DIAGNOSTIC/TROUBLESHOOTING MANUAL

International® DT 466, DT 570, and HT 570

DIESEL ENGINE

EGES-270-1

© 2008 Navistar, Inc.

Printed in the United States of America

Table of Contents

Foreword.....1

Service Diagnosis.....2

Safety Information.....3

Engine Systems.....5

Engine and Vehicle Features.....59

Diagnostic Software Operation.....65

Engine Symptoms Diagnostics.....99

Hard Start and No Start Diagnostics.....141

Performance Diagnostics.....203

Electronic Control Systems Diagnostics.....279

Diagnostic Tools and Accessories.....555

Abbreviations and Acronyms.....579

Terminology.....583

Appendix A: DT 466 Performance Specifications 2004 Model Year.....593

Appendix B: DT 570 and HT 570 Performance Specifications 2004 Model Year.....617

Appendix C: Diagnostic Trouble Code Index.....641

Appendix D: Technical Service Information (TSI).....649

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Foreword

International Truck and Engine Corporation 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 International® diesel engines. See vehicle manuals and Technical Service Information (TSI) bulletins for additional information.

Technical Service Literature

1171809R5	*DT 466, DT 570 and HT 570 Engine Operation and Maintenance Manual*
EGES-265-1	*DT 466, DT 570 and HT 570 Service Manual*
EGES-270	*DT 466, DT 570 and HT 570 Diagnostic Manual*
EGED-285	DT 466, DT 570 and HT 570 Electronic Control Systems Diagnostic Form (Pad of 50)
EGED-290-1	DT 466, DT 570 and HT 570 Diagnostic Form (Pad of 50)

Technical Service Literature is revised periodically and mailed automatically to “Revision Service” subscribers. If a technical publication is ordered, the latest revision will be supplied.

To order technical service literature, contact your International dealer.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

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
- Electronic Control Systems Diagnostics Forms
- Service Bulletins

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

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.

©August 2008 Navistar, Inc.

- Do not expose batteries to open flames or sparks.
- Do not smoke in workplace.

Compressed Air

- Use an OSHA approved blow gun rated at 207 kPa (30 psi).
- Limit shop air pressure to 207 kPa (30 psi).
- 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.

©August 2008 Navistar, Inc.

Table of Contents

Engine Identification.....7
- **Engine Serial Number**.....7
- **Engine Emission Label**.....7
- **Engine Description**.....9
- **Engine Component Locations**.....12

Engine Systems.....18
- **Engine System Diagram**.....18

Air Management System.....19
- **Air Management Components and Air Flow**.....19
- **Charge Air Cooler (CAC)**.....20
- **Variable Geometry Turbocharger (VGT)**.....21
- **Exhaust Gas Recirculation (EGR) System**.....23
- **Exhaust System**.....24

Fuel Management System.....25
- **Fuel Management Components**.....25
- **Injection Control Pressure (ICP) System Components and High-Pressure Oil Flow**.....26
- **Fuel Injectors**.....29

Fuel Supply System.....33
- **Fuel System Components and Fuel Flow**.....33
- **Fuel Flow Schematic**.....34

Engine Lubrication System 37
- **Lubrication System Components and Oil Flow**.....37

Cooling System.....40
- **Cooling System Components and Coolant Flow**.....40

Electronic Control System.....43
- **Electronic Control System Components**.....43
- **Injection Drive Module (IDM)**.....45
- **Engine and Vehicle Sensors**.....47

Diamond Logic® Engine Brake.....53
- **Engine Brake Components**.....53
- **Engine Brake Control**.....54
- **Operation of Diamond Logic® Engine Brake in Braking Mode**.....56

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Engine Identification

Engine Serial Number

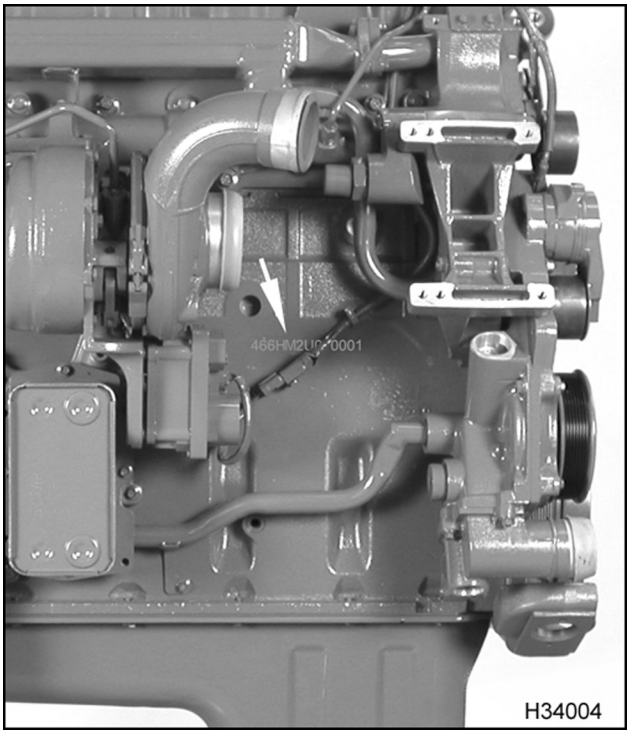


Figure 1 Engine serial number

The engine serial number is in two locations:

- Stamped on a crankcase pad on the right side of the crankcase below the cylinder head
- On the engine emission label on the valve cover

Engine Serial Number Examples

DT 466 engine: 466HM2U2000001

DT 570 engine: 570HM2U2000001

Engine Serial Number Codes

466 – Engine displacement
570 – Engine displacement
H – Diesel, turbocharged, Charge Air Cooler (CAC), and electronically controlled
M2 – Motor truck
A2 – Unknown (Stripped and service engines)
U – United States
7 digit suffix – Engine serial number sequence beginning with 2

Engine Emission Label

A common emission label is issued for the International® DT 466 and DT 570 diesel engines.

INTERNATIONAL®

IMPORTANT ENGINE INFORMATION
IMPORTANT MOTRUR INFORMATIONS
ENGINE MANUFACTURED BY:
MOTEUR FABRIQUE PAR:
INTERNATIONAL TRUCK AND ENGINE CORPORATION

MODEL YEAR MODELE	2004	MODEL MODELE	D260
ADV. BHP @ RPM PUISS_NOM_A TR/MIN	260 @ 2300	Engine Family Famille De moteur	DT 466 HT
LB-FT TORQ @ RPM COUPLE LB-PI A TR/MIN	800 @ 1400	DISPLACEMENT CYLINDREE	466 IN 3 7.6L

Emission family	4NVXH0466ANA
Label number	1800000C1
Emission control system	DI, ECM, TAA, EGR, OC

FEL INFORMATION IF APPLICABLE

Valve lash COLD .483 mm (.019 in) INT and EX

Curb idle, fuel rates, and injection timing are non-adjustable

EPA notes

EURO notes

Reserved **EXAMPLE**

ENGINE S/N 466HM2U1234567

H34005

Figure 2 Engine emission label (Example)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The Environmental Protection Agency (EPA) emission label is on top of the valve cover. The engine label includes the following:

- Model year
- Engine family, model, and displacement
- Advertised brake horsepower and torque rating
- Emission family and control systems
- U.S. Family Emission Limits (FEL), if applicable
- Valve lash specifications
- Engine serial number
- EPA, EURO, and reserved fields for specific applications

Engine Accessories

The following engine accessories may have manufacturer's labels or identification plates:

- Air compressor (for brake or suspension system)
- Air conditioning compressor
- Alternator
- Cooling fan clutch
- EVRT® electronically controlled turbocharger – International's version of a Variable Geometry Turbocharger (VGT)
- Power steering pump
- Starter motor

Labels or identification plates include information and specifications helpful to vehicle operators and technicians.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Engine Description

International® DT 466 , DT 570, and HT 570 Features and Specifications	
Engine	4 stroke, inline six cylinder diesel
Configuration	Four valves per cylinder
Displacement	7.6 L (466 in^3)
Displacement	9.3 L (570 in^3)
Bore (sleeve diameter)	116.6 mm (4.59 in)
Stroke	
• DT 466	119 mm (4.68 in)
• DT 570 and HT 570	146 mm (5.75 in)
Compression ratio	
• DT 466	16.5 : 1
• DT 570 and HT 570	17.5 : 1
Aspiration	VGT turbocharged and Charge Air Cooled (CAC)
Rated power @ rpm[1]	
• DT 466	210 bhp @ 2600 rpm
• DT 570	285 bhp @ 2200 rpm
Peak torque @ rpm[1]	
• DT 466	520 lbf•ft @ 1400 rpm
• DT 570	800 lbf•ft @ 1200 rpm
Engine rotation (facing flywheel)	Counterclockwise
Combustion system	Direct injection turbocharged
Fuel system	International® electro-hydraulic generation 2 injection
Total engine weight (dry without accessories)	
• DT 466	671 kg (1,480 lbs)
• DT 570 and HT 570	708 kg (1,560 lbs)
Cooling system capacity (engine only)	12.8 L (13.5 qts US)
Lube system capacity (including filter)	28 L (30 qts US)
Lube system capacity (overhaul only, with filter)	34 L (36 qts US)
Firing order	1-5-3-6-2-4

[1] Base rating shown. See Appendix A or B in this manual for additional ratings.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Engine Features

Standard Features	Optional Features
Four valves per cylinder	Air compressor
Dual timing sensors	Power steering pump
Replaceable piston and sleeve configuration	Front cover PTO access
Gerotor lube oil pump	Engine Fuel Pressure (EFP) sensor
International® electro-hydraulic generation 2 injection system	Diamond Logic® engine brake
Variable Geometry Turbocharger (VGT)	Diamond Logic® exhaust brake
Exhaust Gas Recirculation (EGR)	Fuel heater
Water supply housing (Freon® compressor bracket)	Oil pan heater
Alternator bracket	Coolant heater assembly
Control modules	
Water In Fuel (WIF) separation	
Water In Fuel (WIF) sensor	
Inlet Air Heater (IAH)	

Standard Features

DT 466, DT 570, and HT 570 are inline six cylinder engines (medium range). Engine displacements are 7.6 liters (466 cubic inches) for the DT 466 and 9.3 liters (570 cubic inches) for the DT 570, and HT 570. The firing order of the cylinders is 1–5–3–6–2–4.

The cylinder head has four valves per cylinder for improved air flow. Each fuel Injector is centrally located between the four valves and directs fuel over the piston bowl for improved performance and reduced emissions. The overhead valve train includes mechanical roller lifters, push rods, rocker arms, and dual valves that open using a valve bridge.

A one piece crankcase withstands high-pressure loads during diesel operation.

The lower end of the DT 570 and HT 570 engines (for ratings above 300 hp) includes a crankcase ladder designed to absorb additional loads generated by increased horsepower. Seven main bearings support the crankshaft for DT 466, DT 570, and HT 570 engines. Fore and aft thrust are controlled at the rear bearing. Four insert bushings support the camshaft. The rear oil seal carrier is part of the flywheel housing. The open crankcase breather assembly uses a road draft tube to vent crankcase pressure and an oil separator that returns oil to the crankcase.

The crankshaft (CKP) and camshaft (CMP) sensors are used by the ECM and IDM to calculate rpm, fuel timing, fuel quantity, and duration of fuel injection.

Two different types of pistons are used in the inline engines:

- The DT 466 engine has one piece aluminum alloy pistons.
- The DT 570 and HT 570 engines have two piece articulated pistons with a steel crown.

All pistons are mated to fractured cap joint connecting rods. Replaceable wet cylinder sleeves are used with the pistons.

A gerotor lube oil pump, mounted to the front cover, is driven directly by the crankshaft. All engines use an oil cooler and spin-on oil filter.

A low-pressure fuel supply pump draws fuel from the fuel tank through a fuel filter assembly that includes a strainer, filter element, primer pump, drain valves, and Water In Fuel (WIF) sensor. After filtering, fuel is pumped to the cylinder head fuel rail.

The International® electro-hydraulic generation 2 injection system includes a cast iron oil manifold, fuel injectors, and a high-pressure oil pump.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The VGT has actuated vanes in the turbine housing. The vanes modify flow characteristics of exhaust gases through the turbine housing. The benefit is the ability to control boost pressure for various engine speeds and load conditions. An additional benefit is lower emissions.

An EGR control valve regulates cooled exhaust gases entering the inlet air stream. Cool exhaust gas increases engine tolerance for EGR, while reducing smoke formed by gas dilution in the mixture. Three EGR coolers are available depending on applications.

The water supply housing, which includes auxiliary water connections, serves the dual function as the Freon® compressor bracket.

Three control modules monitor and control the electronic engine systems:

- Diamond Logic® engine controller – Electronic Control Module (ECM)
- Injector Drive Module (IDM)
- Exhaust Gas Recirculation (EGR) drive module

Water In Fuel (WIF) separation occurs when the filter element repels water molecules and water collects at the bottom of the element cavity in the fuel filter housing.

A Water In Fuel (WIF) sensor in the element cavity of the fuel filter housing detects water. When enough water accumulates in the element cavity, the WIF sensor signal changes to the Electronic Control Module (ECM). The ECM sends a message to illuminate the amber water and fuel lamp, alerting the operator. A fuel drain valve handle on the housing can be opened to drain water from the fuel filter housing.

Optional Features

An air compressor is available for applications requiring air brakes or air suspension.

A hydraulic power steering pump can be used with or without an air compressor.

The front cover includes a mounting flange for Power Take Off (PTO) accessories. The air compressor drive gear train, used with a spline adapter, provides power for front mounted PTO accessories.

An optional Engine Fuel Pressure (EFP) sensor detects low pressure caused by high fuel filter restriction and sends a signal to the ECM; the ECM illuminates the amber FUEL FILTER lamp on the instrument panel.

The Diamond Logic® exhaust brake system uses only the VGT to restrict exhaust flow for additional braking. The operator controls the exhaust brake for different operating conditions.

The Diamond Logic® engine brake is new for medium range diesel engines. This compression braking system uses a high-pressure rail assembly and the VGT for additional braking. The operator controls the engine brake for different operating conditions.

The Inlet Air Heater (IAH) warms intake air entering the cylinder head.

Options for vehicles and applications used in cold climates include the following:

- **Oil pan heater**

  The oil pan heater warms engine oil in the pan and ensures oil flow to the injectors.

- **Coolant heater**

  The coolant heater raises the temperature of coolant surrounding the cylinders for improved performance and fuel economy during start-up.

- **Fuel heater**

  The fuel heater (a 300 watt element) in the base of the fuel filter assembly heats the fuel for improved performance.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Engine Component Locations

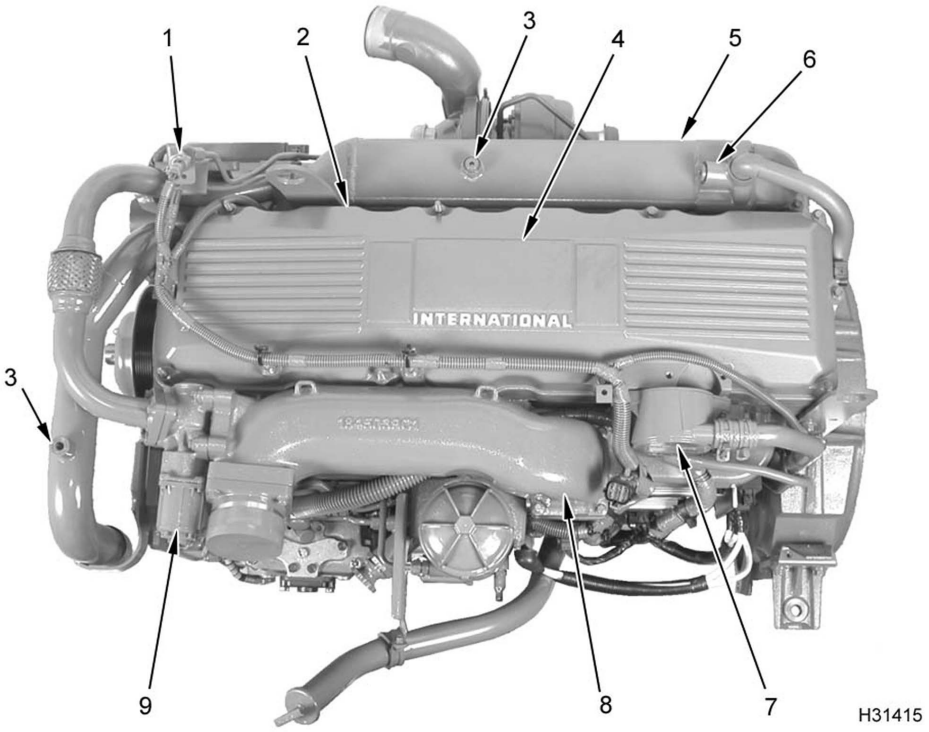


Figure 3 Component location – top

1. Exhaust Back Pressure (EBP) sensor
2. Valve cover
3. Dearation port
4. Exhaust emission label (location)
5. EGR cooler assembly
6. Secondary air heater supply
7. Breather assembly
8. Inlet and EGR mixer duct
9. EGR control valve

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

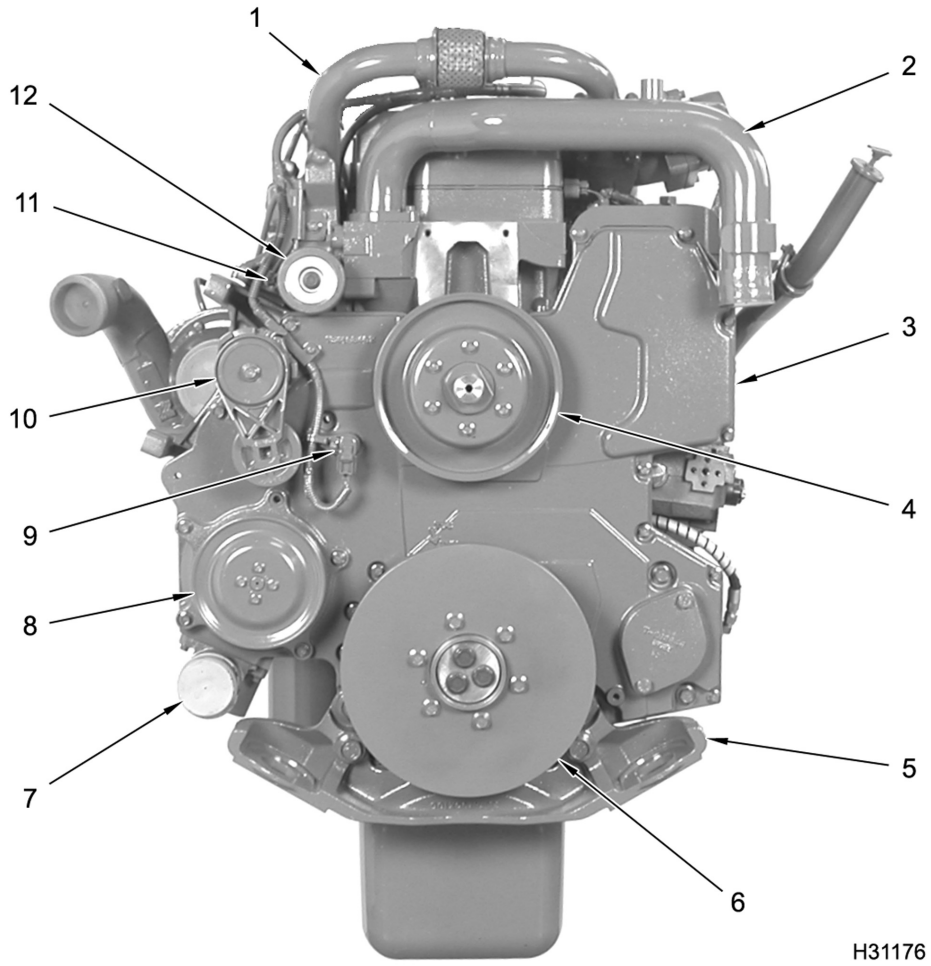


Figure 4 Component location – front

1. Exhaust gas crossover (EGR cooler to EGR valve)
2. Water outlet tube assembly (thermostat outlet)
3. Front cover (front half)
4. Fan drive pulley
5. Engine mounting bracket (front)
6. Vibration damper
7. Water inlet elbow
8. Water pump pulley
9. Camshaft Position (CMP) sensor
10. Auto tensioner assembly (belt)
11. ECT sensor (location)
12. Flat idler pulley assembly

