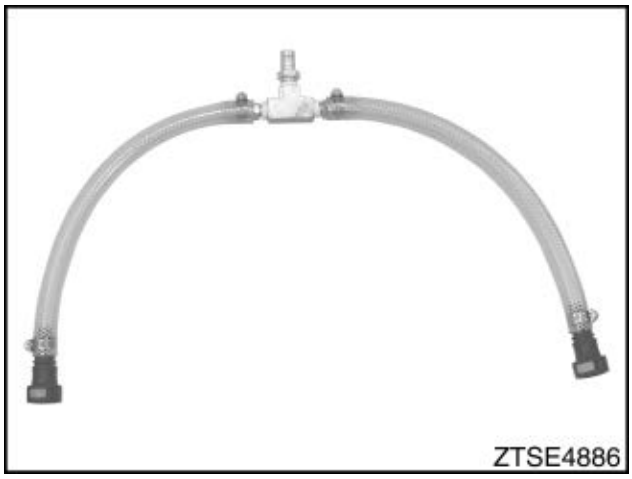

Figure 866 ZTSE4886

The Fuel Inlet Restriction and Aeration Tool is used to check for pressure and aerated fuel in the low fuel pressure system.

Fuel Line Coupler

Figure 867 ZTSE4906

The Fuel Line Coupler is used in conjunction with the Fuel Inlet Restriction and Aeration Tool to measure the fuel pressure in the return line.

Fuel Line Disconnect Tool 11.8 mm

Figure 868 ZTSE4773

The Fuel Line Disconnect Tool 11.8 mm is used to release the locking mechanism on low pressure fuel line connectors.

Fuel Line Disconnect Tool 16 mm

Figure 869 ZTSE4772

The Fuel Line Disconnect Tool 16 mm is used to release the locking mechanism on low pressure fuel line connectors.

Fuel/Oil Pressure Test Coupler

Figure 870 ZTSE4526

The Fuel / Oil Pressure Test Coupler is used with the fuel pressure test fitting for an easy connection to measure fuel pressure.

Fuel Pressure Gauge

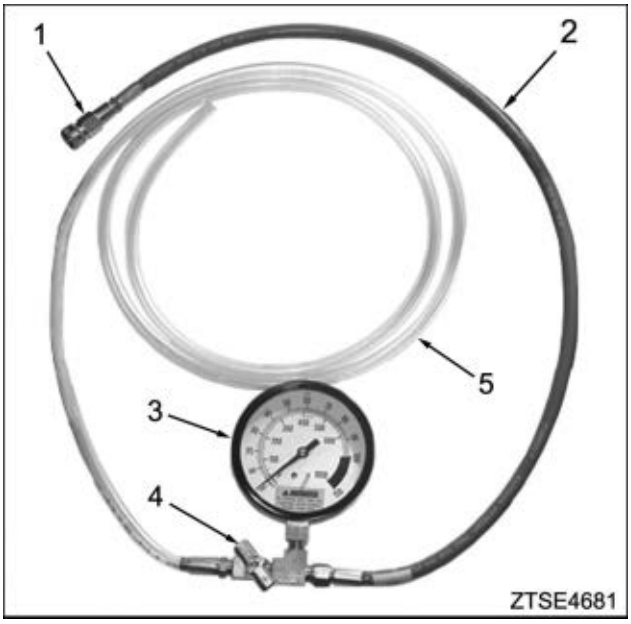

Figure 871 ZTSE4681

1. Quick disconnect check valve
2. Fuel test line
3. Fuel Pressure Gauge
4. Inline shut-off valve
5. Clear test line

The Fuel Pressure Gauge is used to check for fuel pressure and aerated fuel in the low fuel pressure system.

High Pressure Rail Plugs

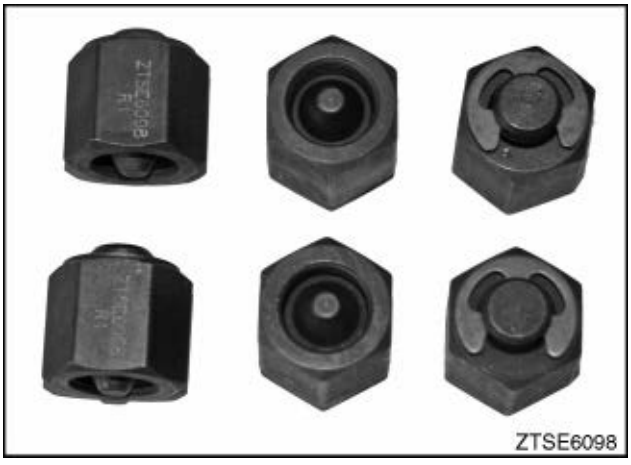

Figure 872 ZTSE6098

The High Pressure Rail Plugs are used to isolate individual injectors by blocking the pressure pipe rail output.

High Pressure Return Line Tester

Figure 873 ZTSE4887

The High Pressure Return Line Tester is used to check for fuel returning from the pressure pipe rail or from the cylinder head fuel return port. Tool consists of two adapters, ZTSE4887-1 (17mm) and ZTSE4887-2 (19mm), and hose ZTSE4887-3.

Pressure Test Kit

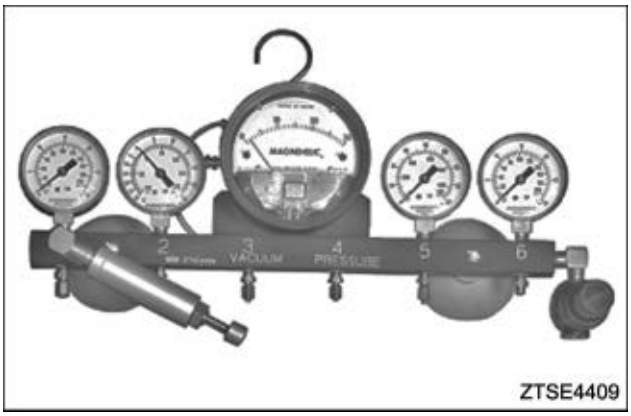

Figure 874 ZTSE4409

The Pressure Test Kit is used to measure intake manifold (boost) pressure, fuel system inlet restriction, fuel pressure, oil pressure, air cleaner intake restriction, and crankcase pressure.

- 0 to 200 kPa (0 to 30 psi) measures intake manifold pressure.
- 0-30 in Hg vacuum /0 to 200 kPa (0 to 30 psi) compound gauge measures fuel system inlet restriction and intake manifold pressure.

  0-30 in H2O 0 to 7.5 kPa (0 to 1 psi) maximum pressure magnehelic gauge measures crankcase pressure and air inlet restriction.

- 60 to 1100 kPa (0 to 160 psi) gauge may be used to check the fuel pressure and oil pressure.

Radiator Pressure Test Kit

Figure 875 ZTSE2384

The Radiator Pressure Test Kit is used to check pressure caps and cooling systems. The pressure gauge indicates if the pressure cap holds the correct pressure and whether the cooling system has leaks or holds pressure.

Slack Tube® Manometer

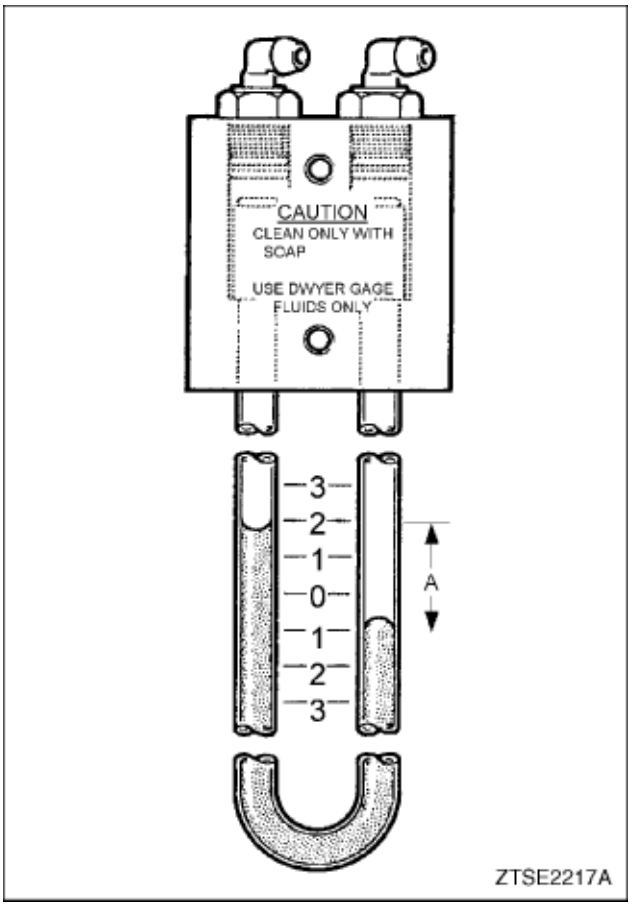

Figure 876 ZTSE2217A

The Slack Tube® Manometer is a U-shaped tube with a scale mounted between the legs of the tube. When the portability of the Pressure Test Kit is not required, this manometer is used to measure low vacuum for intake restriction, low pressure for crankcase, or exhaust back pressure.

Filling

Fill the manometer with water before checking pressure. Use only distilled water. Add some colored water vegetable dye so the scale can be read more easily. With both legs of the manometer open to the atmosphere, fill the tube until the top of the fluid column is near the zero mark on the scale. Shake the tube to eliminate any air bubbles.

Installing, Reading, and Cleaning

1. Support the manometer vertically. Make sure the fluid level is in line with the zero indicator on the graduated scale.
2. Connect one leg of the manometer to the source of the pressure or vacuum. Leave the other leg open to atmospheric pressure.
3. Start the engine and allow it to reach normal operating temperature. Then run the engine to high idle. The manometer can be read after 10 seconds.

4. Record the average position of the fluid level when it is above and below the zero indicator. Add the two figures together. The sum of the two is the total column of fluid (distance A). This represents the crankcase pressure in inches of water (in H_2O).

   At times, both columns of the manometer will not travel the same distance. This is no concern if the leg not connected to the pressure or vacuum source is open to the atmosphere.

5. Compare the manometer reading with engine specifications.
6. When the test is done, clean the tube thoroughly using soap and water. Avoid liquid soaps and solvents.

UV Leak Detection Kit

Figure 877 ZTSE4618

The UV Leak Detection Kit is used with fuel dye to quickly identify leaks. The fuel dye combines with fuel and migrates out at the leak. The ultraviolet lamp illuminates the leaking fuel dye, which appears fluorescent yellow-green in color.

Vacuum Analyzer and Fuel Pump Tester

Figure 878 ZTSE2499

The Vacuum Analyzer and Fuel Pump Tester is used to test the operation of the fuel pump.

Diesel Exhaust Fluid Refractometer

Figure 879 5025

The Diesel Exhaust Fluid (DEF) Refractometer 5025 is used to measure the DEF Urea/Water concentration, which is important for proper SCR system operation.

Aftertreatment Injector Test Kit

Figure 880 12-559-01

The Aftertreatment Injector Test Kit is used when performing tests on the Aftertreatment Fuel Injector (AFTFI).

DEF Doser Valve Spray Test Kit

Figure 881 18-559-01

The DEF Doser Valve Spray Test Kit is used when performing tests on the Diesel Exhaust Fluid Doser Valve (DEFDV).

Pressure Gauge Adapter 18-538-01

Figure 882 18-538-01

Pressure Gauge Adapter 18-538-01 converts Aftertreatment (AFT) temperature sensor ports to 1/8-in NPT thread so a standard pressure gauge can be used to measure exhaust pressure.

DEF Doser Cleaning Kit

Figure 883 18-200-01

18-200-01 DEF Doser Cleaning Kit is used to flush contaminated Diesel Exhaust Fluid (DEF) from the supply module.

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Engine Component Locator

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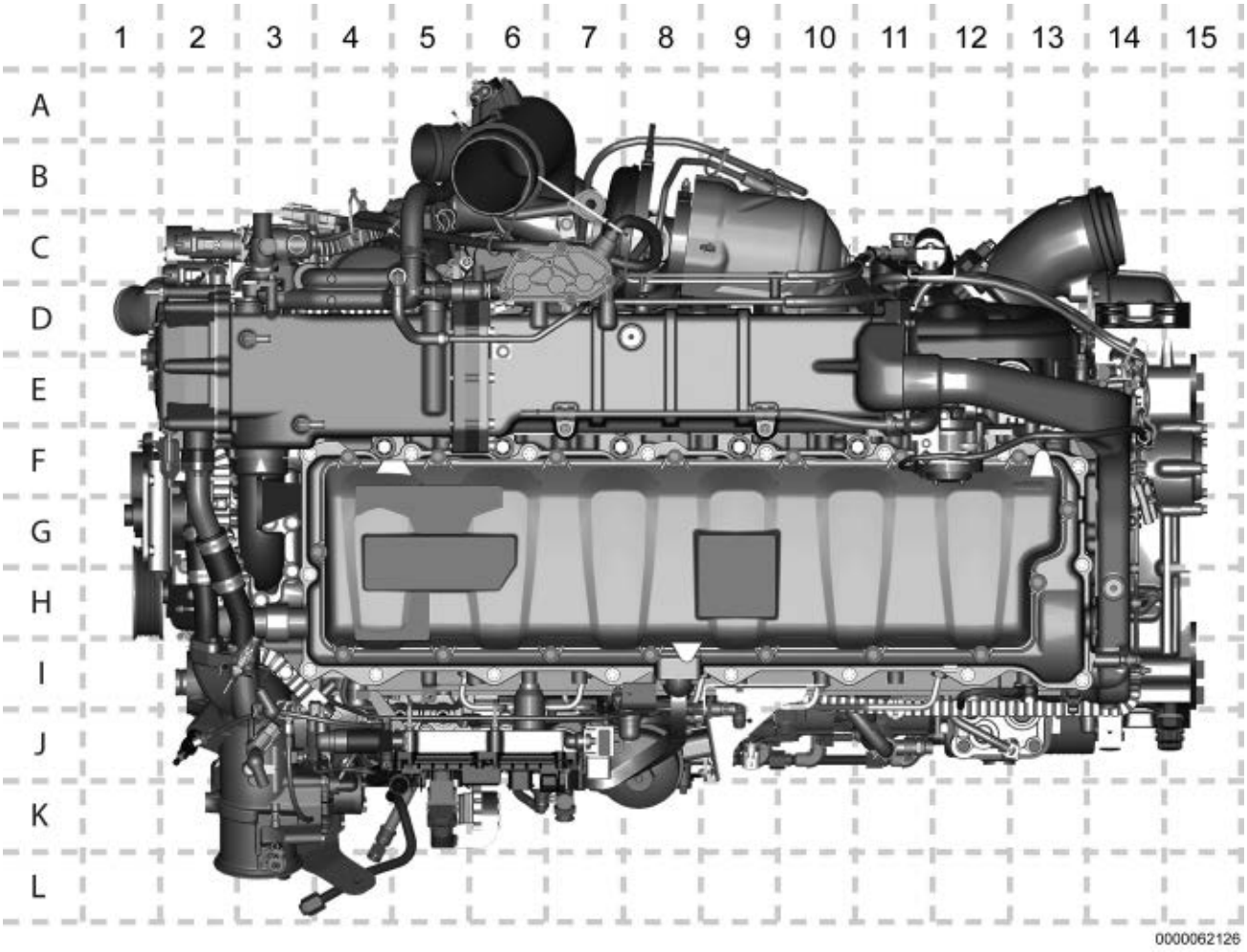
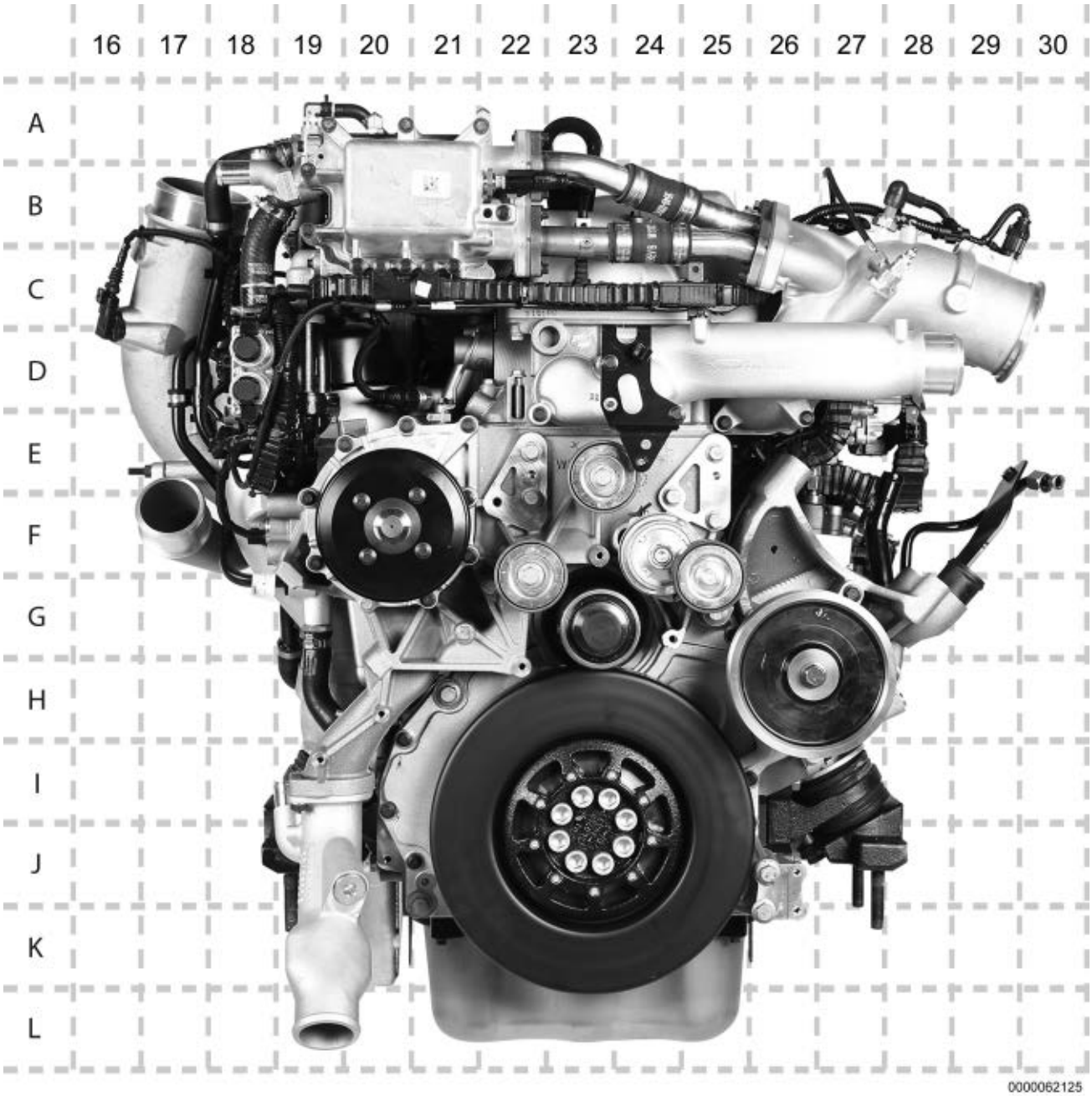


Front View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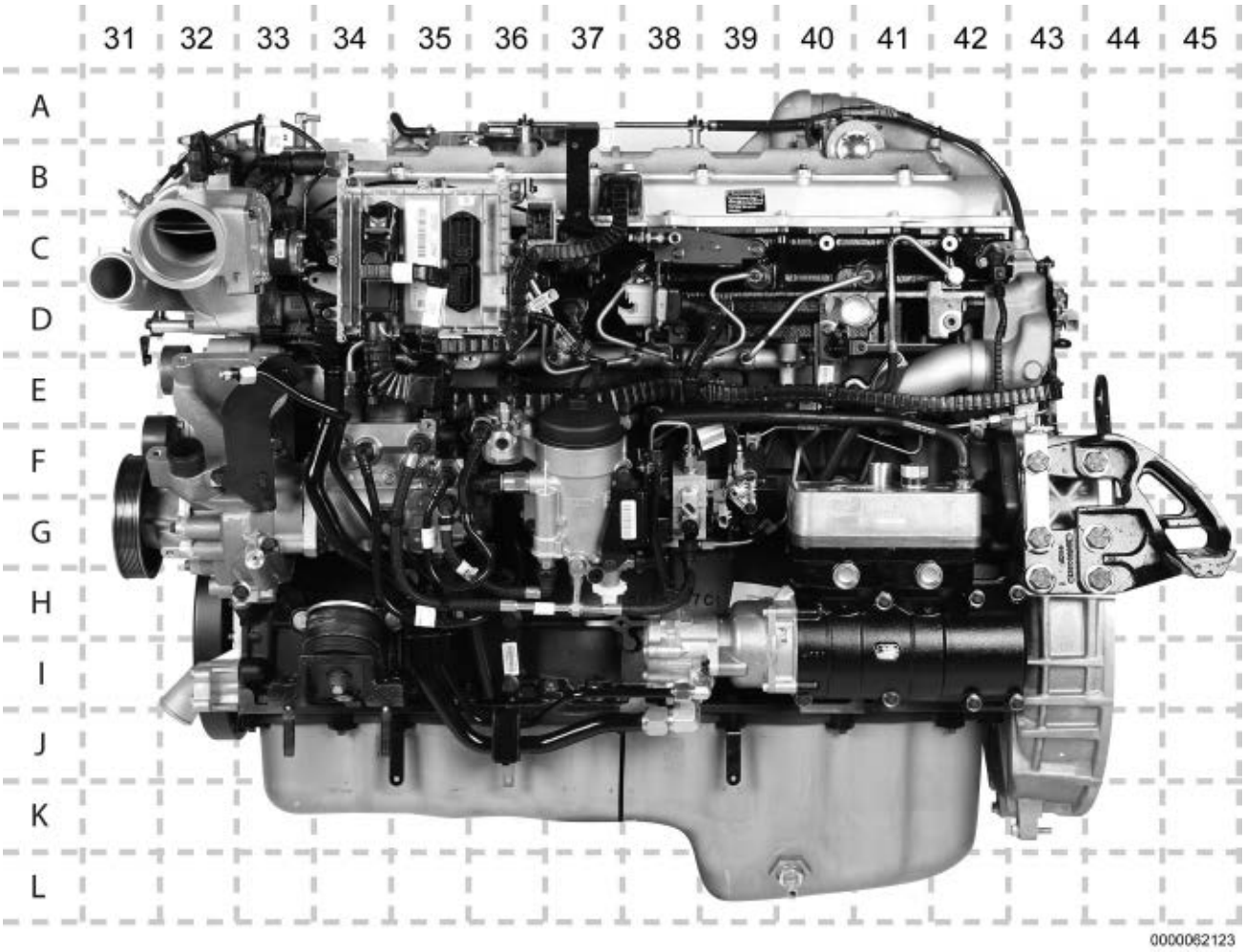
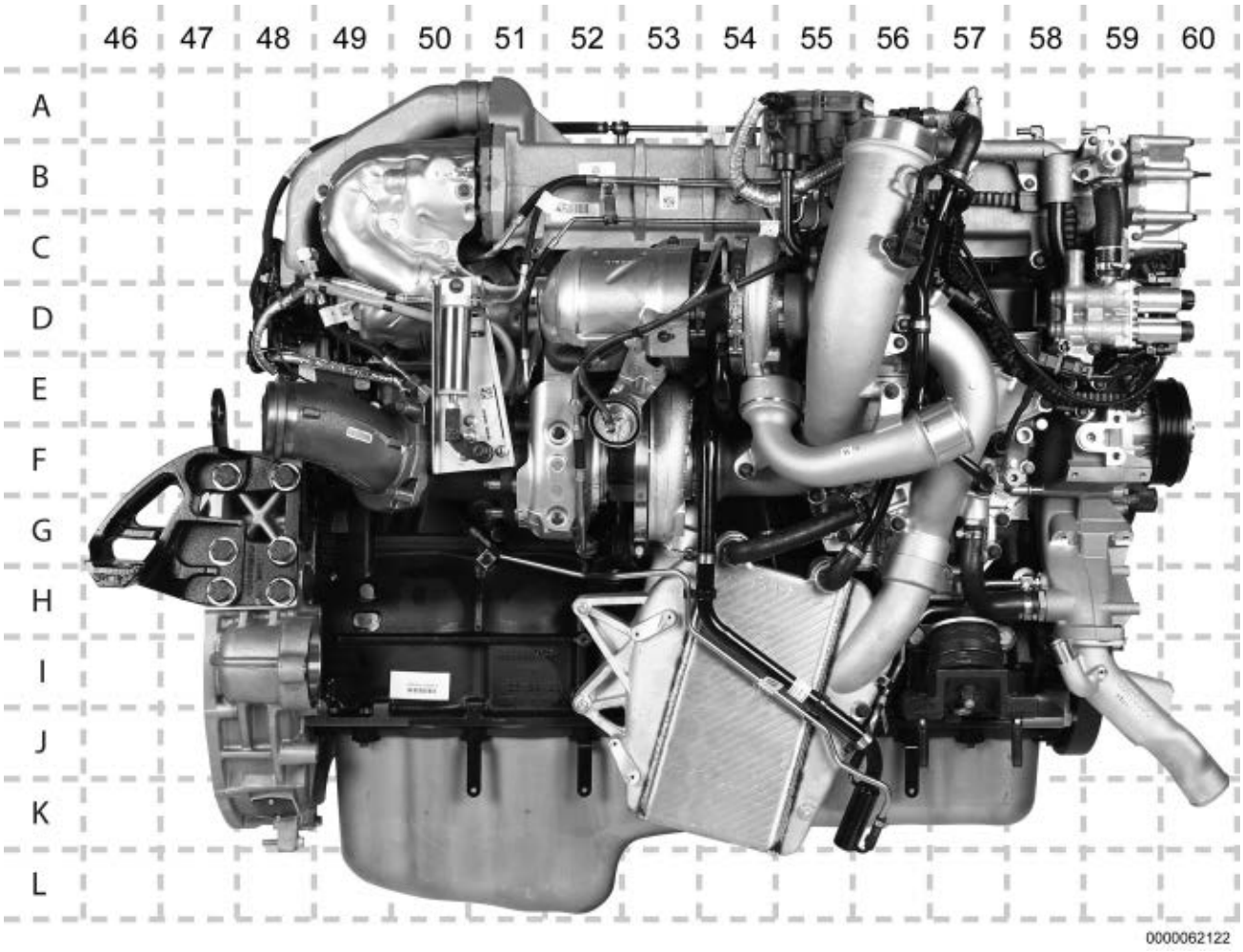
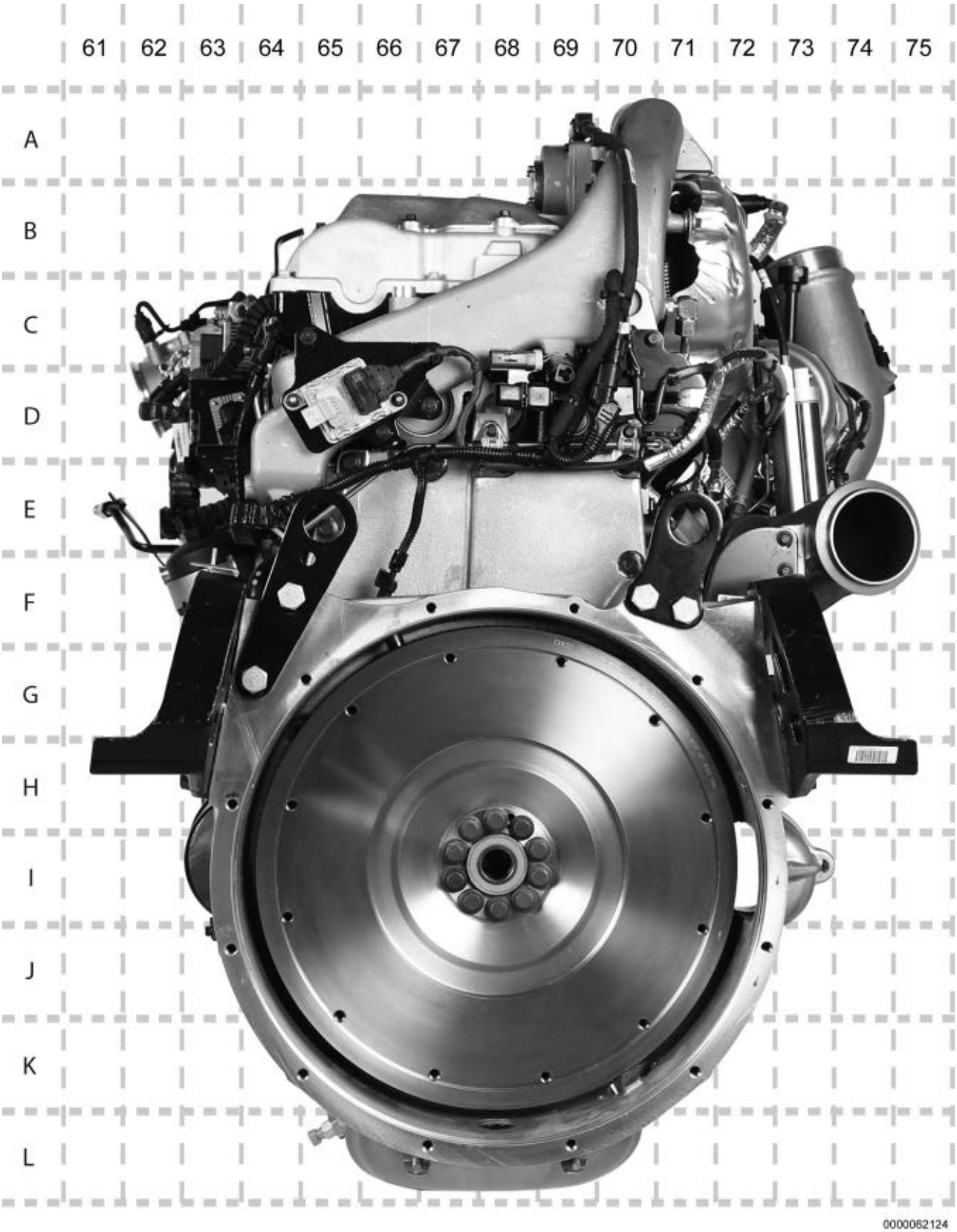
Left Side View



Right Side View



Back View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Component Locator Table

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Aftertreatment Component Locator