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

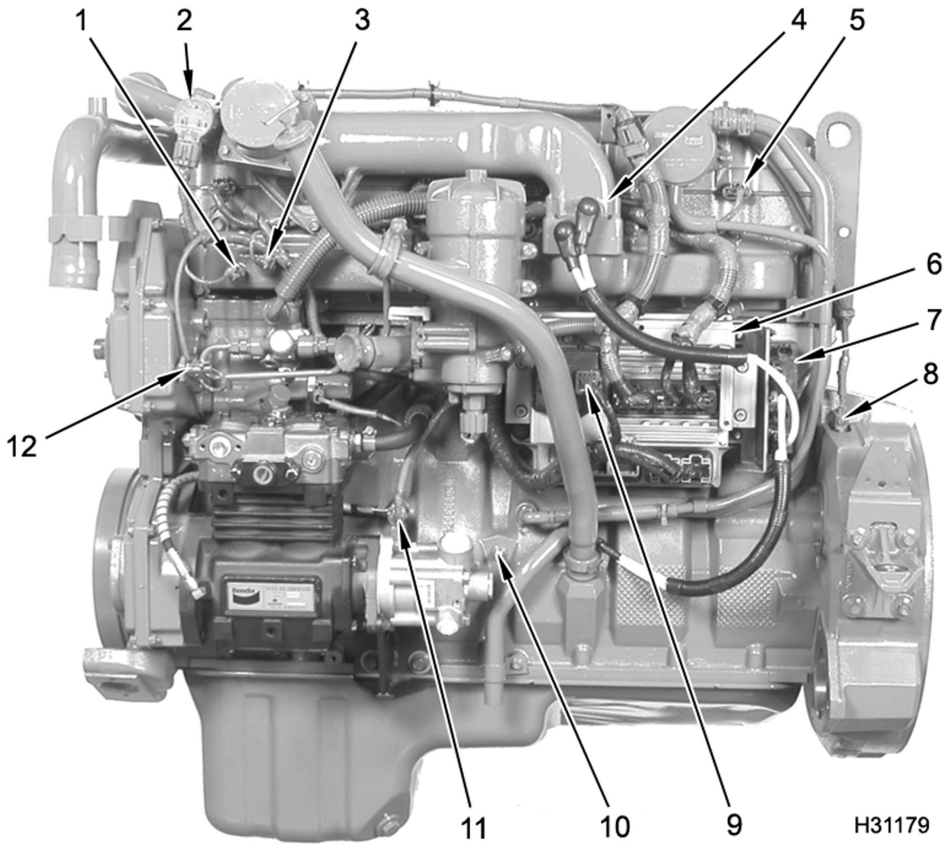


Figure 5 Component location, electrical– left

1. Manifold Absolute Pressure (MAP) sensor
2. EGR control valve
3. Manifold Air Temperature (MAT) sensor
4. Inlet Air Heater (IAH) assembly
5. Valve cover gasket pass-through connector
   a. (Six) four wire connectors for fuel injectors
   b. (One) three wire connector for ICP sensor
   c. Engine brake application – (one) three wire connector for the BCP sensor and (one) three wire connector for the brake shut-off valve.
6. ECM and IDM module assembly
7. IAH relay
8. Crankshaft Position (CKP) sensor
9. EGR drive module
10. Ground stud
11. Engine Oil Pressure (EOP) sensor
12. Engine Oil Temperature (EOT) sensor

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

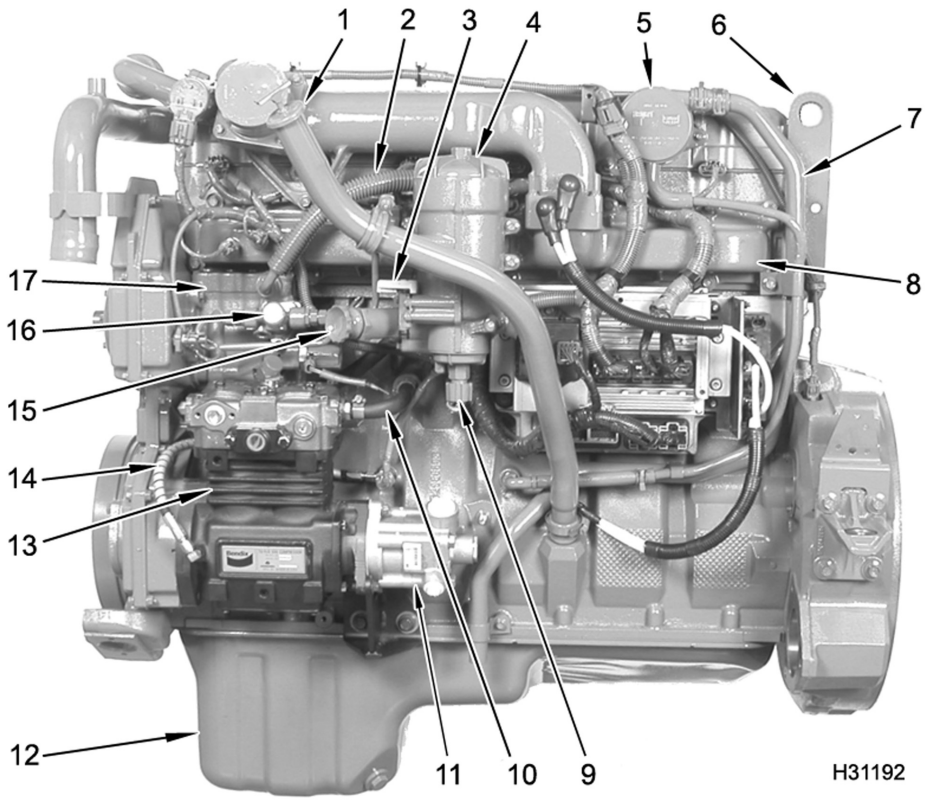


Figure 6 Component location, mechanical – left

1. Oil level gauge tube
2. High-pressure oil hose
3. Water drain valve (fuel)
4. Fuel filter header assembly
5. Breather assembly
6. Lifting eye
7. Vent and drain tube assembly
8. Intake manifold
9. Drain valve (fuel strainer)
10. Coolant hose (supply)
11. Power steering pump
12. Oil pan assembly
13. Air compressor
14. Oil supply line
15. Fuel primer pump assembly
16. Low-pressure fuel supply pump
17. High-pressure oil pump assembly

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

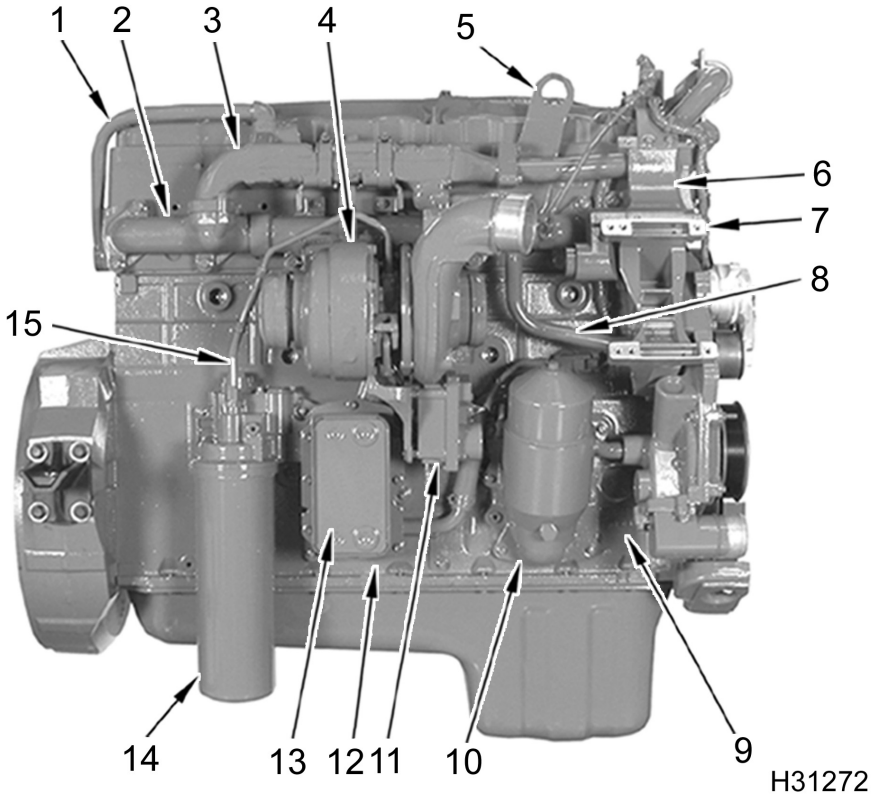


Figure 7 Component location – right

1. EGR cooler return tube assembly
2. Exhaust manifold assembly
3. EGR cooler assembly
4. Variable Geometry Turbocharger (VGT)
5. Lifting eye
6. Water supply housing (Freon® compressor bracket)
7. Alternator bracket
8. EGR cooler supply tube assembly
9. Crankcase
10. Secondary filtration filter (early engines only)
11. Turbocharger control module
12. Coolant drain plug (underneath location)
13. Oil cooler
14. Oil filter
15. Turbo oil inlet tube (supply)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

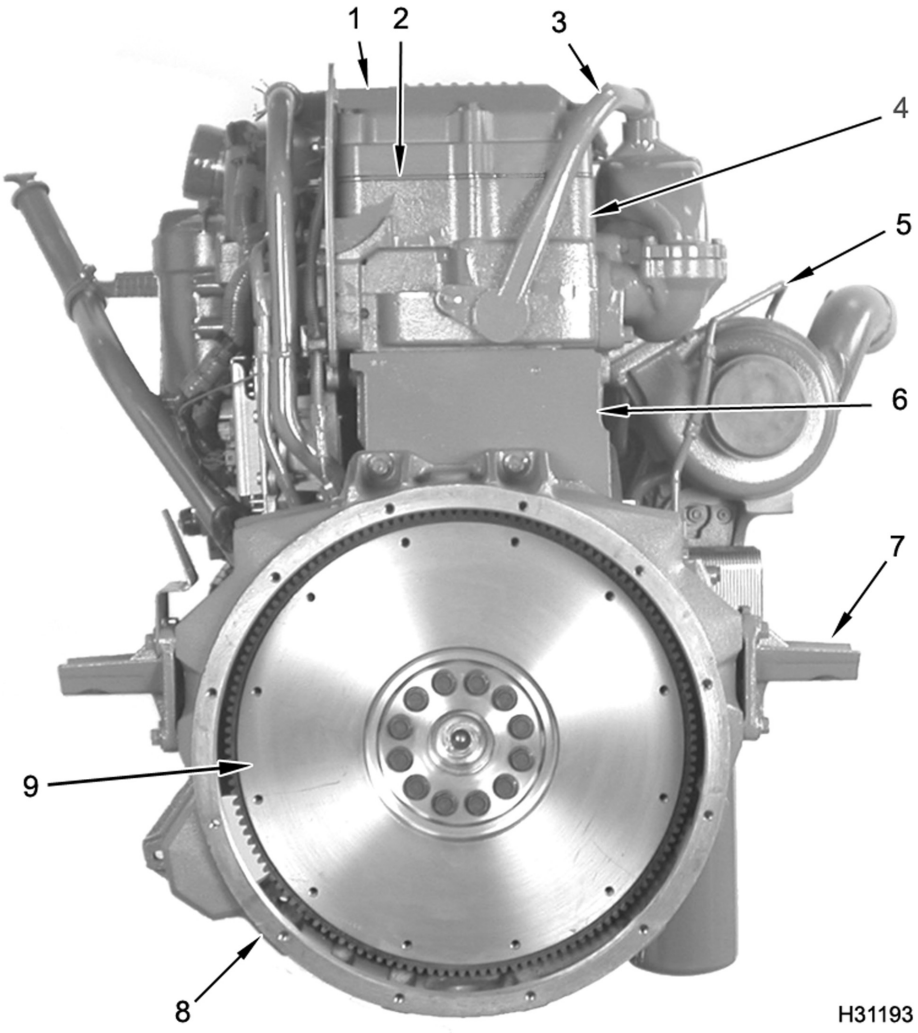


Figure 8 Component location – rear

1. Valve cover
2. Valve cover gasket with pass-through connectors
3. EGR cooler return tube assembly
4. Cylinder head assembly
5. Turbo oil inlet tube (supply)
6. Crankcase
7. Rear engine mount bracket (2)
8. Flywheel housing
9. Flywheel or flexplate assembly

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Engine Systems

Engine System Diagram

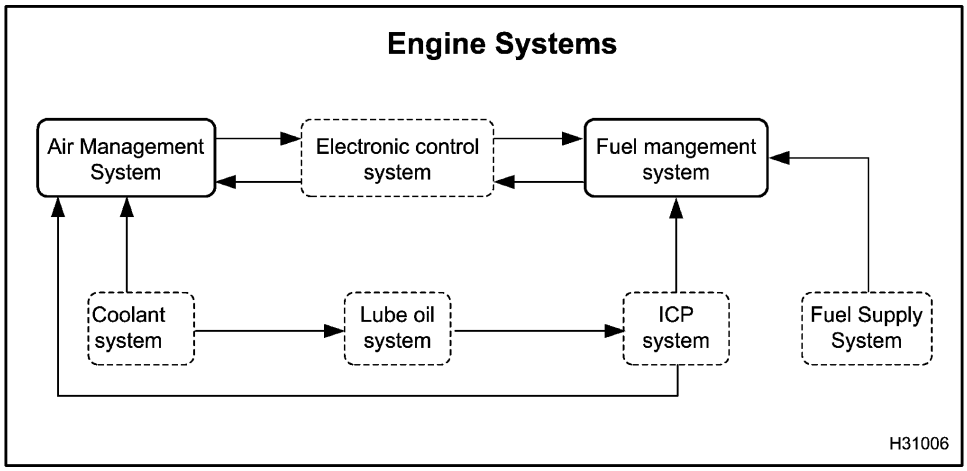


Figure 9 Engine systems

The primary engine systems are Air Management and Fuel Management which share some subsystems or have a subsystem that contributes to their operation.

- The Electronic Control system controls the Air Management System and Fuel Management System.
- The Coolant System provides heat transfer for crankcase and cylinder sleeves, cylinder head, EGR gases, and lubrication oil.
- The Lube Oil System provides lubrication and heat transfer for engine components.
- The ICP system uses lube oil for hydraulic fluid to actuate the fuel injectors and the optional engine brake.
- The Fuel Supply System pressurizes fuel for transfer to the fuel injectors.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Air Management System

Air Management Components and Air Flow

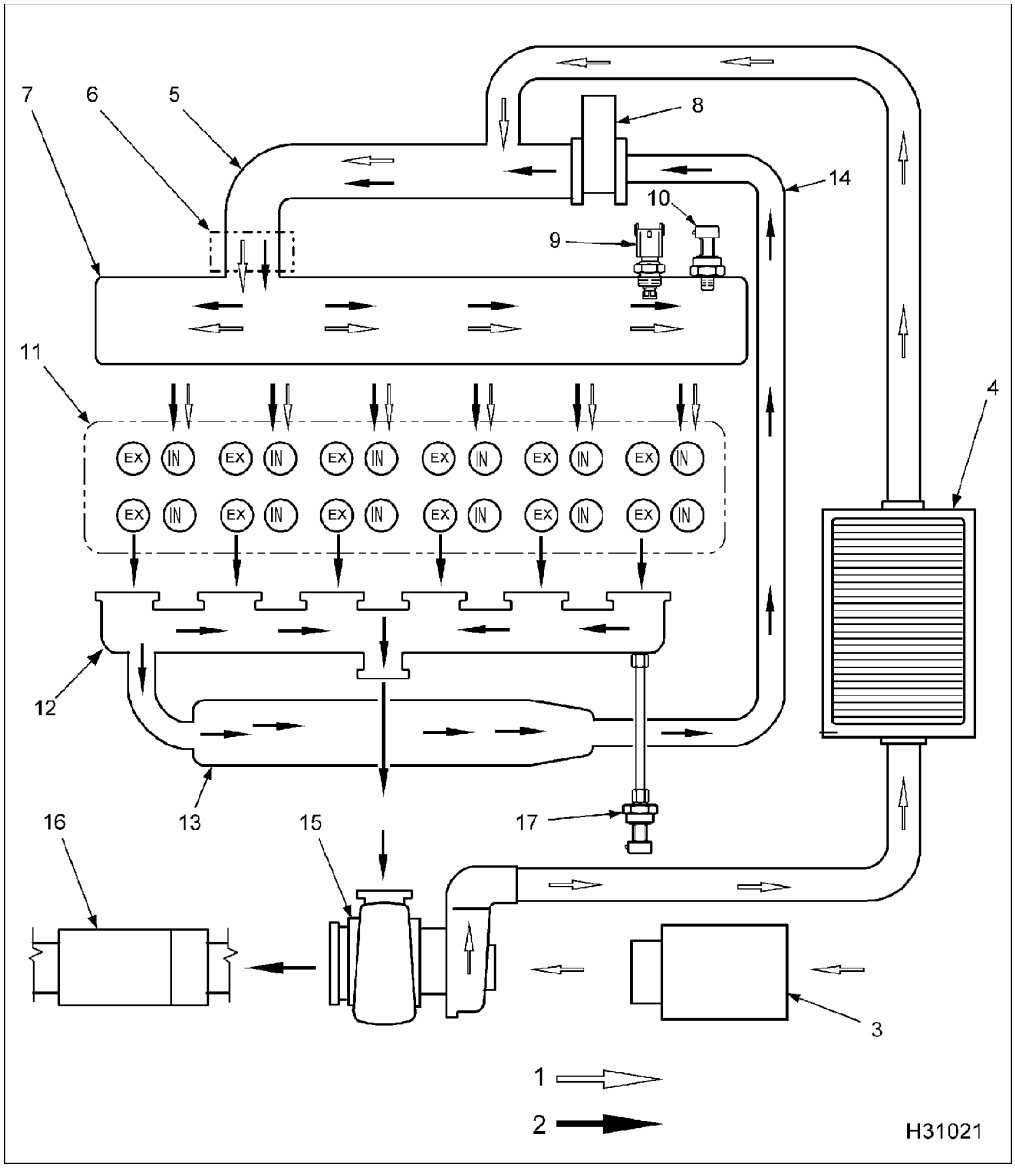


Figure 10 Air Management System (AMS)

1. Intake air
2. Exhaust gas
3. Air filter assembly
4. Charge Air Cooler (CAC)
5. Inlet and EGR mixer duct
6. Inlet Air Heater (IAH) assembly
7. Intake manifold
8. EGR valve
9. Manifold Air Temperature (MAT) sensor
10. Manifold Absolute Pressure (MAP) sensor
11. Cylinder head
12. Exhaust manifold
13. EGR cooler
14. Exhaust gas crossover
15. Variable Geometry Turbocharger (VGT)
16. Muffler
17. Exhaust Back Pressure (EBP) sensor

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The Air Management system includes the following:

- Air filter assembly
- Chassis mounted Charged Air Cooler (CAC)
- Variable Geometry Turbocharger (VGT)
- Inlet Air Heater (IAH) assembly
- Intake manifold
- Exhaust Gas Recirculation (EGR) system
- Exhaust system
- Intake and EGR mixer duct
- Diamond Logic® engine brake
- Catalytic converter– dependent on application
- Catalyzed Diesel Particulate Filter (CDPF) – dependent on application

Air Flow

Air flows through the air filter assembly and enters the Variable Geometry Turbocharger (VGT). The compressor in the VGT increases the pressure, temperature, and density of the intake air before it enters the Charge Air Cooler (CAC). Cooled compressed air flows from the CAC into the EGR mixer duct.

- If the EGR control valve is open, exhaust gas will mix with filtered intake air and flow into the intake manifold.
- If the EGR control valve is closed, only filtered air will flow into the intake manifold.

After combustion, exhaust gas is forced through the exhaust manifold to the EGR cooler and VGT.

- Some exhaust gas is cooled in the EGR cooler and flows through the EGR control valve to the EGR mixer duct. When exhaust gas mixes with filtered air, Nitrogen Oxide (NOx) emissions and noise are reduced.
- The rest of the exhaust gas flows to the VGT, spins and expands through the turbine wheel, varying boost pressure.
- The VGT compressor wheel, on the same shaft as the turbine wheel, compresses the mixture of filtered air.

The VGT responds directly to engine loads. During heavy load, an increased flow of exhaust gases turns the turbine wheel faster. This increased speed turns the compressor impeller faster and supplies more air or greater boost to the intake manifold. Conversely, when engine load is light, the flow of exhaust gas decreases and less air is directed into the intake manifold.

Charge Air Cooler (CAC)

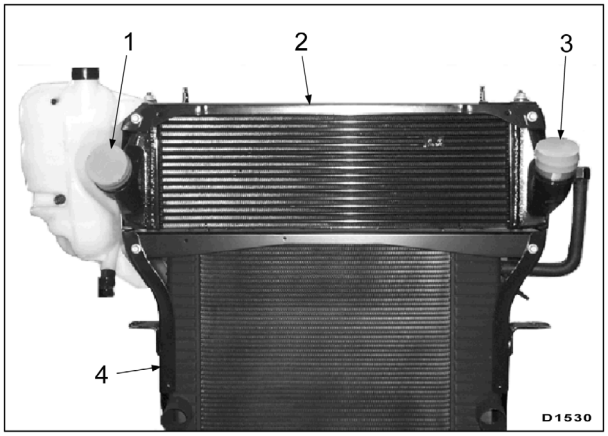


Figure 11 Charge Air Cooler (typical)

1. Air outlet
2. Charge Air Cooler (CAC)
3. Air inlet
4. Radiator

The CAC is mounted on top of the radiator. Air from the turbocharger passes through a network of heat exchanger tubes before entering the EGR mixer duct. Outside air flowing over the tubes and fins cools the charged air. Charged air is cooler and denser than the uncooled air; cooler and denser air improves the fuel-to-air ratio during combustion, resulting in improved emission control and power output.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Variable Geometry Turbocharger (VGT)

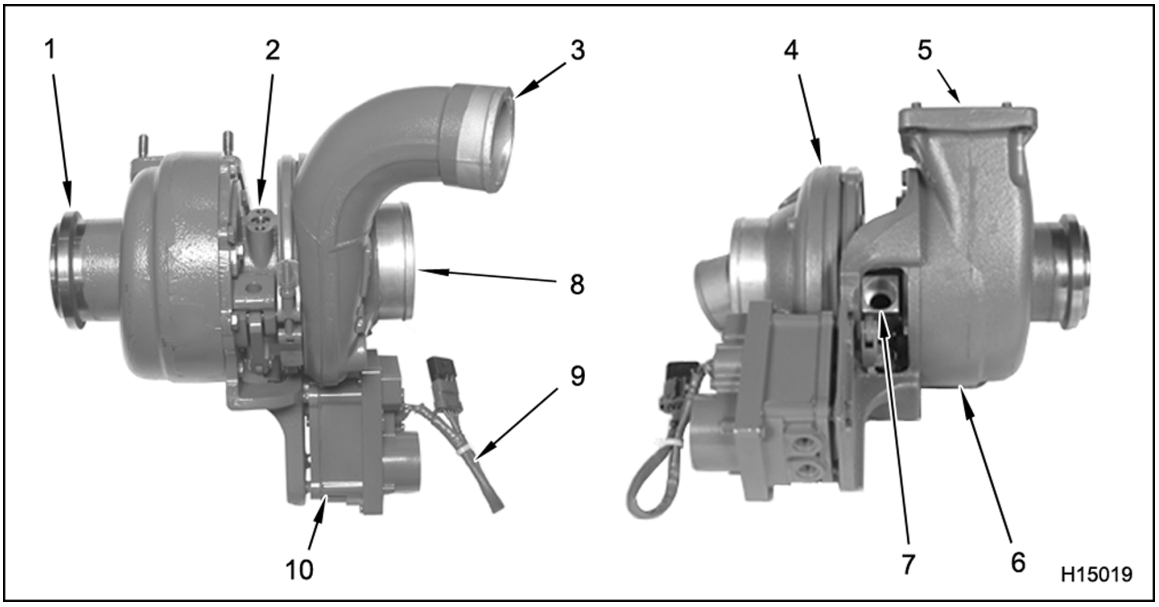


Figure 12 Variable Geometry Turbocharger (VGT)

1. Turbine outlet
2. Oil supply port
3. Compressor outlet
4. Compressor housing
5. Turbine inlet
6. Turbine housing
7. Oil drain port
8. Compressor inlet
9. Electrical connector and wire
10. Turbocharger control module

The Variable Geometry Turbocharger (VGT) has actuated vanes in the turbine housing. The vanes modify flow characteristics of exhaust gases through the turbine housing. The benefit is the ability to control boost pressure for various engine speeds and load conditions. An additional benefit is lower emissions.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

VGT Closed Loop System

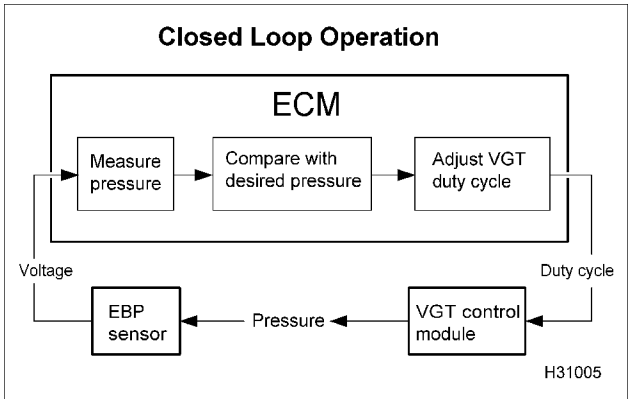


Figure 13 VGT closed loop system

The Variable Geometry Turbocharger (VGT) is a closed loop system that uses the Exhaust Back Pressure (EBP) sensor to provide feedback to the ECM. The ECM uses the EBP sensor to continuously monitor EBP and adjust the duty cycle to the VGT to match engine requirements.

VGT Control

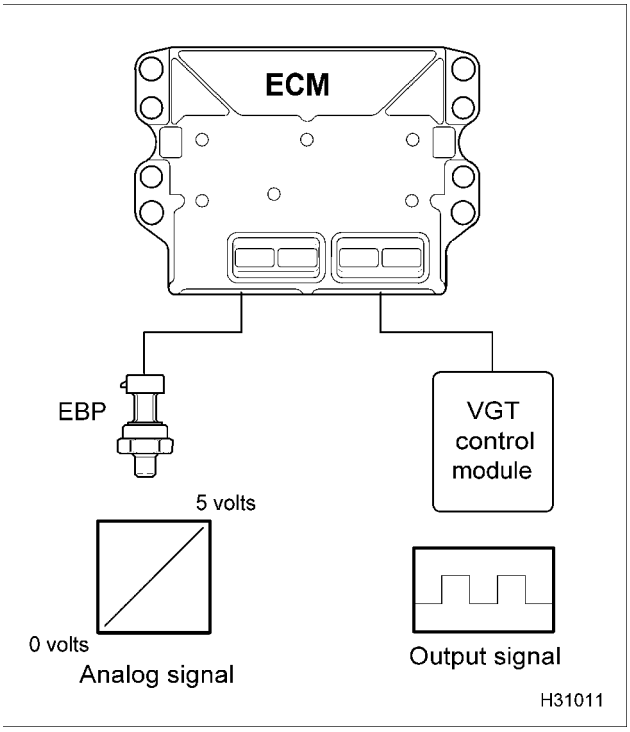


Figure 14 VGT control

The VGT actuator is a control module that contains a microchip and a DC motor. The VGT actuator is located below the turbocharger. The microchip operates a DC motor which rotates a crank lever controlling the vane position in the turbine housing. The position of the vanes is based off the pulse-width modulated signal sent from the ECM.

Actuated vanes are mounted around the inside circumference of the turbine housing. A unison ring links all the vanes. When the unison ring moves, all vanes move to the same position. Unison ring movement occurs when the crank lever in the control module moves.

Exhaust gas flow can be regulated depending on required exhaust back pressure for engine speed and load. As demand for EBP increases, the ECM increases the pulse-width modulation to the VGT control module. When EBP demand decreases, the ECM decreases the duty cycle to the control module.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Exhaust Gas Recirculation (EGR) System

The EGR system includes the following:

- EGR control valve
- EGR cooler
- Air intake manifold
- Inlet and EGR mixer duct
- Exhaust manifold
- Exhaust gas crossover

The Exhaust Gas Recirculation (EGR) system reduces Nitrogen Oxide (NOx) emissions.

NO_X forms during a reaction between nitrogen and oxygen at high temperature during combustion. Combustion starts when fuel is injected into the cylinder before or slightly after the piston reaches top-dead-center.

EGR Flow

Some exhaust from the exhaust manifold flows into the EGR cooler. Exhaust from the EGR cooler flows through the exhaust gas crossover to the EGR valve.

When EGR is commanded, the EGR control valve opens allowing cooled exhaust gases to enter the EGR mixer duct to be mixed with filtered intake air.

EGR Control Valve

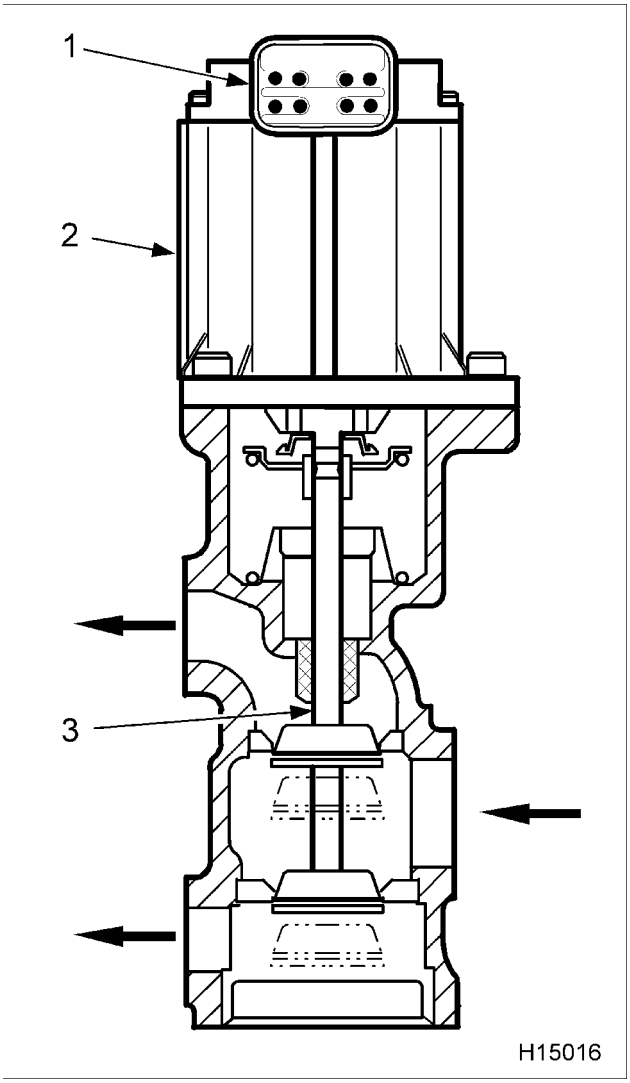


Figure 15 EGR control valve

1. Connector
2. DC motor with position sensor
3. Valve assembly

The EGR valve uses a DC motor to control the position of the valve assembly. The motor pushes directly on the valve assembly. The valve assembly has two valve heads on a common shaft.

The EGR actuator consists of three major components, a valve, an actuator motor, and Integrated Circuit (IC). The IC has three Hall effect position sensors to monitor valve movement. The

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EGR actuator is located at the front of the engine on the intake manifold.

EGR Closed Loop System and Control

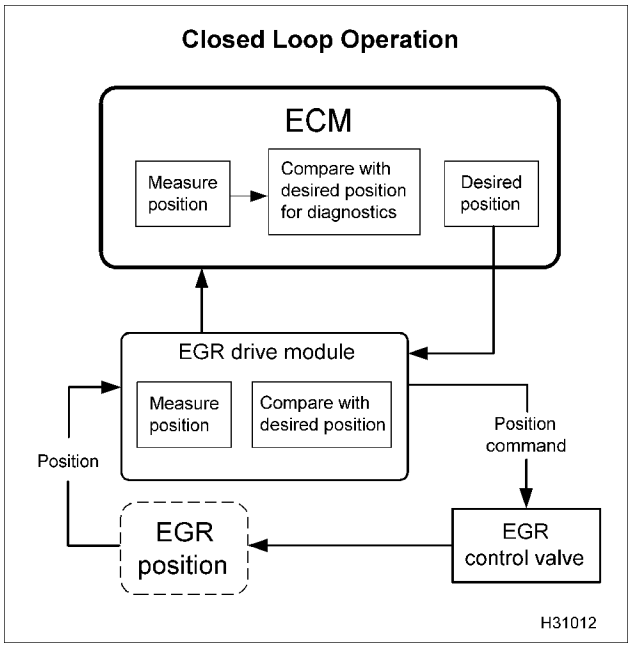


Figure 16 EGR closed loop operation with fault management

The EGR drive module controls the EGR actuator and is located on the left side of the engine on the ECM and Injector Driver Module (IDM).

The EGR drive module receives the desired EGR actuator position from the ECM across the CAN 2 datalink to activate the valve for exhaust gas recirculation. The EGR drive module provides feedback to the ECM on the valve position. The EGR drive module interprets the ECM command and sends the command using three pulse-width modulated signals to the valve actuator.

The system is closed loop control using the EGR position signals.

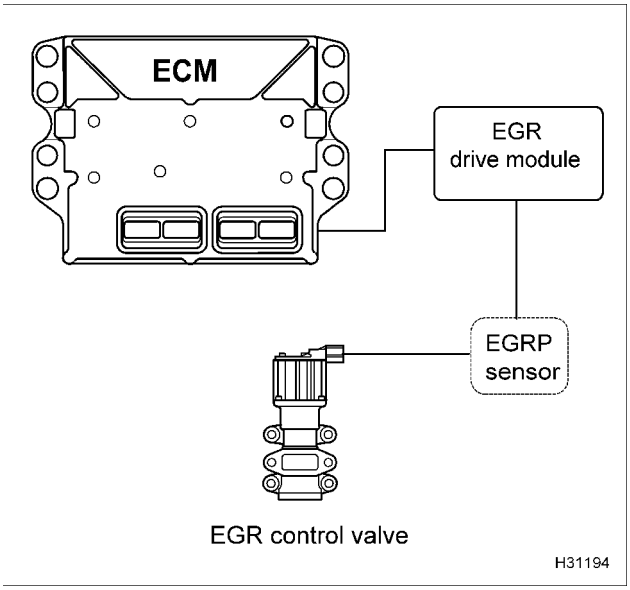


Figure 17 EGR control

Exhaust System

The exhaust system includes the following:

- Exhaust valves
- Exhaust manifold
- Diamond Logic® engine brake
- Variable Geometry Turbocharger (VGT)
- Exhaust piping
- Muffler and catalytic converter – dependent on application
- Catalyzed Diesel Particulate Filter (CDPF) – dependent on application

The exhaust system removes exhaust gases from the engine. Exhaust gases exit from exhaust valves, through exhaust ports, and flow into the exhaust manifold. Expanding exhaust gases are directed through the exhaust manifold. The exhaust manifold directs some exhaust gases into the Exhaust Gas Recirculation (EGR) cooler. Exhaust gases flowing into the turbocharger drive the turbine wheel. Exhaust gases exit the turbocharger and flow into the exhaust piping, through the muffler and catalytic converter or CDPF, depending on application, and out the discharge pipe to the atmosphere.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel Management System

Fuel Management Components

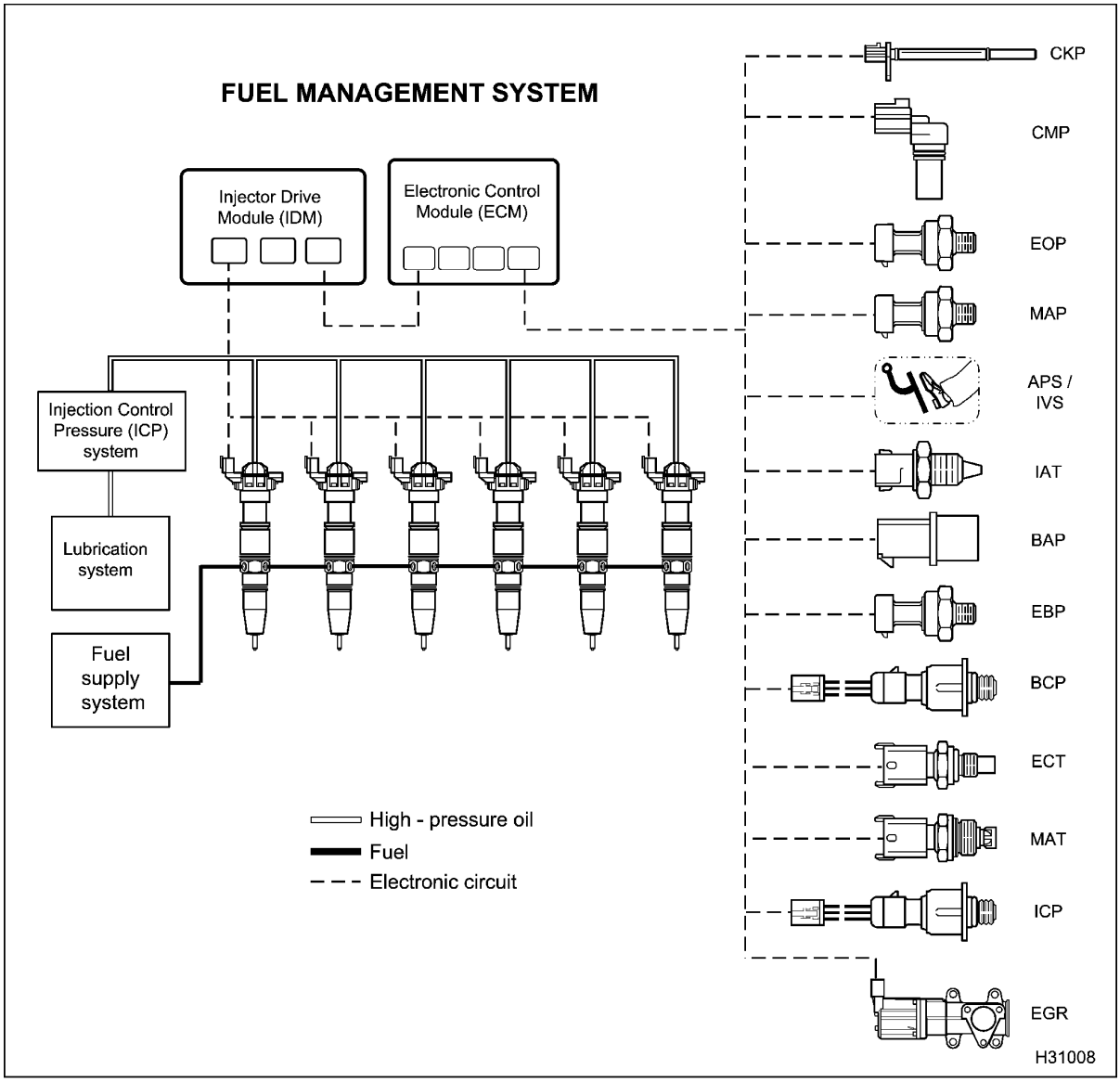


Figure 18 Fuel management system

The fuel management system includes the following:

- Injection Control Pressure (ICP) system
- Fuel supply system
- Fuel injectors
- Lubrication system
- Electronic control system

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Injection Control Pressure (ICP) System Components and High-Pressure Oil Flow

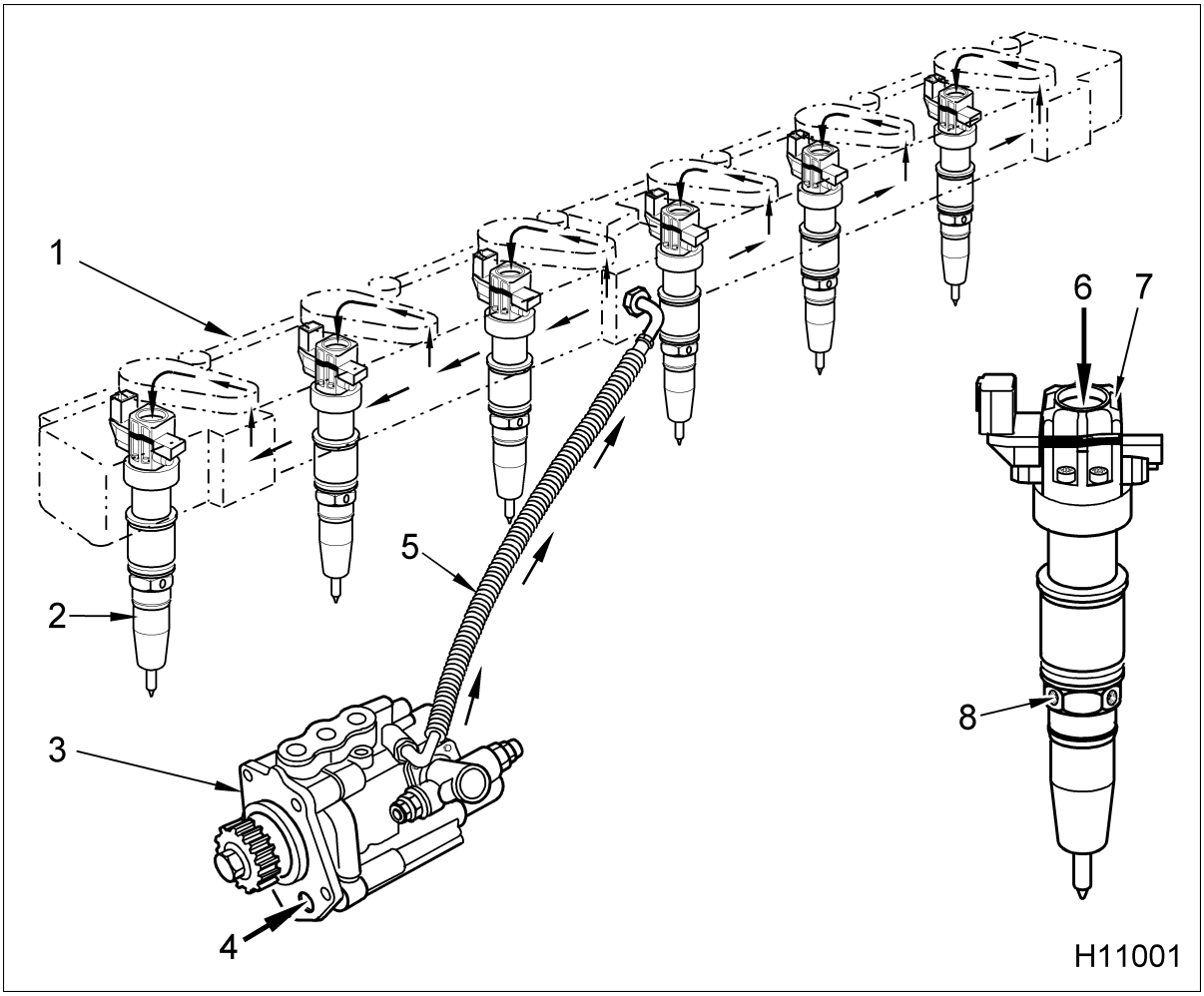


Figure 19 Injection Control Pressure (ICP) system

1. High-pressure oil manifold assembly
2. Fuel injector
3. High-pressure pump assembly
4. Oil inlet (lube oil)
5. High-pressure oil hose
6. High-pressure oil inlet (injector)
7. Oil exhaust port (2)
8. Fuel inlet (4)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

High-Pressure Oil Flow

The oil reservoir in the front cover provides a constant supply of oil to a high-pressure oil pump mounted to the backside of the front cover. Oil drawn from the oil reservoir is constantly refilled by the engine lubrication system.