SCR Switchback Assembly

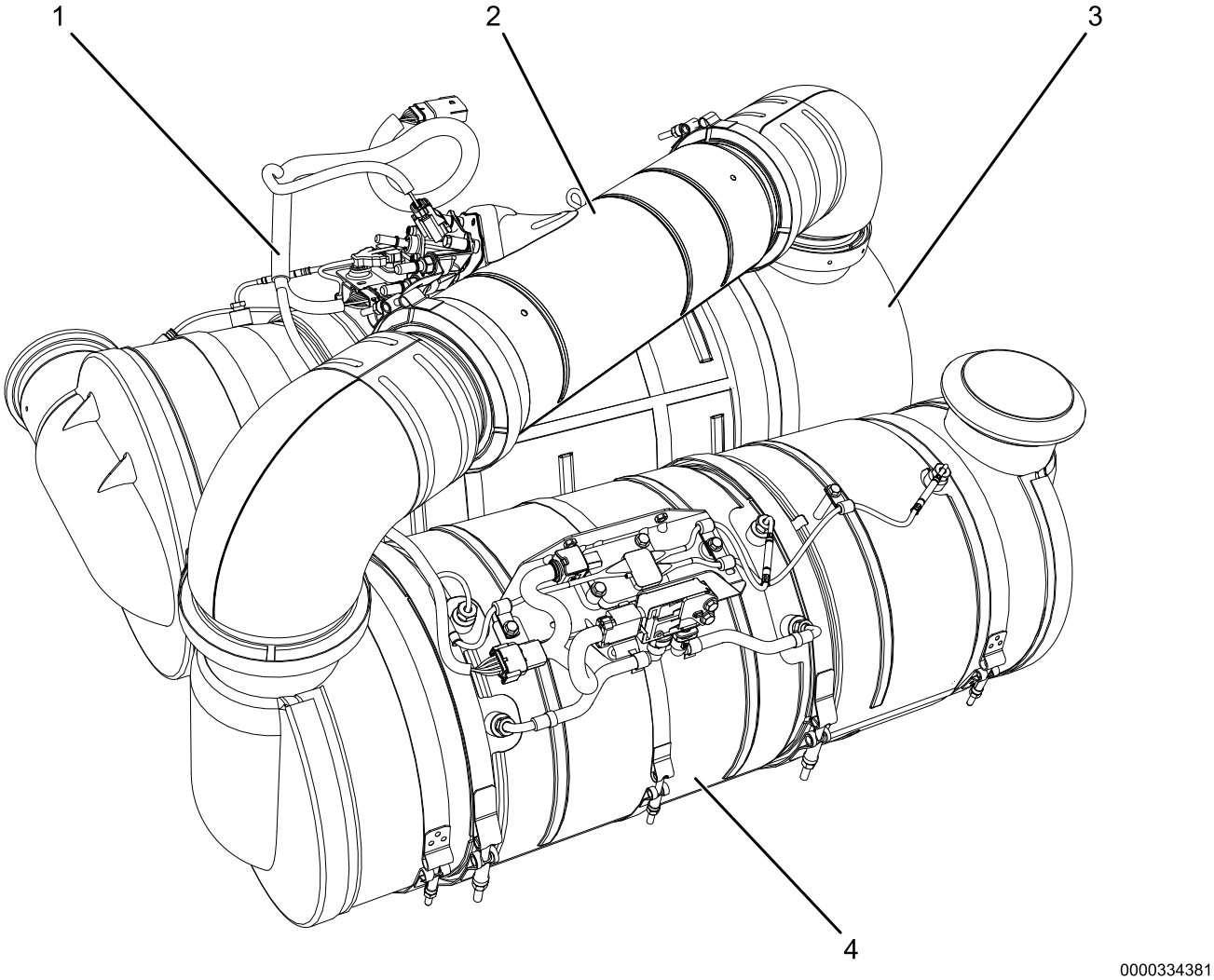

Figure 889 SCR Switchback Assembly

1. Exhaust Jumper Harness
2. Decomposition Reactor Tube
3. Selective Catalyst Reduction (SCR) assembly
4. Diesel Particular Filter (DPF) assembly

DPF Components

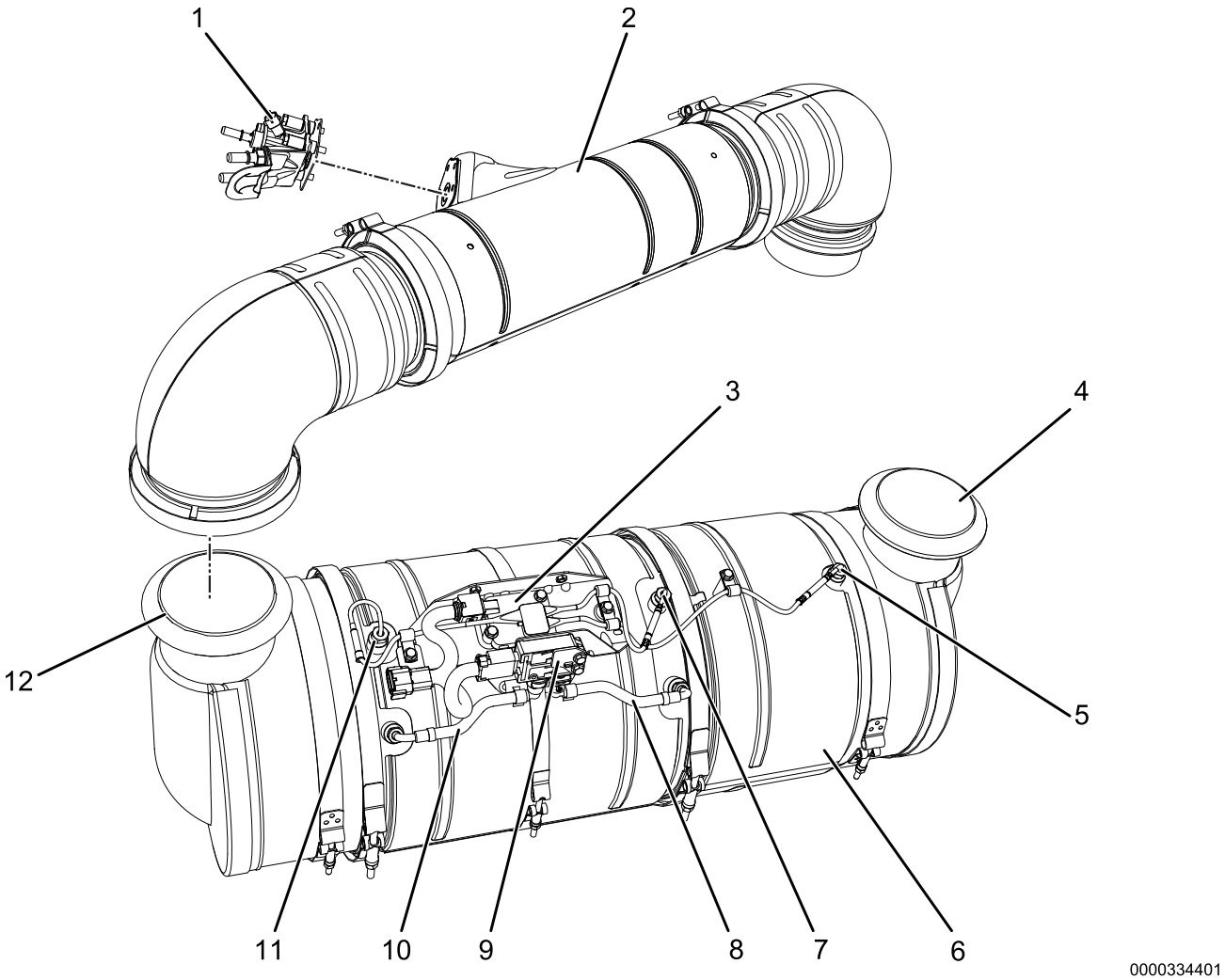

Figure 890 DPF Components

1. Diesel Exhaust Fluid Doser (DEFD)
2. Decomposition Reactor Tube
3. Diesel Oxidation Catalyst (DOC) / DPF Diesel Particulate Filter (DPF) Temperature sensor module
4. DOC Intake
5. Diesel Oxidation Catalyst Intake Temperature (DOCIT) sensor
6. Diesel Particulate Filter (DPF) assembly
7. Diesel Particulate Filter Inlet Temperature (DPFIT) sensor
8. High Pressure Tube
9. Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor module
10. Low Pressure Tube
11. Diesel Particulate Filter Outlet Temperature (DPFOT) sensor
12. DPF Outlet

SCR Components

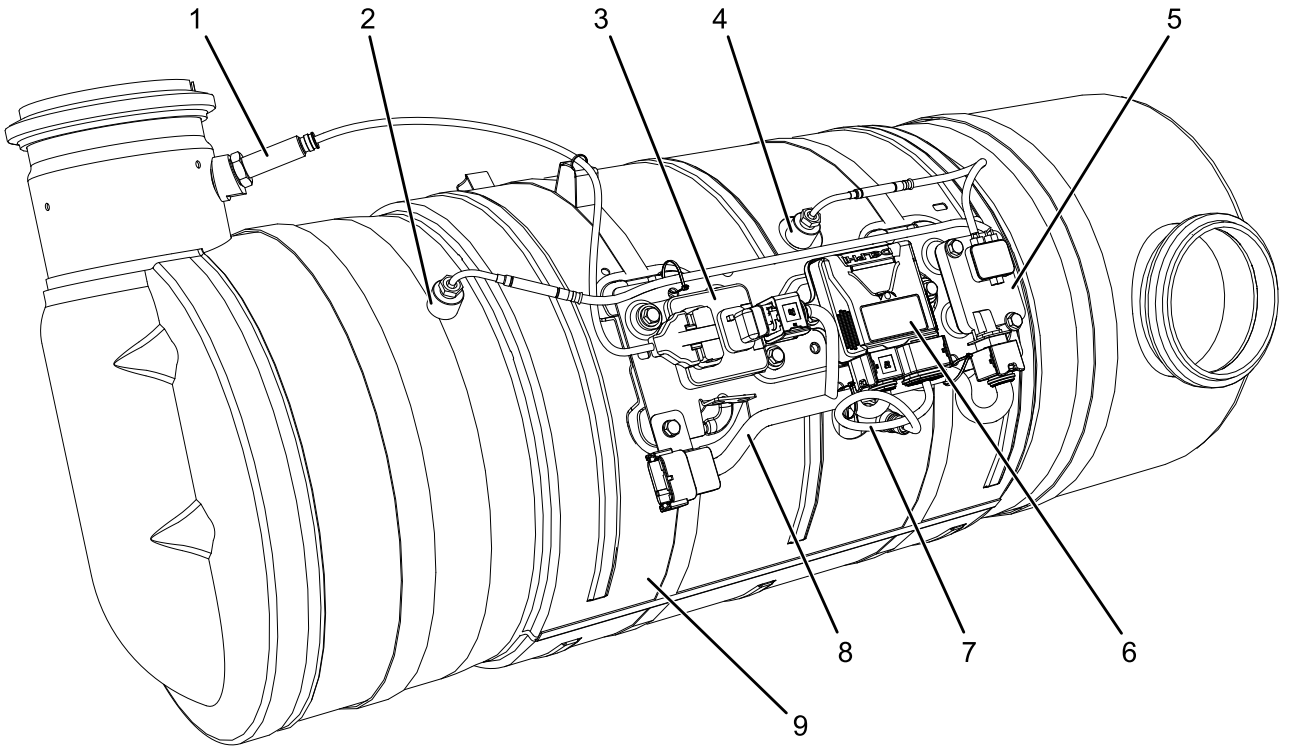

Figure 891 SCR Components

1. NOx Out sensor
2. Selective Catalyst Reduction Outlet Temperature (SCROT) sensor
3. NOx Sensor Module
4. Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor
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Engine Identification

Engine Serial Number

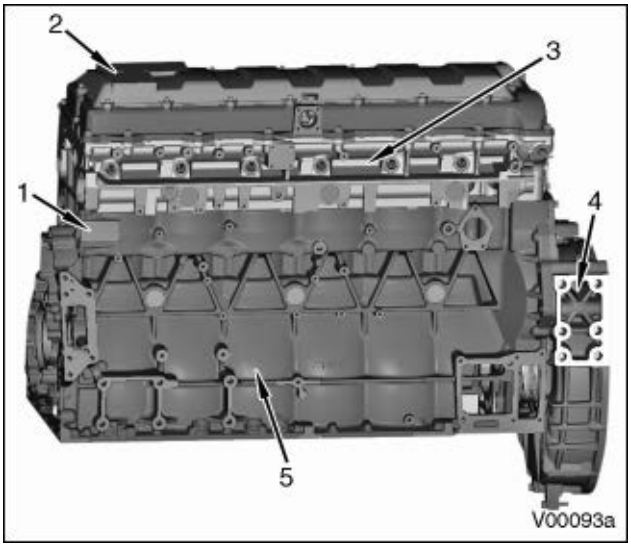

Figure 892 Engine serial number

1. Engine Serial Number (ESN) location
2. Engine emission label
3. Cylinder head
4. Flywheel housing
5. Crankcase

The Engine Serial Number (ESN) is located on the front of the crankcase (left side), below the cylinder head.

Engine Serial Number Examples

Navistar® N13: 126HM2YXXXXXXX

Engine Serial Number Codes

126 – N13 with SCR engines
H – Diesel, turbocharged, Charge Air Cooler (CAC), and electronically controlled
M2 – Motor truck
Y – Huntsville, Alabama
7 digit suffix – Engine serial number sequence

Engine Emission Label

0000054345

Figure 893 2010 U.S. Environmental Protection Agency (EPA) exhaust emission label (example)

The U.S. Environmental Protection Agency (EPA) exhaust emission label is on top of the valve cover (front left side). The EPA label typically includes the following:

- Model year
- Engine family, model, and displacement
- Advertised brake horsepower and torque rating
- Emission family and control systems
- Valve lash specifications
- Engine Serial Number (ESN)
- EPA, Onboard Diagnostics (OBD), EURO, and reserved fields for specific applications

Engine Accessory Labels

The following engine accessories may have manufacturer's labels or identification plates:

- Air compressor
- Air conditioning compressor
- Alternator
- Cooling fan clutch
- Power steering pump

- Starter motor

Engine Specifications

Navistar® N13 Diesel Engine	
Engine Configuration	4 stroke, inline six cylinder diesel
Advertised brake horsepower @ rpm	
• Navistar® N13	See EPA exhaust emission label
Peak torque @ rpm	
• Navistar® N13	See EPA exhaust emission label
Displacement	
• Navistar® N13	12.4 L (758 in³)
Compression ratio	
• Navistar® N13	17.0:1
Stroke	
• Navistar® N13	166 mm (6.54 in)
Bore (sleeve diameter)	
• Navistar® N13	126 mm (4.96 in)
Total engine weight (dry weight without trim or accessories)	
• Navistar® N13	1087 kgs (2392 lbs)
Firing order	1-5-3-6-2-4
Engine rotation direction (facing flywheel)	Counterclockwise
Aspiration	Dual turbocharged and charge air cooled
Combustion system	Direct injection turbocharged
Fuel system	High-pressure common rail
Lube system capacity (including filter)	40 L (42 qts)
• Navistar® N13	
Lube system capacity (overhaul only, with filter)	44 L (46 qts)
• Navistar® N13	
Engine oil pressure at operating temperature with SAE 15W-40 oil	
• Low idle	69 kPa (10 psi) min.
• High idle	276 - 483 kPa (40 - 70 psi)
Idle speed (no load)	600 rpm, nominal
Thermostat operating temperature	

• Primary	83°C - 95°C (181°F - 203°F)
• Secondary	87°C - 102°C (189°F - 216°F)

Heavy Duty On Board Diagnostics (HD-OBD)

The EPA has added new regulations for 2010 to reduce heavy duty vehicle emissions. The HD-OBD system is designed specifically for electronically controlled heavy duty engines. The goal for HD-OBD regulation is to keep engine emissions in specification for as long as a given vehicle is in use.

HD-OBD is legislated to be implemented in three phases:

- 2010: First engine for each Original Equipment Manufacture (OEM) becomes fully certified.
  - The lead engine is determined by a legislated equation based on projected sales volume & useful life of the engine.
  - For Navistar®, this is the EPA 2010® N13 engine.
- 2013: One engine in each engine family becomes fully certified.
  - This will be the largest step of the three phases.
- 2016: All engines must be fully HD-OBD certified.

The HD-OBD system continuously monitors for proper engine operation, and will alert the vehicle operator to emission-related faults using the Malfunction Indicator Lamp (MIL).

The MIL is installed in the Electronic Instrument Cluster. When a detected emissions fault occurs, the MIL will be illuminated. Diagnostic information is also stored in the Engine Control Module (ECM), and may be accessed by the technician for diagnosis and repair of the malfunction. Diagnostic information is accessed by connecting the Electronic Service Tool (EST) to the in-cab Diagnostic Connector.

Engine Description

The Navistar® N13 diesel engine is designed for increased durability, reliability, and ease of maintenance.

The cylinder head has four valves per cylinder for increased airflow. The overhead valve train includes rocker arms and valve bridges to operate the four valves. The fuel injector is centrally located between the four valves, directing fuel over the piston for improved performance and reduced emissions.

The overhead camshaft is supported by seven bearings in the cylinder head. The camshaft gear is driven from the rear of the engine. The overhead valve train includes roller rocker arms and dual valves that open, using a valve bridge.

Navistar® N13 engines use one-piece steel pistons. All pistons use an offset piston axis and centered combustion bowls. Crown markings show correct piston orientation in the crankcase.

The one-piece crankcase uses replaceable wet cylinder liners that are sealed by dual crevice seals.

The crankshaft has seven main bearings with fore and aft thrust controlled at the sixth bearing. One fractured cap connecting rod is attached at each crankshaft journal. The piston pin moves freely inside the connecting rod and piston. Piston pin retaining rings secure the piston pin in the piston. The rear oil seal carrier is part of the flywheel housing.

A gerotor lube oil pump is mounted behind the front cover and is driven by the crankshaft. Pressurized oil is supplied to various engine components. All Navistar® N13 engines also use an engine oil cooler and a cartridge-style engine oil filter, which are installed in the engine lube oil module.

The low-pressure fuel pump draws fuel from the fuel tank(s) through a chassis mounted filter/water separator. The low-pressure fuel pump provides fuel for the engine mounted fuel module. Conditioned low-pressure fuel is supplied from the engine mounted fuel module to the high-pressure fuel pump, Inlet Air Heater fuel solenoid, and the AFT fuel doser module.

The high-pressure fuel system is a direct fuel injected common-rail system. The common-rail includes a high-pressure fuel pump, two fuel rail supply lines, fuel rail, six fuel injectors, and pressure relief valve.

The fuel injectors are installed in the cylinder head under the valve cover and are electronically actuated by the ECM.

Navistar® N13 engines use a dual stage, fixed geometry turbocharger assembly. Each stage includes a Charge Air Cooler (CAC). The High Pressure (HP) turbocharger includes a pneumatically operated wastegate. The Low Pressure Charge Air Cooler (LPCAC) is mounted on the lower right side of the engine, and uses the engine cooling system to regulate charge air temperatures. The High Pressure Charge Air Cooler (HPCAC) is mounted in front of the engine cooling package. The HPCAC is an air-to-air type cooler, and requires no connections to the engine's cooling system.

The Exhaust Gas Recirculation (EGR) system circulates cooled exhaust into the air inlet duct. The dual stage EGR cooler provides regulated cooling of the EGR gases before entering the air inlet duct. This cools the combustion process, and reduces Nitrogen Oxides (NO_x) emissions.

The open crankcase breather system uses a centrifugal Crankcase Oil Separator (CCOS) to return oil mist to the crankcase, and vent the cleaned crankcase gasses to the atmosphere. The CCOS is part of the oil module. The breather system has been redesigned, and uses no crankcase breather filter or external piping. Blowby gases enter the CCOS through the side of the crankcase.

The Inlet Air Heater system warms the incoming air supply during engine cranking and several minutes after cold engine start up to help reduce emissions.

The Navistar® Engine Brake by Jacobs® is optional for Navistar® N13 engine displacements. The engine brake is a compression release system that provides additional vehicle braking performance. The operator can control the engine brake for different operating conditions.

Optional Equipment

Optional cold climate features available are an oil pan heater and a coolant heater. Both heaters use an electric element to warm engine fluids in cold weather.

The oil pan heater warms engine oil to ensure optimum oil flow to engine components.

The coolant heater warms the engine coolant surrounding the cylinders. Warmed engine coolant increases fuel economy and aids start-up in cold weather.

Chassis Mounted Equipment

- The chassis mounted fuel filter/water separator removes a majority of the water and foreign particles that may enter the fuel system from the supply tank(s). This filter works with the engine mounted fuel module to eliminate foreign matter and moisture from the fuel before entering the fuel injection system.
- The Low Temperature Radiator (LTR) regulates the temperature of the LPCAC and the low-temperature stage of the EGR cooler. The LTR is mounted in front of the radiator cooling package, and requires connections to the engine cooling system.
- The HPCAC lowers temperature after the air is compressed by the turbochargers, and has no connections to the engine cooling system. The HPCAC is an air-to-air cooler. The HPCAC is mounted in front of the radiator cooling package.

- The Diesel Oxidation Catalyst (DOC) oxidizes hydrocarbons and carbon monoxide, provides heat for exhaust system warm-up, aids in temperature management for the Diesel Particulate Filter (DPF), and oxidizes NO into NO_2 for passive DPF regeneration. The DOC is monitored by the Aftertreatment Control Module (ACM) using one Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor positioned at the DOC inlet, and one Diesel Particulate Filter Inlet Temperature (DPFIT) sensor positioned at the DPF inlet.
- The DPF temporarily stores carbon-based particulates, oxidizes stored particulates, stores non-combustible ash, and provides required exhaust back pressure for proper engine performance. The DPF is monitored by the ACM using the DOC / DPF temperature sensor module installed on the DPF, and the Diesel Particulate Filter Differential Pressure (DPFDP) / outlet pressure sensor installed on or near the DPF.
- The Selective Catalyst Reduction (SCR) catalyst oxidizes Nitrogen Oxides (NOx) into Nitrogen gas and water. The SCR catalyst is monitored by the ACM using a NOx IN sensor module installed after the HP turbocharger outlet pipe, and a NOx OUT sensor module installed after the outlet of the SCR catalyst. An ammonia (NH_3) sensor provides feedback to the ACM related to Diesel Exhaust Fluid (DEF) injection into the SCR catalyst.

Air Management System

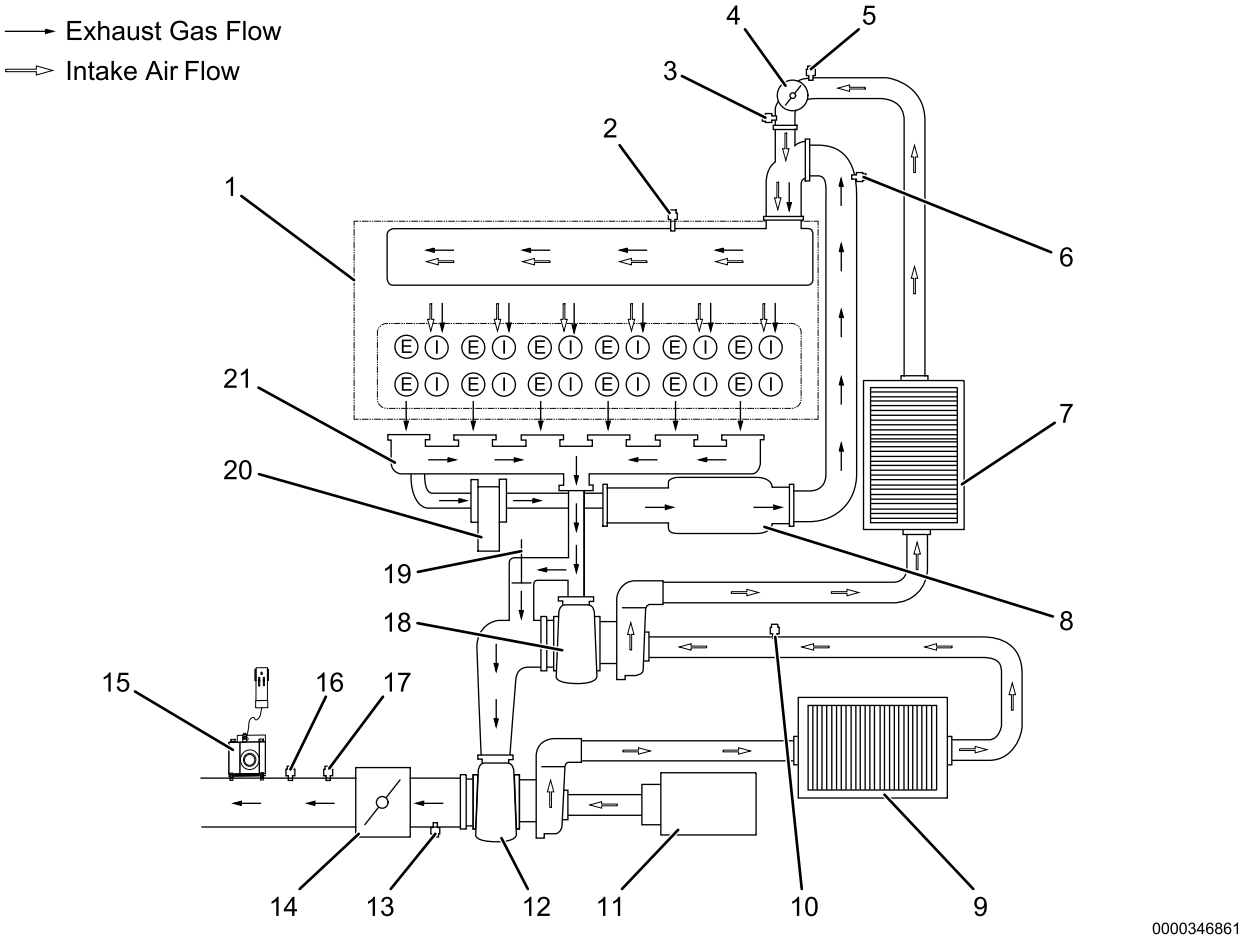

Figure 894 Air Management System

1. Cylinder Head
2. Intake Manifold Temperature (IMT) Sensor
3. Intake Manifold Pressure (IMP) Sensor
4. Engine Throttle Valve (ETV)
5. Charge Air Cooler Outlet Temperature (CACOT) Sensor
6. Exhaust Gas Recirculation Gas Temperature (EGRGT) Sensor
7. High Pressure Charge Air Cooler (HPCAC)
8. Exhaust Gas Recirculation (EGR) Cooler
9. Interstage Cooler (ISC)
10. Turbocharger 2 Compressor Inlet Sensor (TC2CIS)
11. Air Filter Housing
12. Low Pressure (LP) Turbocharger/Turbocharger 1 (TC1)
13. Turbocharger 1 Turbine Outlet Pressure (TC1TOP)
14. Exhaust Back Pressure Valve (EBPV)
15. Aftertreatment Fuel Injector (AFTFI)
16. Nitrogen Oxides Inlet (NO_x In) Sensor
17. Oxygen Sensor (O_2S)
18. High Pressure (HP) Turbocharger/Turbocharger 2 (TC2)
19. High Pressure (HP) Turbocharger Wastegate
20. Exhaust Gas Recirculation (EGR) Valve
21. Exhaust Manifold

Airflow

Air flows through the air filter assembly and enters the Low-Pressure (LP) turbocharger. The LP turbocharger increases air pressure and temperature before entering the Interstage Cooler (ISC). Cooled and compressed air then flows from the ISC into the High Pressure (HP) turbocharger compressor inlet. Hot and highly compressed air flows from the HP turbocharger compressor outlet into the High Pressure Charge Air Cooler (HPCAC) where it is cooled, and into the intake throttle duct, and continues through the Engine Throttle Valve (ETV). The HP and LP turbochargers can increase pressures up to 345 kPa (50 psi).

If the Exhaust Gas Recirculation (EGR) Valve is open, exhaust gases pass through the EGR cooler and into the intake throttle duct where it is mixed with filtered Charge air. This mixture flows into the intake manifold, and then the cylinder head. The intake manifold is an integral part of the cylinder head casting.

During cold weather, the Inlet Air Heater system activates the heater element, vaporizing and igniting small quantities of fuel into the air inlet duct.

After combustion, exhaust gases exit through the cylinder head exhaust valves and ports. The exhaust gas is forced through the exhaust manifold where, depending on EGRV position, it is split between the EGR system and the exit path through the HP turbocharger, LP turbocharger, and Exhaust Back Pressure Valve (EBPV).

The EBPV is operated by the Air Control Valve (ACV), a pneumatic actuator. When the ACV is applied, the EBPV restricts flow and increases exhaust back pressure. Operation of the EBPV is controlled by the ECM using the ACV and the Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor. When the EBPV is opened, exhaust back pressure is released.

Exhaust gases exiting the engine flow through the EBPV, then through the vehicle Aftertreatment (AFT) system, and out the exhaust tail pipe.

Turbochargers

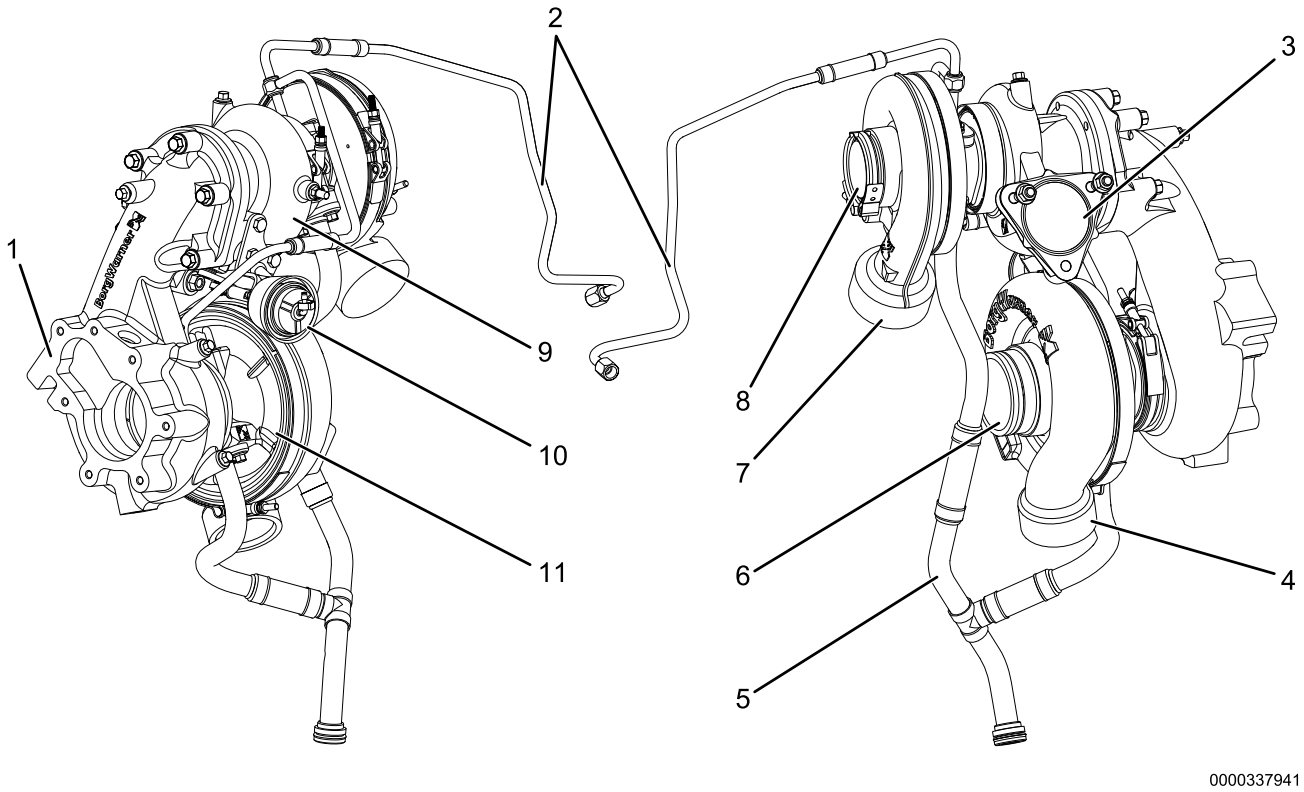

Figure 895 High and Low Pressure Turbocharger Components – Inner and Outer views

1. Low Pressure (LP) turbocharger turbine outlet
2. Turbocharger oil supply tube
3. High Pressure (HP) turbocharger turbine outlet
4. LP turbocharger compressor outlet
5. Oil return tube
6. LP turbocharger compressor inlet
7. HP turbocharger compressor outlet
8. HP turbocharger compressor inlet
9. HP turbocharger
10. HP turbocharger wastegate actuator
11. LP turbocharger

Navistar® N13 engines are equipped with a pneumatically regulated two-stage turbocharger system. The High Pressure (HP) and Low Pressure (LP) turbochargers are installed in parallel on the right side of the engine.