The gear-driven, high-pressure oil pump delivers oil through a high-pressure oil hose, through a cylinder head passage into the high-pressure oil manifold beneath the valve cover. The manifold distributes to the top of each fuel injector.

When the OPEN coil for each injector is energized, the injectors use high-pressure oil to inject and atomize fuel in the combustion chambers. To end injection, the CLOSE coils are energized. Exhaust oil exits through two ports in the top of the fuel injectors, then drains back to sump.

Injection Control Pressure (ICP) Closed Loop System

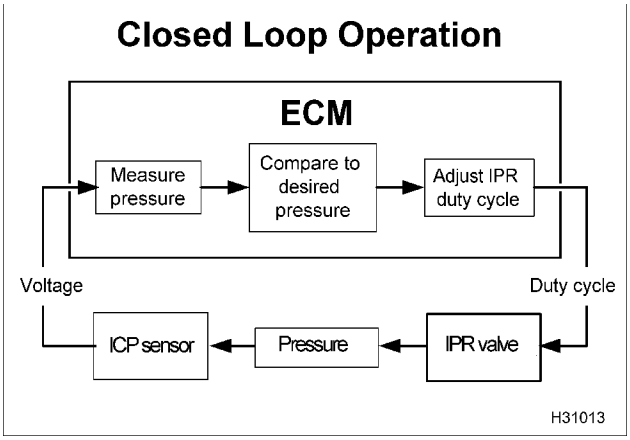


Figure 20 ICP closed loop system

The ICP is a closed loop system that uses the ICP sensor to provide feedback to the ECM. The ECM uses the ICP sensor to continuously monitor injection control pressure and adjust the duty cycle of the IPR valve to match engine requirements.

ICP System Control

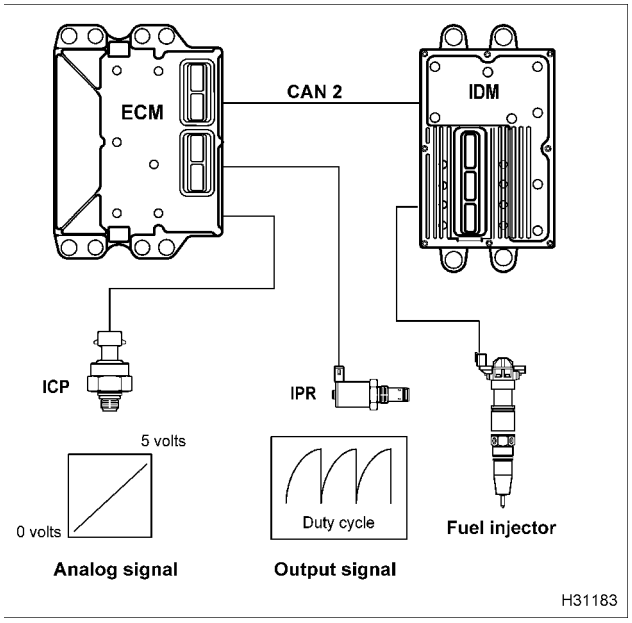


Figure 21 ICP control

ICP Operation

The IPR solenoid receives a pulse-width modulated signal from the ECM that indicates the on and off time the control valve is energized. The pulse is calibrated to control ICP pressure in a range from 5 MPa (725 psi) up to 28 MPa (4,075 psi). Maximum pressure relief occurs at about 32 MPa (4,600 psi).

The IPR valve is mounted in the body of the high-pressure pump. The IPR valve maintains the desired ICP by dumping excess oil back to the crankcase sump.

As demand for ICP increases, the ECM increases the pulse-width modulation to the IPR solenoid. When ICP demand decreases, the ECM decreases the duty cycle to the solenoid, allowing more oil to flow from the drain orifice.

The ECM sets Diagnostic Trouble Codes (DTCs), if the ICP electrical signal is out-of-range. DTCs are also set if an ICP signal corresponds to an out-of-range value for injection control pressure for a given operating condition.

The ECM will ignore ICP signals that are out-of-range and the IPR valve will operate from programmed default values. This is called Open Loop operation.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The ICP sensor is installed under the valve cover, forward of the No. 6 fuel injector in the high-pressure oil rail.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel Injectors

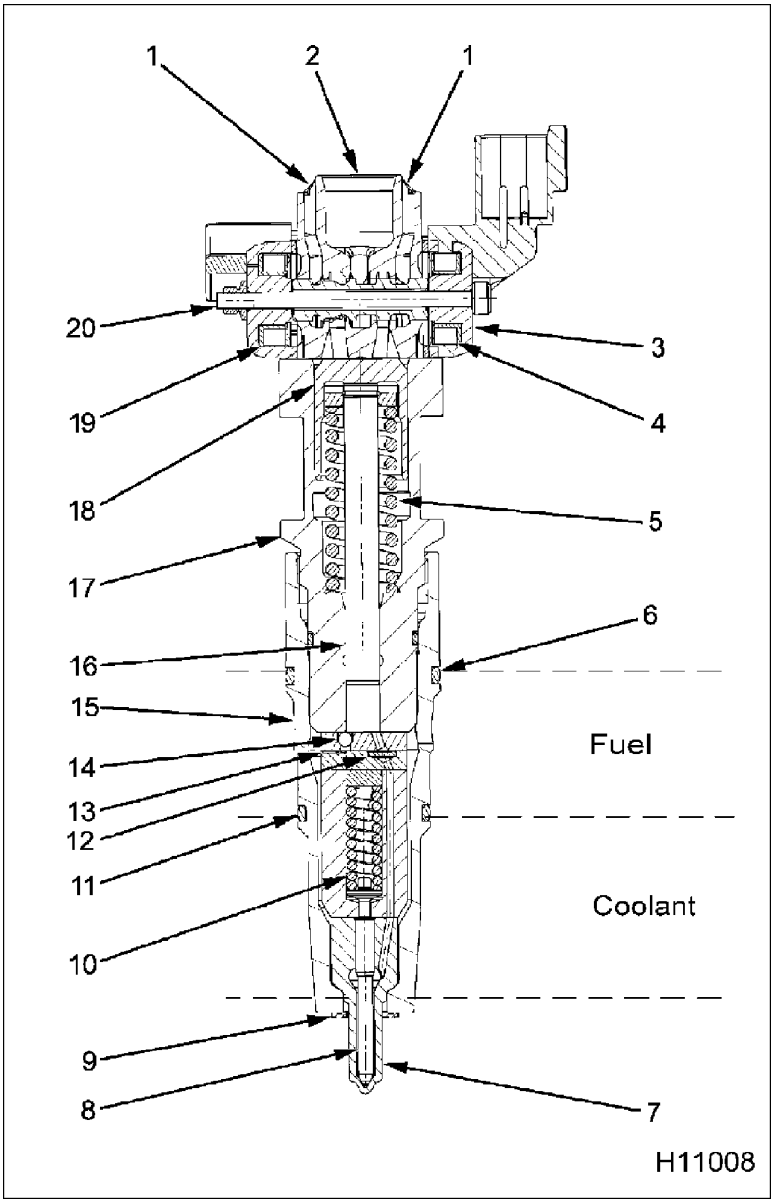


Figure 22 Fuel injector assembly

1. Exhaust port (oil) (2)
2. Inlet port (oil)
3. Control valve body
4. OPEN coil
5. Intensifier piston spring
6. Upper O-ring
7. Nozzle assembly
8. Needle
9. Nozzle gasket
10. Valve Opening Pressure (VOP) spring
11. Lower O-ring
12. Reverse flow check
13. Edge filter
14. Fuel inlet check ball
15. Fuel inlet (4)
16. Plunger
17. Barrel
18. Intensifier piston
19. CLOSE coil
20. Spool valve (control valve)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel Injector Features

Two 48 volt 20 amp coils control a spool valve that directs oil flow in and out of the injector. The injector coils are turned on for approximately 800 µs (microseconds or millionths of a second). Each injector has a single four pin connector that couples to the valve cover gasket assembly.

Injector Coils and Spool Valve

An OPEN coil and a CLOSE coil on the injector move the spool valve from side to side using magnetic force. The spool has two positions:

- When the spool valve is open, oil flows into the injector from the high-pressure oil rail.
- When the spool valve is closed oil exhausts from the top of the fuel injector and drains back to the crankcase.

Intensifier Piston and Plunger

When the spool valve is open, high-pressure oil enters the injector pushing down the intensifier piston and plunger. Since the intensifier piston is 7.1 times greater in surface area than the plunger, the injection pressure is also 7.1 times greater than ICP pressure on the plunger.

Plunger and Barrel

Fuel pressure builds at the base of the plunger in the barrel. When the intensifier piston pushes the plunger down, the plunger increases fuel pressure in the barrel 7.1 times greater than ICP. The plunger has a diamond-like coating to resist scuffing.

Injector Needle

The injector needle opens inward, off its seat when fuel pressure overcomes the Valve Opening Pressure (VOP) of 28 mPa (4,075 psi). Fuel is atomized at high pressure through the nozzle tip.

Fuel Injector Operation

The injection operation has three stages:

- Fill stage
- Main injection
- End of main injection

Fill Stage

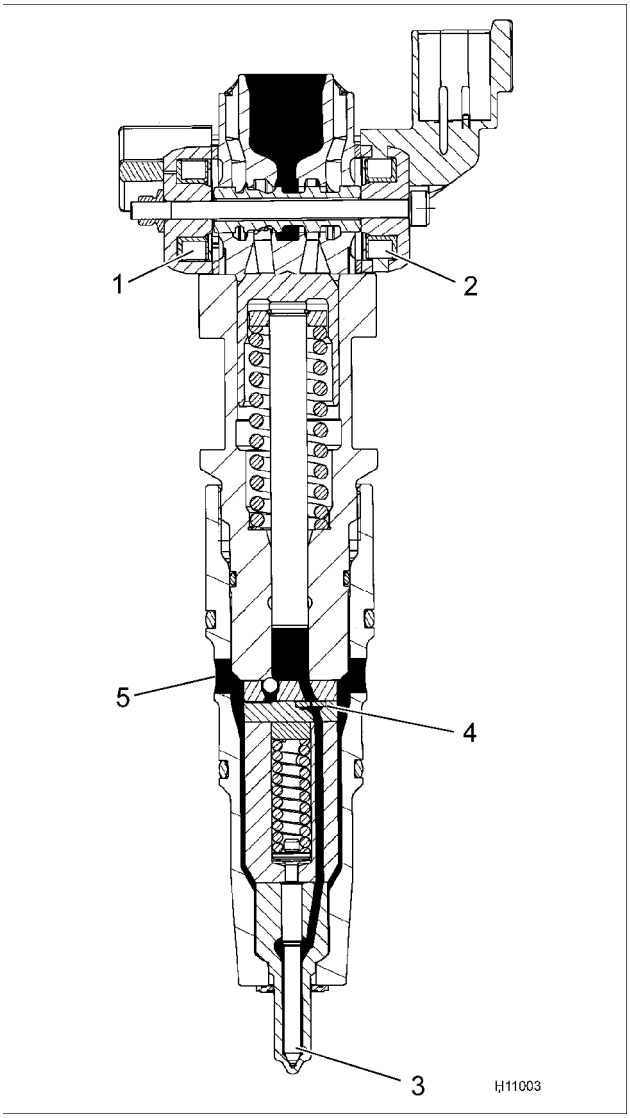


Figure 23 Fill stage

1. CLOSE coil (off)
2. OPEN coil (off)
3. Needle (seated)
4. Disk check (seated)
5. Fuel inlet (4)

During the fill stage both coils are de-energized and the spool valve is closed. High-pressure oil from the high-pressure oil rail is deadheaded at the spool valve.

Low-pressure fuel fills the four ports and enters through the edge filter on its way to the chamber

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

beneath the plunger. The needle control spring holds the needle onto its seat to prevent fuel from entering the combustion chamber.

Main Injection (Step 1)

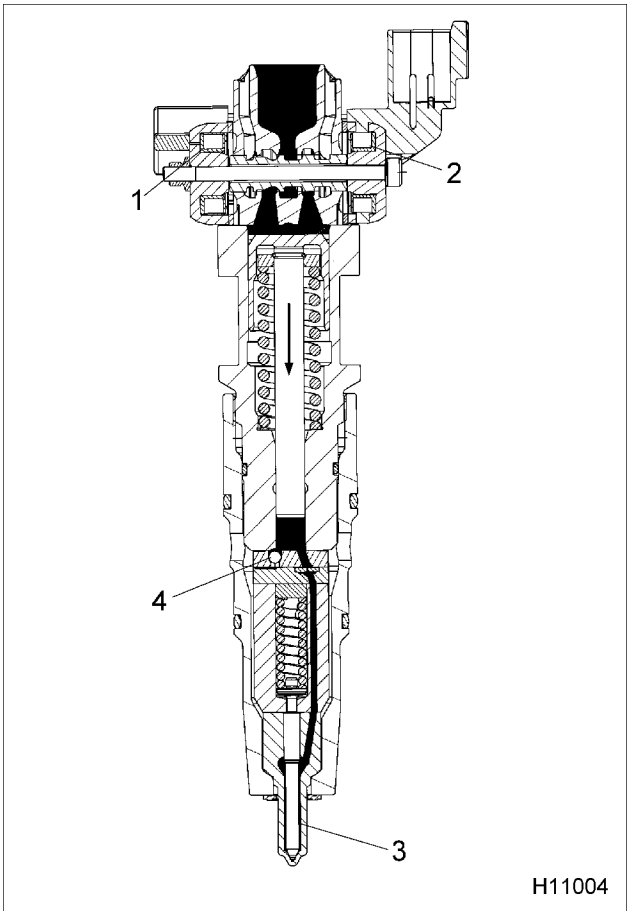


Figure 24 Main injection (Step 1)

1. CLOSE coil (off)
2. OPEN coil (on)
3. Needle (seated)
4. Fuel inlet check ball (seated)

A pulse-width controlled current energizes the OPEN coil. Magnetic force moves the spool valve open. High-pressure oil flows past the spool valve and onto the top of the intensifier piston. Oil pressure overcomes the force of the intensifier piston spring and the intensifier starts to move down. An increase in fuel pressure under the plunger seats the fuel inlet check ball, and fuel pressure starts to build on the needle.

Main Injection (Step 2)

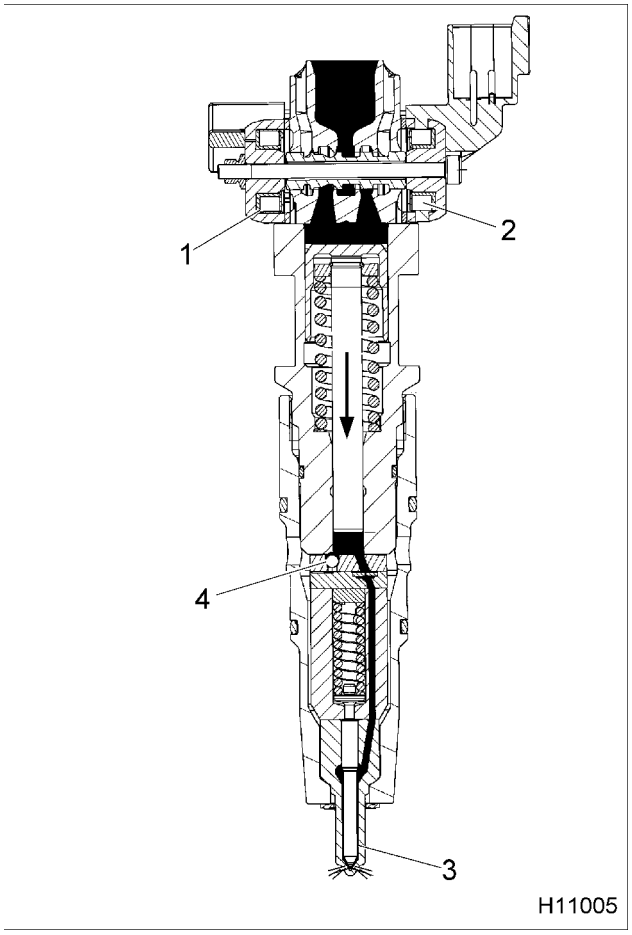


Figure 25 Main injection (Step 2)

1. CLOSE coil (off)
2. OPEN coil (off)
3. Needle (unseated – VOP)
4. Fuel inlet check ball (seated)

The pulse-width controlled current to the OPEN coil is shut off, but the spool valve remains open. High pressure oil from high pressure oil rail continues to flow past the spool valve. The intensifier piston and plunger continue to move and fuel pressure increases in the barrel. When fuel pressure rises above the VOP - about 28 MPa (4,075 psi) - the needle lifts of its seat and injection begins.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

End of Main Injection (Step 1)

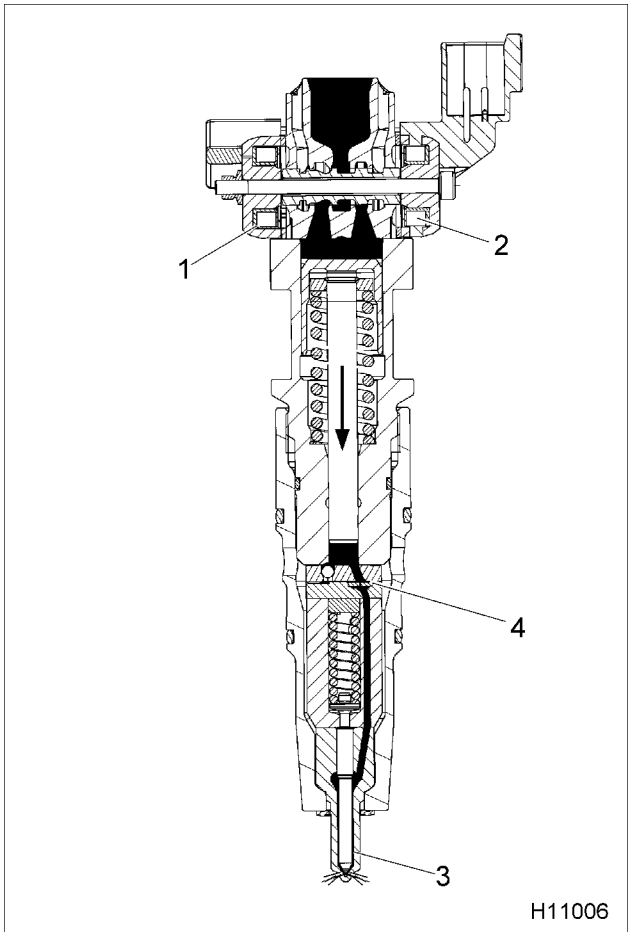


Figure 26 End of main injection (Step 1)

1. CLOSE coil (on)
2. OPEN coil (off)
3. Needle (unseated / closing)
4. Check disk (seated)

When the Injector Drive Module (IDM) determines that the correct injector on-time has been reached (the correct amount of fuel has been delivered), the IDM sends a pulse-width controlled current to the CLOSE coil of the injector. The current energizes the CLOSE coil and magnetic force closes the spool valve. High-pressure oil is deadheaded against the spool valve.