Intake air flow: Filtered air enters the LP compressor, where it is compressed and directed to the Interstage Cooler (ISC). Cooled compressed air then enters the HP compressor, where it is further compressed and directed into the High Pressure Charge Air Cooler (HPCAC). Compressed air then goes through the Engine Throttle Valve (ETV) and the intake throttle duct. This system provides high charge air pressure to improve engine performance and to help reduce emissions.

Exhaust gas flow: The HP turbocharger is connected to the exhaust manifold through the HP turbine inlet. Exhaust gases exit the HP turbine outlet and are directed to the LP turbine inlet. The HP turbocharger is equipped with a wastegate, which is controlled by a pneumatic actuator. The HP turbocharger wastegate is used to regulate boost by controlling the amount of exhaust gas that bypasses the turbine of the turbocharger. When boost demand is low, the wastegate is opened, allowing part of the exhaust gas flow to bypass the HP turbine.

All signals related to the LP turbocharger are designated as Turbocharger 1 (TC1) signals, and are identified below:

- Turbocharger 1 Turbine Outlet Pressure (TC1TOP)

All signals associated with the HP turbocharger are designated as Turbocharger 2 (TC2), and are identified below:

- Turbocharger 2 Wastegate Control (TC2WC)
- Turbocharger 2 Compressor Inlet Pressure Sensor (TC2CIP)
- Turbocharger 2 Compressor Inlet Temperature (TC2CIT) Sensor

Air Control Valve (ACV)

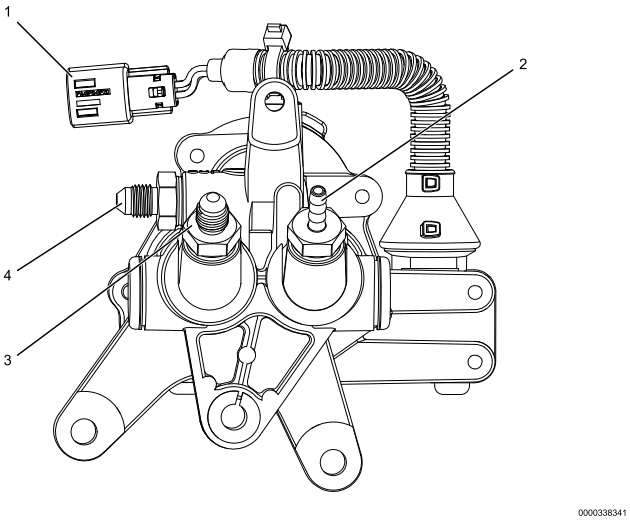

Figure 896 Air Control Valve (ACV) Connections

1. Pigtail harness (to engine sensor harness connector)
2. Vehicle air supply port
3. Exhaust Back Pressure Valve (EBPV) control port
4. High Pressure (HP) turbocharger wastegate control port

The ACV assembly contains the High Pressure (HP) turbocharger wastegate control valve, the Exhaust Back Pressure Valve (EBPV), and the air supply port. Although these components are integral to the ACV, each circuit is controlled by the Engine Control Module (ECM) independently. The ACV controls compressed air for both control valves. The air supply port is connected to the vehicle's air system.

The ECM provides a Pulse Width Modulated (PWM) signal for operation of the wastegate control valve. With no PWM signal, the control valve is closed, and vehicle no air is supplied to the wastegate actuator.

When an increase in the boost is required, the ECM supplies PWM voltage to close the control valve. This reduces air pressure to the wastegate actuator causing the wastegate to close and vent air pressure, results in increased boost. The limit values of the PWM signals are between approximately 9%, corresponding to a fully opened air control valve, and 100% corresponding to a closed air control valve.

The EBPV control valve is in the ACV. The EBPV control valve is also operated by the ECM using PWM, and the TC1TOP sensor is monitored by the ECM. The EBPV control valve operates the EBPV actuator to increase exhaust back pressure.

Boost Control

The wastegate control valve, in the ACV, provides for operation of a pneumatic wastegate actuator for the HP turbocharger. Boost is controlled for HP turbocharger, by signals sent from the ECM to the ACV. In normal operation the wastegate is actuated by the ACV using vehicle compressed air, regulated to 43 psi (296 kPa). Positioning of the wastegate by the ACV is based on boost pressure and temperature signals monitored by the ECM.

Because of the ability to generate very high charge air pressure levels and to avoid Charge Air Cooler (CAC) overloading, the wastegate actuator for the HP turbocharger is also spring loaded. When boost levels increase above specification, boost pressure alone will open the wastegate, and the exhaust gases will bypass the HP turbocharger. Exhaust back pressure is constantly monitored by the ECM using TC1TOP. The TC1TOP sensor is mounted to the air inlet duct, and is connected to the exhaust system by a steel pipe.

Charge Air Cooler Outlet Temperature (CACOT) Sensor

The CACOT sensor monitors the temperature of the air leaving the HPCAC. The ECM monitors the CACOT signal to evaluate the effectiveness and condition of the HPCAC.

Interstage Cooler (ISC)

The ISC is installed between the High Pressure (HP) and Low Pressure (LP) turbochargers, and is mounted to the lower right side of the engine. The ISC air inlet is connected to the LP turbocharger compressor outlet, and uses engine coolant to regulate the LP charge air temperature. The ISC air outlet is connected to the compressor inlet pipe of the HP turbocharger.

High Pressure Charge Air Cooler (HPCAC)

The HPCAC is installed between the HP turbocharger and the Engine Throttle Valve (ETV). The HPCAC air inlet is connected to the HP compressor outlet, and uses ambient airflow entering the front of the vehicle to reduce the charge air temperature. The HPCAC air outlet is connected to the ETV.

Intake Manifold Pressure (IMP) Sensor

Monitors charge air pressure entering the Engine Throttle Valve (ETV) and provides information used for boost and EGR control.

The IMP provides an analog voltage output to the Engine Control Module (ECM) which is proportional to pressure applied to an internal diaphragm in the sensor. The IMP sensor is connected to the ECM by the Reference Voltage (VREF), signal, and ground wires. A transfer function in the ECM software converts the analog voltage to a pressure value which is then used by software strategies.

Intake Manifold Temperature (IMT) Sensor

This sensor monitors charge air temperature in the intake manifold. The temperature measured is an input to the engine coolant control strategy. It also is used for evaluation of on-board diagnostics to ensure proper functionality of the charge air cooling system.

This temperature sensor is a thermistor and has two connections to the Engine Control Module (ECM). A thermistor varies resistance as temperature changes. When interfaced to the ECM circuitry, a change in sensor resistance results in a voltage change internal to the ECM. A transfer function contained in the ECM software translates the measured voltage to a temperature value.

The ECM continuously monitors the voltage resulting from the thermistor's changing resistance. High and low diagnostic voltage thresholds are evaluated to ensure that the output voltage is within a valid range.

Turbocharger 2 Compressor Inlet Sensor (TC2IS)

This sensor is a dual function sensor that detects pressure and temperature of the charge air entering the High Pressure (HP) compressor. It is installed in the piping between the Interstage Cooler (ISC) outlet and the HP compressor inlet. This sensor is used for evaluation by on-board diagnostics to ensure proper functionality of the charge air cooling system.

This sensor consists of a thermistor which varies resistance as temperature changes. When interfaced to the Engine Control Module (ECM) circuitry, a change in sensor resistance results in a voltage change internal to the ECM. An internal diaphragm which deflects due to pressure changes results in an analog voltage output to the ECM which is proportional to the pressure. Transfer functions contained in the ECM software translate the measured voltages into a temperature and a pressure value.

The ECM continuously monitors the voltages resulting from changes in both the temperature and pressure. High and low diagnostic voltage thresholds are evaluated to ensure output voltage is within a valid range.

Exhaust Gas Recirculation (EGR) System

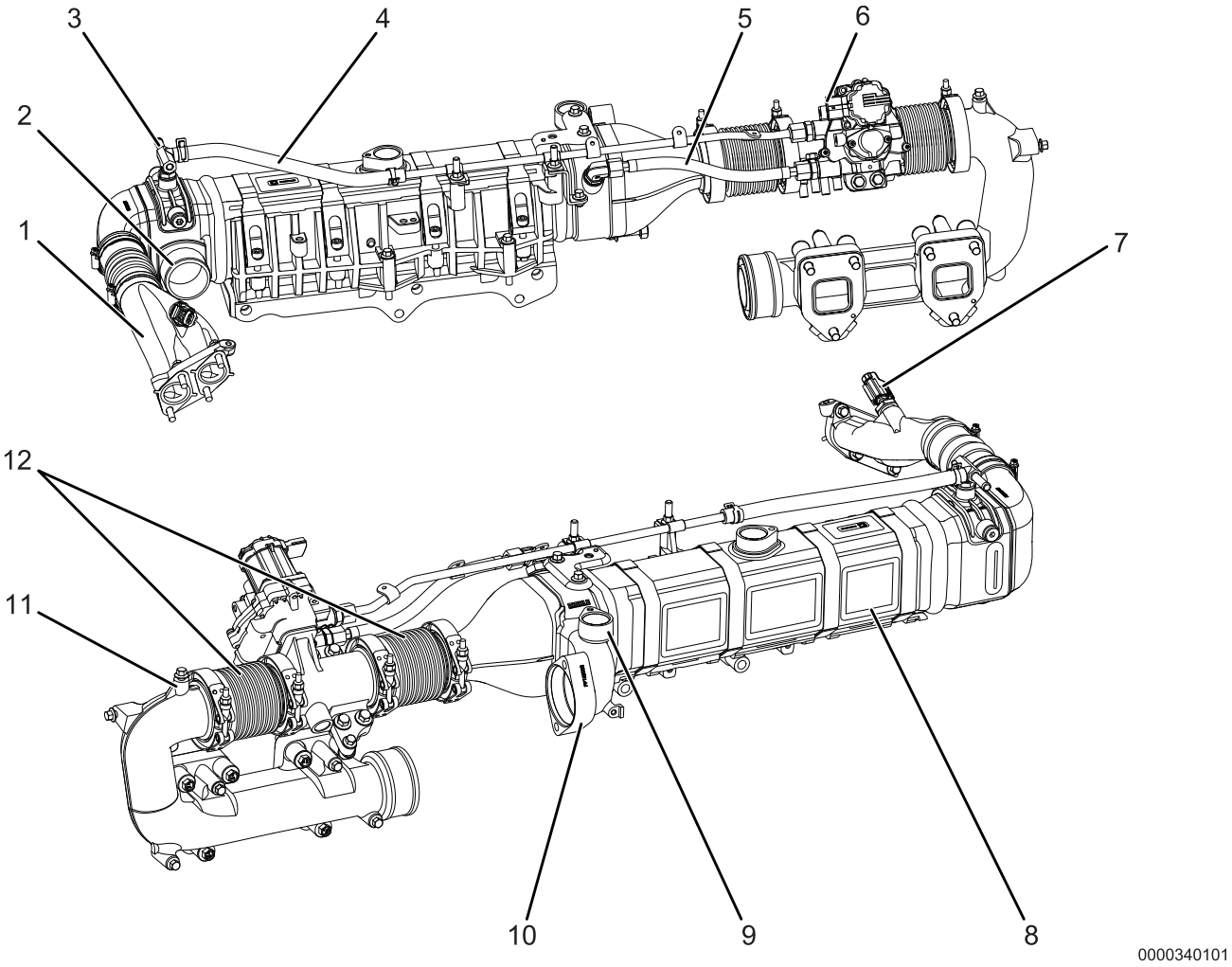

Figure 897 EGR system components

1. EGR cooler gas outlet manifold
2. EGR cooler coolant outlet
3. EGR cooler coolant air bleed and EGR valve coolant return t-fitting
4. EGR Valve coolant return
5. EGR valve coolant supply
6. EGR valve
7. Exhaust gas recirculation gas temperature (EGRGT) sensor
8. EGR cooler
9. Heater core supply
10. EGR cooler coolant inlet
11. Rear exhaust manifold section / EGR cooler gas inlet manifold
12. EGR cooler bellows tubes

EGR System Overview

The EGR system reduces NO_x engine emissions by introducing inert cooled exhaust gas into the air inlet duct. NO_x forms during a reaction between nitrogen and oxygen at high-temperatures during combustion.

The Engine Control Module (ECM) monitors signals from the Charge Air Cooler Outlet Temperature (CACOT) sensor, Oxygen sensor (O_2S), Engine Coolant Temperature 1 (ECT1) sensor, and EGRT sensor to control the EGR system.

EGR is switched Off (EGRV closed) if any of the following conditions are present:

- Engine coolant temperature less than 10°C (50°F) will close the EGR valve
- Intake manifold temperatures less than 7°C (45°F) will close the EGR valve
- During engine brake operation

EGR Flow

Hot exhaust gas from the exhaust manifold flows through the EGR inlet tubes to the Exhaust Gas Recirculation Valve (EGRV). When EGR is commanded, the EGRV opens and allows exhaust gas to enter the EGR cooler. Exhaust gas flows through the EGR cooler, is cooled and then flows through the EGR outlet tubes, and into the intake throttle duct where it is mixed with filtered Charge air.

EGR System Control

The EGR system consists of the EGR Valve, Engine Throttle Valve (ETV), and Oxygen Sensor (O_2S). The EGR Valve is a Controller Area Network (CAN) controlled smart valve connected to the ECM on the private J1939 network.

The EGR Valve is installed at the rear of the EGR cooler, on the right side of valve cover. The EGR Valve limits exhaust gas flow into the EGR cooler.

The ECM commands the EGR Valve to move and hold position. The EGR Position sensor, installed within the EGR Vavle, monitors and provides an EGR Vavle position signal to the ECM over the private J1939 CAN.

The O_2S is installed in the exhaust, in front of the aftertreatment fuel injector. The O_2S has a heater element that heats the sensor to its normal operating temperature of 780°C (1436°F). During initial engine warm-up, the O_2S heater element is activated only after engine coolant reaches 40°C (104°F) and the exhaust gas temperature DOCIT sensor exceeds 100°C (212°F) for more than 30 seconds.

EGRV Control

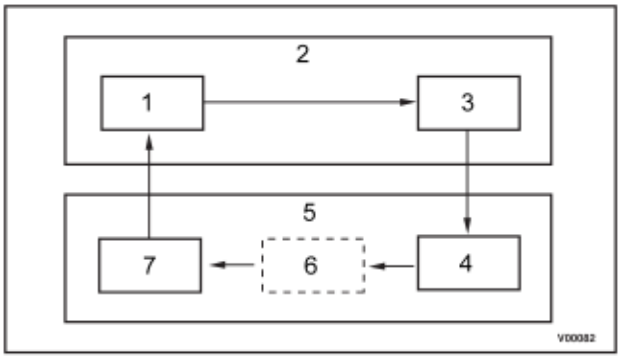

Figure 898 EGR Valve position control

1. EGR Valve position monitored by ECM
2. Engine Control Module (ECM)
3. ECM commands EGR Valve to desired position
4. EGR Valve to desired position
5. EGR Valve
6. EGR Valve position matches ECM command
7. EGR Valve position sent to ECM

The EGR Valve has an integrated position sensor, and provides feedback to the ECM indicating EGR Valve position.

EGR – Open Loop

During engine warm-up and before the Oxygen Sensor (O_2S) reaches normal operating temperature, the Exhaust Gas Recirculation (EGR) system operates in open loop. In open loop, the EGR system is controlled by the ECM based on the charge air temperature, engine coolant temperature, engine speed, and load conditions.

EGR – Closed Loop

After the O_2S reaches operating temperature, the EGR system switches to closed loop operation. In closed loop, the EGR system is controlled by the ECM based on coolant temperature and O2S readings.

Crankcase Oil Separator

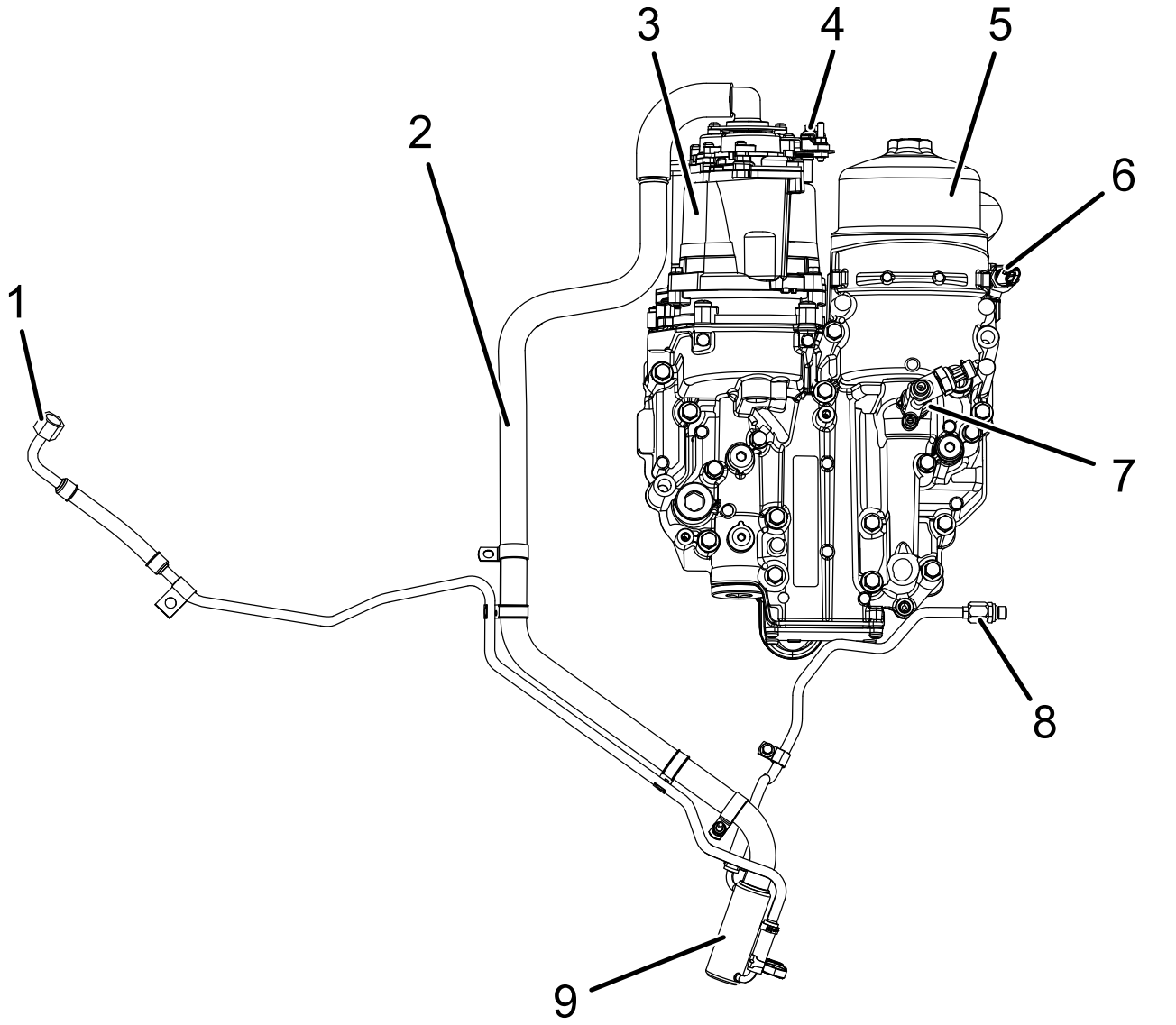

Figure 899 Oil Module with Crankcase Oil Separator

1. Coolant supply line
2. CCOS vent tube
3. Crankcase Centrifuge Oil Separator (CCOS)
4. Crankcase Centrifuge Oil Separator (CCOSS) sensor
5. Oil filter access cap
6. Engine Oil Temperature (EOT) sensor
7. Engine Oil Pressure (EOP) sensor
8. Coolant return line
9. CCOS ventilation tube heater

Crankcase ventilation is provided using the CCOS. Excess crankcase vapors are filtered by the CCOS, and are then vented to the atmosphere.

A centrifugal oil separator, driven by engine oil pressure, separates and directs oil mist to the side of the CCOS housing. The separated oil drains from the oil separator, through the crankcase, and into the oil pan. The oil separator is an integral part of the oil module.

Aftertreatment System

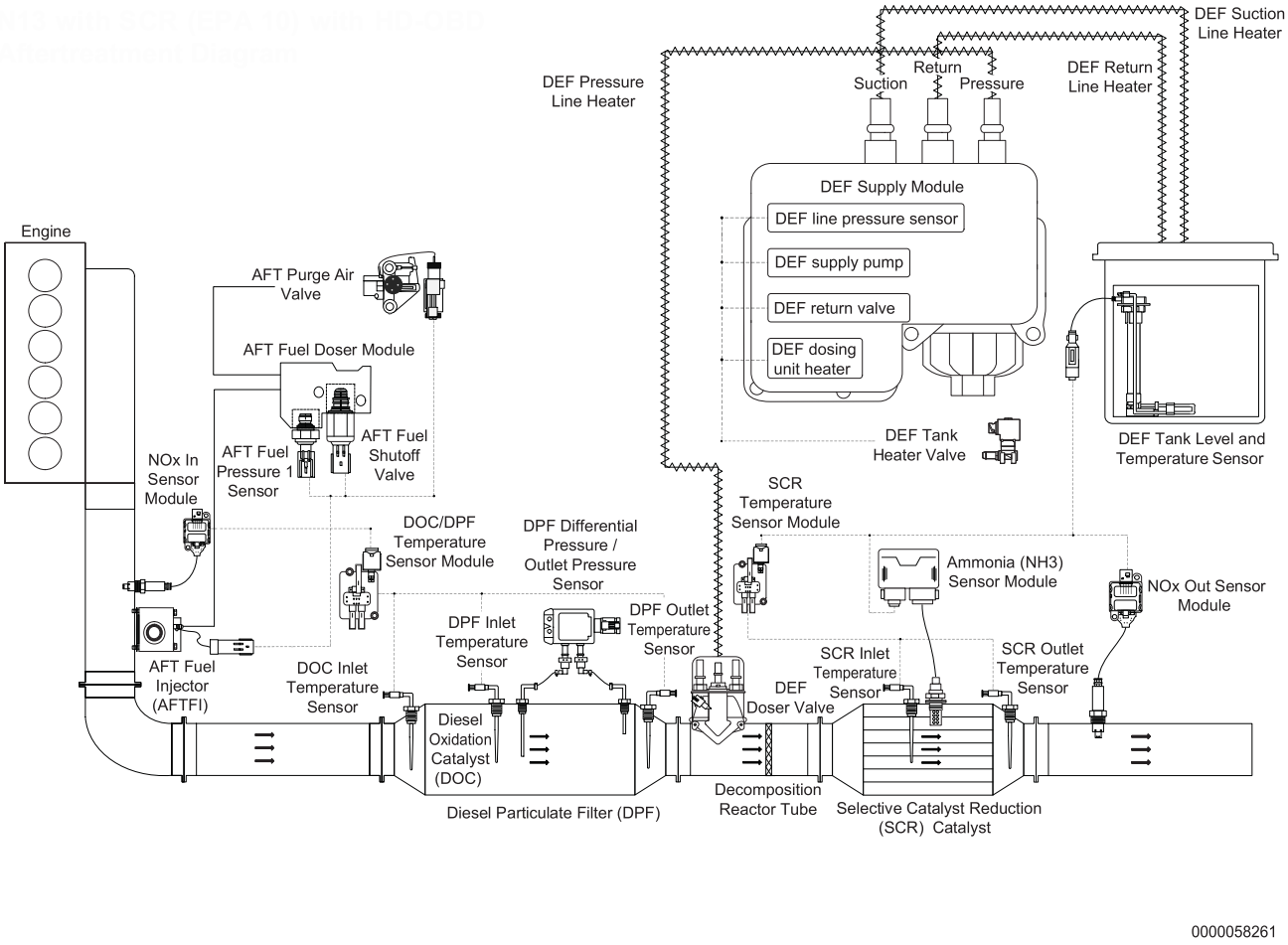

Figure 900 Functional Diagram of AFT system

The AFT system, part of the larger exhaust system, processes engine exhaust to meet emission requirements. The AFT system traps particulate matter (soot) and prevents it from leaving the tailpipe, and reduces Nitrogen Oxides (NOx).

The AFT system performs the following functions:

- Monitors exhaust gas temperatures DOC In, DPF In, DPF Out, SCRIT, SCROT temperature, and Diesel Particulate Filter (DPF) delta pressure. It controls engine operating parameters for emission control and failure recognition.
- May cancel regeneration in the event of catalyst or sensor failure
- Monitors the level of soot accumulation in the DPF
- Initiates regeneration automatically when DPF is full with soot and controls engine operating parameters to increase temperature to have successful regeneration
- Maintains vehicle and engine performance during regeneration
- Monitors NOx levels in the exhaust

- Initiates Diesel Exhaust Fluid (DEF) dosing automatically when NOx levels are above a pre-calibrated threshold

Decomposition Reactor Tube

The decomposition reactor tube does the following:

- Converts DEF to ammonia and CO2
- Uses an internal mixer to ensure even evaporation of DEF into the exhaust stream

Diesel Particulate Filter (DPF)

The DPF does the following:

- Captures and temporarily stores carbon-based particulates in a filter
- Allows for oxidation (regeneration) of stored particulates once loading gets to a particular level (restriction)
- Provides the required exhaust back pressure drop for engine performance
- Stores non-combustible ash

Diesel Oxidation Catalyst (DOC)

The DOC does the following:

- Oxidizes hydrocarbons and carbon monoxide (CO) in exhaust stream
- Provides heat for exhaust system warm-up
- Aids in system temperature management for the DPF

Selective Catalyst Reduction (SCR) Catalyst

The SCR catalyst does the following:

- Completes the breakdown of DEF into ammonia and CO2
- Converts ammonia and NOx to Nitrogen gas and water

Aftertreatment (AFT) System Conditions and Responses

The operator is alerted of system status either audibly or with instrument panel indicators. Automatic or manual regeneration is required when levels of soot exceed acceptable limits. For additional information, see the applicable vehicle Operator's Manual and the vehicle visor placard.

Diesel Exhaust Fluid (DEF) Injection

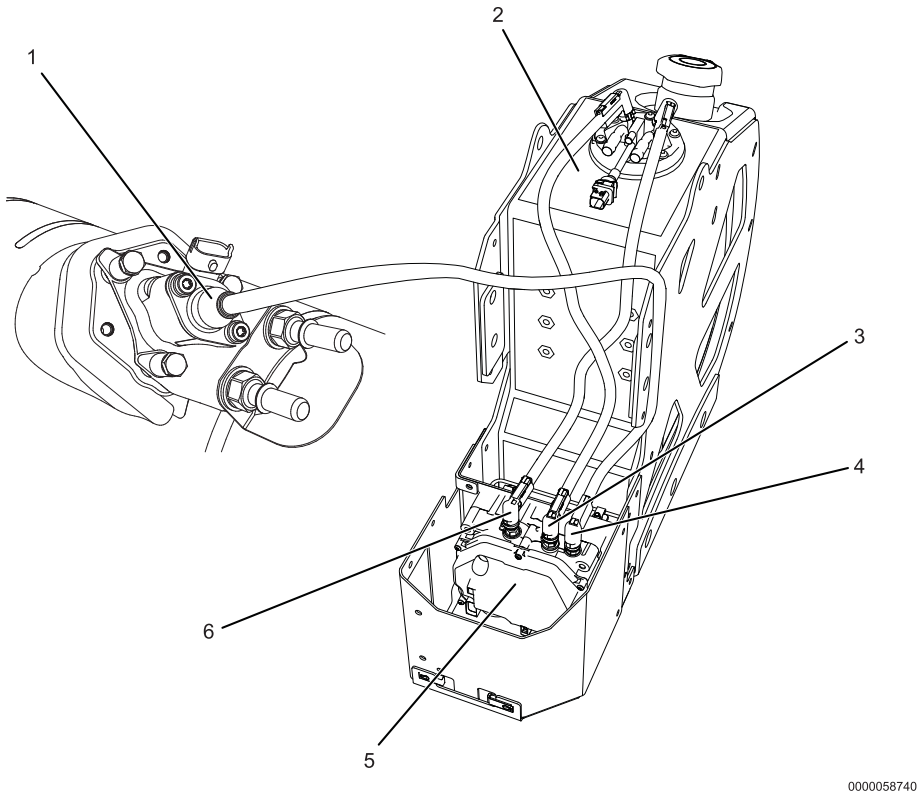

Figure 901 Diesel Exhaust Fluid (DEF) Injection Components

1. Diesel Exhaust Fluid Doser (DEFD) Valve
2. DEF tank
3. DEF return line
4. DEF pressure line
5. DEF supply module
6. DEF suction line

Diesel Exhaust Fluid (DEF) injection is required when Nitrogen Oxides (NOx) levels exceed acceptable limits.

The Aftertreatment Control Module (ACM) determines when DEF injection is required by monitoring signals from the Nitrogen Oxides (NOx) IN sensor module, and NOx OUT sensor module.

When NOx levels are too high, the ACM commands the DEF supply pump ON, allowing DEF to be drawn from DEF tank, through the suction line, and to the DEF supply module. DEF then exits the supply module and travels to the Diesel Exhaust Fluid Doser (DEFD) Valve through the pressure line. The ACM then commands the DEFD Valve ON allowing DEF to be sprayed into the aftertreatment system.

Aftertreatment Fuel Injection

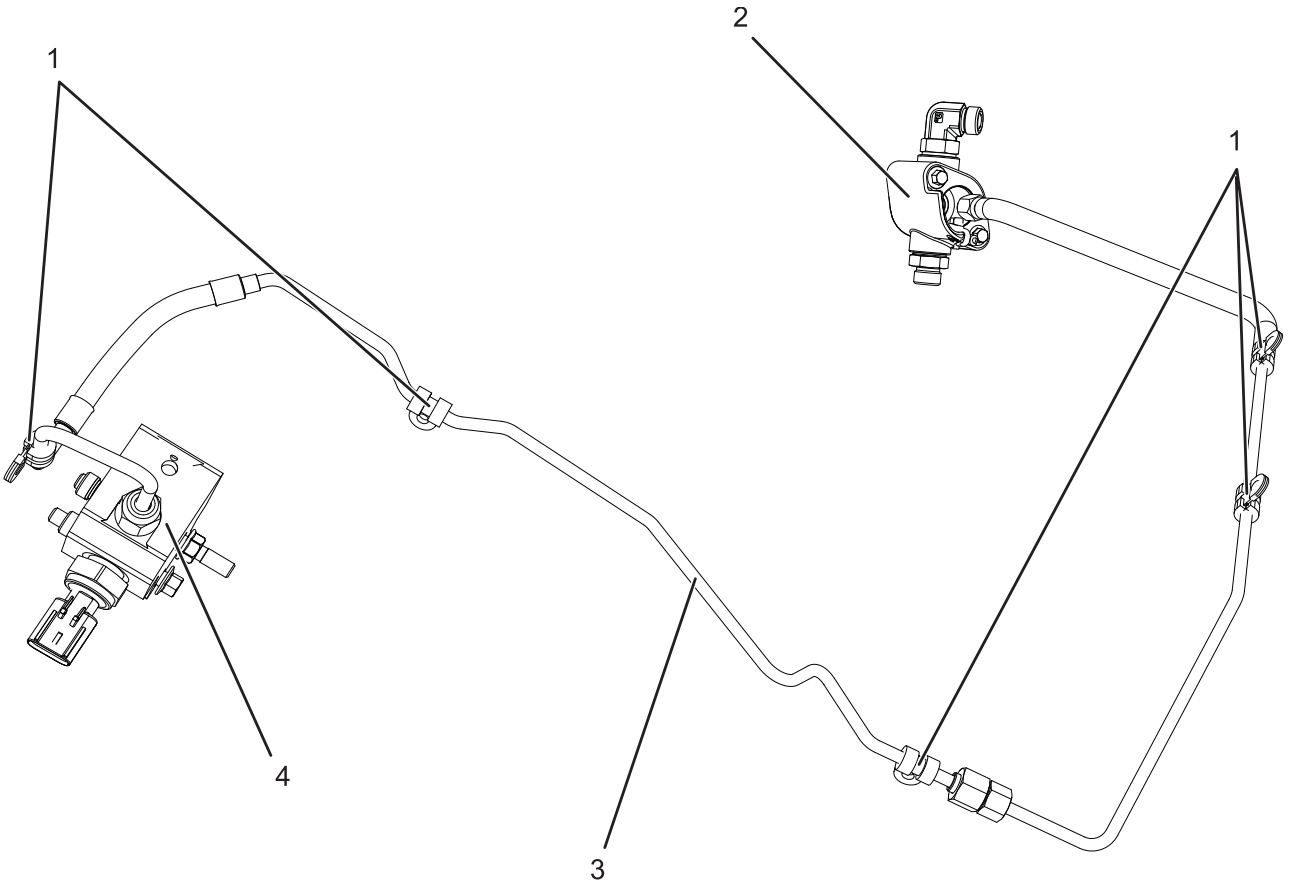

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Figure 902 Aftertreatment Fuel Injection Components (Top View)

1. Fuel line retainers (rear and left side of engine block)
2. Aftertreatment Fuel Injector (AFI)
3. AFI fuel pressure line
4. AFT fuel doser module

The AFT fuel doser module injects fuel into the exhaust system to increase temperature of the Diesel Oxidation Catalyst (DOC), and is necessary for Diesel Particulate Filter (DPF) regeneration. AFT fuel doser module is controlled by the Aftertreatment Control Module (ACM). The ACM receives signals from the Aftertreatment Fuel Pressure 1 (AFTFP1) sensor (installed in the AFT fuel doser module), and control operation when aftertreatment fuel injection (regeneration) is required. The ACM also controls the Aftertreatment Fuel Shutoff Valve (AFTFSV) (installed in the AFT fuel doser module) which controls the volume of fuel sent to the AFI.

AFT Fuel Doser Module Injection

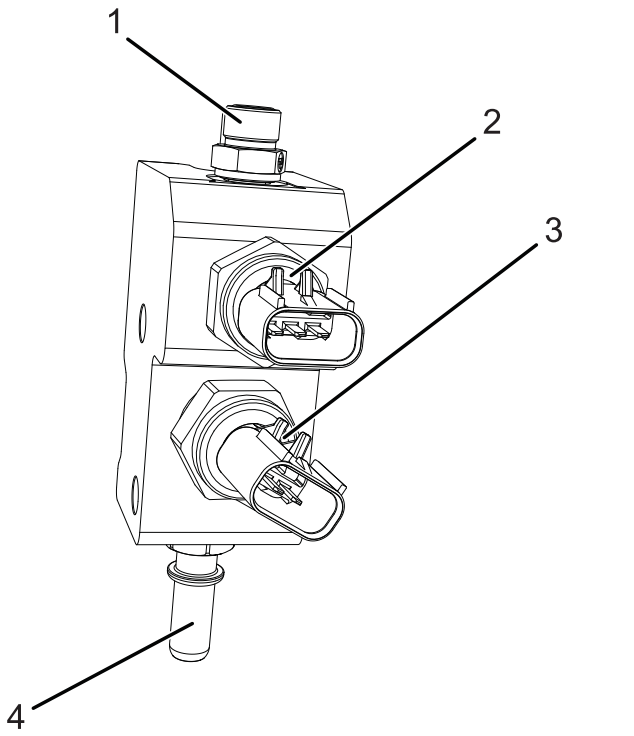

Figure 903 AFT Fuel Doser Module (Left Side View)

1. Fuel outlet port to Aftertreatment Fuel Injector (AFI)
2. Aftertreatment Fuel Pressure 1 (AFTFP1) sensor
3. Aftertreatment Fuel Shutoff Valve (AFTFSV)
4. Fuel supply from fuel filter assembly

The AFT fuel doser module is connected to the clean side of the low-pressure fuel system, and provides a metered amount of fuel to the Aftertreatment Fuel Injector (AFI). The AFT fuel doser module provides pressurized fuel injection pulses to the AFI. The AFI is a solenoid type injector, and will only inject fuel when commanded ON by the Aftertreatment Control Module (ACM). The AFT fuel doser module is installed on the left side of the engine, to the rear of the fuel module.

The AFTFP1 sensor monitors fuel pressure in the AFT fuel doser module, and provides constant feedback to the ACM.

Aftertreatment Fuel Injector (AFI)

The AFI is installed on the right side of the engine, in the exhaust pipe after the exhaust Oxygen Sensor (O_2S).

Pressurized fuel is supplied to the AFI thru the AFT fuel doser module using the Aftertreatment Fuel Shutoff Valve (AFTFSV). When conditions required for regeneration are met, the ACM commands the AFTFSV ON, allowing pressurized fuel to reach the AFI.

To protect the AFI internal components, continuous engine coolant flow through the AFI is maintained by external coolant supply and return lines.

Fuel Management and Fuel Supply System

Fuel System Components

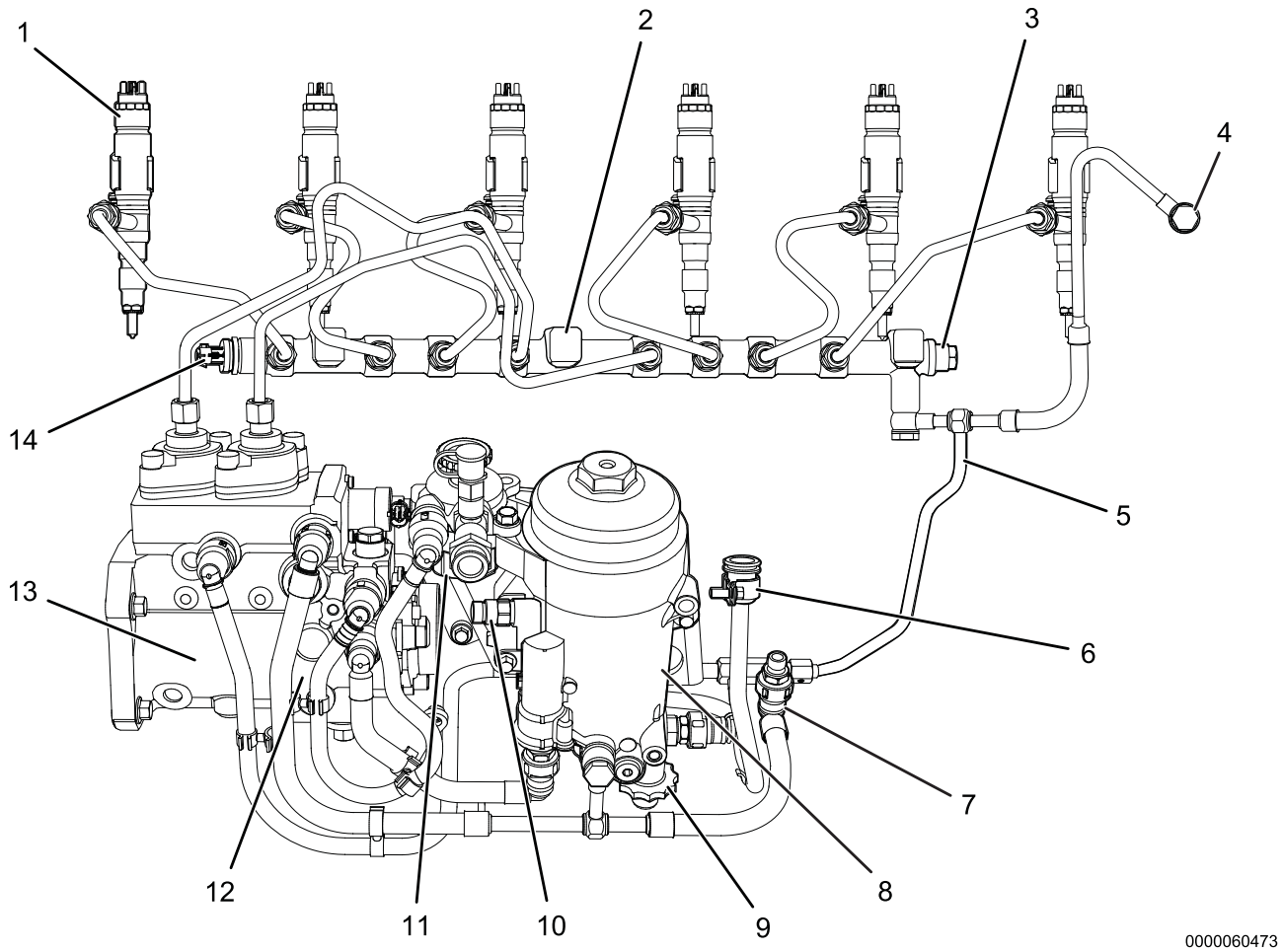

Figure 904 Fuel system

1. (Fuel) Injector (6)
2. Fuel Rail
3. Fuel rail pressure limiting valve
4. Fuel return from cylinder head
5. Fuel return line
6. Engine fuel return connection (to chassis filter)
7. Fuel supply to AFT fuel doser module
8. Fuel filter housing assembly
9. Fuel filter drain screw
10. Fuel Delivery Pressure (FDP) sensor
11. Fuel primer pump assembly
12. Low Pressure (LP) fuel pump
13. High Pressure (HP) fuel pump
14. Fuel Rail Pressure (FRP) sensor

Navistar® N13 engines are equipped with a high-pressure common rail fuel injection system which provides pressurized fuel to the fuel injectors for optimal fuel atomization in the combustion chamber.

Excess fuel is returned to the chassis mounted filter separator, before returning to the fuel tank.

The fuel system is controlled by the Engine Control Module (ECM), various sensors, and the Fuel Pressure Control Valve (FPCV) installed in the HP fuel pump.

Fuel Flow

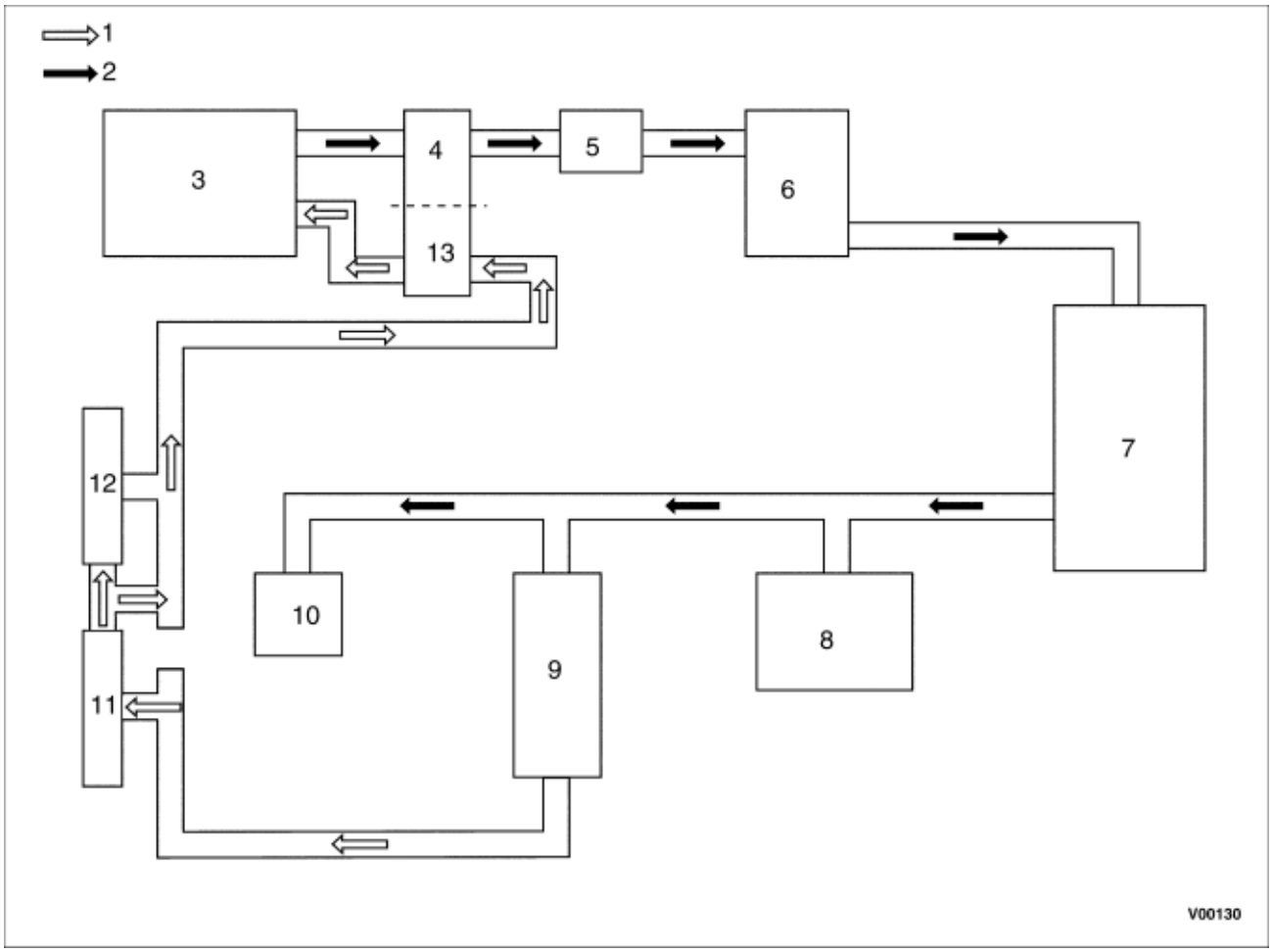

Figure 905 Fuel supply flow diagram

1. Fuel Return
2. Fuel supply
3. Fuel tank
4. Chassis mounted fuel filter/water separator (Top portion)
5. Fuel primer pump assembly with fuel strainer element
6. Low Pressure (LP) fuel pump
7. Fuel filter housing assembly (engine mounted)
8. AFT fuel doser module
9. High Pressure (HP) fuel pump
10. Inlet Air Heater Fuel Solenoid (IAHFS)
11. Fuel rail
12. Fuel injectors
13. Chassis mounted fuel filter/water separator (bottom portion)

Fuel is pumped from the tank, through the chassis mounted fuel filter/water separator using the Low Pressure (LP) fuel pump. Fuel is pumped from the LP fuel pump to the engine mounted fuel filter assembly, before being supplied to the High Pressure (HP) fuel pump. The HP fuel pump supplies high-pressure fuel to the fuel rail, which feeds the fuel injectors through individual tubes. The LP fuel pump and HP fuel pump are assembled as one gear driven unit, and are serviced as an assembly.

Low Pressure Fuel System

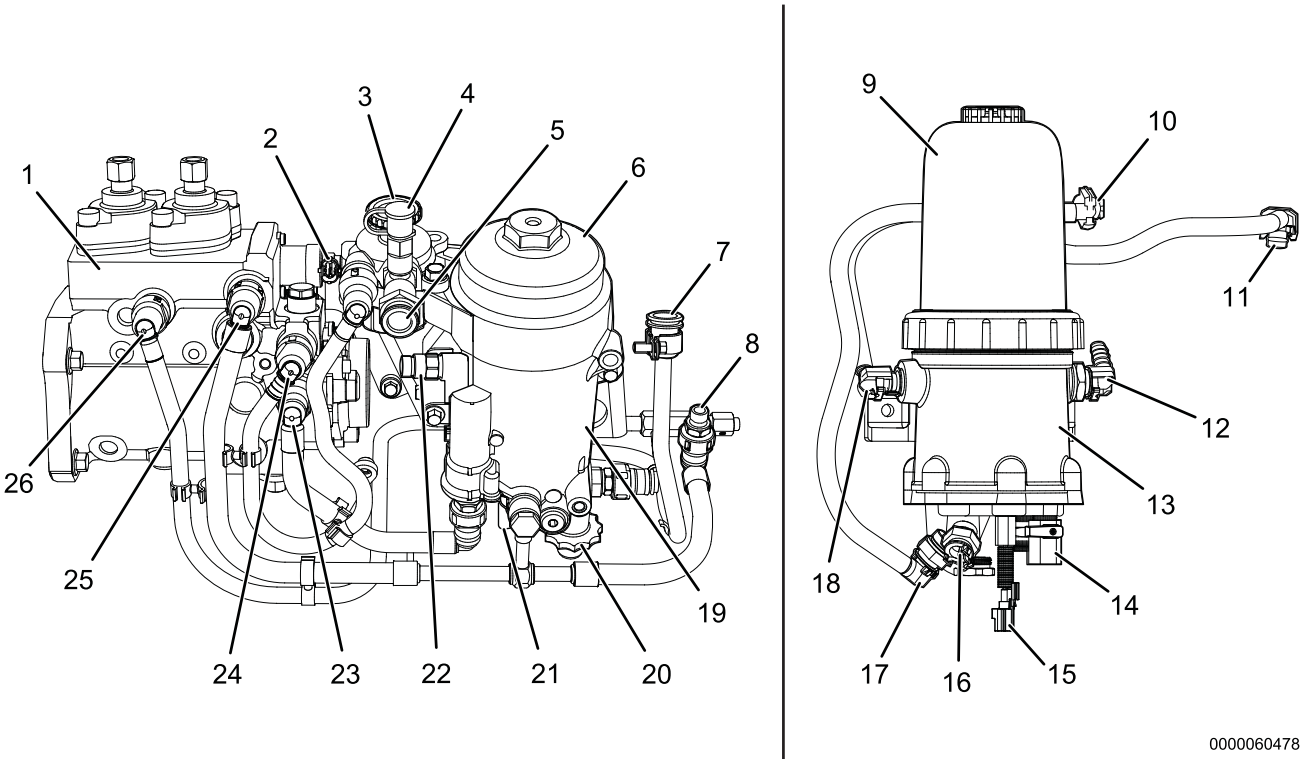

Figure 906 Low Pressure (LP) fuel system

1. High Pressure (HP) fuel pump
2. Fuel Pressure Control Valve (FPCV)
3. Fuel primer pump assembly w/ fuel strainer element
4. Fuel pressure test port
5. Engine fuel supply connection
6. Engine mounted secondary fuel filter access
7. Engine fuel return connection
8. Fuel supply to AFT fuel doser module
9. Chassis mounted primary fuel filter access
10. Fuel supply to engine
11. Fuel return from engine
12. Fuel supply from tank
13. Chassis mounted fuel filter/water separator
14. Fuel Heater
15. Water In Fuel (WIF) sensor
16. Fuel return to tank
17. Fuel return from engine
18. Fuel supply to engine
19. Fuel filter housing assembly (engine mounted)
20. Fuel filter drain screw
21. Inlet air heater port
22. Fuel Delivery Pressure (FDP) sensor
23. LP fuel pump outlet
24. LP fuel pump inlet
25. HP fuel pump inlet
26. HP fuel pump return

The LP fuel pump pumps fuel from the tank through the chassis mounted fuel filter/water separator, fuel strainer element, and engine filter element, then to the high-pressure fuel system, inlet air heater system, and AFT fuel doser module.

In addition to providing high-pressure fuel to the injectors, the fuel system provides filtered low-pressure fuel to the downstream injection and Inlet air heater systems.

Chassis Mounted Filter/Water Separator

The chassis mounted filter/water separator removes debris and water from the fuel before it enters the fuel primer pump and low-pressure fuel pump. The chassis mounted filter/water separator includes a Water In Fuel (WIF) sensor and optional fuel heater.

Fuel Primer Pump Assembly

During fuel system priming, fuel is drawn from the tank through the chassis mounted filter/water separator by the fuel primer pump assembly. The fuel primer pump assembly has an integrated fuel strainer element that can be cleaned. The fuel primer pump assembly is manually operated, and is used to prime the low-pressure fuel system anytime the fuel system has been emptied. The primer pump provides unrestricted fuel flow to the low-pressure pump during normal engine operation.

Low Pressure (LP) Fuel Pump

The LP fuel pump and the High Pressure (HP) fuel pump are one assembly. Fuel is drawn through the fuel primer pump assembly and into the LP fuel pump. The LP pump supplies fuel to the fuel filter housing assembly at pressures varying between approximately 85 psi (586 kPa) at idle, and 120 psi (827 kPa) at rated speed. The LP fuel pump has an internal pressure regulator that relieves the fuel pressure internally if the pressure exceeds 189 psi (1300 kPa).

Fuel Filter Assembly

The fuel filter assembly is installed on the left side of the engine and has a disposable filter element. A Fuel Delivery Pressure (FDP) sensor is installed on the front side of the fuel filter assembly, which measures fuel pressure between the LP fuel pump and the filter element. The fuel filter assembly also has a drain screw that allows water and dirt to be drained periodically. Because water may accumulate inside the fuel filter assembly, use the drain screw to drain water per maintenance schedule in the *Engine Operation and Maintenance Manual*. An additional function of the fuel filter assembly is fuel system self-deaeration. The air separated from fuel is pushed back into the fuel tanks through the return line. The fuel filter assembly also provides filtered fuel to the AFT fuel doser module and inlet air heater system. An orifice regulator is integrated into the fuel filter assembly, and regulates the fuel pressure for the inlet air heater system to approximately 10 psi (70 kPa).

High Pressure Fuel System

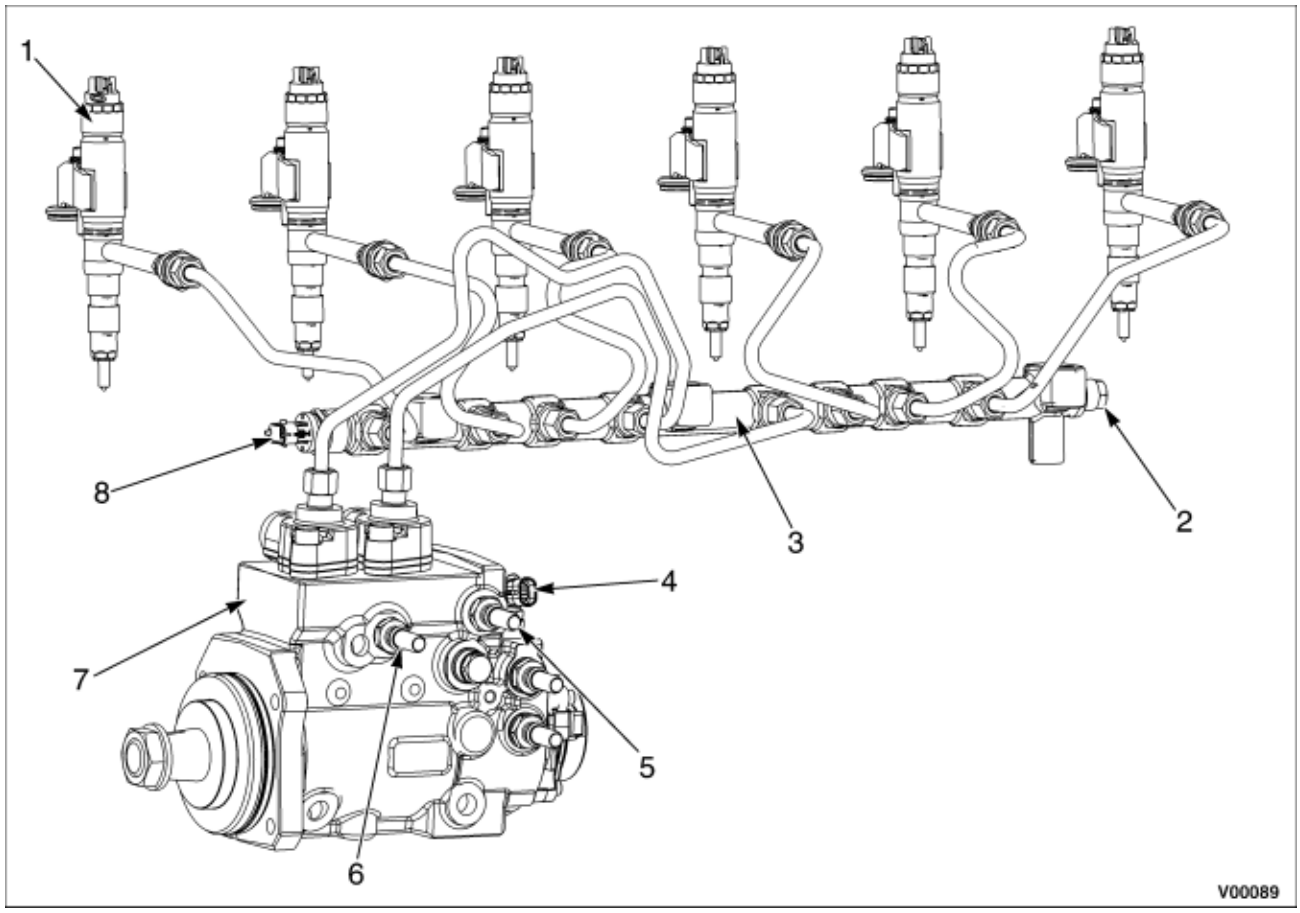

Figure 907 High Pressure (HP) fuel system

1. (Fuel) Injector (6)
2. Rail pressure limiting valve
3. Fuel rail
4. Fuel Pressure Control Valve (FPCV)
5. Fuel inlet - HP fuel pump
6. Fuel return - HP fuel pump
7. HP fuel pump
8. Fuel Rail Pressure (FRP) sensor

Pressurization and injection are separate in the common rail injection system. Optimal fuel injection pressure is generated by the high-pressure pump at any engine speed. High-pressure fuel quantity from the high-pressure pump is controlled by the FPCV. Injection timing and quantity are calculated in the Engine Control Module (ECM) and implemented by solenoid valve controlled injectors. The use of solenoid valve controlled injectors allows three injections per cycle.

The first injection is used to reduce combustion noise and emissions by introducing a small amount of fuel into the cylinder, preventing a rapid rise in cylinder pressure when combustion begins. The second injection is the main injection. This injection allows high-temperatures to be maintained during combustion, but not long enough to allow generation of large soot amounts. The third injection is done during the power stroke to maximize cylinder temperature and reduce engine soot generation.

The high-pressure fuel system consists of the high-pressure pump with integrated Fuel Pressure Control Valve (FPCV), pressure pipe rail, high-pressure fuel lines, injectors, FRP sensor, and rail pressure limiting valve.

High Pressure (HP) Pump

The HP pump supplies the necessary quantity of HP fuel for all operating engine modes. The HP pump is gear driven and is fuel lubricated. Fuel from the LP fuel pump is forced through the fuel module assembly, and into the HP pump. The flow of fuel to the suction chamber of the HP pump is controlled by the FPCV, in order to control HP fuel output.

Fuel Pressure Control Valve (FPCV)

The FPCV is a variable position actuator installed on the suction side of the high-pressure pump and controls the output fuel pressure. The Engine Control Module (ECM) sends a Pulse Width Modulated (PWM) signal to control the FPCV. A 100% duty cycle PWM signal corresponds to minimum fuel pressure delivery, while a 0% duty cycle PWM corresponds to maximum fuel pressure delivery.

Fuel Rail

The fuel rail is a HP fuel storage unit. The storage volume of the fuel rail is designed to reduce pressure pulses caused by the HP pump and injectors, and to maintain constant fuel pressure even when large fuel quantities are injected into the cylinders. Connection between the fuel rail and injectors are made through two individual injection lines.

Fuel Rail Pressure (FRP) Sensor

The FRP sensor is a variable resistance sensor that monitors fuel pressure in the High Pressure (HP) fuel rail. The FRP sensor is mounted in the front of the fuel rail, on the left side of the engine.

Rail Pressure Limiting Valve

The rail pressure limiting valve maintains fuel pressure inside the fuel rail below approximately 37,700 psi (260,000 kPa). If HP fuel pump output exceeds specification the rail pressure limiting valve opens and fuel flows into the fuel return line. With the pressure limiting valve open, fuel pressure in the high-pressure fuel rail drops to approximately 15,950 psi (110,000 kPa).

Fuel Injectors

Navistar® N13 engines are equipped with electronically controlled fuel injectors. During engine operation, injectors are supplied with high-pressure fuel, and the injector solenoid valves open up to three times per combustion cycle. The injectors are positioned vertically in the center of the cylinder head and are held in place by clamps. The seal between the injectors and the combustion chamber consists of a copper washer on the tip of each injector.

Intake Air Heater System

Intake Air Heater System Components

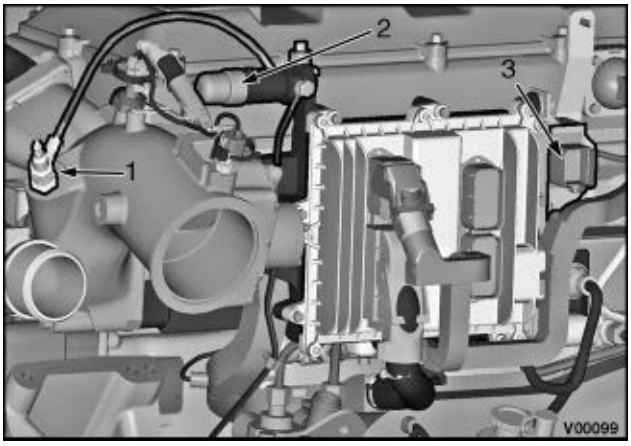

Figure 908 Intake Air Heater System

1. Intake Air Heater Fuel Igniter (IAHFI)
2. Intake Air Heater Fuel Solenoid (IAHFS) valve
3. Intake Air Heater Relay (IAHR)

Intake Air Heater Fuel Igniter (IAHFI)

The Intake Air Heater system rapidly activates the heater element, vaporizing and igniting small quantities of fuel into the air intake duct.

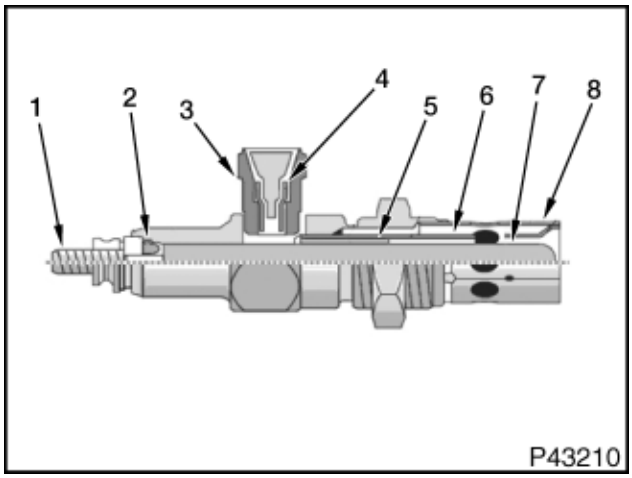

Figure 909 Intake Air Heater Fuel Igniter (partial cut away view)

1. Electrical connection
2. Insulation
3. IAHFI fuel line connection
4. Metering device
5. Vaporizer filter
6. Vaporizer tube
7. Heater element
8. Protective sleeve

The IAHFI has an internal fuel metering device, vaporizer filter, vaporizer tube, heater element, and a protective sleeve. The protective sleeve has holes that allow enough air to pass through the IAHFI to enable fuel vaporization and combustion.

The IAHFI is installed on the left front side of the engine, in the intake throttle duct.

Intake Air Heater Relay (IAHR)

The IAHR is installed on the left side of the engine at the rear of the Engine Control Module (ECM). The IAHR provides voltage to the IAHFI, and is controlled by the ECM.