End of Main Injection (Step 2)

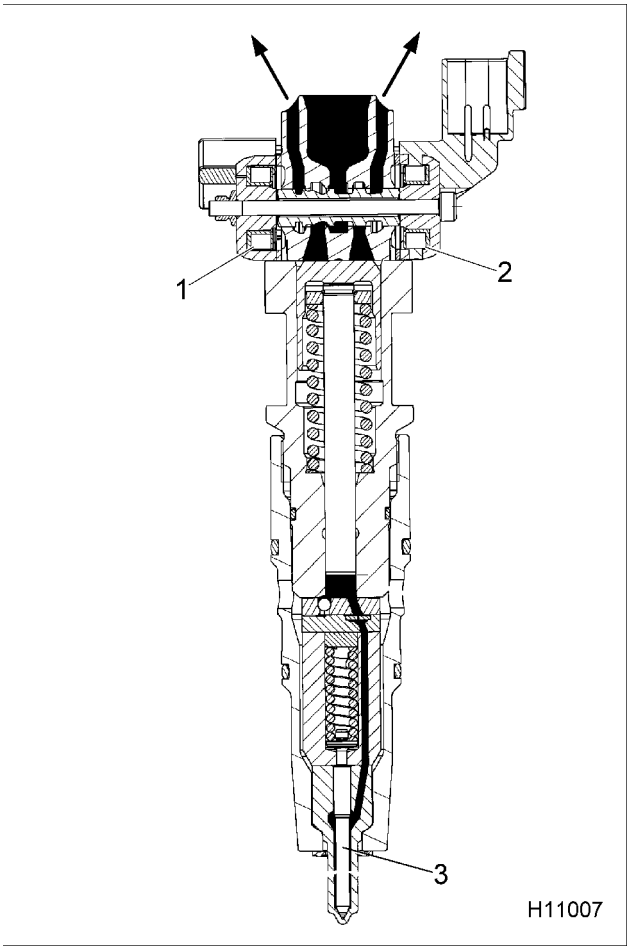


Figure 27 End of main injection (Step 2)

1. CLOSE coil (off)
2. OPEN coil (off)
3. Needle (seated)

The pulse-width controlled current to close the coil is shut off, but the spool valve remains closed. The intensifier piston and plunger return to their initial positions. Oil above the intensifier piston flows past the spool valve through the exhaust ports. Fuel pressure decreases until the needle control spring forces the needle back onto its seat.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel Supply System

Fuel System Components and Fuel Flow

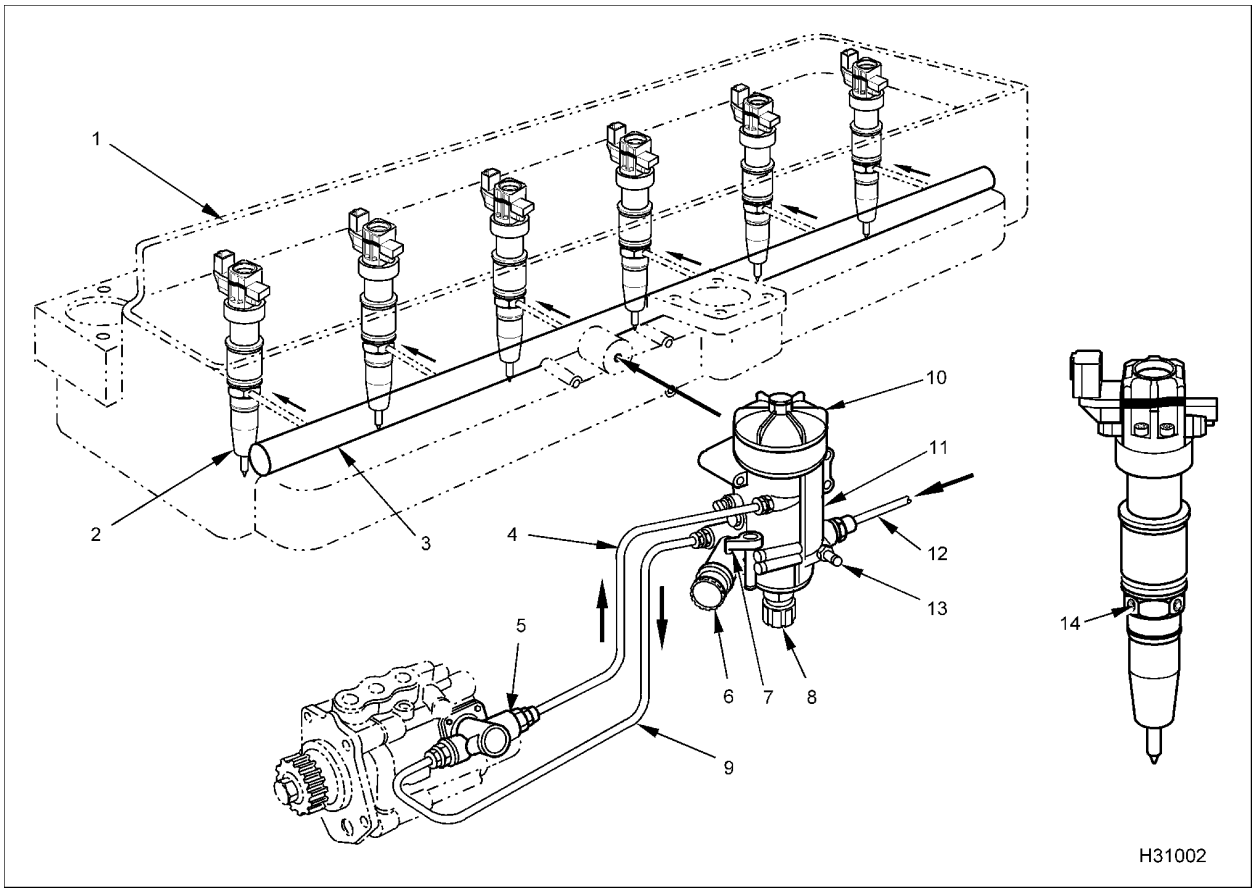


Figure 28 Fuel supply system

1. Cylinder head assembly
2. Fuel injector
3. Low-pressure fuel rail
4. Transfer pump outlet tube assembly
5. Transfer pump fuel supply pump
6. Primer pump assembly
7. Water drain valve
8. Drain valve (fuel)
9. Transfer pump inlet tube assembly
10. Fuel filter access cap
11. Fuel filter header assembly
12. Fuel line from tank
13. Test fitting
14. Fuel inlet (4)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel Flow Schematic

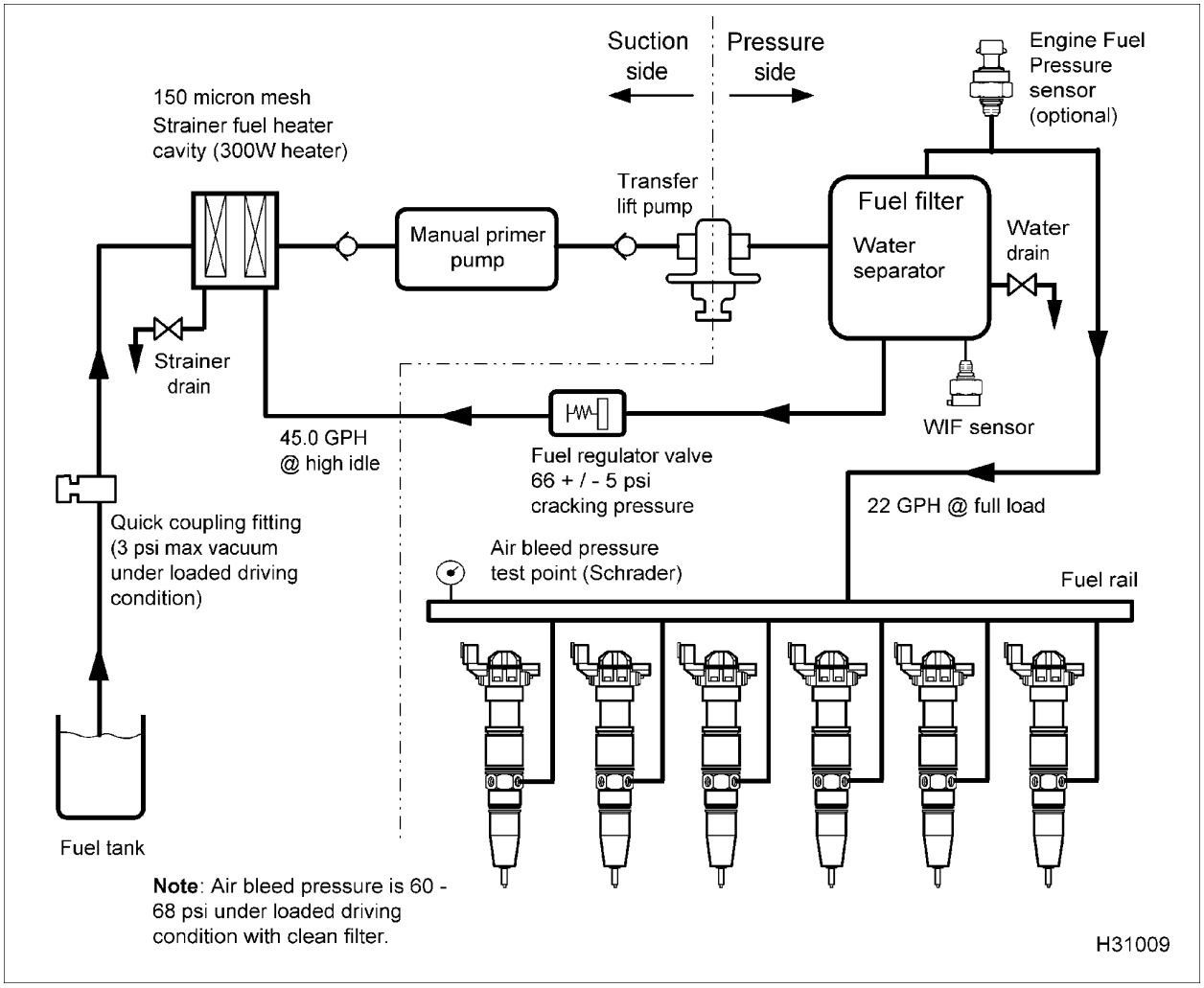


Figure 29 Fuel flow

The fuel filter housing includes the following components:

- 150 micron fuel strainer
- 300 W fuel heating element (optional)
- Primer pump assembly
- Fuel filtering element
- Water separator
- Water In Fuel (WIF) sensor
- Water drain valve
- Fuel pressure regulator
- Engine Fuel Pressure (EFP) sensor (optional)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel Flow

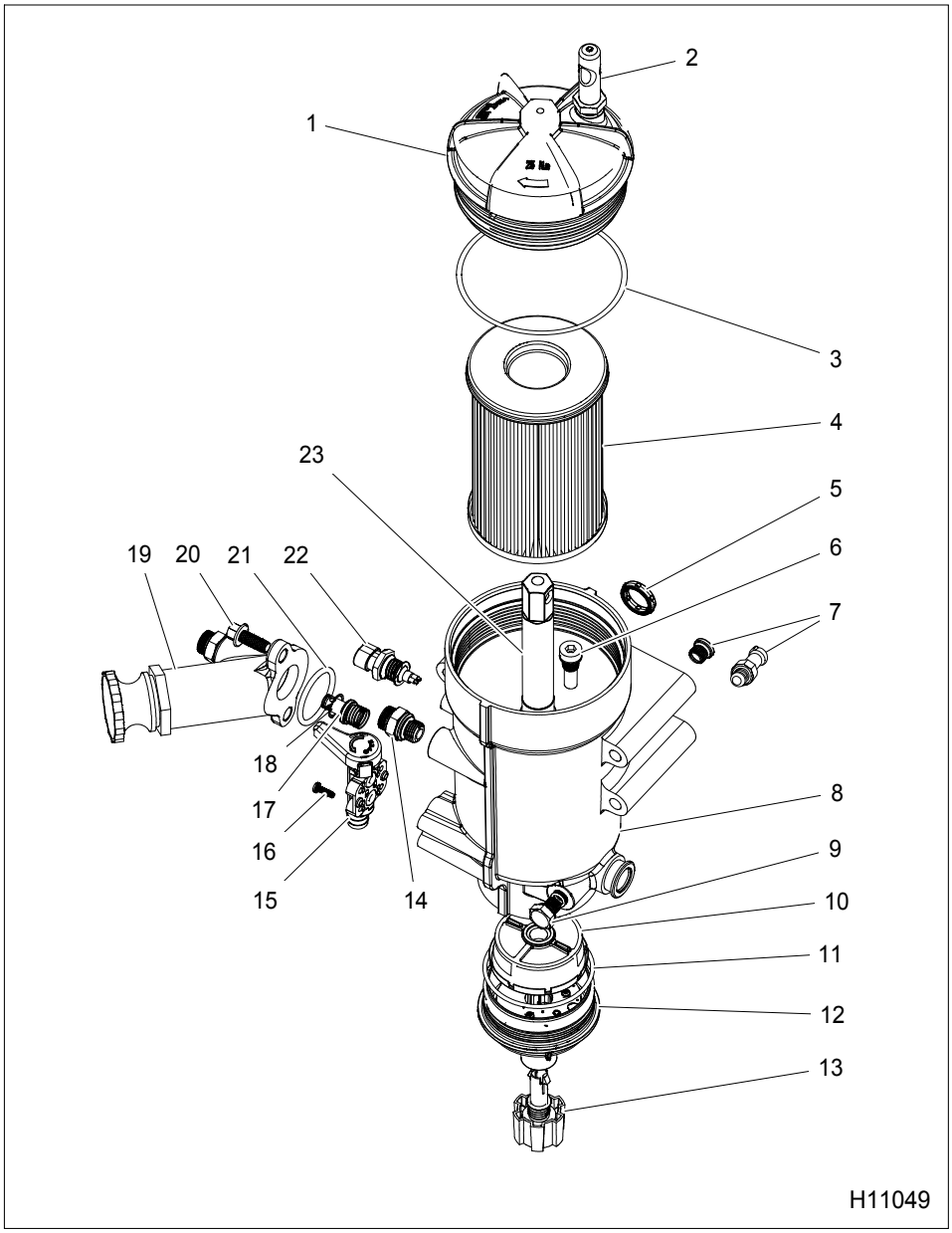


Figure 30 Fuel filter assembly

1. Housing cover assembly
2. M12 port fitting (factory fill)
3. O-ring seal
4. Fuel filter element
5. O-ring seal
6. Fuel pressure regulator assembly
7. Plug or EFP sensor (optional)
8. Fuel filter housing
9. Plug assembly, M10
10. Fuel strainer
11. Bowl O-ring seal
12. Fuel bowl (with heater option)
13. Drain valve
14. Fitting assembly, ⅜ tube
15. Water drain valve assembly
16. Self tapping screw (4)
17. Cartridge check valve
18. Retainer ring
19. Primer pump assembly
20. Bolt, M8 x 20 (2)
21. Primer pump seal
22. Water In Fuel (WIF) sensor
23. Stand pipe

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NOTE: Early fuel filter assemblies may have item 2 in the location of item 9. Item 2 is used by the assembly plants as a fuel fill.

- If item 2 is installed on housing cover assembly, it can be used to measure unfiltered fuel pressure.
- If item 2 is installed in item 9 location, it can be used to measure fuel inlet restriction.

The low-pressure fuel supply pump draws fuel from the fuel tank through a 150 micron strainer in the fuel filter assembly.

An optional electric heating element in the fuel filter housing warms incoming fuel to prevent waxing.

If water is in the fuel, the filter element repels water molecules, water collects at the bottom of the element cavity in the fuel filter housing, and a Water In Fuel (WIF) sensor in the element cavity detects water in the fuel. When enough water accumulates in the element cavity, the WIF sensor signal changes to the Electronic Control Module (ECM). The ECM sends a message to illuminate the amber water and fuel lamp, alerting the operator. A fuel drain valve handle on the housing can be opened to drain contaminants (usually water) from the fuel filter housing. Another drain valve in the bottom of the housing drains strainer cavity.

A built-in fuel regulator valve, calibrated to open at about 414 - 482 kPa (60 - 70 psi), regulates and relieves excessive pressure. During idle and light engine loads, when injector demand is low, most of the fuel is recycled between the fuel filter housing and fuel pump. When engine demand increases, engine fuel consumption increases resulting in less fuel recycling. Under heavy loads fuel flows through the filter with little or no recycling.

Fuel is conditioned as it flows through a main filter and stand-pipe. The stand-pipe prevents fuel from draining from the fuel rail during servicing.

An optional Engine Fuel Pressure (EFP) sensor detects low pressure caused by high fuel filter restriction and sends a signal to the ECM. The ECM illuminates the amber FUEL FILTER lamp on the instrument panel.

Fuel flows from the fuel filter housing into the fuel rail, through the fuel rail into six separate passages, one for each injector.

When the fuel injectors are activated, fuel flows (from fuel rail) into four inlets in each injector.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Engine Lubrication System

Lubrication System Components and Oil Flow

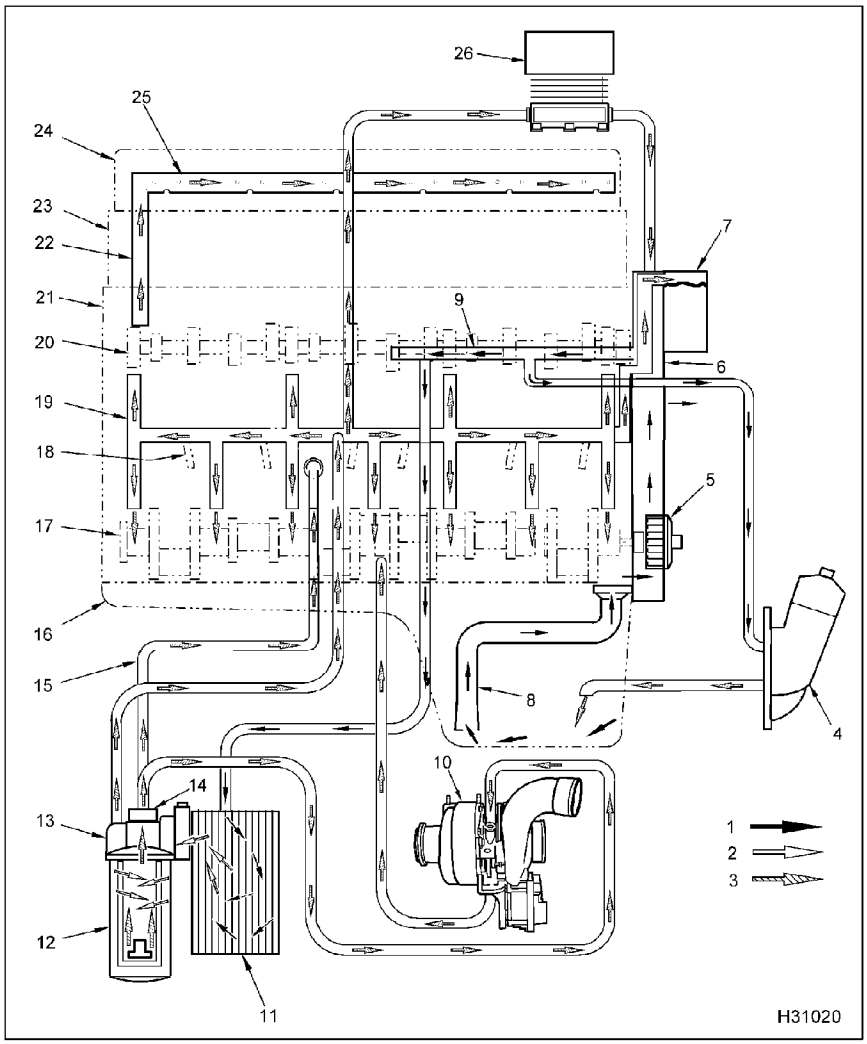


Figure 31 Lubrication system

1. Unfiltered oil
2. Cooled unfiltered oil
3. Filtered oil
4. Secondary filtration filter (optional)
5. Gerotor oil pump
6. Front cover
7. Reservoir for high-pressure oil pump
8. Pick-up tube
9. Unfiltered oil gallery
10. Variable Geometry Turbocharger (VGT)
11. Oil cooler
12. Oil filter
13. Oil cooler / filter header assembly
14. Oil pressure regulator relief valve
15. Regulator relief valve drain to crankcase
16. Oil pan assembly
17. Crankshaft
18. Piston cooling tube (6)
19. Main filtered oil gallery
20. Camshaft
21. Crankcase
22. Vertical gallery
23. Cylinder head
24. Valve cover
25. Rocker arm assembly
26. Air compressor (optional)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Oil Flow Diagram