Intake Air Heater Fuel Solenoid (IAHFS) Valve

The IAHFS valve is installed on the left side of the engine and is controlled by the ECM. The IAHFS valve is supplied with low-pressure fuel regulated from the fuel filter assembly.

When the ECM provides battery voltage to the IAHFS valve, the solenoid opens and allows fuel to flow to the IAHFI through the IAHFI fuel line.

Intake Air Heater System Operation

The Intake Air Heater system operates only in temperatures lower than 10°C (50°F).

When the truck operator turns the ignition switch to ON, the wait-to-start lamp in the instrument cluster illuminates. Based on the temperature readings from the Engine Coolant Temperature (ECT) sensors, the ECM activates the IAHR heater element. The IAHR then energizes the IAHFI for approximately 35 seconds.

Once the IAHFI is heated to approximately 1000°C (1832°F), the wait-to-start lamp starts to flash and the operator can crank the engine. When the engine is rotating, the IAHFS valve opens and allows fuel to enter the IAHFI. Inside the IAHFI, fuel passes through the vaporizer tube. The vaporized fuel then mixes with in coming air and ignites in contact with the heater element.

With the engine running, the IAHFI remains energized and fuel continues to be injected, and the wait-to-start lamp continues to flash for a maximum of four minutes. When the wait-to-start lamp stops flashing, the IAHFI and the IAHFS valve are deactivated. If the operator accelerates while the wait-to-start lamp is flashing, the Intake Air Heater system will shutdown.

Engine Lubrication System

Oil Flow and Components

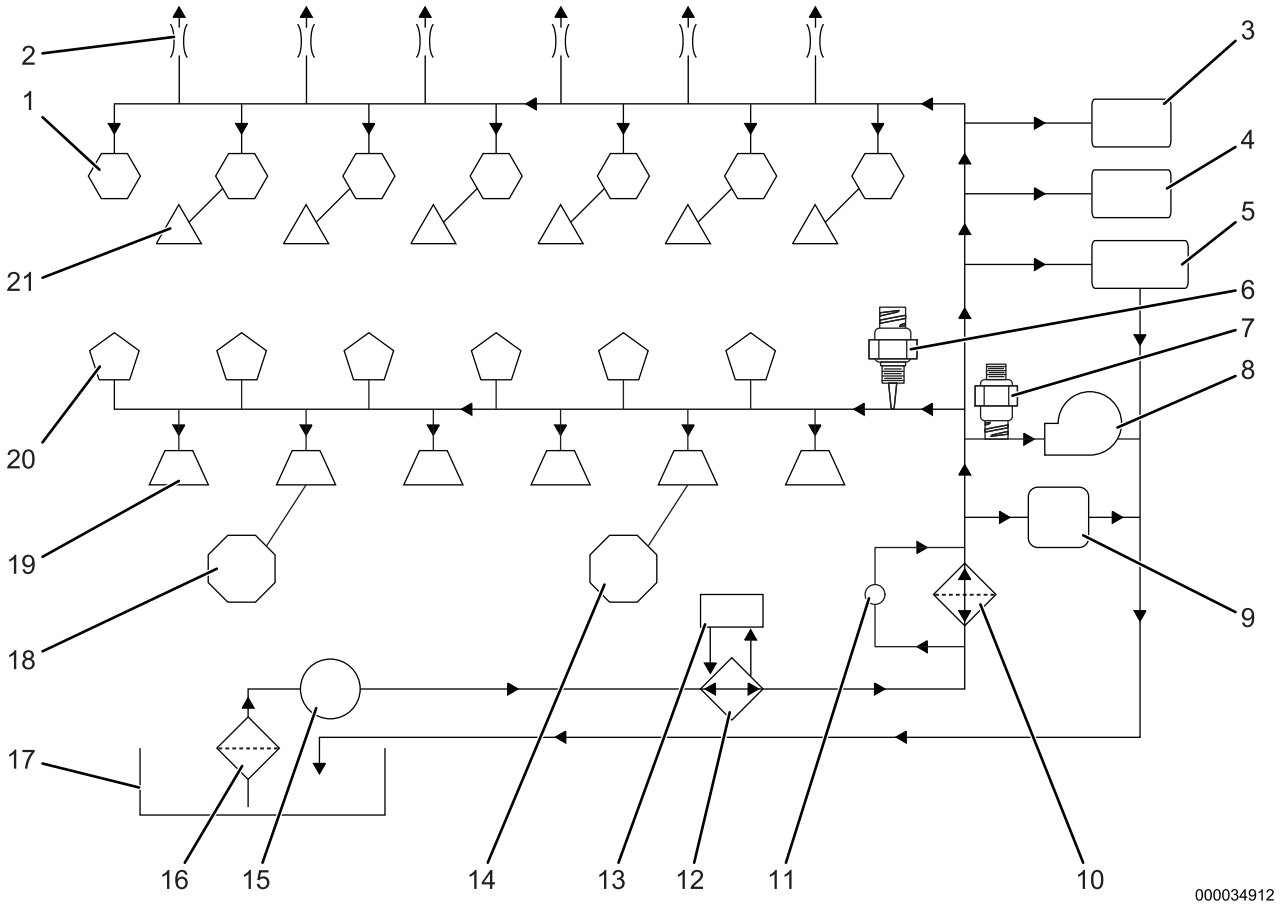

Figure 910 Oil flow

1. Main Bearings
2. Piston Cooling Jets
3. Rear Geartrain
4. Front Geartrain
5. Air Compressor
6. Engine Oil Temperature (EOT) Sensor
7. Engine Oil Pressure (EOP) Sensor
8. Dual Turbochargers
9. Oil Pressure Regulator
10. Oil Filter
11. Oil Filter Bypass
12. Oil Cooler
13. Engine Coolant
14. Engine Brake Assembly 1
15. Oil Pump (Gerotor Pump)
16. Oil Pickup Tube and Screen
17. Oil Sump
18. Engine Brake Assembly 1
19. Rocker Arm Assemblies
20. Cam Bearings
21. Connecting Rods

Unfiltered oil is drawn from the oil pan through the pickup tube and front cover passage by the crankshaft driven gerotor pump. Pressurized oil is moved through a vertical crankcase passage and into the oil module.

Inside the oil module, unfiltered oil flows through plates in the oil cooler heat exchanger. Engine coolant flows around the plates to cool the surrounding oil. An oil return shutoff valve installed at the exit from the oil cooler prevents oil from draining through the oil pump and back into the oil pan when the engine is stopped. If oil

pressure coming out of the oil pump is too high, a pressure relief valve allows excess oil to return through the crankcase into the oil pan before entering the oil cooler.

Oil that exits the oil cooler flows through a return shutoff valve that prevents the oil from draining back into the oil pan. From the return shutoff valve, oil enters the oil filter element and flows from the outside to the inside of the filter element to remove debris. When the filter is restricted, an oil filter bypass valve opens and allows oil to bypass the filter so engine lubrication is maintained. If oil pressure inside the oil filter element is too high, an oil pressure relief valve, installed at the bottom of the oil filter element housing, allows the excess oil to return to the oil pan.

After passing through the oil filter element, oil flow is directed to the cylinder head and crankcase.

Clean oil enters the cylinder head through an external flange elbow connected to the oil module. Inside the cylinder head, oil flows through passages to lubricate the camshaft bearings, rocker arms, exhaust valve bridges, and cylinder head intermediate gear.

Clean oil enters the crankcase from the oil module to lubricate the crankshaft, high-pressure pump, air compressor, and intermediate gears. The crankshaft has cross-drillings that direct oil to the connecting rods.

Oil sprayer nozzles direct cooled oil to the bottom of the piston crowns.

The turbochargers are lubricated with filtered oil from an external supply tube that connects the oil filter module to the center housing of each turbocharger. Oil drains back to the oil pan through the low and high-pressure turbocharger oil return pipes connected to the crankcase.

A service oil drain valve, installed at the bottom of the filter element cavity, opens automatically when the filter element is lifted for replacement, and allows the oil from the oil filter element cavity to drain into the oil pan.

Oil is also supplied to the Navistar® Engine Brake housings (under valve cover) through specially designed rocker mounting bolts.

Oil Filter Module

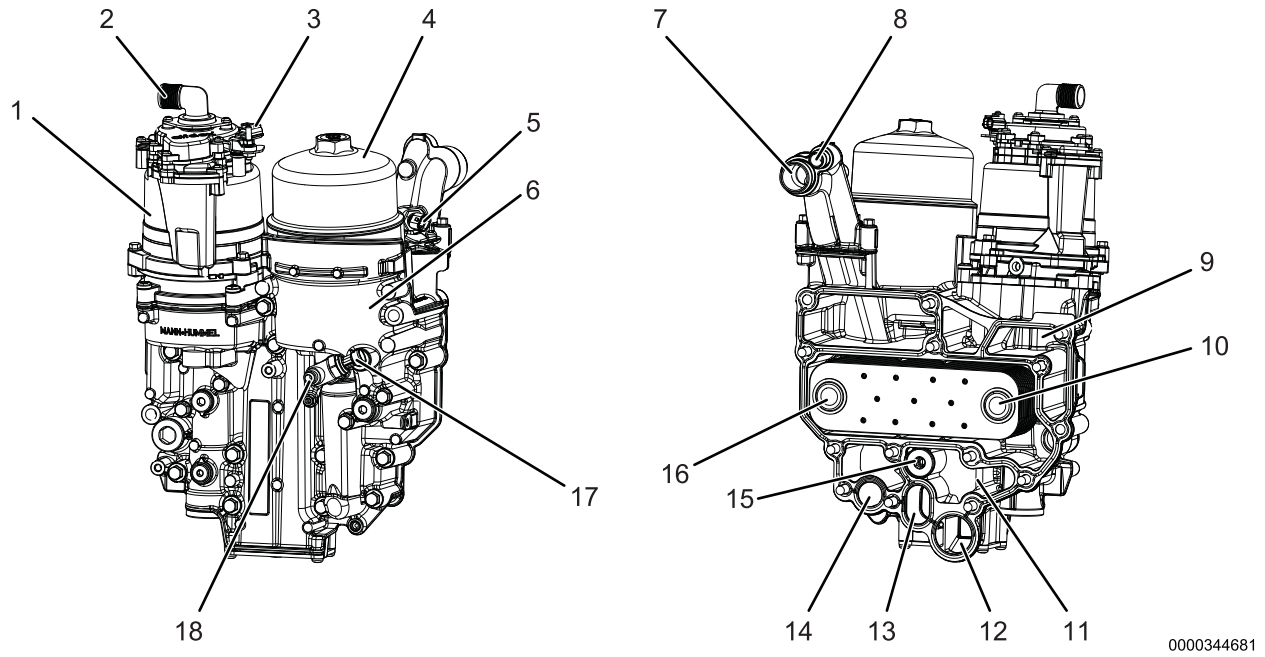

Figure 911 Oil module with crankcase oil separator assembly (inner and outer views)

1. Crankcase Oil Separator (CCOS)
2. CCOS vent outlet
3. Crankcase Oil Separator Speed (CCOSS) sensor
4. Filter cover
5. Engine Oil Temperature (EOT) sensor
6. Oil filter assembly
7. Oil return from cylinder head
8. Oil supply to cylinder head
9. Crankcase gas inlet
10. Oil cooler inlet
11. Oil supply from oil pump
12. CCOS oil return
13. Oil module pressure relief port
14. Oil out to crankcase
15. Regulator
16. Oil cooler outlet to crankcase
17. Sensor Tee-Fitting
18. Engine Oil Pressure (EOP) sensor

The oil module contains a canister style filter, oil cooler, EOP and EOT sensors, a pressure relief valve, an oil filter bypass valve, and an oil return shutoff valve. The oil module also collects, and directs crankcase emissions to the CCOS. The oil that separates from the crankcase emissions is drained back into the oil pan through the oil return port.

Remote Mounted Centrifugal Oil Filter (Optional)

The remote mounted centrifugal oil filter is used to remove particulates from engine oil, reducing wear and extending engine oil change intervals. During operation, dirty oil enters the oil supply port to a regulator valve. When engine oil pressure exceeds approximately 248 kPa (36 psi), the regulator valve opens, and oil enters the centrifugal element through the center hollow spindle. Inside the element, centrifugal acceleration separates contaminants from oil. Contaminants accumulate inside the serviceable filter element as a solid cake. Clean oil exits through opposing twin nozzles that power the centrifuge and returns to the crankcase from the oil level control base. Oil level is managed by the oil float. When the oil float raises, compressed air enters the system to force oil back to the crankcase. When the oil float drops, the air supply port is closed.

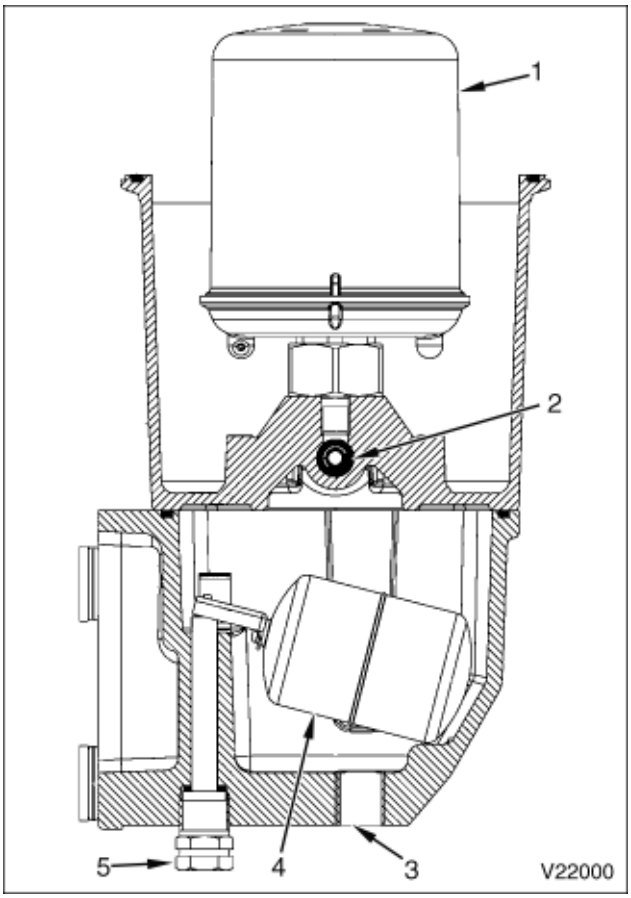

Figure 912 Remote Mounted Centrifugal Oil Filter

1. Serviceable filter element
2. Oil supply port (regulator valve)
3. Oil return port
4. Oil float
5. Air supply port (regulator valve)

Engine Cooling System

Cooling System Flow

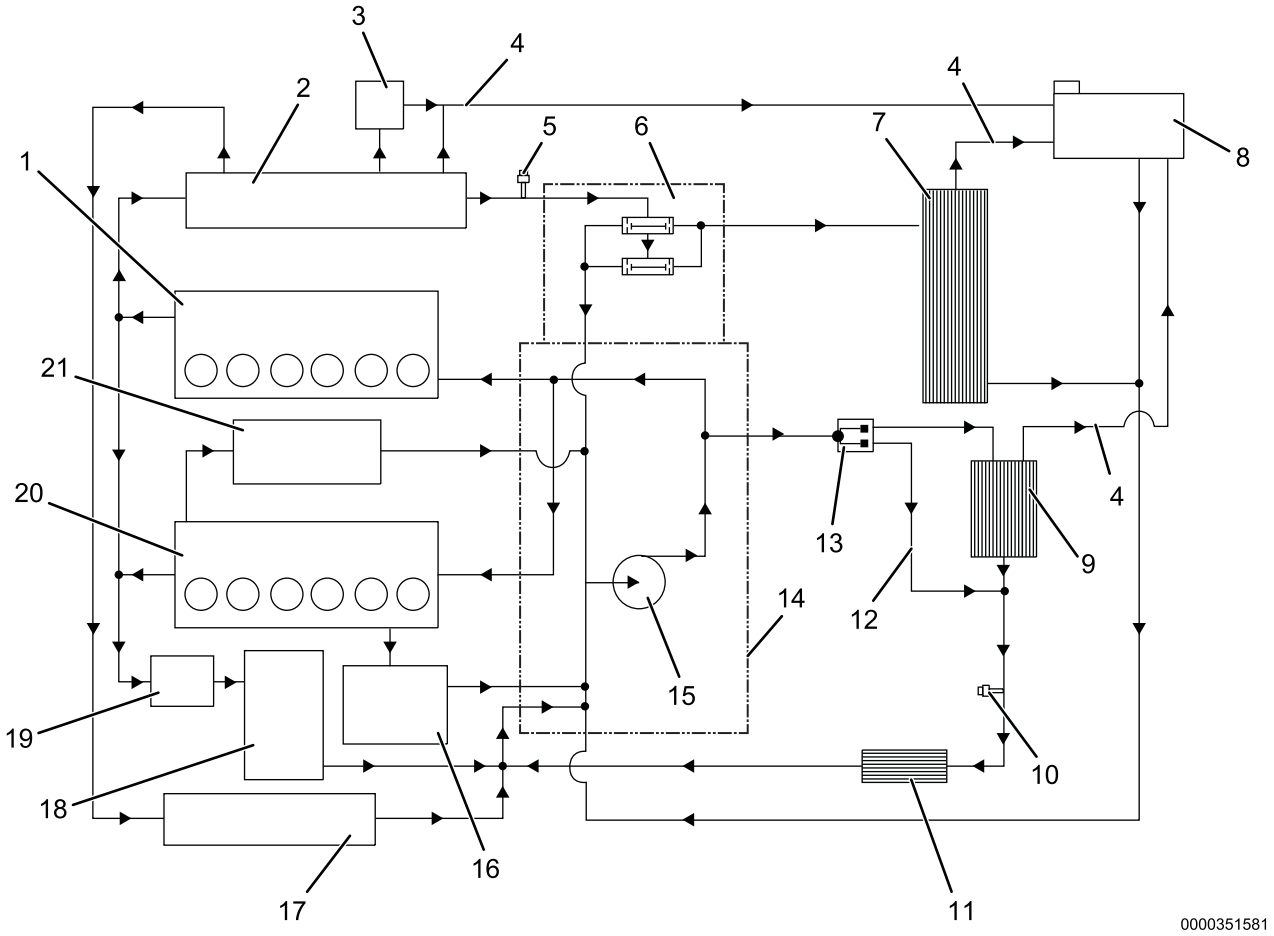

Figure 913 Cooling system flow

1. Cylinder Head
2. Exhaust Gas Recirculation (EGR) Cooler
3. Exhaust Gas Recirculation (EGR) Valve
4. Vent
5. Engine Coolant Temperature 1 (ECT1) Sensor
6. Thermostats
7. Radiator
8. Deaeration Tank
9. Low Temperature Radiator (LTR)
10. Engine Coolant temperature 2 (ECT2) Sensor
11. Interstage Cooler (ISC)
12. Bypass
13. Low Temperature Radiator (LTR) Thermostat
14. Front Gear Cover
15. Water Pump
16. Oil Cooler
17. Cab Heater Core
18. Road Draft tube Heater
19. Aftertreatment Fuel Injector (AFI)
20. Crankcase
21. Air Compressor

The water pump is installed on the water distribution housing and draws coolant from the radiator through the coolant inlet.

Navistar® N13 engines have no coolant passages between the crankcase and cylinder head through the cylinder head gasket. This eliminates the possibility of coolant leaks at the cylinder head gasket. Coolant in and out of the crankcase and cylinder head is directed through external passages. Coolant flows through the crankcase and cylinder head from front to rear. This coolant flows around the cylinder liners and combustion chambers to absorb heat from combustion.

Coolant exiting the crankcase and cylinder head at the rear of the engine is directed through an external coolant pipe to the Exhaust Gas Recirculation (EGR) cooler. Coolant passes between the EGR cooler plates, travels parallel to the exhaust flow, into the EGR cooler return manifold, and into the thermostat housing. A deaeration port on top of the EGR cooler directs coolant and trapped air to the coolant deareation tank.

Coolant from the water pump also flows through the Interstage Cooler (ISC) to regulate charge air temperature. Flow through the ISC is controlled by the Low-Temperature Radiator (LTR) Thermostat. Depending on the coolant flow, LTR Thermostat sends coolant through the EGR Cooler, or bypass indirectly to the ISC, after going through the LTR installed in front of the main coolant radiator. When charge air temperature is too low, CMV bypasses the LTR and directs all the coolant through the Charge Air Cooler (CAC). When charge air temperature increases, the CMV directs a percentage of coolant to the LTR before it enters the CAC to cool the charge air. If the engine coolant temperature is too high, CMV sends all of the coolant flow through the LTR and through the ISC to help cool the engine faster.

Coolant flow to the radiator is controlled by two thermostats. When the thermostats are closed, coolant flowing out of the EGR cooler is directed through a bypass port inside the front cover into the water pump. When the thermostats are open the bypass port is blocked, and coolant is directed from the engine into the radiator.

Coolant passes through the radiator and is cooled by air flowing through the radiator from ram air and operation of the coolant fan. The coolant returns to the engine first through the transmission cooler, then through the engine coolant inlet elbow.

The air compressor is cooled with coolant supplied by a hose from the left side of the crankcase. Coolant passes through the air compressor cylinder head and returns through a coolant return line to the engine crankcase.

The oil module receives coolant from a passage in the crankcase. Coolant passes between the oil cooler plates and returns back to the water pump suction passage.

The Diesel Exhaust Fluid Doser (DEFD) Valve and DEF Tank Heater Control (DEFTHC) Valve receive coolant from a supply line running from the lower radiator hose. When DEF tank temperature is too low, the Aftertreatment Control Module (ACM) commands the DEFTHV ON allowing coolant to pass through the DEF tank heating coil. Coolant from the DEF tank heating coil and DEFDC then returns to the water pump inlet through a coolant return line.

Thermostat Operation

Navistar® N13 engines are fitted with two thermostats in a common housing to ensure sufficient coolant flow in all operating conditions. The thermostat housing is installed on top of the water distribution housing.

The thermostat housing assembly has two outlets. One directs coolant to the radiator when the engine is at operating temperature. The second outlet directs coolant to the water pump until the engine reaches operating temperature. The thermostats begin to open at approximately 83°C (181°F) and are fully open at 91°C (196°F).

When engine coolant is below approximately 83°C (181°F), the thermostats are closed, blocking coolant flow to the radiator.

When coolant temperature reaches opening temperature, the thermostats open allowing some coolant to flow to the radiator. When coolant temperature exceeds approximately 91°C (196°F), the lower seat blocks the bypass port directing full coolant flow to the radiator.

Low-Temperature Radiator Operation

The Low-Temperature Radiator (LTR) is part of the cooling package and is installed in front of the engine radiator. The LTR is used to cool a portion of the engine's coolant to a lower temperature than the rest of the engine. This lower temperature coolant is used to cool charge air in the Interstage Cooler mounted on the lower right side of the engine. The coolant flow is controlled by the LTR Thermostat. The operation of the LTR is monitored by the ECM with the Turbocharger 2 Compressor Inlet Temperature (TC2CIT) sensor and Engine Coolant Temperature 2 (ECT2) sensor.

The CCV has two separate solenoid actuated valves. The Coolant Mixer Valve (CMV) and the Coolant Flow Valve (CFV) are part of the CCV assembly and cannot be serviced separately. The CMV and CFV solenoids are controlled by two separate Pulse Width Modulated (PWM) signals from the Engine Control Module (ECM). The PWM signal duty cycles vary between 0% and 100% depending on coolant and charge air temperature.

LTR Thermostat

The LTR Thermostat is a wax element thermostat in a housing with one inlet port and two outlet ports. During cold engine operation (thermostat closed), coolant is directed to the ISC directly, through the bypass port. At normal operating temperature (thermostat open), coolant is directed to the LTR first and then to the ISC. The thermostat begins to open at 71°C (160°F) and is fully open at 86°C (187°F). The LTR thermostat is installed on the water distribution housing on the right side of the engine.

Engine Brake System

Engine Brake Control System Components

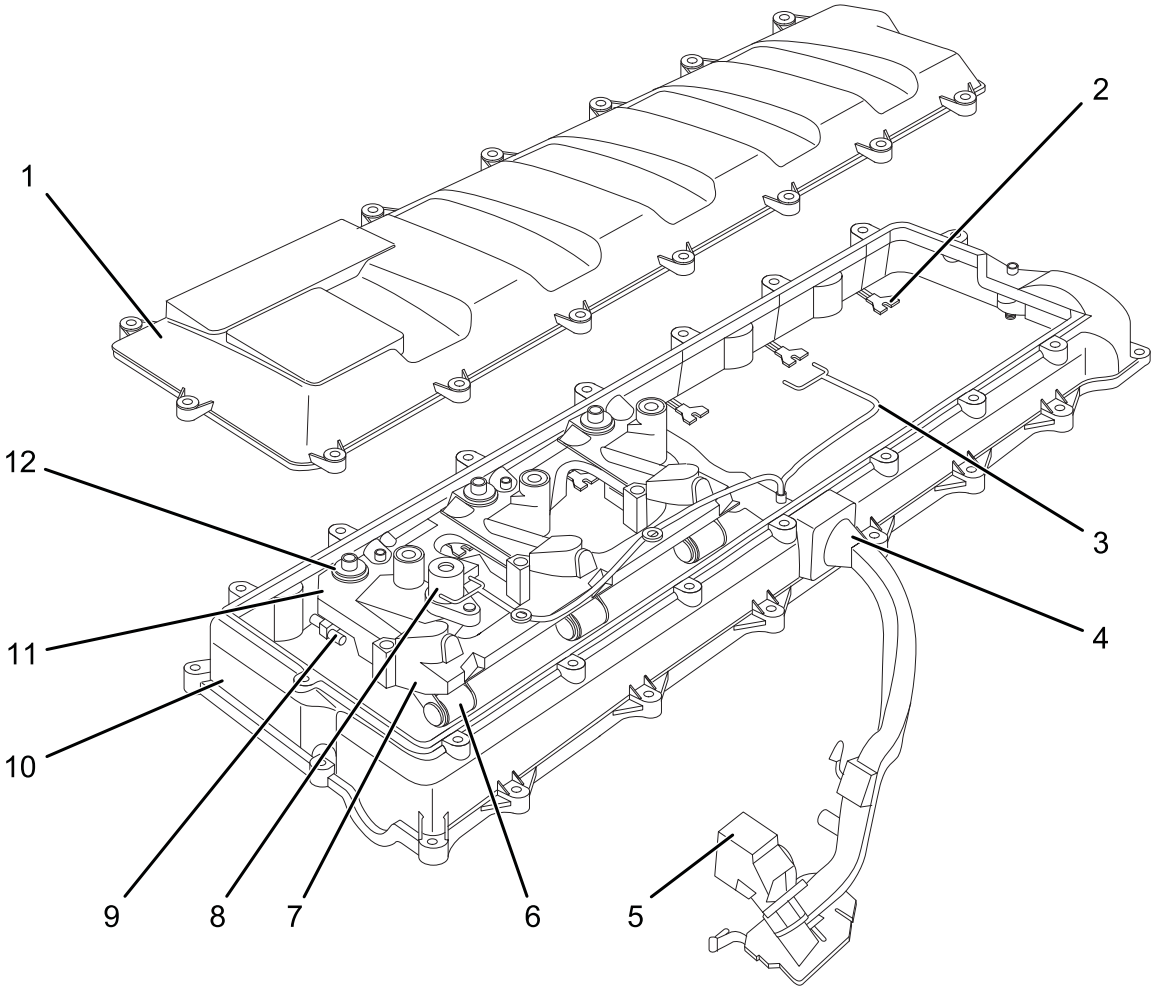

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Figure 914 Engine brake control system components

1. Upper valve cover
2. Injector harness connector
3. Engine brake solenoid harness connector lead (2)
4. Pass through harness
5. ECM E1 connector
6. Master piston roller assembly (3 each housing)
7. Engine brake master piston (within housing)
8. Engine brake solenoid (1 each housing)
9. Exhaust valve bridge
10. Valve cover base
11. Engine brake housing assembly (2)
12. Engine brake slave piston

Engine Brake System Description

The Navistar® Engine Brake by Jacobs® braking system is standard equipment on the ProStar® and optional equipment on the TranStar® and WorkStar® for Navistar®N13 engines. The braking system is a hydro-mechanical device that mounts under the engine's valve cover. It turns your power-producing diesel engine into a power-absorbing air compressor.

Here's how: when the driver releases the accelerator pedal, the forward momentum of the truck continues to turn the drivetrain and engine. The pistons continue to move up and down. Once activated, the engine brake opens the exhaust valves near the peak of the compression stroke, releasing the highly compressed air through the exhaust systems. Little energy is returned to the piston, and as the cycle repeats, the energy of the truck's forward motion is now directed toward motoring the diesel engine, thus reducing the forward motion causing the truck to slow down.

Engine Brake System Operation

The engine brake system consists of two hydraulic braking housings, activated using two Engine Control Module (ECM) actuated brake solenoids, and an exhaust bridge (pin). The engine brake depends on engine oil for operation; minimum oil temperature for retarder activation is approximately 40°C (104°F).

Engine brake operation is automatic after the operator turns it On using the On / Off switch. When the clutch is engaged and the throttle is not depressed, the engine brake is automatically activated.

NOTE: The operator can select various engine brake retarding levels by pressing a HIGH/MEDIUM/LOW switch.

Activation occurs through the following steps:

1. Engine oil pressure fills the housing passages up to the solenoid.
2. Activation of the engine brake is communicated by the ECM using the J1939 Controller Area Network (CAN) data link. When activated, the energized solenoid valve permits engine lube oil to flow under pressure through the control valve to both the master piston and slave piston circuits.
3. Oil pressure causes the master piston roller assembly to move down, picking up the motion of the cam (dedicated braking lobe) pushing the piston back into the housing creating high-pressure oil.
4. High-pressure oil flows back through the master piston, slave piston and control valve circuits.
5. The check ball in the control valve seats, trapping oil in the circuit creating a high-pressure link between the slave piston and master piston.
6. Once the high-pressure link is created, the master piston follows the cam profile causing the slave piston to move down, momentarily opening exhaust valve (single valve opening), while the engine piston is near its top dead center position, releasing compressed cylinder air to the exhaust manifold.
7. Compressed air escapes to atmosphere completing compression braking cycle.

NOTE:

1. The Navistar® Engine Brake by Jacobs® will disengage during Anti-lock Brake System (ABS) braking.
2. Will interact with the vehicle cruise control for smooth operation during engine braking
3. Will interact with the Eaton UltraShift® Transmission for smooth up-shifts under fueling conditions

Electronic Control System

Electronic Control System Components

Navistar®N13 engines are equipped with two control modules, the Engine Control Module (ECM), and the Aftertreatment Control Module (ACM).

Operation and Function

The ECM and ACM monitor and control engine and aftertreatment system operation to ensure maximum performance and adherence to emissions standards. The ECM and ACM, perform the following functions:

- Provide reference voltage (VREF)
- Condition input signals
- Process and store control strategies
- Control actuators

Reference Voltage (VREF)

The ECM and ACM supply 5 volt VREF signals to various input sensors in the electronic control system. By comparing the 5 volt VREF signal sent to the sensors with their respective returned signals, the ECM and ACM determine pressures, positions, and other variables important to engine, aftertreatment, and vehicle functions.

Signal Conditioner

Signal conditioning circuitry in the ECM and ACM convert analog signals to digital signals, squares up sine wave signals, and amplifies low intensity signals.

Microprocessor

The microprocessor, installed inside the ECM and ACM, process stored operating instructions (control strategies) and value tables (calibration parameters). The microprocessor compares stored instructions and values with conditioned input values to determine the correct strategy for all engine operations.

Diagnostic strategies are also programmed into the ECM and ACM. Some strategies monitor inputs continuously and command the necessary outputs for correct performance of the engine and aftertreatment.

Diagnostic Trouble Codes

Diagnostic Trouble Codes (DTCs) are stored by the ECM if inputs or conditions do not comply with expected values. Diagnostic fault codes are communicated using the Suspect Parameter Number (SPN) and Failure Mode Indicator (FMI) identifiers, and are accessed using an electronic service tool with ServiceMaxx™ diagnostic software or other J1939 and J1708 RP1210B compliant interface device.

Microprocessor Memory

The ECM and ACM microprocessors includes Read Only Memory (ROM) and Random Access Memory (RAM).

Read Only Memory (ROM)

ROM stores permanent information for calibration tables and operating strategies. Permanently stored information cannot be changed or lost when the ignition switch is turned to OFF or when power to the control modules is interrupted. ROM includes the following:

- Vehicle configuration, modes of operation, and options
- Engine Family Rating Code (EFRC)
- Engine warning and protection modes

Random Access Memory (RAM)

RAM stores temporary information for current engine conditions. Temporary information in RAM is lost when the ignition switch is turned to OFF or power to control module is interrupted. RAM information includes the following:

- Engine temperature
- Engine rpm
- Accelerator pedal position

Actuator Control

The Engine Control Module (ECM) and Aftertreatment Control Module (ACM) control actuators by applying a low level signal (low-side driver) or a high level signal (high-side driver). When switched on, both drivers complete a ground or power circuit to an actuator.

Actuators are controlled in one of the following ways, depending upon type of actuator:

- H-Bridge circuit (switchable high and low circuits)
- Pulse Width Modulated (PWM)
- Switched On or Off

Actuators

The ECM controls engine operation with the following:

- Fuel Injectors
- Exhaust Back Pressure Valve (EBPV)
- Exhaust Gas Recirculation (EGR) Valve
- Turbocharger 2 Wastegate Control (TC2WC)
- Intake Air Heater Relay (IAHR)
- Intake Air Heater Fuel Solenoid (IAHFS) valve
- Engine Throttle Valve (ETV)
- Fuel Pressure Control Valve (FPCV)
- Engine Compression Brake 1 and 2 (ECB1 and ECB2) Valves
- Engine Fan Control (EFC)

The ACM controls aftertreatment system operation with the following:

- Aftertreatment Fuel Shutoff Valve (AFTFSV)
- Aftertreatment Purge Air Valve (AFTPAV)
- Diesel Exhaust Fluid Supply Module Heater (DEFSMH)
- Diesel Exhaust Fluid Doser (DEFD) Valve
- Diesel Exhaust Fluid Line Heater (DEFLH) Relay
- Diesel Exhaust Fluid Pressure Line Heater (DEFPLH)
- Diesel Exhaust Fluid Return Line Heater (DEFRLH)
- Diesel Exhaust Fluid Reverting Valve (DEFRV)
- Diesel Exhaust Fluid Suction Line Heater (DEFSLH)
- Diesel Exhaust Fluid Supply Pump (DEFSP) and Temperature Sensor
- Diesel Exhaust Fluid Tank Heater Control (DEFTHC) Valve
- Diesel Exhaust Fluid Supply Module Heater (DEFSMHR) Relay

Exhaust Back Pressure Valve (EBPV) Control

The EBPV is controlled using the Air Control Valve (ACV) assembly. The ACV assembly contains the EBPV control valve, and the Turbocharger 2 Turbine Wastegate Control (TC2WC) valve. Both are used by the ECM to control Air Management System operation.

The EBPV regulates air pressure applied to the EBPV pneumatic actuator. The pneumatic cylinder actuates the valve (in the exhaust system) in response to commands by the ECM. The ECM monitors the Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor for proper EBPV operation.

The EBPV actuator is mounted on the right side of the engine, after the turbocharger exhaust connection.

Exhaust Gas Recirculation (EGR) Valve

The EGRV is mounted on the rear of the EGR cooler, on top of the engine. The EGRV assembly receives the desired valve position from the ECM. The EGRV regulates the flow of exhaust gases through the EGR system.

Air Control Valve (ACV)

The ACV contains solenoids used for control of the High Pressure (HP) turbocharger wastegate and EBPV.

ACV solenoids are controlled through pulse width modulated signals sent by the ECM.

The ACV is installed on the front of the engine, just above the water pump.

Intake Air Heater Relay (IAHR)

The Intake Air Heater system warms incoming air supply up to four minutes for cold engine emissions reduction.

The Engine Control Module (ECM) is programmed to energize the Intake Air Heater Fuel Igniter (IAHFI) heater element through the Intake Air Heater Relay (IAHR) while monitoring engine coolant temperature, air inlet temperature, engine oil temperature, and atmospheric pressure.

The IAHR delivers battery voltage to the heater element for a set time, depending on engine coolant temperature and altitude. The ground circuit is supplied from the battery ground. The relay is controlled by switching on a voltage source from the ECM, and is installed to the rear of the ECM.

Intake Air Heater Fuel Solenoid (IAHFS) Valve

The IAHFS valve controls fuel flow to the IAHFI during Intake Air Heater operation.

When Intake Air Heater is required, the ECM provides voltage to open the IAHFS valve.

The IAHFS valve is mounted on the ECM bracket, on the top left side of the engine.

Engine Throttle Valve (ETV)

The ETV controls the flow of fresh air (boosted and cooled) into the engine's air intake path through the Charge Air Cooler (CAC) to help heat the exhaust aftertreatment during regeneration, and to when heavy Exhaust Gas Recirculation (EGR) is requested. The ECM controls the position of the ETV motor using an H-Bridge circuit. The ECM can switch PWR and GND between the valve motor wires. This allows the ECM to move the motor forward and back to properly position the valve.

The ETV is mounted to the intake throttle duct, on the top left side of the engine.

Fuel Pressure Control Valve (FPCV)

The FPCV is a variable position actuator that controls fuel flow to the suction side of the high-pressure fuel pump.

The FPCV changes valve position through pulse width modulated signals from the ECM.

The FPCV is mounted on the upper side of the high-pressure pump. The FPCV can be serviced separately from the pump in case of a failure.

Aftertreatment Fuel Shutoff Valve (AFTFSV)

The AFTFSV is used to control fuel flow to the Aftertreatment Fuel Injector (AFTFI). The AFTFSV is controlled through an On-Off signal sent by the Aftertreatment Control Module (ACM). The AFTFSV is installed in the AFT fuel doser module, located to the rear of the fuel filter assembly, on the left side of the engine.

Aftertreatment Purge Air Valve (AFTPAV)

The AFTPAV is used to purge the AFTFI of fuel after active regeneration of the aftertreatment system. When purging is needed, the Aftertreatment Control Module (ACM) commands the AFTPAV ON, and AFTFI open. This allows pressurized air from the vehicle air tanks, to flow through the AFTPAV, AFT fuel doser module, and out the AFTFI.

The AFTPAV is mounted on the left side of the engine, behind the AFT fuel doser module.

Diesel Exhaust Fluid Supply Module Heater (DEFSMH)

The DEFSMH is used to maintain proper DEF temperature in the DEF supply module.

The ACM is programmed to energize the DEFSMH through the Diesel Exhaust Fluid Supply Module Heater Relay (DESMHR) when DEF supply module temperature is too low.

Diesel Exhaust Fluid Doser (DEFD) Valve

The DEFD Valve is a solenoid assembly controlled by the Aftertreatment Control Module (ACM). When the ACM commands DEF dosing, it opens the doser valve and allows DEF to be sprayed into the exhaust stream.

Diesel Exhaust Fluid Line Heater(DEFLH) Relay

The DEF line heaters are used to maintain proper DEF temperature to avoid DEF freezing. When DEF temperature is too low. The ACM commands the DEFLHR ON, sending power to the DEF line heaters.

The DEFLH Relay is installed in the Aftertreatment Power Distribution Module (PDM), near the DEF tank.

Diesel Exhaust Fluid Pressure Line Heater (DEFPLH)

The DEFPLH is used to maintain proper DEF temperature in the DEF supply module pressure line.

The DEFPLH is wrapped around the pressure line between the DEF supply module and DEFDV.

Diesel Exhaust Fluid Return Line Heater (DEFRLH)

The DEFRLH is used to maintain proper DEF temperature in the DEF supply module return line.

The DEFRLH is wrapped around the return line between the DEF supply module and DEF tank.

Diesel Exhaust Fluid Return Valve (DEFRV)

The DEFRV is switched On or Off by the ACM.

The DEFRV regulates the flow of DEF in the DEF supply module. When purging is needed, the ACM will turn the DEFRV ON, and returns DEF in the lines to the tank.

The DEFRV is part of the DEF supply module, and is not serviceable individually.

Diesel Exhaust Fluid Suction Line Heater (DEFSLH)

The DEFSLH is used to maintain proper DEF temperature in the DEF supply module suction line.

The DEFSLH is wrapped around the suction line between the DEF supply module and DEF tank.

Diesel Exhaust Fluid Supply Pump (DEFSP) and Temperature Sensor

The DEFSP is controlled using a Pulse Width Modulated (PWM) signal from the ACM.

The DEF supply module has an internal temperature sensor used to monitor DEFSP temperature.

The DEFSP is part of the DEF supply module, and is not serviceable individually.

Diesel Exhaust Fluid Tank Heater Control (DEFTHC) Valve

The DEFTHC Valve controls coolant flow to the DEF tank. When DEF temperature is low, the ACM commands the DEFTHC Valve open, allowing coolant flow to warm the DEF tank.

The DEFTHC Valve is typically mounted to the vehicle frame.

Diesel Exhaust Fluid Supply Module Heater (DEFSMH) Relay

The DEFSMH Relay aids in defrosting the DEF supply module. When DEF temperature is too low, the ACM energizes the heater element inside the DEF supply module through the DEFSMH Relay.

Engine and Vehicle Sensors

Thermistor Sensors

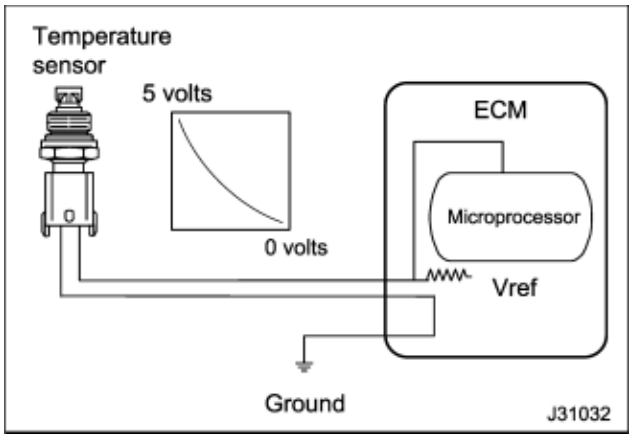

Figure 915 Thermistor

A thermistor sensor changes electrical resistance with changes in temperature. As temperature changes at the thermistor, voltage at the ECM or ACM will change accordingly. Thermistors work with the control module to produce a voltage signal proportional to temperature values.

A thermistor sensor has two electrical connectors, signal return and ground. The output of a thermistor sensor is a non-linear analog signal.

Thermistor type sensors include the following:

- Aftertreatment temperature sensors
- Engine coolant temp sensors
- Engine Oil Temperature (EOT) sensor
- Turbocharger 2 Compressor Inlet Temperature (TC2CIT) Sensor
- Charge Air Cooler Outlet Temperature (CACOT) sensor
- Intake Manifold Temperature (IMT) sensor
- EGR Gas Temperature (EGRGT) sensor
- Ambient Air Temperature (AAT) sensor

Aftertreatment Temperature Sensors

Temperature sensors used in the Aftertreatment System include the following:

- Diesel Exhaust Fluid Tank Temperature (DEFTT) sensor
- DOC / DPF temperature sensor module
    - Diesel Oxidation Catalyst Intake Temperature (DOCIT) sensor
    - Diesel Particulate Filter Intake Temperature (DPFIT) sensor
    - Diesel Particulate Filter Outlet Temperature (DPFOT) sensor
- SCR temperature sensor module
    - Selective Catalyst Reduction Intake Temperature (SCRIT) sensor
    - Selective Catalyst Reduction Outlet Temperature (SCROT) sensor

Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) Sensor Module

The DEFTLT sensor module is a combination sensor that monitors DEF tank level and temperature, and communicates to the Aftertreatment Control Module (ACM) through private J1939 Controller Area Network (CAN) communication.

The DEFTLT sensor module is installed inside the DEF tank.

Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) Temperature Sensor Module

The DOC / DPF temperature sensor module monitors aftertreatment DPF and DOC temperature. The DOC / DPF temperature sensor module monitors signals from the DOC Intake Temperature (DOCIT), DPF Intake Temperature (DPFIT), and DPF Outlet Temperature (DPFOT) sensors, and communicates these signals to the Aftertreatment Control Module (ACM) through private J1939 Controller Area Network (CAN) communication.

The DOCIT, DPFIT, and DPFOT sensors are not serviceable individually, and are part of the DOC / DPF temperature sensor module.

Selective Catalyst Reduction (SCR) Temperature Sensor Module

The SCR temperature sensor module monitors aftertreatment SCR catalyst temperature. The SCR temperature sensor module monitors signals from the SCR Intake Temperature (SCRIT) sensor, and SCR Outlet Temperature (SCROT) sensor, and communicates these signals to the ACM through private J1939 Controller Area Network (CAN) communication.

The SCRIT sensor and SCROT sensor are not serviceable individually, and are part of the SCR temperature sensor module.

Engine Coolant Temperature (ECT) Sensors

The ECT1 and ECT2 sensors are thermistor-type sensors that detect engine coolant temperature.

The ECT1 signal is monitored by the ECM for operation of the instrument panel temperature gauge, coolant temperature compensation, EGR system control, optional Engine Warning Protection System (EWPS), and the wait to start lamp. The ECM uses ECT1 sensor input as a backup, if EOT sensor values are out of range.

The ECT2 signal is used by the ECM to monitor the Low Temperature Radiator (LTR) and Interstage Cooler (ISC) performance.

The ECT1 sensor is installed in the underside of the EGR coolant crossover manifold, at the back of the engine.

The ECT2 sensor is installed in the radiator thermostat housing, on the right side of the engine.

Engine Oil Temperature (EOT) Sensor

The EOT sensor is a thermistor sensor that detects engine oil temperature. The EOT sensor is installed in the side oil module flange, behind the oil filter cover, on the right side of the engine.

Turbocharger 2 Compressor Intake Sensor (TC2CIS)

The TC2CIS sensor includes a thermistor sensor that monitors the temperature of charge air entering the High Pressure (HP) turbocharger. This sensor also monitors boost pressure for the Low Pressure (LP) turbocharger.

The TC2CIS sensor is monitored by the Engine Control Module (ECM), and is used for calculating fuel delivery and controlling turbocharger wastegate operation.

The TC2CIS is installed in the piping between the LP compressor outlet and the HP compressor inlet.

Charge Air Cooler Outlet Temp (CACOT) Sensor

The CACOT sensor is a thermistor sensor that monitors the temperature of charge air entering the intake air duct.

The CACOT signal is monitored by the ECM.

The CACOT sensor is installed on the intake air duct, before the Engine Throttle Valve (ETV).

Intake Manifold Temperature (IMT) Sensor

The IMT sensor is a thermistor sensor that monitors temperature.

The IMT sensor is installed in the intake side of the cylinder head, on the left side of the engine.

Exhaust Gas Recirculation Temperature (EGRT) Sensor

The EGRT sensor is a thermistor sensor that detects the exhaust gas temperature exiting the EGR cooler.

The EGRT signal is monitored by the ECM.

The EGRT sensor is installed in the EGR cooler outlet manifold, at the front of the engine.

Ambient Air Temperature (AAT) Sensor

The AAT sensor is a thermistor sensor that detects the temperature of ambient air.

The AAT signal is monitored by the ECM.

The AAT sensor is installed in various places depending on the vehicle.

Variable Capacitance Sensors

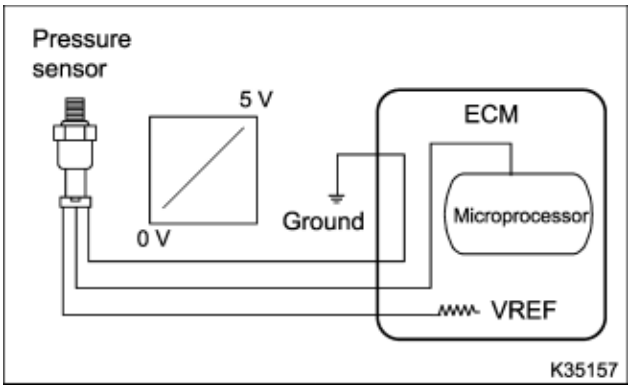

Figure 916 Variable capacitance sensor example

Variable capacitance sensors measure pressure. The pressure measured is applied to a ceramic material. The pressure forces the ceramic material closer to a thin metal disk. This action changes the capacitance of the sensor.

The sensor is connected to the control module through the VREF, signal, and signal ground wires.

The sensor receives the VREF and returns an analog signal voltage to the Engine Control Module (ECM) or Aftertreatment Control Module (ACM). The ECM or ACM compares the voltage with pre-programmed values to determine pressure.

Variable capacitance sensors include the following:

- Aftertreatment Fuel Pressure (AFTFP)
- Diesel Exhaust Fluid Line Pressure Absolute (DEFLPA) Sensor
- Diesel Particulate Filter Differential Pressure (DPFDP)/Diesel Particulate Filter Outlet Pressure (DPFOP) sensor
- Fuel Delivery Pressure (FDP) sensor
- Engine Oil Pressure (EOP) sensor
- Fuel Rail Pressure (FRP) sensor
- Intake Manifold Pressure (IMP) sensor
- Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor

Aftertreatment Fuel Pressure (AFTFP) Sensor

The AFTFP sensor is a variable capacitance sensor that the ACM uses to monitor fuel pressure into the aftertreatment system.

The AFTFP sensor is installed in the AFT fuel doser module, to the rear of the fuel filter assembly.

Diesel Exhaust Fluid Line Pressure Absolute (DEFLPA) Sensor

The DEFLPA sensor is a variable capacitance sensor that measures DEF pressure from the DEF Supply Pump (DEFSP).

The DEFLPA sensor provides feedback to the ACM for the DEF dosing system.

The DEFLPA sensor is not serviceable individually and is part of the DEF supply module.

Diesel Particulate Filter Differential Pressure (DPFDP)/Diesel Particulate Filter Outlet Pressure (DPFOP) sensor

The DPFDP/DPFOP outlet pressure sensor provides a feedback signal to the ACM indicating the pressure difference between the inlet and outlet of the DPF. The DPFDP/DPFOP sensor also has an individual signal for the outlet pressure of the DPF.

The DPFDP/DPFOP outlet pressure sensor is a differential pressure sensor with two tap-offs installed at the DPF. A tap-off is installed before and after the DPF.

Fuel Delivery Pressure (FDP) Sensor

The FDP sensor is a variable capacitance sensor that measures fuel supply pressure.

The FDP sensor provides feedback to the ECM for the low-pressure fuel system.

The FDP sensor is installed in the front of the fuel filter assembly on the left side of the engine.

Engine Oil Pressure (EOP) Sensor

The EOP sensor is a variable capacitance sensor that detects engine oil pressure.

The EOP signal is monitored by the ECM for operation of the instrument panel pressure gauge and optional Engine Warning and Protection System (EWPS).

The EOP sensor is installed in the oil module, on the right side of the engine.

Fuel Rail Pressure (FRP) Sensor

The FRP sensor is a variable capacitance sensor that monitors fuel pressure in the high-pressure fuel rail.

The FRP sensor measures fuel pressure just before injection.

The FRP sensor is mounted in the front of the fuel rail on the left side of the engine.

Intake Manifold Pressure (IMP) Sensor

The IMP sensor is a variable capacitance sensor that monitors the pressure of charge air entering the intake air duct.

The IMP signal is monitored by the ECM for control of the EGR system and turbocharger wastegates.

The IMP sensor is installed in the intake air duct, after the Engine Throttle Valve (ETV).

Turbocharger 1 Turbine Outlet Pressure (TC1TOP)

The TC1TOP sensor is a variable capacitance sensor that monitors exhaust back pressure.

The sensor measures back pressure in the exhaust system. A tap for the TC1TOP is installed in the exhaust, between the low-pressure turbocharger and Exhaust Back Pressure Valve (EBPV).

The TC1TOP sensor is installed on the sensing tube connected to the exhaust on the right side of the engine.

Magnetic Pickup Sensors

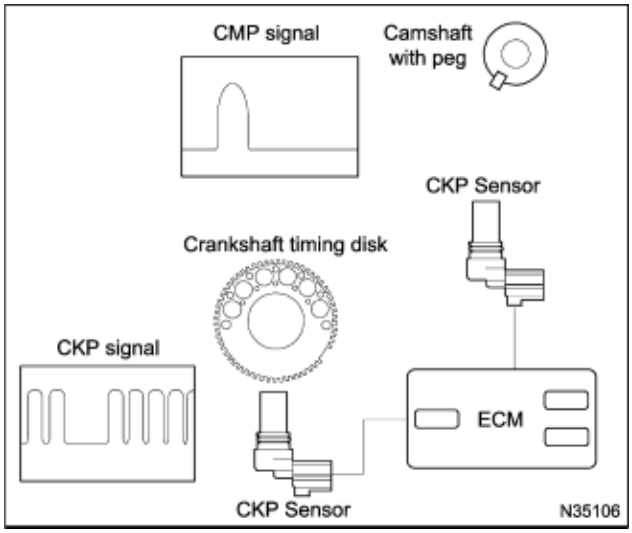

Figure 917 Magnetic pickup sensor examples

A magnetic pickup sensor contains a permanent magnet core that is surrounded by a coil of wire. The sensor generates a voltage signal through the collapse of a magnetic field created by a moving metal trigger. The movement of the trigger then creates Alternate Current (AC) voltage in the sensor coil.

Magnetic pickup sensors used include the following:

- Crankshaft Position (CKP) sensor
- Camshaft Position (CMP) sensor
- Transmission Output Shaft Speed (TOSS)
- Crankcase Oil Separator Speed (CCOSS) Sensor

Crankshaft Position (CKP) Sensor

The CKP sensor is a magnetic pickup sensor that indicates crankshaft speed and position.

The CKP sensor sends a pulsed signal to the Engine Control Module (ECM) as the crankshaft turns. The CKP sensor reacts to holes drilled into the flywheel adjacent to the ring gear. For crankshaft position reference, teeth 59 and 60 are missing. By comparing the CKP signal with the CMP signal, the ECM calculates engine rpm and timing requirements.

The CKP sensor is installed in the top left of the flywheel housing.

Camshaft Position (CMP) Sensor

The CMP sensor is a magnetic pickup sensor that indicates camshaft speed and position.

The CMP sensor sends a pulsed signal to the ECM as a toothed wheel on the camshaft rotates past the CMP sensor. The ECM calculates camshaft speed and position from CMP signal frequency.

The CMP sensor is installed in the left rear of the cylinder head.

Transmission Output Shaft Speed (TOSS)

The TOSS provides the ECM with transmission tail shaft speed by sensing the rotation of a 16-tooth gear on the rear of the transmission. The detected sine wave signal (AC) received by the ECM, is used with tire size and axle ratio to calculate vehicle speed. The TOSS is installed on the left side of the transmission housing for automatic transmissions, or at rear of the transmission housing for manual transmissions.

Crankcase Oil Separator Speed (CCOSS) sensor

The CCOSS sensor sends the ECM information about the speed of the crankcase oil separator internal components. The detected sine wave signal (AC) received by the ECM is used to monitor operation of the centrifugal oil separator, installed inside the breather assembly on the engine oil filter assembly.

Potentiometer Sensors

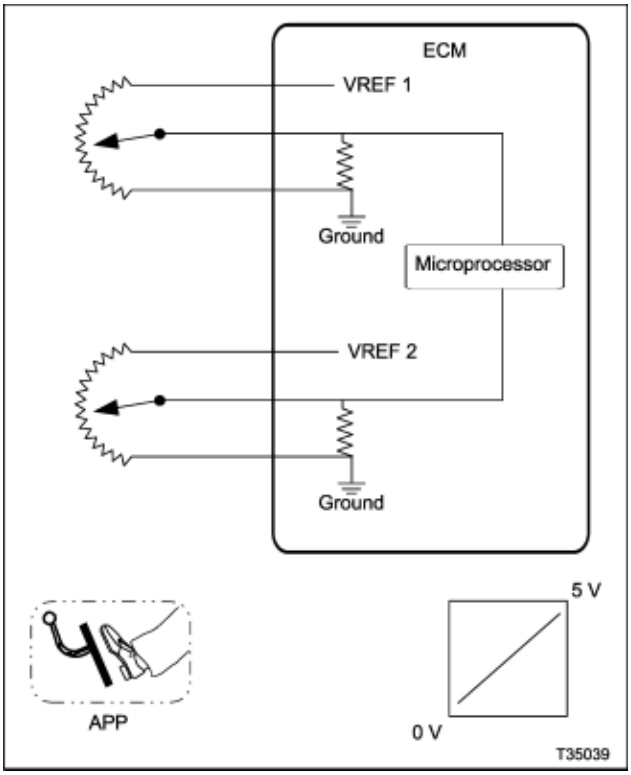

Figure 918 Potentiometer example

A potentiometer is a variable voltage divider that senses the position of a mechanical component. A reference voltage is applied to one end of the potentiometer. Mechanical rotary or linear motion moves the wiper along the resistance material, changing voltage at each point along the resistive material. Voltage is proportional to the amount of mechanical movement.

The engine has two potentiometers, both contained in the Accelerator Pedal Position (APP) Sensor.

Accelerator Pedal Position (APP)

The APP provides the ECM with a dual feedback signal (dual linear analog voltages) that indicate the operator's demand for power. The APP contains two potentiometers, and provides two individual signals (APP1 and APP2) to the ECM. The APP is installed in the cab on the accelerator pedal assembly.

Switches

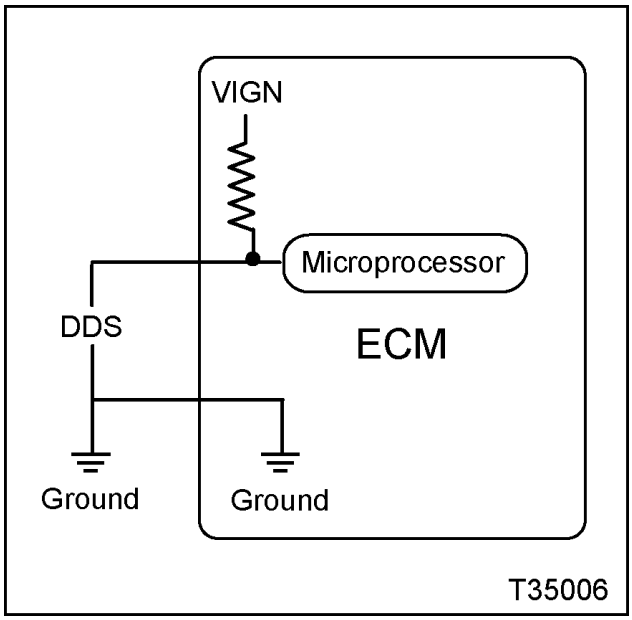

Figure 919 Switch example

Switch sensors indicate position, level, or status. They operate open or closed, regulating the flow of current. A switch sensor can be a voltage input switch or a grounding switch. A voltage input switch supplies the control module with a voltage when it is closed. A grounding switch grounds the circuit when closed, causing a zero voltage signal. Grounding switches are usually installed in series with a current limiting resistor.

Switches include the following:

- Driveline Disengagement Switch (DDS)
- Engine Coolant Level (ECL)

Driveline Disengagement Switch (DDS)

The DDS determines if a vehicle is in gear. For manual transmissions, the clutch switch serves as the DDS. For automatic transmissions, the neutral indicator switch functions as the DDS. The DDS signal is sent to the Body Controller (BC) and transmitted on the Public J1939 Controller Area Network (CAN) datalink to the engine ECM for manual transmissions. The Transmission Control Module (TCM) sends the DDS signal over the Public J1939 CAN for automatic transmissions.

Engine Coolant Level (ECL) Switch

The ECL switch is part of the Engine Warning and Protection System (EWPS). The ECL switch is installed on the deaeration tank. When the magnetic switch is open, the tank is considered full of coolant.

If engine coolant is low, the switch closes and the red ENGINE lamp on the instrument panel is illuminated.

Oil Level Sensor (OLS)

The OLS is part of the EWPS. The OLS is installed in the engine oil pan. The OLS measures the volume of oil in the oil pan and broadcast the percentage volume over J1939 Controller Area Network (CAN).

If the level of engine lube oil is low, the red ENGINE lamp on the instrument panel is illuminated.

Additional Sensors

Engine Oil Level (EOL) Sensor

The EOL sensor is part of the EWPS. The EOL sensor is installed in the engine oil pan. The EOL sensor measures the level of engine lube oil in the oil pan and returns its signal to the ECM. If the level of engine lube oil is low, the red ENGINE lamp on the instrument panel is illuminated.

Nitrogen Oxides (NOx) IN Sensor Module

The Nitrogen Oxides (NOx) IN sensor module is a smart device used to measure the NOx emissions at the intake of the aftertreatment system. The NOx IN sensor module performs internal diagnostics and reports malfunctions back to the ACM using the J1939 CAN data link.

The NOx IN sensor is not serviceable individually, and is part of the NOx IN sensor module.

Nitrogen Oxides (NOx) OUT Sensor Module

The Nitrogen Oxides (NOx) OUT sensor module is a smart device used to measure NOx emissions at the outlet of the SCR catalyst. The NOx OUT sensor module performs internal diagnostics and reports malfunctions back to the ACM using the J1939 CAN data link.

The NOx OUT sensor is permanently attached to the NOx control module. They are not serviceable independently and it is a single component.

Oxygen Sensor (O_2S)

The O_2S monitors oxygen levels in the exhaust.

O_2S input is used by the ECM to control EGR flow to a specified ratio by monitoring the level of unused oxygen in the exhaust stream.

The O_2S compares oxygen levels in the exhaust stream with oxygen levels in the outside air. The sensor generates an analog voltage and is monitored by the ECM. The level of voltage generated by the O2S corresponds to the oxygen levels in the exhaust stream.

The O_2S is installed in the turbocharger exhaust pipe, after the Exhaust Back Pressure Valve (EBPV).

Heavy Duty On Board Diagnostics (HD-OBD)

Overview

The Environmental Protection Agency (EPA) and Air Research Board (ARB) has added new regulations for 2010 to reduce heavy duty vehicle emissions. The HD-OBD system is designed specifically for electronically controlled heavy duty engines. The goal for HD-OBD regulation is to keep engine emissions within specification for as long as a given vehicle is in use.

HD-OBD is legislated to be implemented in the three following phases:

- 2010: First engine for each Original Equipment Manufacturer (OEM) becomes fully certified.
- 2013: One engine in each engine family becomes fully certified.
- 2016: All engines must be fully HD-OBD certified.

The HD-OBD system continuously monitors for proper engine operation, and will alert the vehicle operator to emission-related faults using the Malfunction Indicator Lamp (MIL). The MIL is installed in the Electronic Instrument Cluster. When a detected emissions fault occurs, the MIL will be illuminated. Diagnostic information is also stored in the Engine Control Module (ECM), and may be accessed by the technician for diagnosis and repair of the malfunction. Diagnostic information is accessed by connecting the Electronic Service Tool (EST) to the in-cab Vehicle Diagnostic Connector.

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Standard Electronic Control Features

NOTE: For additional feature operation, and parameter information, use the Navistar® 13 Engine Feature Documentation found on the Body Builder Website Link within Navistar® Service Portal. This includes parameter details of description, possible values, whether or not it is customer programmable, and recommended settings.