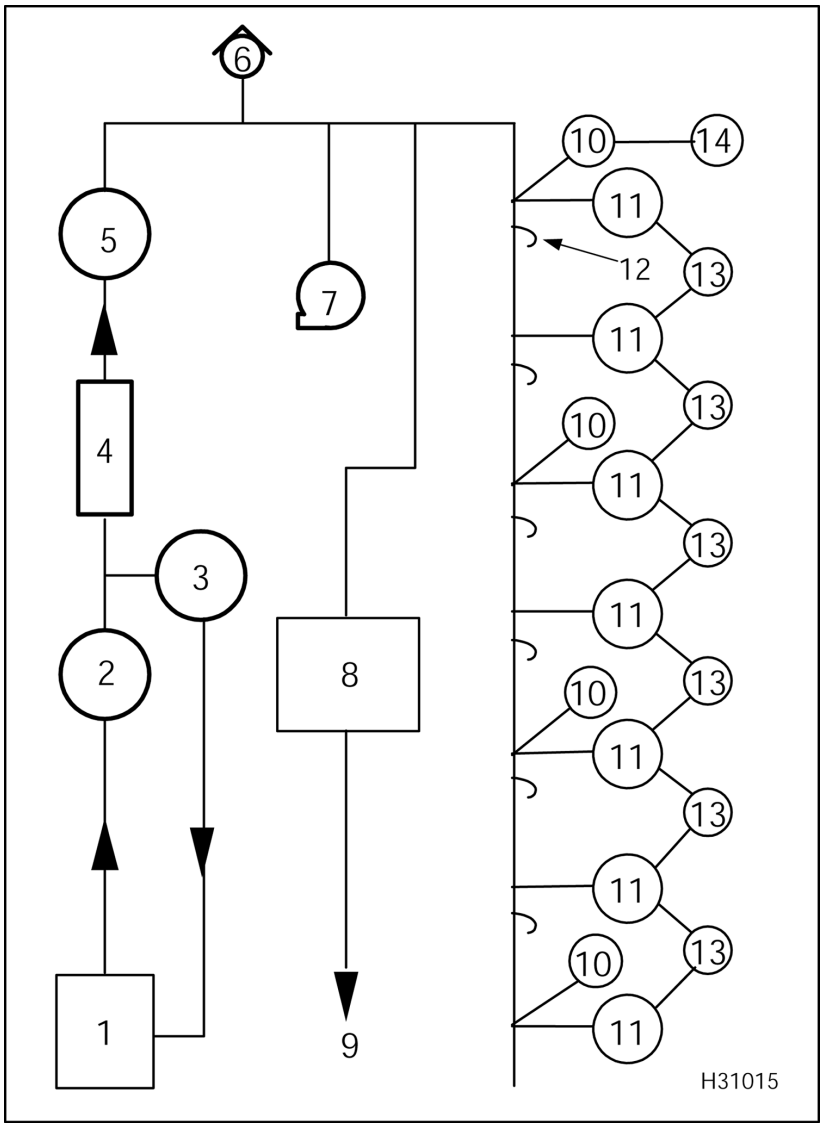


Figure 32 Lubrication system

1. Sump
2. Oil pump
3. Secondary filter
4. Oil cooler
5. Oil filter
6. Oil pressure regulator relief valve
7. Variable Geometry Turbocharger (VGT)
8. Oil reservoir for high-pressure pump
9. To high-pressure oil system
10. Cam bearing
11. Main bearings
12. Piston cooling tube (6)
13. Connecting rods
14. Rocker arm shaft

The gerotor oil pump, driven by the engine crankshaft, draws unfiltered oil from the oil pan through an oil pick-up tube into the inlet port of the front cover. Unfiltered oil (under pressure) flows through the outlet port in the front cover into the unfiltered oil gallery in the crankcase.

The unfiltered oil gallery has one exit port to the header of the oil cooler. The oil is then internally

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

diverted to the oil cooler plate stack or by-passed into the oil cooler/filter module.

An oil temperature control valve, in the oil cooler/filter header, senses inlet oil temperature. During engine start-up, when the oil is cold, the oil temperature control valve allows unfiltered oil to bypass the oil cooler plate stack. When the unfiltered oil reaches engine operating temperature, the oil temperature control valve routes unfiltered oil to the oil cooler. Oil flows through both the oil cooler core and bypass gallery when the valve is partially open.

Unfiltered oil at full flow moves through plates in the oil cooler. Engine coolant flows through the plates to cool the surrounding oil.

The cooled, unfiltered oil leaving the oil cooler stack mixes with the uncooled, unfiltered oil (that bypassed the oil cooler). The oil mixture flows through the oil filter (from element outside to element inside). The oil filter bypass valve in the header ensures full flow of oil to the engine should the filter element become plugged. Oil bypass occurs within the module when differential filter pressure reaches 345 kPa (50 psi).

Cooled, filtered oil flows to and past the oil pressure regulator relief valve, in the oil cooler module. The oil pressure regulator valve maintains correct operating oil pressure.

The pressure regulator valve opens at 379 kPa (55 psi) and dumps excess oil into the crankcase. The filtered oil continues to the main oil gallery for distribution throughout the engine.

Connecting rod bearings are fed through drilled passages in the crankshaft from main journals to rod journals, that receive pressurized oil from the main bearings.

Camshaft journals are fed through passages drilled vertically in the main bearing webs. Pressurized oil from the main gallery, through piston cooling tubes, lubricates and cools the pistons.

Valve rocker arms are lubricated through an annulus on the outside of the rear camshaft bushing. The oil passes up and through the vertical gallery in the rear of the crankcase, through a passage in the cylinder head. Oil continues through rocker arm shaft pedestal and into the rocker arm shaft. Oil continues flowing through drillings in the rocker arm shaft to the rocker arms. The oil then drains to the oil pan sump through push rod holes.

Filtered oil from the main gallery flows up through a passage in the front of the crankcase and front cover into the oil reservoir for the high-pressure oil pump.

The turbocharger receives filtered oil through an external tube connected to the oil cooler header. Oil drains back to the oil pan sump through a tube connected to the crankcase.

The air compressor (if equipped) receives filtered oil from the main oil gallery through an external tube connected to the left side of the crankcase. Oil drains to the front cover and back to the oil pan.

The front gear train is splash lubricated with oil draining from the high-pressure reservoir and the air compressor (if equipped).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Cooling System

Cooling System Components and Coolant Flow

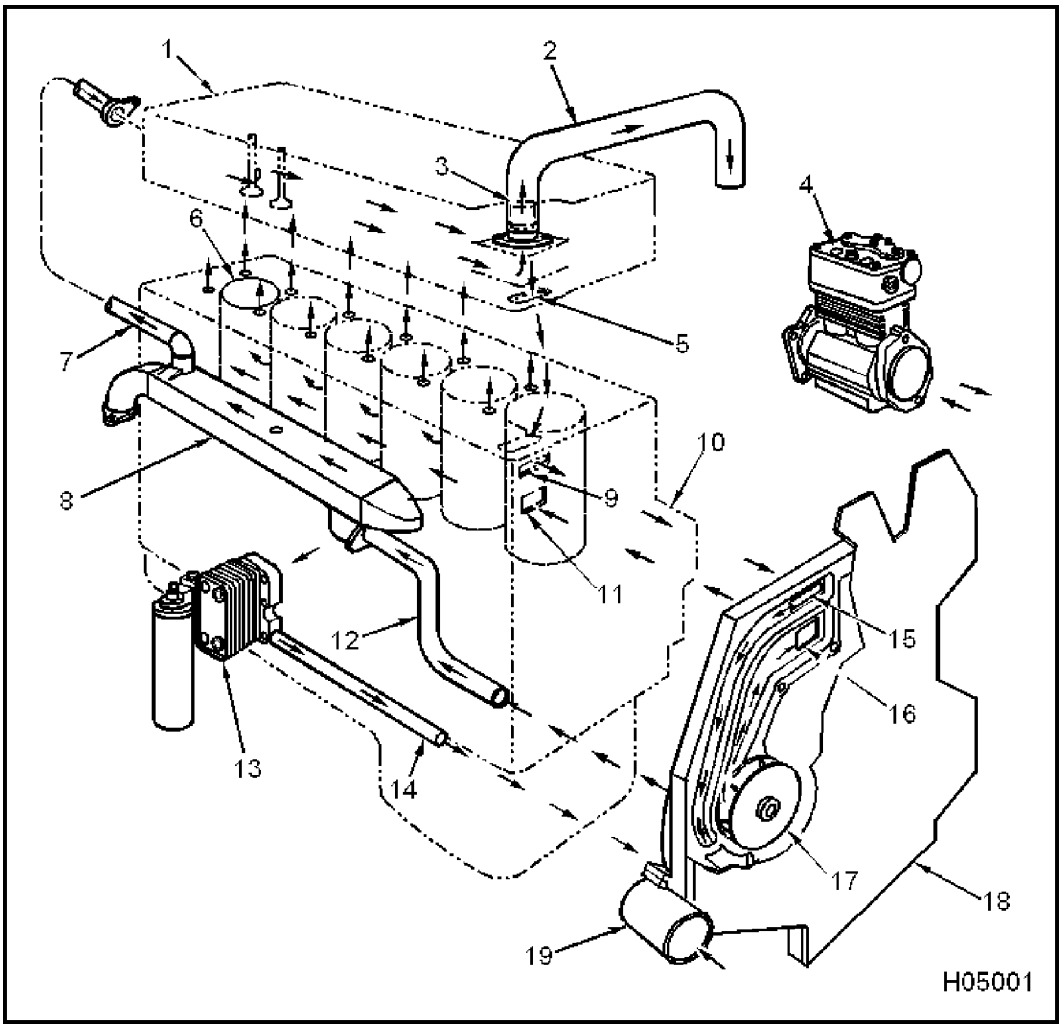


Figure 33 Engine cooling system

1. Cylinder head assembly
2. Water outlet tube assembly (thermostat outlet)
3. Thermostat assembly
4. Air compressor
5. Water return from cylinder head to crankcase
6. Cylinder sleeve
7. EGR cooler return tube assembly
8. EGR cooler assembly
9. Water outlet from crankcase to front cover
10. Crankcase
11. Water inlet to crankcase
12. EGR cooler supply tube
13. Oil module assembly
14. Oil cooler tube
15. Water inlet to front cover and water pump
16. Water supply from front cover to crankcase
17. Water pump impeller assembly
18. Front cover
19. Water inlet elbow

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Cooling System Flow

The cooling system keeps the engine within a designated temperature range. The major components of the cooling system include the following:

- Radiator and fan combination (chassis components)
- Water pump assembly
- Thermostat assembly
- Oil system module assembly
- EGR cooler assembly

A belt-driven centrifugal water pump is set into the front cover. The front cover has three related passages. One passage channels coolant from the water pump to the crankcase, the second returns coolant to the water pump, and the third (a bypass) channels coolant back to the water pump when the thermostat is closed.

Incoming coolant flows from the bottom of the radiator through a water inlet elbow to the front cover and water pump. Coolant is pumped to the crankcase through a passage in the front cover and crankcase.

Water jackets in the crankcase direct coolant from front to rear, distributing coolant evenly to the lower sections of the cylinder sleeves. Coolant flow is directed tangent to each cylinder sleeve, causing a swirling motion up to the cylinder head. The swirling action improves heat absorption.

Coolant flows from the cylinder sleeve areas in three ways:

- Coolant flows into the oil system module assembly through the right side of the crankcase, passes through the oil system module, and returns through a tube to the front cover.
- Coolant is routed through hoses to and from the air compressor on the left side of the crankcase.
- Coolant exits the crankcase at the upper end of each cylinder sleeve bore and is distributed evenly through metering holes in the cylinder head gasket. Coolant then flows through the cylinder head (back to front) to the thermostat.

The EGR cooler receives coolant from the front cover. Coolant flows from the front of the cooler and exits the rear of the cooler into the rear of the cylinder head. A deaeration port is on top of the EGR cooler.

Thermostat Operation

The thermostat has two outlets. One directs coolant to the radiator when the engine is at operating temperature. The other directs coolant to the water pump until the engine reaches operating temperature. The thermostat begins to open at 88 °C (190 °F) and is fully open at 96 °C (205 °F).

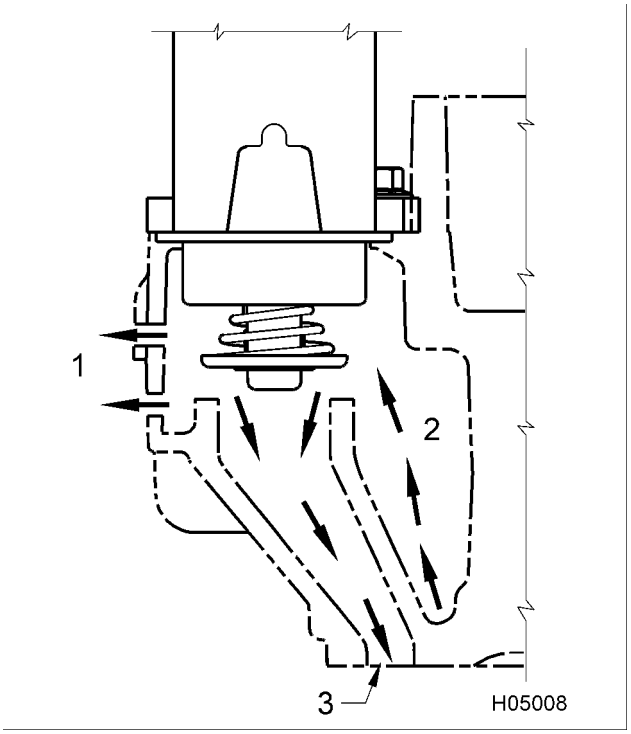


Figure 34 Thermostat closed

1. Coolant flow to heater port
2. Coolant in from engine
3. Bypass to water pump

When engine coolant is below the 88 °C (190 °F) the thermostat is closed, blocking flow to the radiator. Coolant is forced to flow through a bypass port back to the water pump.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

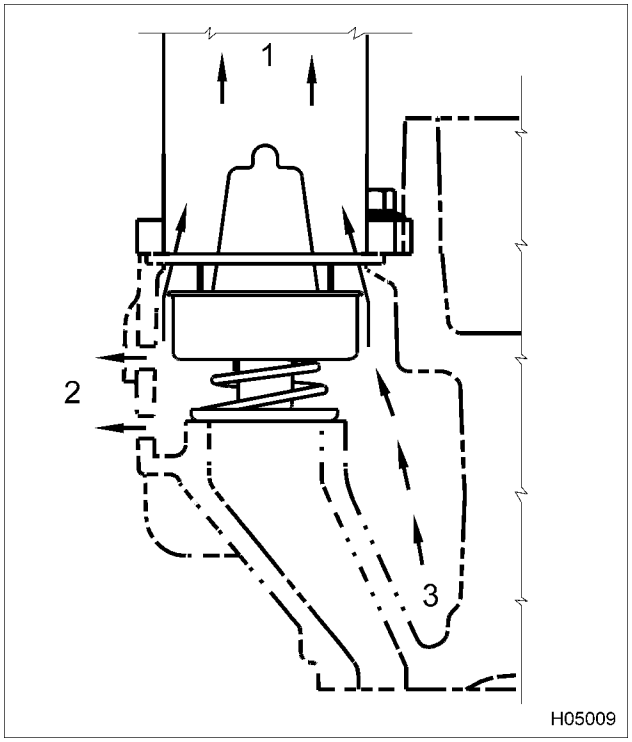


Figure 35 Thermostat open

1. Coolant out to radiator
2. Coolant flow to heater port
3. Coolant in from engine

When coolant temperature reaches the nominal opening temperature (88 °C [190 °F]) the thermostat opens allowing some coolant to flow to the radiator. When coolant temperature exceeds 96 °C (205 °F), the lower seat blocks the bypass port directing full coolant flow to the radiator.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Electronic Control System

Electronic Control System Components

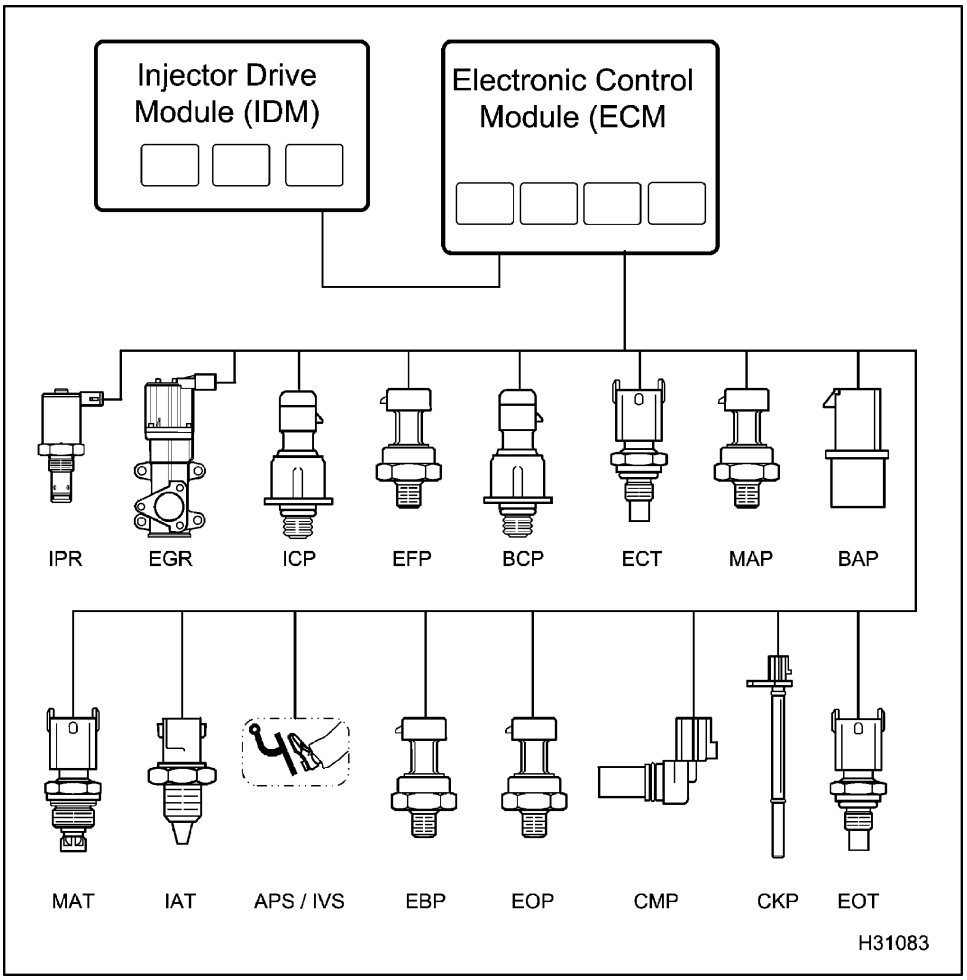


Figure 36 Electronic Control System

Operation and Function

The Electronic Control Module (ECM) monitors and controls engine performance to ensure maximum performance and adherence to emissions standards. The ECM has four primary functions:

1. Provides Reference Voltage (V_{REF})
2. Conditions input signals
3. Processes and stores control strategies
4. Controls actuators

1. Voltage reference(V_{REF})

The ECM supplies a 5 volt V_{REF} signal to input sensors in the electronic control system. By comparing the 5 volt V_{REF} signal sent to the sensors with their respective returned signals, the ECM determines pressures, positions, and other variables important to engine and vehicle functions.

The ECM supplies two independent circuits for V_{REF}:

- V_{REF} A supplies 5 volts to engine sensors
- V_{REF} B supplies 5 volts to vehicle sensors

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

2. 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.

3. Microprocessor

The ECM microprocessor stores operating instructions (control strategies) and value tables (calibration parameters). The ECM compares stored instructions and values with conditioned input values to determine the correct operating strategy for all engine operations.

Continuous calculations in the ECM occur at two different levels or speeds: Foreground and Background.

- Foreground calculations are much faster than background calculations and are normally more critical for engine operation. Engine speed control is an example.
- Background calculations are normally variables that change at slower rates. Engine temperature is an example.

Diagnostic Trouble Codes (DTCs) are generated by the microprocessor, if inputs or conditions do not comply with expected values.

Diagnostic strategies are also programmed into the ECM. Some strategies monitor inputs continuously and command the necessary outputs to achieve the correct performance of the engine.

Microprocessor Memory

The ECM microprocessor includes Read Only Memory (ROM) and Random Access Memory (RAM).

ROM

ROM stores permanent information for calibration tables and operating strategies. Permanently stored information cannot be changed or lost by turning the ignition switch to OFF or when ECM power is interrupted. ROM includes the following:

- Vehicle configuration, modes of operation, and options
- Engine Family Rating Code (EFRC)
- Engine warning and protection modes

RAM

RAM stores temporary information for current engine conditions. Temporary information in RAM is lost when the ignition switch is turned to OFF or when ECM power is interrupted. RAM information includes the following:

- Engine temperature
- Engine rpm
- Accelerator pedal position

4. 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, the drivers complete a ground or power circuit to an actuator.

Actuators are controlled in three ways, determined by the kind of actuator.