Aftertreatment (AFT) System

The AFT system, part of the larger exhaust system, processes engine exhaust so that it meets tailpipe emission requirements. The AFT system traps particulate matter (soot) and prevents it from leaving the tailpipe. The trapped particulate matter is then rendered to ash by heating the exhaust and injecting fuel through a process called regeneration. Regeneration reduces the frequency of AFT system maintenance without adversely affecting emissions.

For additional information, see Aftertreatment (AFT) System in the “Engine Systems” section of this manual.

Cold Ambient Protection (CAP)

CAP protects the engine from damage caused by prolonged idle at no load condition during cold weather.

CAP maintains engine coolant temperature by increasing engine rpm. CAP also improves cab warm-up.

CAP is standard on trucks without an Idle Shutdown Timer (IST).

Coolant Temperature Compensation (CTC)

NOTE: CTC is disabled in emergency vehicles and school buses that require 100 percent power on demand.

CTC reduces fuel delivery if the engine coolant temperature is above cooling system specifications.

Before standard engine warning or optional warning/protection systems engage, the ECM begins reducing fuel delivery when engine coolant temperature reaches approximately 107°C (225°F). A rapid fuel reduction of 15 percent is achieved when engine coolant temperature reaches approximately 110°C (230°F).

Data Plate

The ECM stores data to help identify the vehicle and engine components. The data plate feature is used to display text data descriptions in order to assist with reports and make data tracking easier.

The parameters associated with this feature only need to be modified when a related component is replaced, and can only be updated through your authorized dealer.

Electronic Speedometer and Tachometer

The engine control system calibrates vehicle speed up to 157 pulses per mile. The calculated vehicle speed is a function of transmission tail shaft speed, number of teeth on the tail shaft, rear axle ratio, and tire revolutions per mile. Use the Electronic Service Tool (EST) with ServiceMaxx™ software to program new speed calibrations into the ECM.

The tachometer signal is generated by the ECM by computing the signals from the Camshaft Position (CMP) sensor and the Crankshaft Position (CKP) sensor. The calculated engine speed is then sent to the instrument cluster through the J1939 CAN Data Link.

Engine Crank Inhibit (ECI)

The ECI will not allow the starting motor to engage when the engine is running and the drivetrain is engaged.

The ECI will not allow the starting motor to engage with the engine running if the key is turned to START while the clutch pedal is pressed.

Engine Electronic Governor Control

The governor controls engine rpm within a safe and stable operating range.

The low idle governor prevents engine rpm from dropping below a stable speed to prevent stalling when various loads are demanded on the engine.

The high idle governor prevents engine rpm from going above a safe speed that would cause engine damage.

Engine Fan Control (EFC)

The engine fan control feature is designed to allow configuration of the engine for various fan control features on a particular vehicle application.

The primary purpose of the engine fan is to allow the engine to run at its regulated operating temperature increasing engine performance. It is also used to assist in cooling the refrigerant in the A/C condenser. Factory set parameters within the ECM provide engine fan control based on the fan type installed in the vehicle. Choosing whether the fan is engaged during engine speed control, commonly referred to as PTO, operation is a customer programmable parameter. For additional information, see EFC (Engine Fan Control) in the “Electronic Control Systems Diagnostics” section of this manual.

Event Logging System

The event logging system records vehicle operation above the maximum speed setting (overspeed) and engine operation above maximum rpm (overspeed), coolant temperature out of operational range, low coolant level, or low oil pressure. The readings for the odometer and hourmeter are stored in the ECM memory at the time of an event and can be retrieved using the EST.

Fast Idle Advance

The ECM monitors the Engine Coolant Temperature (ECT) sensor. If the engine coolant temperature is below 10 °C (50 °F), the ECM activates the fast idle advance.

Fast idle advance increases engine idle speed to 700 rpm for a period of up to 100 seconds to assist in faster warm-up to operating temperature. This occurs by the ECM monitoring the engine coolant temperature and adjusting the fuel injector operation accordingly.

Low idle speed is resumed when engine coolant temperature reaches temperatures above 10 °C (50 °F), or the 100 second period times out.

Intake Air Heater Assist

The Intake Air Heater (IAH) feature improves engine start-up in cold weather. The Engine Control Module (ECM) controls the IAH Relay and monitors the Engine Temperature sensors. When the key is turned to the ON position, the ECM monitors the sensors. If a sensor is below 11°C (52°F), the ECM enables the IAHR. The IAHR energizes the IAH Fuel Igniter (IAHFI). When the IAHFI reaches the proper operating temperature, the wait to start lamp flashes. As the engine is cranked, the ECM energizes the IAH Fuel Solenoid (IAHFS) valve, introducing fuel into the IAHFI, which ignites and warms the air being drawn into the engine. Do not accelerate the engine until the wait to start lamp goes out.

For additional information, see Intake Air Heater System in the “Engine Systems” section of this manual.

IST (Idle Shutdown Timer) System (Clean Low Idle)

IST (Clean Low Idle)

The Idle Shutdown Timer (IST) ("Clean Low Idle") allows the ECM to shut down the engine during extended idle. When parking brake is set, the idle time can be programmed up to 5 minutes. When parking brake is released, the idle time can be programmed up to 15 minutes. During service, the idle time can be programmed up to 60 minutes. The ECM deactivates the IST when the PTO is active.

Thirty seconds before engine shutdown, the IST engine lamp illuminates. This continues until the engine shuts down or the low idle shutdown timer is reset. Idle time is measured from the last clutch or APP. The engine must be out of gear for the IST to work. Engine shutdown time resets for one or more of the following conditions:

- Engine speed is not at idle speed.
- Vehicle movement or a Transmission Output Shaft Speed (TOSS) fault is detected.
- DPF Regeneration is enabled (Any REGEN State).
- Accelerator pedal movement or an Accelerator Pedal Position (APP) fault is detected.
- Engine coolant operating temperature is below 16 °C (60 °F).
- Brake pedal movement or a brake switch fault is detected.
- Parking brake transition is detected.
- Clutch pedal is pressed or clutch pedal switch fault is detected (manual transmissions, if equipped with a clutch switch).
- Shift selector is moved from neutral (automatic transmissions).
- If the IST is enabled, the CAP will not function.

IST (Idle Shutdown Timer) System (Federal - Optional)

IST (Federal - Optional) Sensor Circuit Operation

The optional Idle Shutdown Timer (IST) allows the ECM to shut down the engine during extended idle. Idle time can be programmed from 5 to 120 minutes. The ECM can be programmed to deactivate the IST when the Power Takeoff (PTO) is active.

- Engine speed is not at idle speed (600 rpm).

- Vehicle movement or a Vehicle Speed Sensor (VSS) fault is detected.
- Manual DPF Regeneration is enabled.
- Accelerator pedal movement or an Accelerator Pedal Position (APP) fault is detected.
- Engine coolant operating temperature is below 60 °C (140 °F).
- Ambient temperature below 16° C (60 °F) or above 44 °C (110 °F).
- Brake pedal movement or a brake switch fault is detected.
- Parking brake transition is detected.
- Clutch pedal is pressed or clutch pedal switch fault is detected (manual transmissions, if equipped with a clutch switch).
- Shift selector is moved from neutral (automatic transmissions).
- If the IST is enabled, the CAP will not function.

J1939 Datalink

The vehicle is equipped with an SAE standard J1939 CAN datalink:

- The J1939 datalink is used for diagnostics and calibration communications for the Engine Control Module (ECM and ACM).
- The J1939 datalink is used for communications between the ECM, Electronic Gauge Cluster (EGC), and Body Controller (BC).

The J1939 datalink is accessed through the cab diagnostic connector pins C and D. The datalink provides communication between the ECM and the Electronic Service Tool (EST).

The J1939 datalink supports:

- Transmission of engine parameter data
- Transmission and clearing of Diagnostic Trouble Codes (DTCs)
- Diagnostics and troubleshooting
- Programming engine and vehicle features
- Programming calibrations and strategies
- Inter-module communications between the:
    - Engine Control Module (ECM)
    - Body Controller (BC)
    - Electronic Gauge Cluster (EGC)
    - Automatic Transmission Controller
    - Electronic Service Tool (EST)

For additional information, see J1939 Datalink in the “Electronic Control Systems Diagnostics” section in this manual.

Password Protection

The ECM allows the vehicle to be configured to help the owner optimize fuel economy and reliability. The password protection feature provides protection to prevent unauthorized users from changing parameter values in the ECM. With the password set, the service tool will prompt for the current password and will not allow any parameter to be changed until that password is entered. The password parameter is customer programmable.

Service Diagnostics

The EST provides diagnostic information using the J1939 Controller Area Network (CAN) datalink.

Faults from sensors, actuators, electronic components, and engine systems are detected by the ECM. The faults are accessed by the EST through the Diagnostic Connector, and are displayed as Diagnostic Trouble Codes (DTCs) on the EST. Effective engine diagnostics require and rely on DTCs.

Trip Reporting

The trip reporting feature is designed to monitor, collect, and store engine related operational information. This information can be downloaded and organized into useful reports using a service tool. Trip reporting operational data is recorded in two ways; non-resettable cumulative data, which consists of running totals, and resettable trip data, which consists of data collected since the last trip reset.

Vehicle Setup

The vehicle setup feature consists of various parameters within the ECM, which are based on the vehicle configuration. Most parameters are pre-programmed by the original equipment manufacturer (OEM) and will not require any adjustment for the life of the vehicle.

Optional Electronic Control Features

NOTE: For additional feature operation, and parameter information, use the Navistar® N13 Engine Feature Documentation found on the Body Builder Website Link within Navistar® Service Portal. This includes parameter details of description, possible values, whether or not it is customer programmable, and recommended settings.

Cruise Control

Cruise Control is a well-known feature that offers driving comfort by providing a method for an operator to set and maintain a constant vehicle speed without using the accelerator pedal. It is especially useful when the operator is required to drive on highways at a constant speed for many miles.

This cruise control feature is unique due to a parameter, which allows the cruise control set speed to be maintained in the ECM memory. Additional programming flexibility is included to allow a trade-off to be made between performance and fuel economy.

Driver Reward

The driver reward feature is designed to give the operator incentives for driving more efficiently. The feature accomplishes this by measuring the driver's habits based on fuel economy, time at idle, or both.

The rewards include higher maximum vehicle speed and higher cruise control speed limit. Lower maximum vehicle speed or cruise control speed limits may result as a penalty for failing to meet the standards.

Customer programmable parameters within the ECM provide driver reward related options that can be adjusted to suit the customer's needs.

Navistar® Engine Brake

The engine brake feature is a hydro-mechanical device designed to help decelerate the vehicle by providing additional engine load. It mounts under the engine valve cover and turns your power-producing diesel engine into a power-absorbing air compressor. This will reduce brake wear in vehicles which require frequent braking. This feature assumes the vehicle is equipped with a factory installed engine brake system; otherwise there may be engine components, additional switches, harnesses, and software modifications which may also be required.

Programmable parameters within the ECM provide engine brake related options that can be adjusted to suit the customer's needs. Choosing whether the engine brake is activated by pressing the service brake pedal or by releasing the accelerator pedal is one example. For a detailed feature description, see Engine Brake System in the "Engine Systems" section of this manual.

Engine Warning Protection System (EWPS)

NOTE: Emergency vehicles are not equipped with EWPS.

The Engine Warning and Protection System (EWPS) feature is designed to protect the engine from damage by monitoring critical engine data such as the engine speed, temperature, oil pressure, and coolant level. The EWPS feature will alert the operator by using a combination of visual and audible warnings if critical engine parameters are exceeded. Depending on the severity of the problem, there may be a reduction in power associated with the visual warnings. EWPS also visually alerts the operator with an amber warning lamp if the vehicle speed exceeds a threshold. The vehicle overspeed incidents are logged and can be downloaded into a report. Refer to the "Trip Reporting" feature for more information.

Customer programmable parameters within the ECM provide EWPS related options that can be adjusted to suit the customer's needs. For example the customer may choose that the EWPS feature activate a flashing red lamp and audible warning 30 seconds before engine shut down, to provide an additional level of engine protection.

Gear Down Protection (GDP)

The Gear Down Protection (GDP) feature is designed to encourage the driver to operate in the engine's most efficient range for fuel economy. This is done by limiting the vehicle speed until the driver shifts into a higher gear. This encourages the driver to upshift to the next highest gear, and helps to maintain the engine's most efficient speed range for fuel economy.

There are several customer programmable parameters for this feature.

Idle Shutdown Timer (IST)

The idle shutdown timer is used to limit the amount of engine idle time by automatically shutting down the engine after a pre-programmed time has expired. Programmable parameters within the ECM determine the time and conditions required before the engine shuts down. Some customer programmable parameters provide idle shutdown related options that can be adjusted to suit the customer's needs.

Thirty seconds before engine shutdown occurs, there will be an amber lamp illuminated in the instrument panel (if equipped) and an audible warning will sound. This will continue until the engine shuts down or the idle shutdown timer is reset. This feature shuts down the engine, but the vehicle electrical system and accessories will remain active until the key switch is turned off.

Progressive Shift

The progressive shift feature is designed to limit the engine speed to encourage the driver to up-shift early, which in turn improves fuel economy. This feature provides engine speed limit parameters optimized for each transmission gear, to encourage the use of the higher gears during cruise control and low engine load operations.

Customer programmable parameters within the ECM provide progressive shift related options that can be adjusted to suit the customer's needs.

Power Take Off (PTO) - In Cab

The engine speed control feature, commonly referred to as "PTO", provides a method for an operator to set and maintain a constant engine speed without using the accelerator pedal. It is commonly used for powering auxiliary devices.

The in-cab engine speed control feature provides three conditions under which the operator may select PTO speeds:

- Stationary Preset - Permits the operator to select up to six preset speeds while the vehicle is stationary
- Stationary Variable Speed - Permits the operator to select any engine speed within the PTO boundaries
- Mobile Variable Speed - Permits the operator to select a desired variable speed for moving or stationary PTO operations

Customer programmable parameters within the ECM provide in-cab engine speed control related options that can be adjusted to suit the customer's needs. Choosing whether the operator is allowed to increase the engine speed using the accelerator pedal without disengaging the PTO is one example.

Power Take Off (PTO) - Remote

When control over engine speed is required from outside the vehicle's cab, remote mounted switches must be used to turn on PTO engine speed control and select the desired engine speed. This functionality is referred to as Remote Engine Speed Control (RESC). The engine speed can be ramped up and down with RESC similar to the way the in cab PTO feature works; however, the RESC feature includes two additional switches (remote preset & remote variable), which allow the operator to choose the mode of engine speed control operation.

Customer programmable parameters within the ECM provide RESC related options that can be adjusted to suit the customer's needs. Choosing whether a remote throttle pedal is used for PTO operation is one example.

Service Interval

The service interval feature is designed to provide a visual reminder to the operator of service interval information such as, oil change interval has expired, and that routine maintenance procedures should be performed. The term “interval” in this case is used to describe the distance, time, or fuel used between the last maintenance performed on the vehicle and the next maintenance, which is due.

Customer programmable parameters within the ECM provide options that can be adjusted to suit the customer’s needs. For example, the engine hours, fuel used, and vehicle distance can be used individually or in combination to determine the service interval.

It is essential that operators are trained to know the maintenance schedules and instructions regarding the operation and reset functionality of the service interval for the feature to be effective. Refer to Integral Digital Display in Section 3 – Instruments, Indicators, and Switches of the Navistar® 11 and 13 *Engine Operation and Maintenance Manual* for more information.

Traction Control

Traction control is a system that identifies when a wheel is spinning faster than the other wheels during acceleration.

When a traction control condition occurs, a datalink message is sent to the ECM to limit fuel for the purpose of reducing engine torque.

Vehicles must have a transmission and an Anti-lock Brake System (ABS) that supports traction control.

Up-Shift Indicator

The up-shift indicator feature provides an indication to the operator that the transmission should be shifted into a higher gear. This helps to maintain the engine’s most efficient speed range for fuel economy.

The feature is commonly used on manual transmissions and automated manuals in manual mode.

Road Speed Limiter

Road Speed Limiter (RSL) is a feature with customer programmable parameters designed to regulate the maximum vehicle speed as controlled by the accelerator pedal.

The following additional features are available with RSL:

- **Adjustable RSL:** Provides a customer programmable secondary vehicle speed limit, lower than the limit provided by RSL, useful for spreader applications and construction, etc.
- **RSL Override:** Raises the vehicle speed limit provided by the RSL feature to a customer programmable speed when the driver identifies a "passing situation."
- **RSL Anti-Tampering:** Customer selectable option, which checks whether the vehicle speed signal (VSS) input is valid or if it has been subject to tampering.

These options can be enabled by programmable parameters within the ECM.

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Abbreviations and Acronyms.....1981

Abbreviations and Acronyms

A or amp – Ampere
AAT – Ambient Air Temperature
ABDC – After Bottom Dead Center
ABS – Antilock Brake System
AC – Alternating Current
A/C – Air Conditioner
ACC – Air Conditioner Control
ACCEL – Accelerator
ACD – Air Conditioner Demand
ACM – Aftertreatment Control Module
ACV – Air Control Valve
AFTFI – Aftertreatment Fuel Injector
AFT – Aftertreatment
AFTFP1 – Aftertreatment Fuel Pressure 1
AFTFSV – Aftertreatment Fuel Shutoff Valve
AFTPAV – Aftertreatment Purge Air Valve
Amb – Ambient
amp or A – Ampere
AMS – Air Management System
API – American Petroleum Institute
APP – Accelerator Pedal Position
APP1 – Accelerator Pedal Position 1
APP2 – Accelerator Pedal Position 2
APS – Accelerator Position Sensor
APS/IVS – Accelerator Position Sensor / Idle Validation Switch
ASTM – American Society for Testing and Materials
ATA – American Trucking Association
ATAH – American Trucking Association Link High
ATAL – American Trucking Association Link Low
ATDC – After Top Dead Center
AWG – American Wire Gauge
AWL – Amber Warning Lamp

B+ or VBAT – Battery Voltage
BAP or BARO – Barometric Absolute Pressure
BARO or BAP – Barometric Absolute Pressure
BBDC – Before Bottom Dead Center
BC – Body Controller
BCP – Brake Control Pressure
BCS – Boost Control Solenoid
BDC – Bottom Dead Center
bhp – Brake Horsepower
BNO – Brake Normally Open
BOO – Brake On / Off
BPP – Brake Pedal Position
BPS – Brake Pressure Switch
BSV – Brake Shut-off Valve
BTDC – Before Top Dead Center
BTU – British Thermal Unit

C – Celsius
CAC – Charge Air Cooler
CACOT – Charge Air Cooler Outlet Temperature
CAN – Controller Area Network
CAP – Cold Ambient Protection
CARB – California Air Resources Board
cc – Cubic centimeter
CCA – Cold Cranking Ampere
CCV – Coolant Control Valve
CCOSS – Crankcase Oil Separator Speed
CCPS – Crankcase Pressure Sensor
CCS – Cruise Control Switches
CDR – Crankcase Depression Regulator
cfm – Cubic feet per minute
cfs – Cubic feet per second
CFV – Coolant Flow Valve
CID – Cubic Inch Displacement
CKP – Crankshaft Position
CKPH – Crankshaft Position High
CKPL – Crankshaft Position Low
CKPO – Crankshaft Position Out
cm – Centimeter
CMP – Camshaft Position
CMPH – Camshaft Position High
CMPL – Camshaft Position Low
CMPO – Camshaft Position Out
CMV – Coolant Mixer Valve
CO – Carbon Monoxide
COO – Cruise On / Off switch
CPU – Central Processing Unit
CTC – Coolant Temperature Compensation
Cyl – Cylinder

DB – Decibel
DC – Direct Current
DCA – Diesel Coolant Additive
DDI – Digital Direct Fuel Injection
DDS – Driveline Disengagement Switch
DEF – Diesel Exhaust Fluid
DEFDUH – Diesel Exhaust Fluid Dosing Unit Heater
DEFDV – Diesel Exhaust Fluid Doser Valve
DEFLHR – Diesel Exhaust Fluid Line Heater Relay
DEFLP – Diesel Exhaust Fluid Line Pressure
DEFLT – Diesel Exhaust Fluid Line Temperature
DEFPLH – Diesel Exhaust Fluid Pressure Line Heater
DEFRLH – Diesel Exhaust Fluid Return Line Heater
DEFRV – Diesel Exhaust Fluid Return Valve
DEFSLH – Diesel Exhaust Fluid Suction Line Heater
DEFSP – Diesel Exhaust Fluid Supply Pump
DEFTHV – Diesel Exhaust Fluid Tank Heater Valve
DEFTL – Diesel Exhaust Fluid Tank Level

DEFTLT – Diesel Exhaust Fluid Tank Level and Temperature
DEFTT – Diesel Exhaust Fluid Tank Temperature
DEFUHR – Diesel Exhaust Fluid Unit Heater Relay
DLC – Data Link Connector
DME – Dimethyl Ether
DMM – Digital Multimeter
DOC – Diesel Oxidation Catalyst
DOCIT – Diesel Oxidation Catalyst Inlet Temperature
DOCOT – Diesel Oxidation Catalyst Outlet Temperature
DPF – Diesel Particulate Filter
DPFDP – Diesel Particulate Filter Differential Pressure
DPFOP – Diesel Particulate Filter Outlet Pressure
DPFIT – Diesel Particulate Filter Inlet Temperature
DPFOT – Diesel Particulate Filter Outlet Temperature
DSI – Down Stream Injection
DT – Diesel Turbocharged
DTC – Diagnostic Trouble Code
DTCs – Diagnostic Trouble Codes
DTRM – Diesel Thermo Recirculation Module

EBC – Exhaust Brake Controller
EBP – Exhaust Back Pressure
EBPD – Exhaust Back Pressure Desired
EBPV – Exhaust Back Pressure Valve
ECB – Engine Compression Brake
ECB1 – Engine Compression Brake 1
ECB2 – Engine Compression Brake 2
ECB3 – Engine Compression Brake 3
ECBP – Engine Compression Brake Pressure
ECI – Engine Crank Inhibit
ECL – Engine Coolant Level
ECM – Engine Control Module
ECM GND – Engine Control Module Ground
ECM PWR – Engine Control Module Power
ECS – Engine Coolant System
ECSR – Engine Controlled Shutdown Request
ECT – Engine Coolant Temperature
ECT1 – Engine Coolant Temperature 1
ECT2 – Engine Coolant Temperature 2
EFAN – Engine Fan
EFANS – Engine Fan Speed
EFC – Engine Fan Control
EFP – Engine Fuel Pressure
EFRC – Engine Family Rating Code
EFS – Engine Fan Speed
EFT – Engine Fuel Temperature
EG – Ethylene Glycol
EGC – Electronic Gauge Cluster
EGBP – Exhaust Gas Back Pressure
EGDP – Exhaust Gas Differential Pressure
EGR – Exhaust Gas Recirculation

EGRC – Exhaust Gas Recirculation Control
EGRH – Exhaust Gas Recirculation High control
EGRL – Exhaust Gas Recirculation Low control
EGROT – Exhaust Gas Recirculation Outlet Temperature
EGRP – Exhaust Gas Recirculation Position
EGRT – Exhaust Gas Recirculation Temperature
EGT – Exhaust Gas Temperature
EGT1 – Exhaust Gas Temperature 1
EGT2 – Exhaust Gas Temperature 2
EGT3 – Exhaust Gas Temperature 3
ELS – Exhaust Lambda Sensor
EMI – Electromagnetic Interference
EMP – Exhaust Manifold Pressure
EMT – Exhaust Manifold Temperature
EOL – Engine Oil Level
EOP – Engine Oil Pressure
EOT – Engine Oil Temperature
EOT2 – Engine Oil Temperature 2
EPA – Environmental Protection Agency
EPR – Engine Pressure Regulator
ESC – Electronic System Controller
ESN – Engine Serial Number
EST – Electronic Service Tool
ETC – Engine Throttle Control
ETCH – Engine Throttle Control High
ETCL – Engine Throttle Control Low
ETP – Engine Throttle Position
ETV – Engine Throttle Valve
EVB – Exhaust Valve Brake
EWPS – Engine Warning Protection System

F – Fahrenheit
FCV – Fuel Coolant Valve
FDP – Fuel Delivery Pressure
FEL – Family Emissions Limit
fhp – Friction horsepower
FMI – Failure Mode Indicator
FPC – Fuel Pump Control
FPCV – Fuel Pressure Control Valve
fpm – Feet per minute
FPM – Fuel Pump Monitor
fps – Feet per second
FRP – Fuel Rail Pressure
ft – Feet
FVCV – Fuel Volume Control Valve

GND – Ground (electrical)
gal – Gallon
gal/h – U.S. Gallons per hour
gal/min – U.S. Gallons per minute
GCW – Gross Combined Weight

GCWR – Gross Combined Weight Rating
GVW – Gross Vehicle Weight

H_2O – Water
HC – Hydrocarbons
HCI – Hydrocarbon Injection
HEST – High Exhaust System Temperature
HFCM – Horizontal Fuel Conditioning Module
Hg – Mercury
hp – Horsepower
HPCAC – High-Pressure Charge Air Cooler
HPCR – High-Pressure Common Rail
HPFP – High-Pressure Fuel Pump
hr – Hour
HS – Humidity Sensor
Hyd – Hydraulic

IAH – Inlet Air Heater
IAHC – Inlet Air Heater Control
IAHD – Inlet Air Heater Diagnostic
IAHFI – Inlet Air Heater Fuel Igniter
IAHFS – Inlet Air Heater Fuel Solenoid
IAHR – Inlet Air Heater Relay
IAHS – Inlet Air Heater Solenoid
IAT – Inlet Air Temperature
IC – Integrated Circuit
ICP – Injection Control Pressure
ICPR – Injection Control Pressure Regulator
ICG1 – Injector Control Group 1
ICG2 – Injector Control Group 2
ID – Inside Diameter
IGN – Ignition
ILO – Injector Leak Off
IMP – Intake Manifold Pressure
IMT – Intake Manifold Temperature
in – Inch
inHg – Inch of mercury
inH_2O – Inch of water
INJs – Injectors
IPR – Injection Pressure Regulator
IPR PWR – Injection Pressure Regulator Power
ISC – Interstage Cooler
IST – Idle Shutdown Timer
ITP – Internal Transfer Pump
ITV – Intake Throttle Valve
ITVH – Intake Throttle Valve High control
ITVL – Intake Throttle Valve Low control
ITVP – Intake Throttle Valve Position
IVS – Idle Validation Switch

J1939H – J1939 Data Link High

J1939L – J1939 Data Link Low
JCT – Junction (electrical)

kg – Kilogram
km – Kilometer
km/h – Kilometers per hour
km/l – Kilometers per liter
KOEO – Key-On Engine-Off
KOER – Key-On Engine-Running
kPa – Kilopascal

L – Liter
L/h – Liters per hour
L/m – Liters per minute
L/s – Liters per second
lb – Pound
lbf – Pounds of force
lb/s – Pounds per second
lbf ft – Pounds of force per foot
lb in – Pounds of force per inch
lbm – Pounds of mass
LPCAC – Low-pressure Charge Air Cooler
LSD – Low Sulfur Diesel

m – Meter
m/s – Meters per second
MAF – Mass Air Flow
MAF GND – Mass Air Flow Ground
MAG – Magnetic
MAP – Manifold Absolute Pressure
MAP/IAT – Manifold Absolute Pressure / Inlet Air Temperature
MAT – Manifold Air Temperature
mep – Mean effective pressure
mi – Mile
MIL – Malfunction Indicator Lamp
mm – Millimeter
mpg – Miles per gallon
mph – Miles per hour
MPR – Main Power Relay
MSDS – Material Safety Data Sheet
MSG – Micro Strain Gauge
MSM – Multiplex System Module
MY – Model Year

NC – Normally Closed (electrical)
NETS – Navistar Electronics Technical Support
NH_3 – Ammonia sensor
Nm – Newton meter
NO – Normally Open (electrical)
NO_x – Nitrogen Oxides
NO_x IN – Nitrogen Oxides Inlet sensor

NO_x OUT – Nitrogen Oxides Outlet sensor
O_2S – Oxygen Sensor
O_2SH – Oxygen Sensor Heater
OAT – Organic Acid Technology
OCC – Output Circuit Check
OCP – Overcrank Protection
OD – Outside Diameter
OL – Over Limit
ORH – Out-of-Range High
ORL – Out-of-Range Low
OSHA – Occupational Safety and Health Administration
OWL – Oil/Water Lamp

PID – Parameter Identifier
P/N – Part Number
ppm – Parts per million
PROM – Programmable Read Only Memory
psi – Pounds per square inch
psia – Pounds per square inch absolute
psig – Pounds per square inch gauge
pt – Pint
PTO – Power Takeoff
PWM – Pulse Width Modulate
PWR – Power (voltage)

qt – Quart

RAM – Random Access Memory
RAPP – Remote Accelerator Pedal Position
RAS – Resume / Accelerate Switch (speed control)
REPTO – Rear Engine Power Takeoff
RFI – Radio Frequency Interference
rev – Revolution
rpm – Revolutions per minute
RPRE – Remote Preset
RSE – Radiator Shutter Enable
RVAR – Remote Variable

SAE – Society of Automotive Engineers
SART – Stand Alone Real Time Clock
SCA – Supplemental Cooling Additive
SCCS – Speed Control Command Switches
SCR – Selective Catalyst Reduction
SCRIT – Selective Catalyst Reduction Inlet Temperature
SCROT – Selective Catalyst Reduction Outlet Temperature
SCS – Speed Control Switch
SHD – Shield (electrical)
SID – Subsystem Identifier
SIG GND – Signal Ground
SIG GNDB – Signal Ground Body
SIG GNDC – Signal Ground Chassis

SIG GNDE – Signal Ground Engine
S/N – Serial Number
SPEEDO – Speedometer
SPN – Suspect Parameter Number
SW – Switch (electrical)
SWBAT – Switch Battery
SYNC – Synchronization

TACH – Tachometer output signal
TBD – To Be Determined
TC2CIP – Turbocharger 2 Compressor Inlet Pressure
TC2CIS – Turbocharger 2 Compressor Inlet Sensor
TC2CIT – Turbocharger 2 Compressor Inlet Temperature
TC1TOP – Turbocharger 1 Turbine Outlet Pressure
TC2TOP – Turbocharger 2 Turbine Outlet Pressure
TC2WC – Turbocharger 2 Wastegate Control
TCAPE – Truck Computer Analysis of Performance and Economy
TCM – Transmission Control Module
TDC – Top Dead Center
TDE – Transmission Driving Engaged
TOP – Transmission Oil Pressure
TOSS – Transmission Output Shaft Speed
TOT – Transmission Oil Temperature
TTS – Transmission Tailshaft Speed

ULSD – Ultra-Low Sulfur Diesel
UVC – Under Valve Cover

V – Volt
VBAT or B+ – Battery Voltage
VC – Volume Control
VEPS – Vehicle Electronics Programming System
VGT – Variable Geometry Turbo
VIGN – Ignition Voltage
VIN – Vehicle Identification Number
VOP – Valve Opening Pressure
VRE – Vehicle Retarder Enable
VREF – Reference Voltage
VREFB – Reference Voltage Body
VREFC – Reference Voltage Chassis
VREFE – Reference Voltage Engine
VSO – Vehicle Speed Output
VSO or VSS_CAL – Vehicle Speed Output
VSS – Vehicle Speed Sensor
VSS_CAL or VSO – Vehicle Speed Output
VSSH – Vehicle Speed Sensor High
VSSL – Vehicle Speed Sensor Low

WTSL – Wait to Start Lamp
WEL – Warn Engine Lamp
WIF – Water In Fuel

WIFL – Water In Fuel Lamp
WTEC – World Transmission Electronically Controlled automatic transmissions (Allison)

XCS – Transfercase
XMSN – Transmission

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Terminology.....**1993**

Terminology

Accelerator Pedal Position (APP) sensor – A potentiometer sensor that indicates the position of the throttle pedal.

Accessory work – The work per cycle required to drive engine accessories (normally, only those essential to engine operation).

Actuator – A device that performs work in response to an input signal.

Actuator Control – The ECM controls the actuators by applying a low-level signal (low-side driver) or a high-level signal (high- side driver). When switched On, both drivers complete a ground or power circuit to an actuator.

Aeration – The entrainment of air or combustion gas in coolant, lubricant, or fuel.

Charge Air Cooler (CAC) – A heat exchanger mounted in the charge air path between the turbocharger and engine intake manifold. The Charge Air Cooler reduces the charge air temperature by transferring heat from the charge air to a cooling medium (usually air).

Aftertreatment Control Module (ACM) – An electronic processor that monitors and controls the aftertreatment system.

Aftertreatment (AFT) fuel doser module – The AFT fuel doser module controls fuel flow to the AFTFI.

Aftertreatment Fuel Injector (FI) – Injects fuel into the exhaust system to increase temperature of the exhaust gases.

Aftertreatment Purge Air Valve (AFTPAV) – Uses vehicle air to purge the AFT fuel doser module and AFTFI of fuel following active or parked regeneration of the aftertreatment system.

Aftertreatment (AFT) system – A part of the exhaust system that processes engine exhaust to meet emission requirements and traps particulate matter (soot) to prevent it from leaving the tailpipe.

Air Control Valve (ACV) – Contains the HP turbocharger wastegate control port and the Exhaust Back Pressure Valve (EBPV) control port. Although these components are integral to the ACV, each circuit is controlled by the Engine Control Module (ECM). The ACV controls compressed air for each control valve.

Ambient temperature – The environmental air temperature in which a unit is operating. In general, the temperature is measured in the shade (no solar radiation) and represents the air temperature for other engine cooling performance measurement purposes. Air entering the radiator may or may not be the same ambient due to possible heating from other sources or recirculation. (SAE J1004 SEP81)

Ammonia (NH_3) – A chemical found in Diesel Exhaust Fluid (DEF) that combines with Nitrogen Oxides (NOx) in the Selective Catalyst Reduction (SCR) system to form Nitrogen gas and water.

Ampere (amp) – The standard unit for measuring the strength of an electrical current. The flow rate of a charge in a conductor or conducting medium of one coulomb per second. (SAE J1213 NOV82)

Analog – A continuously variable voltage.

Analog to digital converter (A/D) – A device in the ECM that converts an analog signal to a digital signal.

American Trucking Association (ATA) Datalink – A serial datalink specified by the American Trucking Association and the SAE.

Boost pressure – Pressure of charge air leaving the turbocharger.

Inlet manifold pressure greater than atmospheric pressure. Obtained by turbocharging.

Bottom Dead Center (BDC) – The lowest position of the piston during the stroke.

Brake Horsepower (bhp) – The power output from an engine, not the indicated horsepower. The power output of an engine, sometimes-called flywheel horsepower, is less than the indicated horsepower by the amount of friction horsepower consumed in the engine.

Brake Horsepower (bhp) net – Net brake horsepower is measured with all engine components. The power of an engine when configured as a fully equipped engine. (SAE J1349 JUN90)

Calibration – ECM programming strategy to solve engine performance equations and make decisions. Calibration values are stored in ROM and put into the processor during programming to allow the engine to operate within certain parameters.

Camshaft Position (CMP) sensor – A magnetic pickup sensor that provides the ECM with a camshaft speed and position signal.

Carbon Monoxide (CO) – A colorless, odorless, highly poisonous gas that is formed by the incomplete combustion of carbon burning diesel engine. It is present in the exhaust gases of diesel engines.

Catalyst – A substance that produces a chemical reaction without undergoing a chemical change itself.

Catalytic converter – An antipollution device in the exhaust system that contains a catalyst for chemically converting some pollutants in the exhaust gases (carbon monoxide, unburned hydrocarbons, and oxides of nitrogen) into harmless compounds.

Cavitation – A dynamic condition in a fluid system that forms gas-filled bubbles (cavities) in the fluid.

Cetane number – 1. The auto-ignition quality of diesel fuel.

2. A rating applied to diesel fuel similar to octane rating for gasoline.

3. A measure of how readily diesel fuel starts to burn (self-ignites) at high compression temperature.

Diesel fuel with a high cetane number self-ignites shortly after injection into the combustion chamber. Therefore, it has a short ignition delay time. Diesel fuel with a low cetane number resists self-ignition. Therefore, it has a longer ignition delay time.

Charge air – Dense, pressurized, heated air discharged from the turbocharger.

Charge Air Cooler (CAC) – See **Aftercooler**.

Charge Air Cooler Outlet Temperature (CACOT) sensor – A thermistor sensor that monitors the temperature of charge air entering the intake air duct.

Closed crankcase – A crankcase ventilation that recycles crankcase gases through a breather, then back to the clean air intake.

Closed loop operation – A system that uses sensors to provide feedback to the ECM. The ECM uses the sensor input to continuously monitor variables and adjust actuators to match engine requirements.

Cloud point – The point when wax crystals occur in fuel, making fuel cloudy or hazy. Usually below -12°C (10°F).

Cold cranking ampere rating (battery rating) – The sustained constant current (in amperes) needed to produce a minimum terminal voltage under a load of 7.2 volts per battery after 30 seconds.

Cold Start Emissions Reduction (CSER) – A type of monitoring strategy used to monitor emission levels during engine warm-up.

Controller Area Network (CAN) – A J1939 high-speed communication link.

Coolant – A fluid used to transport heat from one point to another.

Coolant level switch – A switch sensor used to monitor coolant level.

Coolant Flow Valve (CFV) – The CFV is ECM controlled and redirects coolant through the fuel cooler, based on EFT, when directed.

Coolant Mixer Valve (CMV) – Controls coolant flow through the low-temperature radiator.

Continuous Monitor Test – An ECM function that continuously monitors the inputs and outputs to ensure that readings are within set limits.

Count – Number of events where a specific SPN / FMI setting criteria are meet. Example: 58 counts of 1000 cycles for misfire on cylinder #5.

Crankcase – The housing that encloses the crankshaft, connecting rods, and allied parts.

Crankcase breather – A vent for the crankcase to release excess interior air pressure.

Crankcase Oil Separator Speed (CCOSS) sensor – The CCOSS sensor sends the ECM information about the speed of the crankcase oil separator internal components.

Crankcase pressure – The force of air inside the crankcase against the crankcase housing.

Crankshaft Position (CKP) sensor – A magnetic pickup sensor that determines crankshaft position and speed.

Current – The flow of electrons passing through a conductor. Measured in amperes.

Damper – A device that reduces the amplitude of torsional vibration. (SAE J1479 JAN85)

Deaeration – The removal or purging of gases (air or combustion gas) entrained in coolant or lubricating oil.

Deaeration tank – A separate tank in the coolant system used for one or more of the following functions:

- Deaeration
- Coolant reservoir (fluid expansion and afterboil)
- Coolant retention
- Filling
- Fluid level indication (visible)

Decomposition reactor tube – Converts DEF to ammonia and CO_2 and ensures even evaporation of DEF into the exhaust stream.

Diagnostic Trouble Code (DTC) – 2010 model year vehicles no longer utilize DTC identification by number. DTCs are now identified using the Suspect Parameter Number (SPN) and Failure Mode Indicator (FMI) identifiers only.

Diesel Exhaust Fluid (DEF) – Diesel Exhaust Fluid (DEF) is a nontoxic, nonflammable, colorless liquid that delivers ammonia to the Selective Catalyst Reduction (SCR) system.

Diesel Exhaust Fluid Supply Module Heater (DEFSMH) – Maintains proper temperature and prevents freezing of DEF in the DEF supply module.

Diesel Exhaust Fluid Doser Valve (DEFD) – Injects DEF into the Selective Catalyst Reduction (SCR) system.

Diesel Exhaust Fluid Line Heater Relay – Supplies power to the DEF line heaters when commanded ON by the Aftertreatment Control Module (ACM).

Diesel Exhaust Fluid Line Pressure (DEFLP) Sensor – A variable capacitance sensor that measures DEF pressure from the Diesel Exhaust Fluid Supply Pump (DEFSP).

Diesel Exhaust Fluid Pressure Line Heater (DEFPLH) – Maintains proper DEF temperature and prevents freezing of the DEF pressure line.

Diesel Exhaust Fluid Return Line Heater (DEFRLH) – Maintains proper DEF temperature and prevents freezing of the DEF return line.

Diesel Exhaust Fluid Return Valve (DEFRV) – Regulates DEF flow exiting the DEF supply module.

Diesel Exhaust Fluid Supply Line Heater (DEFSLH) – Maintains proper DEF temperature and prevents freezing of the DEF suction line.

Diesel Exhaust Fluid Supply Pump (DEFSP) – Pressurizes outgoing DEF to the Diesel Exhaust Fluid Doser Valve (DEFDV).

Diesel Exhaust Fluid Tank Heater Control (DEFTHC) Valve – Controls coolant flow to the DEF tank heating coil.

Diesel Exhaust Fluid Tank Level and Temperature (DEFTLT) sensor module – A combinations sensor that monitors DEF tank level and temperature.

Diesel Exhaust Fluid Supply Module Heater Relay – Sends power to the Diesel Exhaust Fluid Dosing Unit Heater (DEFDUH) when commanded ON by the Aftertreatment Control Module (ACM).

Diesel Particulate Filter (DPF) – A diesel particulate filter, sometimes called a DPF, is a device designed to remove diesel particulate matter or soot from the exhaust gas of a diesel engine.

Diesel Oxidation Catalyst (DOC) – A DOC is part of the diesel exhaust Aftertreatment system. DOCs are devices that use a chemical process to break down pollutants in the exhaust stream into less harmful components. More specifically, DOCs utilize rare metals such as palladium and platinum to reduce hydrocarbon based Soluble Organic Fraction (SOF) and carbon monoxide content of diesel exhaust by simple oxidation. The DOC can be used during an active regeneration to create higher exhaust temperatures, thereby reducing soot in the DPF.

Diesel Oxidation Catalyst (DOC) / Diesel Particulate Filter (DPF) temperature sensor module – Monitors signals from the Diesel Oxidation Catalyst Inlet Temperature (DOCIT) sensor, Diesel Particulate Filter Inlet Temperature (DPFIT) sensor, and Diesel Particulate Filter Outlet Temperature (DPFOT) sensor and communicates these signals to the Aftertreatment Control Module (ACM).

Digital Multimeter (DMM) – An electronic meter that uses a digital display to indicate a measured value. Preferred for use on microprocessor systems because it has a very high internal impedance and will not load down the circuit being measured.

Disable – A computer decision that deactivates a system and prevents operation of the system.

Displacement – The stroke of the piston multiplied by the area of the cylinder bore multiplied by the number of cylinders in the engine.

Diesel Particulate Filter (DPF) / outlet pressure sensor – Measures the pressure differential across the Diesel Particulate Filter (DPF) and communicates this back to the Aftertreatment Control Module (ACM).

Downstream Injection (DSI) metering unit – The DSI metering unit provides a metered amount of fuel to the Aftertreatment Fuel Injector (FI).

Driver (high side) – A transistor within an electronic module that controls the power to an actuator circuit.

Driver (low side) – A transistor within an electronic module that controls the ground to an actuator circuit.

Dual Stage Turbocharger – An assembly of two turbochargers (low-pressure and high-pressure) in series to provide a wide range of charge air pressures efficiently.

Duty cycle – A control signal that has a controlled on/off time measurement from 0 to 100%. Normally used to control solenoids.

EGR Cooler – A cooler that allows heat to dissipate from the exhaust gasses before they enter the intake manifold.

Engine Back Pressure Valve (EBPV) – The ECM commands the EBPV to control the Exhaust Brake.

Engine Compression Brake (ECB) valve – The ECB valve controls pressure entering the brake oil gallery from the high-pressure oil rail gallery. This activates the brake actuator pistons and opens the exhaust valves.

Engine Compression Brake 1 (ECB1) solenoid – The ECB1 solenoid controls pressure entering the brake oil gallery from the high-pressure oil rail gallery.

Engine Compression Brake 2 (ECB2) solenoid – The ECB2 solenoid controls pressure entering the brake oil gallery from the high-pressure oil rail gallery.

Engine Compression Brake Pressure (ECBP) sensor – A high-pressure sensor that provides a feedback signal to the ECM indicating brake control pressure.

Engine Control Module (ECM) – An electronic processor that monitors and controls the engine.

Engine Coolant Level (ECL) sensor – A switch sensor that monitors coolant level.

Engine Coolant Temperature 1 (ECT1) sensor – A thermistor sensor that detects engine coolant temperature.

Engine Coolant Temperature 2 (ECT2) sensor – A thermistor sensor that detects engine coolant temperature.

Engine Fuel Temperature (EFT) sensor – A thermistor sensor that measures fuel temperature.

Engine lamp – An instrument panel lamp that comes on when DTCs are set. DTCs can be read as flash codes (red and amber instrument panel lamps).

Engine OFF tests – Tests that are done with the ignition switch ON and the engine OFF.

Engine Oil Pressure (EOP) sensor – A variable capacitance sensor that measures oil pressure.

Engine Oil Temperature (EOT) sensor – A thermistor sensor that measures oil temperature.

Engine rating – Engine rating includes **Rated hp** and **Rated rpm**.

Engine RUNNING tests – Tests done with the engine running.

Engine Throttle Valve (ETV) and Engine Throttle Position Sensor – The ETV valve is used to control airflow during a regeneration process of the aftertreatment system. The ETV valve is also used to ensure a smooth engine shut down by restricting airflow to the engine at shut down.

Engine Warning Protection System (EWPS) – Safeguards the engine from undesirable operating conditions to prevent engine damage and to prolong engine life.

Event – a condition where a fault threshold has set. Example: cylinder misfire event, an instance when the cylinder misfired.

Exhaust Back Pressure (EBP) – The pressure present in the exhaust system during the exhaust period.

Exhaust Back Pressure Valve (EBPV) – A valve that regulates the amount of air pressure applied to the EBPV pneumatic actuator.

Exhaust brake – A brake device using engine exhaust back pressure as a retarding medium.

Exhaust Gas Recirculation (EGR) – A system used to recirculate a portion of the exhaust gases into the power cylinder in order to reduce oxides of nitrogen.

Exhaust Gas Temperature (EGT) – The temperature of exhaust gases.

Exhaust Gas Recirculation Temperature (EGRT) sensor – A thermistor sensor that detects the exhaust gas temperature entering the EGR cooler.

Exhaust Gas Recirculation (EGR) valve – The EGRV controls the flow of exhaust gases to the intake manifold. The EGRV is integrated with an EGR Position (EGRP) sensor.

Exhaust manifold – Exhaust gases flow through the exhaust manifold to the turbocharger exhaust inlet and are directed to the EGR cooler.

Fault detection/management – An alternate control strategy that reduces adverse effects that can be caused by a system failure. If a sensor fails, the ECM substitutes a good sensor signal or assumed sensor value in its place. A lit amber instrument panel lamp signals that the vehicle needs service.

Failure Mode Indicator (FMI) – Identifies the fault or condition effecting the individual component.

Filter restriction – A blockage, usually from contaminants, that prevents the flow of fluid through a filter.

Flash code – See **Diagnostic Trouble Code (DTC)**.

Fuel Delivery Pressure (FDP) sensor – A variable capacitance sensor that monitors fuel pressure coming from the fuel tank and sends a signal to the ECM.

Fuel inlet restriction – A blockage, usually from contaminants, that prevents the flow of fluid through the fuel inlet line.

Fuel pressure – The force fuel exerts on the fuel system as it is pumped through the fuel system.

Fuel Pressure Control Valve (FPCV) – The FPCV controls the fuel pressure to the fuel rails and is controlled by the ECM. FPCV control depends on fuel pressure and fuel temperature.

Fuel Rail Pressure (FRP) – The amount of pressure in the fuel rail.

Fuel Rail Pressure (FRP) sensor – A variable capacitance sensor that monitors fuel pressure in the fuel rail and sends a signal to the ECM.

Fuel strainer – A pre-filter in the fuel system that keeps larger contaminants from entering the fuel system.

Fully equipped engine – A fully equipped engine is an engine equipped with only those accessories necessary to perform its intended service. A fully equipped engine does not include components that are used to power auxiliary systems. If these components are integral with the engine or, for any reason are included on the test engine, the power absorbed may be determined and added to the net brake power. (SAE J1995 JUN90)

Fusible link (fuse link) – A fusible link is a special section of low tension cable designed to open the circuit when subjected to an extreme current overload. (SAE J1156 APR86)

Gradeability – The maximum percent grade, which the vehicle can transverse for a specified time at a specified speed. The gradeability limit is the grade upon which the vehicle can just move forward. (SAE J227a)

Gross Combined Weight Rating (GCWR) – Maximum combined weight of towing vehicle (including passengers and cargo) and the trailer. The GCWR indicates the maximum loaded weight that the vehicle is allowed to tow.

Gross brake horsepower – The power of a complete basic engine, with air cleaner, without fan, and alternator, and air compressor not charging.

H-Bridge Circuit – An H-Bridge (bipolar) circuit operates like putting a power source on one side of a motor and connecting the other side of the motor to a ground. This turns the motor. By shifting the leads on the motor, it will turn in the opposite direction.

Hall effect – The development of a transverse electric potential gradient in a current-carrying conductor or semiconductor when a magnetic field is applied.

Hall effect sensor – Transducer that varies its output voltage in response to changes in a magnetic field. Commonly used to time the speed of wheels and shafts.

High-pressure Fuel Pump (HPFP) assembly – The HPFP is a volumetric pump that supplies fuel at high-pressure. The HPFP is mounted in the rear valley on the top of the engine and is driven by the camshaft.

High-pressure Piezo Common Rail (HPCR) – The HPFP pumps fuel through separate tubes to each fuel rail. Each fuel rail has four fuel tubes, one for each injector, that maintain constant pressure from the high-pressure pump to each injector.

High-speed digital inputs – Inputs to the ECM from a sensor that generates varying frequencies (engine speed and vehicle speed sensors).

Horsepower (hp) – Horsepower is the unit of work done in a given period of time, equal to 33,000 pounds multiplied by one foot per minute. 1 hp = 33,000 lb x 1 ft. /1 min.

Humidity Sensor (HS) – A sensor that measures the moisture content of filtered air entering the intake system.

Hydrocarbons – Organic compounds consisting of hydrogen and carbon (fuel and oil).

Injection Pressure Regulator (IPR) valve – A valve that is used to maintain desired injection control pressure.

Injection Control Pressure (ICP) sensor – Provides a feedback signal to the ECM indicating injection control pressure.

Inlet Air Heater (IAH) – Heats incoming air to help reduce cold start emissions.

Inlet Air Heater Fuel Igniter (IAHFI) – The IAHFI heats the intake air by vaporizing and igniting fuel in the air inlet duct.

Inlet Air Heater Fuel Solenoid (IAHFS) – When the engine is cold and cranked, the ECM energizes the IAHFS valve, allowing fuel into the IAHFI, which ignites and warms air drawn into the engine.

Inlet Air Heater Relay (IAHR) – The IAHR provides voltage to the IAHFI, and is controlled by the ECM.

Intake manifold – Engine component that evenly supplies air to each intake port in the cylinder head(s).

Intake Manifold Pressure (IMP) sensor – A variable capacitance sensor used to indicate air pressure in the intake manifold.

Intake Manifold Temperature (IMT) sensor – A thermistor sensor used to indicate air temperature in the intake manifold.

Internal Transfer Pump (ITP) – The ITP is part of the HPFP assembly and driven off the same shaft as the HPFP assembly. The ITP supplies fuel at a slightly higher pressure and flow to the HPFP though the Fuel Volume Control Valve (FVCV). The ITP also provides fuel for cooling and lubrication of the HPFP. Fuel is rerouted as pump return flow through the HPFP cooling and lubrication valve. Pressure is maintained at the inlet of the HPFP piston pump by an ITP regulator.

International NGV Tool Utilized for Next Generation Electronics (INTUNE) – The diagnostics software for chassis related components and systems.

Interstage Cooler (ISC) – Uses cooled coolant to lower the charged air temperature that exits from the turbocharger low-pressure compressor and enters the turbocharger high-pressure compressor.

Low speed digital inputs – Switched sensor inputs that generate an on/off (high/low) signal to the ECM. The input to the ECM from the sensor could be from a high input source switch (usually 5 or 12 volts) or from a grounding switch that grounds the signal from a current limiting resistor in the ECM that creates a low signal (0 volts).

Low temperature radiator thermostat – Coolant flow to the low temperature radiator is regulated by the low temperature radiator thermostat.

Lubricity – Lubricity is the ability of a substance to reduce friction between solid surfaces in relative motion under loaded conditions.

Lug (engine) – A condition when the engine is run at an overly low RPM for the load being applied.

Manifold Absolute Pressure (MAP) – Boost pressure in the manifold that is a result of the turbocharger.

Manifold Absolute Pressure (MAP) sensor – A variable capacitance sensor that measures boost pressure.

Manometer – A double-leg liquid-column gauge, or a single inclined gauge, used to measure the difference between two fluid pressures. Typically, a manometer records in inches of water.

Mass Air Flow – The intake airflow in an engine.

Mass Air Flow (MAF) sensor – The MAF sensor is used for closed loop control of the EGR valve and ITV. The ECM monitors the MAF signal so that the ECM can control the EGR and intake throttle systems.

Magnehelic Gauge – A gauge that measures pressure in inches of water.

Magnetic Pickup Sensor – A magnetic pickup sensor generates an alternating frequency that indicates speed. Magnetic pickups have a two-wire connection for signal and ground. This sensor has a permanent magnetic core surrounded by a wire coil. The signal frequency is generated by the rotation of the gear teeth that disturb the magnetic field.

Microprocessor – An integrated circuit in a microcomputer that controls information flow.

Micro Strain Gauge (MSG) Sensor – A MSG sensor measures pressure. Pressure exerts force on a pressure vessel that stretches and compresses to change resistance of strain gauges bonded to the surface of the pressure vessel. Internal sensor electronics convert the changes in resistance to a ratiometric voltage output.

Nitrogen Oxides (NO_x) – Nitrogen oxides form by a reaction between nitrogen and oxygen at high temperatures and pressures in the combustion chamber.

Normally closed – Refers to a switch that remains closed when no control force is acting on it.

Normally open – Refers to a switch that remains open when no control force is acting on it.

NOx IN sensor module – A smart device used to measure the NOx emission at the intake of the aftertreatment system.

NOx OUT sensor module – A smart device used to measure the NOx emissions at the outlet of the SCR catalyst.

Ohm (Ω) – The unit of electrical resistance. One ohm is the value of resistance through which a potential of one volt will maintain a current of one ampere. (SAE J1213 NOV82)

On demand test – A self-test the technician initiates using the EST that is run from a program in the software.

Output Circuit Check (OCC) – An on-demand test done during an Engine OFF self-test to check the continuity of selected actuators.

Oxides of Nitrogen (NOx) – Nitrogen oxides formed by a reaction between nitrogen and oxygen at high temperatures.

Oxygen Sensor (O_2S) – A sensor that monitors oxygen levels in the exhaust.

pH – A measure of the acidity or alkalinity of a solution.

Particulate matter – Particulate matter includes mostly burned particles of fuel and engine oil.

Power – Power is a measure of the rate at which work (force x distance) is done during a specific time. Compare with Torque.

Power TakeOff (PTO) – Accessory output, usually from the transmission, used to power a hydraulic pump for a special auxiliary feature (garbage packing, lift equipment, etc).

Pulse Width Modulation (PWM) – Succession of digital electrical pulses, rather than an analog signal. Efficient method of providing power between fully on and fully off.

Random Access Memory (RAM) – Computer memory that stores information. Information can be written to and read from RAM. Input information (current engine speed or temperature) can be stored in RAM to be compared to values stored in Read Only Memory (ROM). All memory in RAM is lost when the ignition switch is turned off.

Rated gross horsepower – Engine gross horsepower at rated speed as declared by the manufacturer. (SAE J1995 JUN90)

Rated horsepower – Maximum brake horsepower output of an engine as certified by the engine manufacturer. The power of an engine when configured as a basic engine. (SAE J1995 JUN90)

Rated net horsepower – Engine net horsepower at rated speed as declared by the manufacturer. (SAE J1349 JUN90)

Rated speed – The speed, as determined by the manufacturer, at which the engine is rated. (SAE J1995 JUN90)

Rated torque – Maximum torque produced by an engine as certified by the manufacturer.

Ratiometric Voltage – In a Micro Strain Gauge (MSG) sensor, pressure to be measured exerts force on a pressure vessel that stretches and compresses to change resistance of strain gauges bonded to the surface of the pressure vessel. Internal sensor electronics convert the changes in resistance to a ratiometric voltage output.

Reference voltage (V_{REF}) – A 5 volt reference supplied by the ECM to operate the engine sensors.

Reserve capacity – Time in minutes that a fully charged battery can be discharged to 10.5 volts at 25 amperes.

Regeneration – Oxidation of accumulated soot (carbon-based particulates) in the Diesel Particulate Filter (DPF). The soot is reduced to ash and stored in the PDF.

Return Fuel System – The return fuel system moves unused fuel from the fuel injectors to the fuel cooler. Excess fuel out of the FVCV and the FPCV mix with fuel from the fuel injectors on the way to the fuel cooler.

Selective Catalyst Reduction (SCR) catalyst – Breaks down DEF into ammonia and CO_2 and also converts ammonia and NOx to Nitrogen gas and water.

Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor – Monitors inlet temperature of the SCR catalyst and sends a signal to the SCR temperature sensor module.

Selective Catalyst Reduction Outlet Temperature (SCROT) sensor – Monitors outlet temperature of the SCR catalyst and sends a signal to the SCR temperature sensor module.

Selective Catalyst Reduction (SCR) temperature sensor module – Monitors signals from the Selective Catalyst Reduction Inlet Temperature (SCRIT) sensor and Selective Catalyst Reduction Outlet Temperature (SCROT) sensor, and communicates these signals to the Aftertreatment Control Module (ACM).

ServiceMaxx™ software – Diagnostics software for engine and aftertreatment related components and systems.

Setting criteria – Conditions required by a monitor to set a fault code. Once the setting criteria is met for the required amount of time, the fault code will become either active or pending. Example: SPN 168 FMI 18 sets when battery voltage supplied to the ACM is less than 6.5 volts (setting criteria) for 4 seconds (time required).

Signal Conditioner – The signal conditioner in the internal microprocessor converts analog signals to digital signals, squares up sine wave signals, or amplifies low-intensity signals to a level that the ECM microprocessor can process.

Signal ground – The common ground wire to the ECM for the sensors.

Speed Control Command Switches (SCCS) – A set of switches used for cruise control, Power Take Off (PTO), and remote hand throttle system.

Steady state condition – An engine operating at a constant speed and load and at stabilized temperatures and pressures. (SAE J215 JAN80)

Strategy – A plan or set of operating instructions that the microprocessor follows for a desired goal. Strategy is the computer program itself, including all equations and decision making logic. Strategy is always stored in ROM and cannot be changed during calibration.

Stroke – The movement of the piston from Top Dead Center (TDC) to Bottom Dead Center (BDC).

Substrate – Material that supports the wash coating or catalytic materials.

Suspect Parameter Number (SPN) – A 19-bit number used to identify the item for which diagnostics are being reported. The SPN is used for multiple purposes, some that are specific to diagnostics are as follows;

- Identify the least repairable subsystem that has failed.
- Identify subsystems or assemblies that may not have hard failures but may be exhibiting abnormal operating performance.
- Identify a particular event or condition that will be reported.
- Report a component and non-standard failure mode.

System restriction (air) – The static pressure differential that occurs at a given airflow from air entrance through air exit in a system. Usually measured in inches (millimeters) of water. (SAE J1004 SEP81)

Tachometer output signal – Engine speed signal for remote tachometers.

Thermistor – A semiconductor device. A sensing element that changes resistance as the temperature changes.

Thermistor Sensor – Changes electrical resistance with changes in temperature. Resistance in the thermistor decreases as temperature increases, and increases as temperature decreases. Thermistors work with a resistor that limits current to form a voltage signal matched with a temperature value.

Thrust load – A thrust load pushes or reacts through a bearing in a direction parallel to the shaft.

Time required – The amount of time needed for a monitor to set a fault code when the setting criteria is met. Example: SPN 168 FMI 18 sets when battery voltage supplied to the ACM is less than 6.5 volts (setting criteria) for 4 seconds (time required).

Top Dead Center (TDC) – The uppermost position of the piston during the stroke.

Torque – A force having a twisting or turning effect. For a single force, the cross product of a vector from some reference point to the point of application of the force within the force itself. Also known as moment of force or rotation moment. Torque is a measure of the ability of an engine to do work.

Trip (driving cycle) – Legal definition about what defines a drive cycle or trip to calculate the denominator in the IUMPR (In-Use Monitoring Performance Ratio). For some faults a trip can be a key cycle (including housekeeping time to reset the ECM). Example: out of range circuit checks for sensors. For other faults the trip includes a warm up cycle, driving in certain conditions, etc. Example: thermostat monitor

Trip (MIL illumination and OBD executive) – Amount of trips when the fault must be present to illuminate the MIL, latch the MIL, and store historic fault information. Most faults are two trip faults.

Truck Computer Analysis of Performance and Economy (TCAPE) – A computer program that simulates the performance and fuel economy of trucks.

Turbocharger – A turbine driven compressor mounted on the exhaust manifold. The turbocharger increases the pressure, temperature and density of intake air to charge air.

Turbocharger 1 Turbine Outlet Pressure (TC1TOP) sensor – A variable capacitance sensor that monitors exhaust back-pressure.

Turbocharger 2 Compressor Inlet (TC2CIS) sensor – The TC2CIS sensor includes a thermistor sensor that monitors the temperature of charge air entering the HP turbocharger. This sensor also monitors boost pressure for the LP turbocharger.

Turbocharger 2 Wastegate Control (TC2WC) solenoid – Controls the TC2WC actuator by regulating the amount of charge air pressure supplied to the wastegate actuator. The TC2WC solenoid is controlled by signals from the ECM in response to engine speed, required fuel quantity, boost, exhaust back-pressure, and altitude. The TC2WC actuator is part of the turbocharger assembly.

Variable capacitance sensor – A variable capacitance sensor measures pressure. The pressure forces a ceramic material closer to a thin metal disc in the sensor, changing the capacitance of the sensor.

Vehicle Electronic System Programming System – The computer system used to program electronically controlled vehicles.

Vehicle Retarder Enable/Engage – Output from the ECM to a vehicle retarder.

Transmission Output Shaft Speed (TOSS) sensor – Normally a magnetic pickup sensor mounted in the tailshaft housing of the transmission, used to indicate vehicle speed.

Viscosity – The internal resistance to the flow of any fluid.

Viscous fan – A fan drive that is activated when a thermostat, sensing high air temperature, forces fluid through a special coupling. The fluid activates the fan.

Volt (v) – A unit of electromotive force that will move a current of one ampere through a resistance of one Ohm.

Voltage – Electrical potential expressed in volts.

Voltage drop – Reduction in applied voltage from the current flowing through a circuit or portion of the circuit current multiplied by resistance.

Voltage ignition – Voltage supplied by the ignition switch when the key is ON.

Washcoat – A layer of alumina applied to the substrate in a monolith-type converter.

Water In Fuel (WIF) sensor – A switch sensor that measures the amount of water in the fuel.