- A duty cycle (percent time on/off)
- A controlled pulse-width
- Switched on or off

ECM Control of Engine Operation

The ECM controls engine operation with the following:

- Variable Geometry Turbocharger (VGT) control module
- EGR drive module and control valve
- Diamond Logic® engine brake (brake shut-off valve)
- IPR valve
- Inlet Air Heater (IAH) assembly

Variable Geometry Turbocharger (VGT) Control Module

The VGT control module controls vane position in the turbine housing. Vane position is controlled by a switching voltage source in the ECM. The ground circuit is supplied directly from the battery ground at all times.

The actuator control is set by a pulse-width modulated signal in response to engine speed, desired fuel quantity, boost or exhaust back pressure and altitude.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Exhaust Gas Recirculation (EGR) Control Valve

The EGR valve controls the flow of exhaust gases into the inlet and EGR mixer duct.

The EGR drive module controls the EGR actuator.

The EGR drive module receives the desired EGR actuator position from the ECM across the CAN 2 datalink to activate the valve for exhaust gas recirculation. The EGR drive module provides feedback to the ECM on the valve position.

The EGR drive module constantly monitors the EGR actuator. When an EGR control error is detected, the EGR drive module sends a message to the ECM and a DTC is set.

Brake Shut-off Valve

The brake shut-off valve controls pressure in the oil gallery of the high-pressure oil rail. When the engine brake is activated, the ECM provides power to activate the brake shut-off valve to allow oil from the injector oil gallery to flow to the brake oil gallery. High oil pressure activates the brake actuator pistons to open the exhaust valves.

Injection Pressure Regulator (IPR)

The IPR valve controls pressure in the Injection Control Pressure (ICP) system. The IPR valve is a variable position valve controlled by the ECM. This regulated pressure actuates the fuel injectors. The valve position is controlled by switching the ground circuit in the ECM. The voltage source is supplied by the ignition switch.

Inlet Air Heater (IAH)

The IAH system warms the incoming air supply prior to cranking to aid cold engine starting and reduce white smoke during warm-up.

The ECM is programmed to energize the IAH elements through the IAH relays while monitoring certain programmed conditions for engine coolant temperature, engine oil temperature, and atmospheric pressure.

Injection Drive Module (IDM)

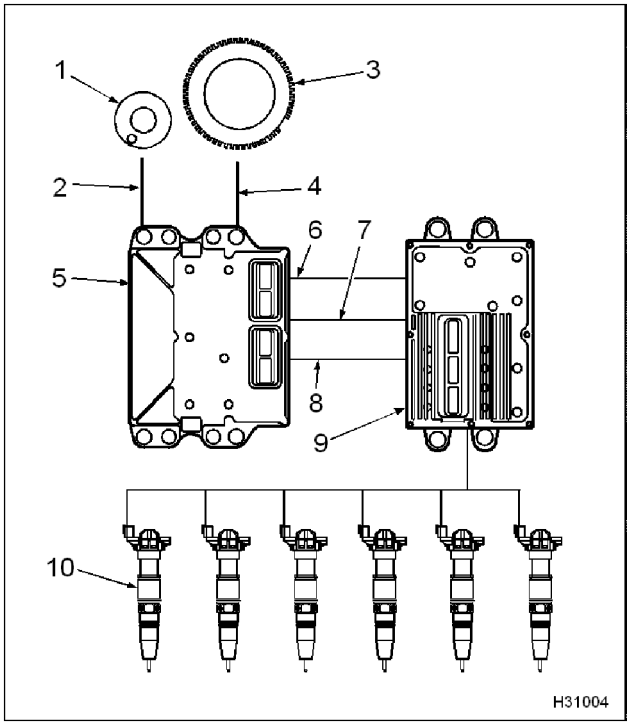


Figure 37 Injection Drive Module (IDM)

1. Camshaft with peg
2. Camshaft Position (CMP) signal
3. Crankshaft position sensor timing disk
4. Crankshaft Position (CKP) signal
5. Electronic Control Module (ECM)
6. Camshaft Position Output (CMPO) signal
7. Crankshaft Position Output (CKPO) signal
8. Controller Area Network (CAN 2) communication
9. Injection Drive Module (IDM)
10. Fuel injectors

The IDM has three functions:

- Electronic distributor for injectors
- Power source for injectors
- IDM and injector diagnostics

Electronic Distributor for Injectors

The IDM distributes current to the injectors. The IDM controls fueling to the engine by sending high voltage pulses to the OPEN and CLOSE coils of the injector. The IDM uses information from the ECM to determine the timing and quantity of fuel for each injector.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The ECM uses CMP and CKP input signals to calculate engine speed and position. The ECM conditions both input signals and supplies the IDM with CMP and CKP output signals. The IDM uses CMP and CKP output signals to determine the correct sequence for injector firing.

The ECM sends information (fuel volume, EOT, and ICP) through the CAN 2 datalink to the IDM; the IDM uses this information to calculate the injection cycle.

Injector Power Source

The IDM creates a constant 48 volt (DC) supply to all injectors by making and breaking a 12 volt source across a coil in the IDM. The 48 volts created by the collapsed field is stored in capacitors until used by the injectors.

The IDM controls when the injector is turned on and how long the injector is active. The IDM first energizes the OPEN coil, then the CLOSE coil. The low side driver supplies a return circuit to the IDM for each injector coil (open and close). The high side driver controls the power supply to the injector. During each injection event, the low and high side drivers are switched on and off for each coil.

IDM and Injector Diagnostics

The IDM determines if an injector is drawing enough current. The IDM sends a fault to the ECM, indicating potential problems in the wiring harness or injector, and the ECM will set a DTC. The IDM also does self-diagnostic checks and sets a DTC to indicate failure of the IDM.

On demand tests can be done using the Electronic Service Tool (EST). The EST sends a request to the ECM and the ECM sends a request to the IDM to do a test. Some tests generate a DTC when a problem exists. Other tests require the technician to evaluate parameters, if a problem exists.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Engine and Vehicle Sensors

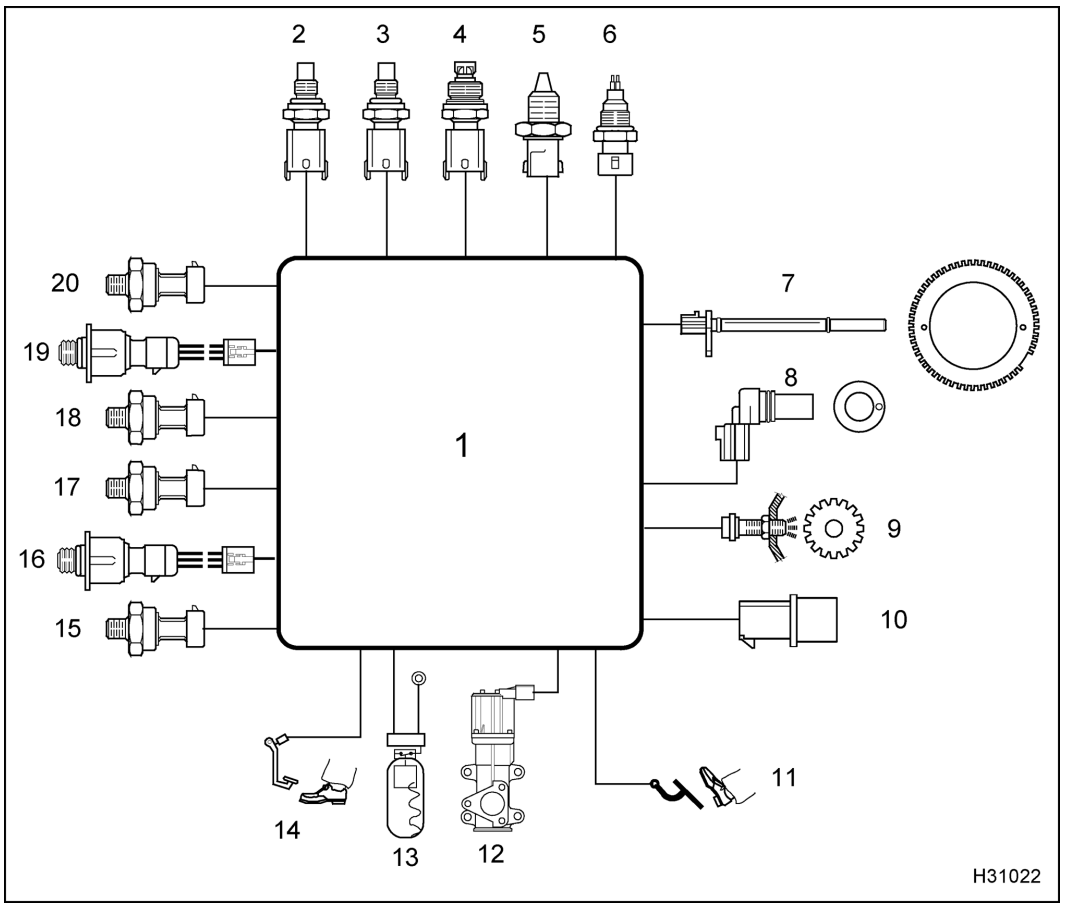


Figure 38 Engine and vehicle sensors

1. Electronic Control Module (ECM)
2. Engine Oil Temperature (EOT)
3. Engine Coolant Temperature (ECT)
4. Manifold Air Temperature (MAT)
5. Intake Air Temperature (IAT)
6. Water In Fuel (WIF)
7. Crankshaft Position (CKP)
8. Camshaft Position (CMP)
9. Vehicle Speed Sensor (VSS)
10. Barometric Absolute Pressure (BAP)
11. Accelerator Position Sensor (APS)
12. Exhaust Gas Recirculation valve Position (EGRP)
13. Engine Coolant Level (ECL)
14. Driveline Disengagement Switch (DDS)
15. Manifold Absolute Pressure (MAP)
16. Brake Control Pressure (BCP)
17. Engine Oil Pressure (EOP)
18. Engine Fuel Pressure (EFP)
19. Injection Control Pressure (ICP)
20. Exhaust Back Pressure (EBP)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

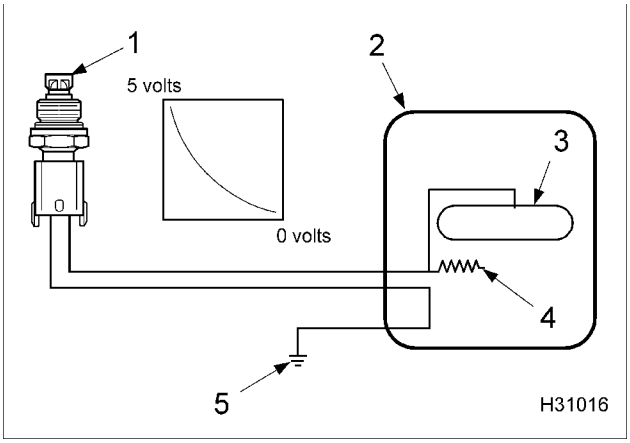


Figure 39 Thermistor

1. Temperature sensor
2. Electronic Control Module (ECM)
3. Microprocessor
4. Voltage reference (V_{REF})
5. Ground

Thermistors

- ECT
- EOT
- IAT
- MAT

A thermistor sensor changes its 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 in the ECM to form a voltage signal matched with a temperature value.

The top half of the voltage divider is the current limiting resistor inside the ECM. A thermistor sensor has two electrical connectors, signal return and ground. The output of a thermistor sensor is a nonlinear analog signal.

Engine Coolant Temperature (ECT)

The ECM monitors the ECT signal and uses this information for the instrument panel temperature gauge, coolant compensation, Engine Warning Protection System (EWPS), and inlet air heater operation. The ECT is a backup, if the EOT is out-of-range. The ECT sensor is installed in the water supply housing (Freon® compressor bracket), right of the flat idler pulley assembly.

Engine Oil Temperature (EOT)

The ECM monitors the EOT signal to control fuel quantity and timing when operating the engine. The EOT signal allows the ECM and IDM to compensate for differences in oil viscosity for temperature changes. This ensures that power and torque are available for all operating conditions. The EOT sensor is installed in the rear of the front cover, left of the high-pressure oil pump assembly.

Intake Air Temperature (IAT)

The ECM monitors the IAT signal to control timing and fuel rate during cold starts. The IAT sensor is chassis mounted on the air filter housing.

Manifold Air Temperature (MAT)

The ECM monitors the MAT signal for EGR operation. The MAT sensor is installed right of the MAP sensor in the intake manifold.

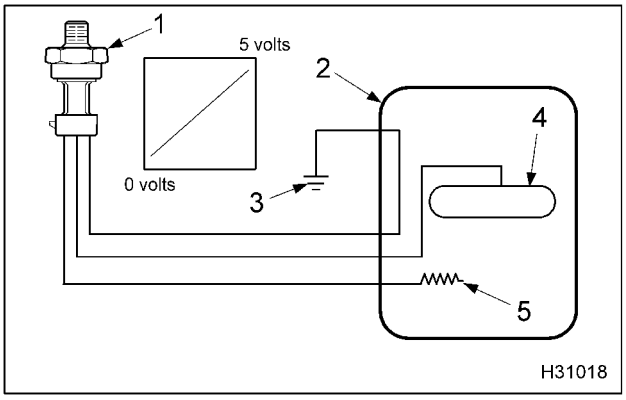


Figure 40 Variable capacitance sensor

1. Pressure sensor
2. Electronic Control Module (ECM)
3. Ground
4. Microprocessor
5. Voltage reference (V_{REF})

Variable Capacitance Sensors

- BAP
- MAP
- EBP

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- EFP
- EOP

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 ECM by three wires:

- V_{REF}
- Signal return
- Signal ground

The sensor receives the V_{REF} and returns an analog signal voltage to the ECM. The ECM compares the voltage with pre-programmed values to determine pressure.

The operational range of a variable capacitance sensor is linked to the thickness of the ceramic disk. The thicker the ceramic disk the more pressure the sensor can measure.

Barometric Absolute Pressure (BAP)

The ECM monitors the BAP signal to determine altitude, adjust timing, fuel quantity, and inlet air heater operation. The BAP sensor is located in the cab.

Manifold Absolute Pressure (MAP)

The ECM monitors the MAP signal to determine intake manifold pressure (boost). This information is used to control fuel rate and injection timing. The MAP sensor is installed left of the MAT sensor in the intake manifold.

Engine Oil Pressure (EOP)

The ECM monitors the EOP signal, and uses this information for the instrument panel pressure gauge and EWPS. The EOP sensor is installed in the left side of the crankcase below and left of the fuel filter housing.

Exhaust Back Pressure (EBP)

The EBP sensor measures exhaust back pressure so that the ECM can control the VGT and EGR systems. The sensor provides feedback to the ECM for closed loop control of the Variable Geometry Turbocharger (VGT). The EBP sensor is installed in a bracket mounted on the water supply housing (Freon® compressor bracket).

Engine Fuel Pressure (EFP)

The ECM uses the EFP sensor signal to monitor engine fuel pressure and give an indication when the fuel filter needs to be changed. The EFP sensor is installed in the rear of the fuel filter assembly (crankcase side).

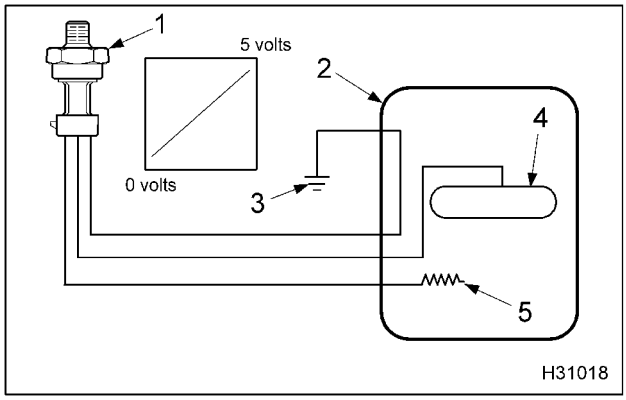


Figure 41 Micro Strain Gauge sensor

1. Pressure sensor
2. Electronic Control Module (ECM)
3. Ground
4. Microprocessor
5. Voltage reference (V_{REF})

Micro Strain Gauge (MSG) Sensors

- BCP
- ICP

A Micro Strain Gauge (MSG) sensor measures pressure. 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.

The sensor is connected to the ECM by three wires:

- V_{REF}
- Signal return
- Signal ground

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The sensor receives the V_{REF} and returns an analog signal voltage to the ECM. The ECM compares the voltage with pre-programmed values to determine pressure.

Brake Control Pressure (BCP)

The ECM monitors the BCP signal to determine the oil pressure in the brake gallery of the high-pressure oil rail. The BCP sensor is under the valve cover, forward of the No. 2 fuel injector in the high-pressure oil rail.

Injection Control Pressure (ICP)

The ECM monitors the ICP signal to determine the injection control pressure for engine operation. The ICP signal is used to control the IPR valve. The ICP sensor provides feedback to the ECM for Closed Loop ICP control. The ICP sensor is under the valve cover, forward of the No. 6 fuel injector in the high-pressure oil rail.

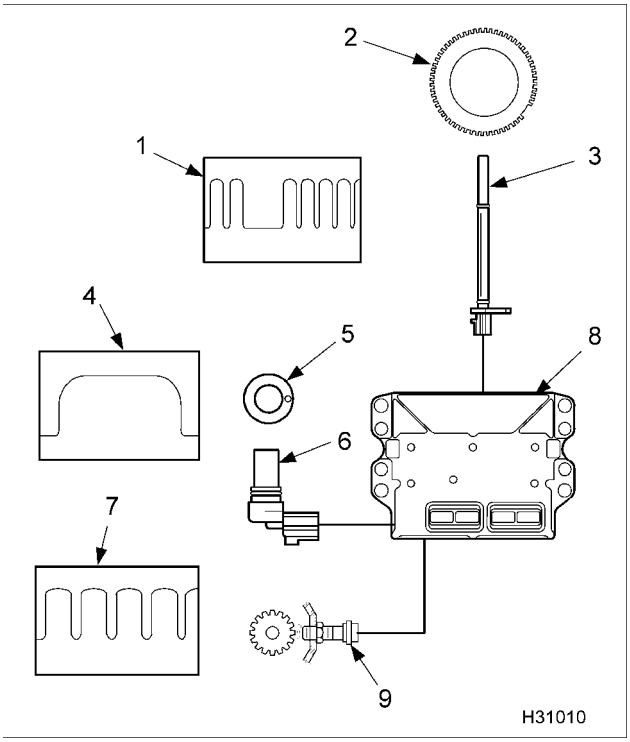


Figure 42 Magnetic pickups

1. Crankshaft Position (CKP) signal
2. Crankshaft position sensor timing disk
3. Crankshaft Position (CKP) sensor
4. Camshaft position (CMP) signal
5. Camshaft with peg
6. Camshaft position (CMP) sensor
7. Vehicle speed signal
8. Electronic Control Module (ECM)
9. Vehicle Speed Sensor (VSS)

Magnetic Pickup Sensors

- CKP
- CMP
- VSS

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 gear teeth that disturb the magnetic field.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Crankshaft Position (CKP)

The CKP sensor provides the ECM with a signal that indicates crankshaft speed and position. As the crankshaft turns the CKP sensor detects a 60 tooth timing disk on the crankshaft. 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 is installed in the top left side of the flywheel housing.

NOTE: This long CKP sensor, used with International® DT 466, DT 570, and HT 570 diesel engines, is the Camshaft Position (CMP) sensor used with other International® diesel engines.

Camshaft Position (CMP)

The CMP sensor provides the ECM with a signal that indicates camshaft position. As the cam rotates, the sensor identifies the position of the cam by locating a peg on the cam. The CMP is installed in the front cover, above and to the right of the water pump pulley.

NOTE: This short CMP sensor, used with International® DT 466, DT 570, and HT 570 diesel engines, is the Crankshaft Position (CKP) sensor used with other International® diesel engines.

Vehicle Speed Sensor (VSS)

The VSS 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 VSS is on left side of the transmission.

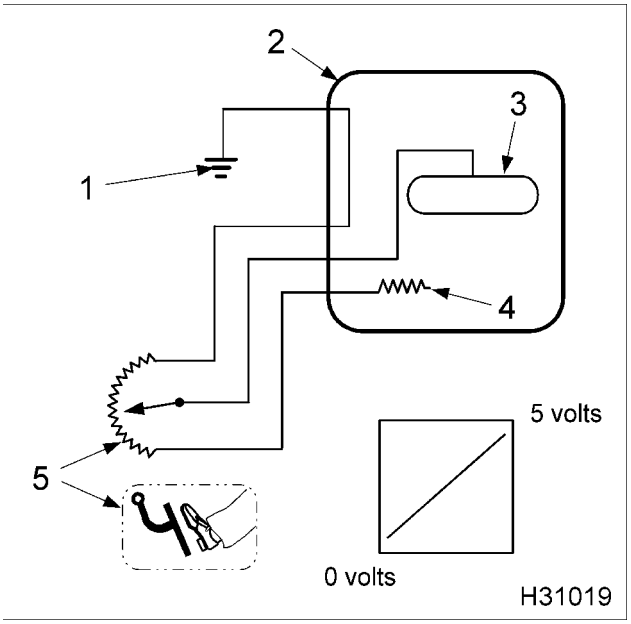


Figure 43 Potentiometer

1. Ground
2. Electronic Control Module (ECM)
3. Microprocessor
4. Voltage reference (V_{REF})
5. Accelerator Position Sensor (APS)

Potentiometers

- APS

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.

Accelerator Position Sensor (APS)

The APS provides the ECM with a feedback signal (linear analog voltage) that indicates the operator's demand for power. The APS is mounted in the accelerator pedal.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

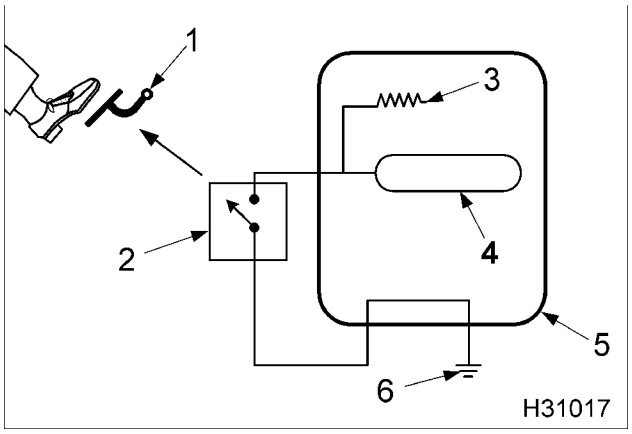


Figure 44 Switch

1. Accelerator pedal
2. Idle Validation Switch (IVS)
3. Voltage source with current limiting resistor
4. Microprocessor
5. ECM
6. Ground

Switches

- DDS
- ECL
- IVS
- WIF

Switch sensors indicate position, level, or status. They operate open or closed, allowing or preventing the flow of current. A switch sensor can be a voltage input switch or a grounding switch. A voltage input switch supplies the ECM 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.

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 or datalink communication functions as the DDS.

Engine Coolant Level (ECL)

ECL is part of the Engine Warning Protection System (EWPS). The ECL switch is used in plastic deaeration tanks. When a magnetic switch is open, the tank is full.

If engine coolant is low, the red ENGINE lamp on the instrument panel is illuminated.

Idle Validation Switch (IVS)

The IVS is a redundant switch that provides the ECM with a signal that verifies when the APS is in the idle position.

Water In Fuel (WIF)

A Water In Fuel (WIF) sensor in the element cavity of the fuel filter housing detects water. When enough water accumulates in the element cavity, the WIF sensor signal changes to the Electronic Control Module (ECM). The ECM sends a message to illuminate the amber water and fuel lamp, alerting the operator. The WIF is installed in the base of the fuel filter housing.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Diamond Logic® Engine Brake

Engine Brake Components

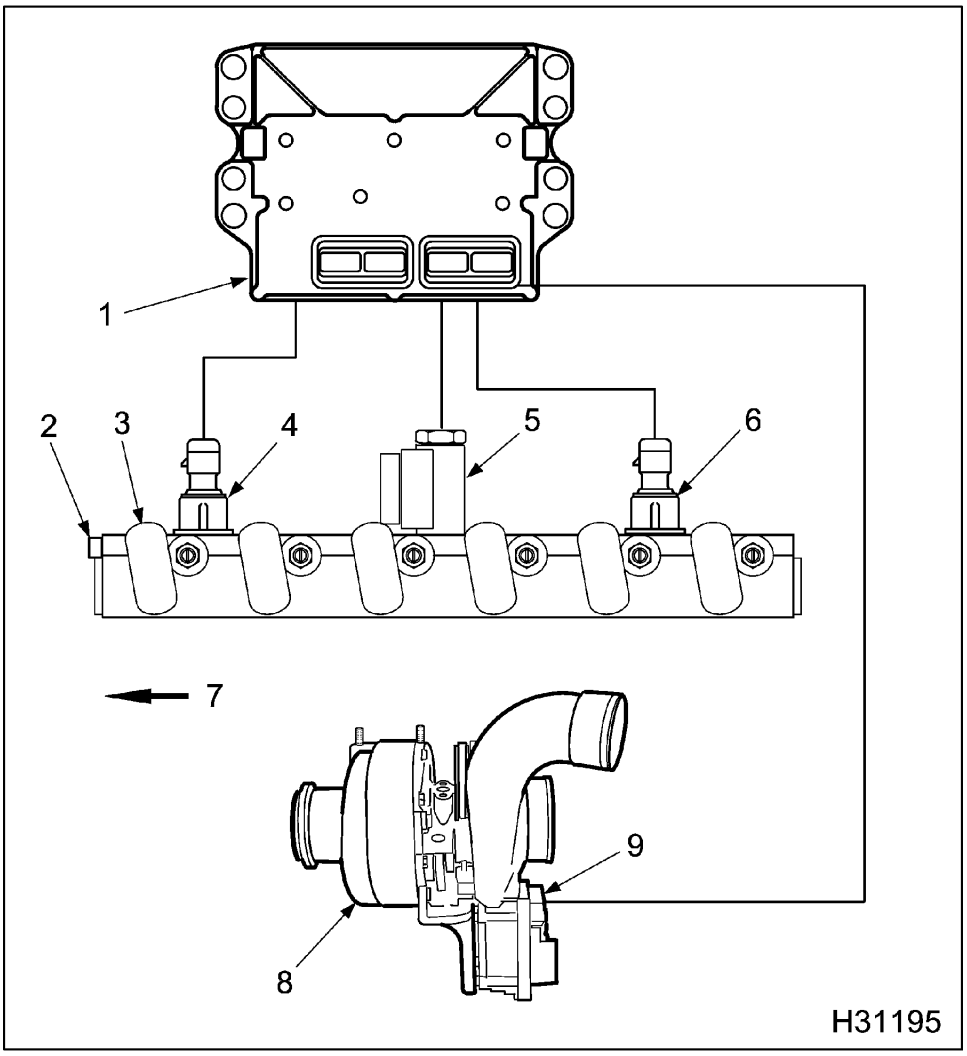


Figure 45 Diamond Logic® engine brake – system

1. ECM
2. Brake pressure relief valve
3. High-pressure oil rail
4. Brake Control Pressure (BCP) sensor
5. Brake shut-off valve assembly
6. Injection Control Pressure (ICP) sensor
7. Front of engine
8. Variable Geometry Turbocharger (VGT)
9. VGT control module

The Diamond Logic® engine brake, a compression release brake system, provides the following:

- Significant noise reduction
- Improved engine braking
- High durability
- Compatibility with cruise control system
- Lower operating cost and longer service life for brake shoes

The Diamond Logic® engine brake is available for all engine displacements. The operator can select one of three brake settings, depending on terrain and

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

driving conditions. See vehicle *Operator's Manual* for complete operating instructions.

Engine Brake Concept

The engine brake system retards vehicle speed during deceleration or braking. During deceleration and braking, the vehicle wheels drive the engine; the engine acts as an energy absorber.

Engine Brake Operation

To absorb energy, the Diamond Logic® engine brake combines bleeding off compressed intake air, VGT controlling exhaust back pressure, and vehicle driven piston movement.

- Energy is absorbed during the compression stroke, when intake air is compressed and forced through a slightly open exhaust valve, providing compressed air flow to the VGT.
- VGT turbine vanes create the desired energy absorbing, back pressure and intake boost.
- At the top of the compression stroke energy dissipates, pressure to force the piston down is eliminated, and energy is absorbed by the vehicle drive pulling the piston down.

Engine Brake Control

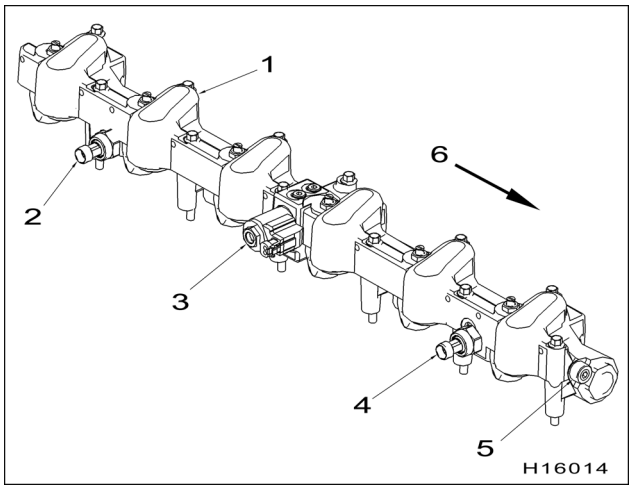


Figure 46 High-pressure oil rail

1. High-pressure oil rail
2. ICP sensor
3. Brake shut-off valve assembly
4. BCP sensor
5. Brake pressure relief valve
6. Front of engine

The high-pressure oil rail uses high-pressure oil from the injection control pressure system to open exhaust valves.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

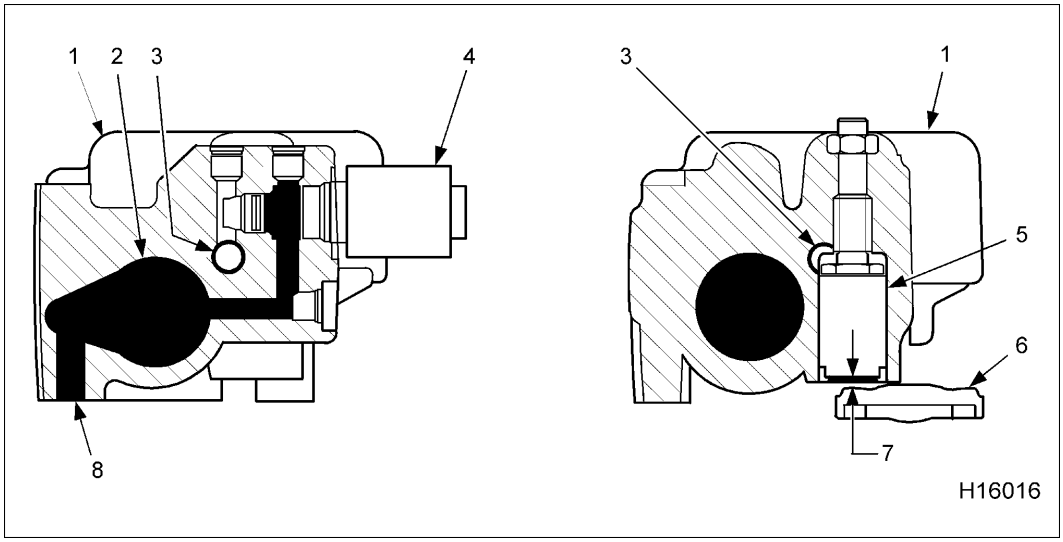


Figure 47 Brake shut-off valve and brake actuator– OFF

1. High-pressure oil rail
2. Injector oil gallery
3. Brake oil gallery
4. Brake shut-off valve assembly
5. Brake actuator piston assembly
6. Exhaust valve bridge
7. Valve lash (actuator retracted)
8. Oil inlet

During normal engine operation, oil in the high-pressure rail goes to the fuel injectors only. A brake shut-off valve, mounted in the high-pressure oil rail, is closed to prevent oil from entering the brake gallery.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Operation of Diamond Logic® Engine Brake in Braking Mode

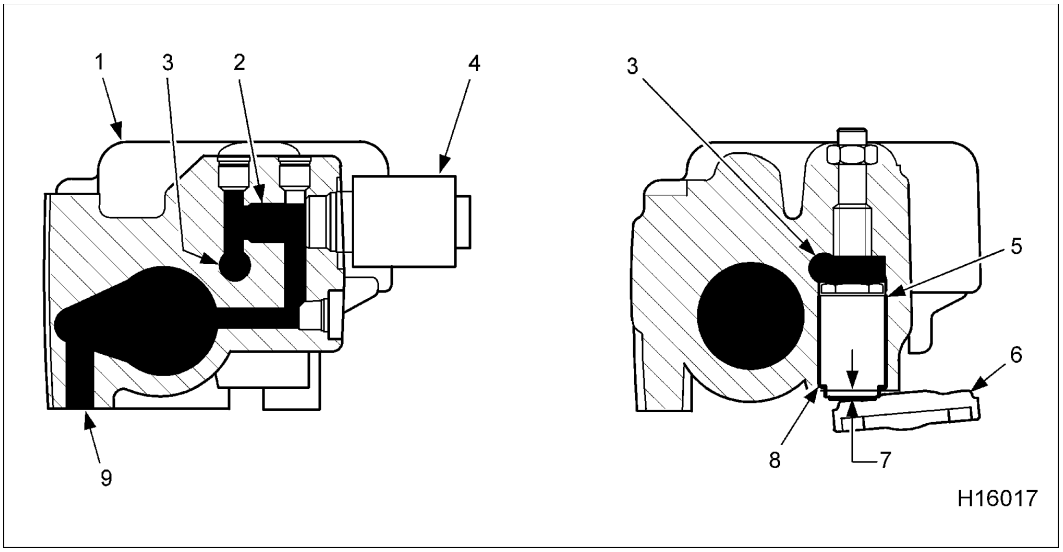


Figure 48 Brake shut-off valve and brake actuator– ON

1. High-pressure oil rail
2. High-pressure oil flow to brake oil gallery
3. Brake oil gallery
4. Brake shut-off valve assembly
5. Brake actuator piston assembly
6. Exhaust valve bridge
7. Valve lash (actuator deployed)
8. Normal oil seepage
9. Oil inlet

The ECM monitors the following criteria to make sure certain conditions are met.

- ABS (inactive)
- RPM (greater than 1200)
- APS (less than 5%)
- Idle validation
- EOT (greater than or equal to 60 °C [140 °C])
- Operator input switches (On/Off) (power selection – Low, Med, High)

If On is selected, and the preceding criteria is met, the engine brake will activate.

When the engine brake is activated, the ECM provides the power to activate the brake shut-off valve to allow oil from the injector oil gallery to flow to the brake oil gallery. High oil pressure activates the brake actuator pistons to open the exhaust valves.

During an ABS event, the engine brake is deactivated. The engine brake is activated once the ABS event is over.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

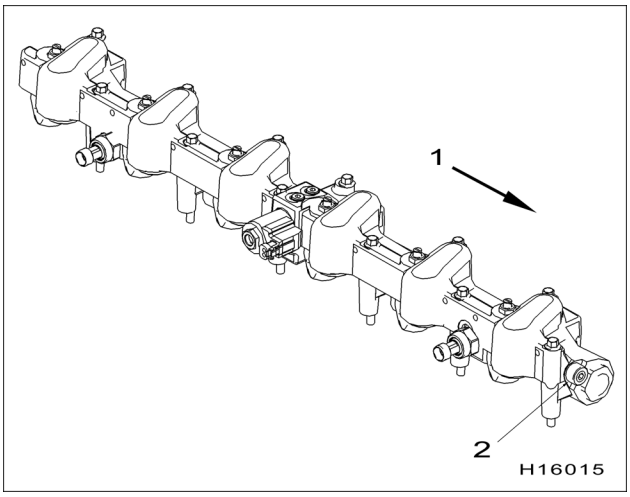


Figure 49 Brake pressure relief valve in high-pressure oil rail

1. Front of engine
2. Brake pressure relief valve

The ECM removes the power source from the brake shut-off valve to deactivate the engine brake. Residual brake gallery pressure initially bleeds from the actuator bore. When brake gallery pressure bleeds down to 6895 kPa (1000 psi), the brake pressure relief valve opens, and oil drains back to sump.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Table of Contents

Standard Features.....61
- **Electronic Governor Control.....61**
- **American Trucking Association (ATA) Datalink 61**
- **Service Diagnostics.....61**
- **Event Logging System.....61**
- **Electronic Speedometer and Tachometer.....61**
- **Inlet Air Heater.....61**
- **Fast Idle Advance.....61**
- **Cold Ambient Protection (CAP).....61**
- **Coolant Temperature Compensation (Engine Over Temperature Protection System).....62**
- **Engine Crank Inhibit (ECI).....62**
- **Change Engine Oil Interval Message.....62**

Optional Features.....62
- **Road Speed Limiting.....62**
- **Cruise Control.....62**
- **Engine Fuel Pressure (EFP) Monitor.....62**
- **Traction Control.....63**
- **Diamond Logic® Engine Brake.....63**
- **Diamond Logic® Exhaust Brake.....63**
- **Engine Warning Protection System (EWPS).....63**
  - **Coolant Temperature Compensation and EWPS.....63**
- **Idle Shutdown Timer (IST).....64**
- **Electronic Fan (EFAN).....64**
- **Radiator Shutter Enable (RSE).....64**

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Standard Features

Electronic Governor Control

International® engines are electronically controlled for all operating ranges.

American Trucking Association (ATA) Datalink

Vehicles are equipped with the ATA datalink connector for communication between the Electronic Control Module (ECM) and the Electronic Service Tool (EST).

The ATA datalink supports:

- Transmission of engine parameter data.
- Transmission and clearing of Diagnostic Trouble Codes (DTCs).
- Diagnostics and troubleshooting.
- Programming performance parameter values.
- Programming engine and vehicle features.
- Programming calibrations and strategies in the ECM and Injector Drive Module (IDM).

For additional information, see “ATA Datalink” in Section 7 (page 309).

Service Diagnostics

The EST provides diagnostic information using the ATA datalink. The recommended EST is the EZ-Tech® with MasterDiagnostics® software provided by International®.

Faults from sensors, actuators, electronic components, and engine systems are detected by the ECM and sent to the EST as DTCs. Effective engine diagnostics require and rely on DTCs.

Event Logging System

The event logging system records engine operation above maximum rpm (overspeed), high coolant temperature, 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.

Electronic Speedometer and Tachometer

The engine control system calibrates vehicle speed up to 157,157 pulses per mile. The new speed calibration information must be programmed with an EST.

The tachometer signal is generated by the ECM by computing signals for the Camshaft Position (CMP) sensor and Crankshaft Position (CKP) sensor. Calculations for each sensor are sent to the instrument panel through the Drivetrain Datalink (CAN 1) and to the EST through the ATA datalink.

Inlet Air Heater

The inlet air heater feature improves engine start-up in cold weather. The ECM controls the intake air heater and monitors the engine temperature. When the engine is ready for cranking, the ECM sends a message to shut off the WAIT TO START lamp.

For additional information, see “IAH System” in Section 7 (page 444).

Fast Idle Advance

Fast idle advance increases engine idle speed up to 750 rpm for faster warm-up to operating temperature. This occurs by the ECM monitoring the EOT sensor input and adjusting the fuel injector operation accordingly.

Low idle speed is increased proportionally when the engine oil temperature is between 15 °C (59 °F) at 700 rpm to below -10 °C (14 °F) at 750 rpm.

Cold Ambient Protection (CAP)

CAP protects the engine from damage caused by prolonged idle at no load during cold weather. CAP also improves cab warm-up.

CAP maintains engine coolant temperature by increasing the engine rpm to a programmed value when the ambient air temperature is at or below 0 °C (32 °F) and the engine coolant temperature is below 65 °C (149 °F) while the engine has been idling with no load for more than 5 minutes.

CAP is standard on trucks without an Idle Shutdown Timer (IST).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Coolant Temperature Compensation (Engine Over Temperature Protection System)

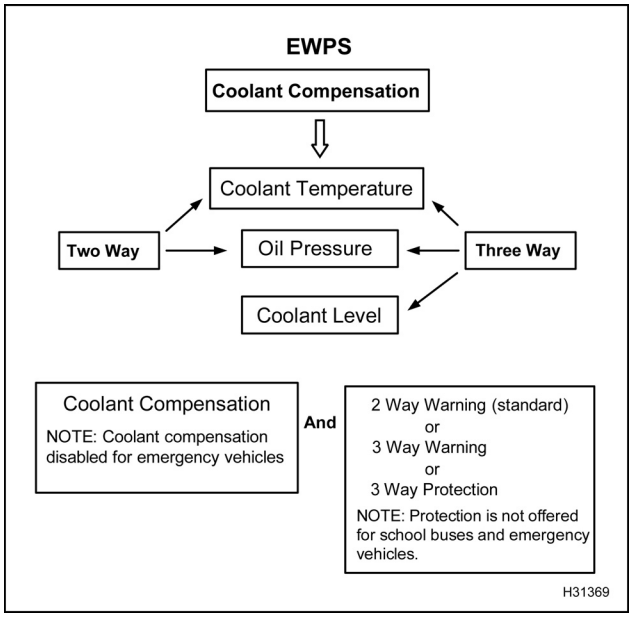


Figure 50 Coolant Temperature Compensation

Coolant temperature compensation reduces fuel delivery if the engine coolant temperature is above the cooling system specifications.

Before standard engine warning or optional warning/protection systems engage, the reduction in fuel delivery begins when the engine coolant temperature reaches approximately 107 °C (225 °F). A rapid reduction of 15 percent is achieved when engine coolant temperature reaches approximately 110 °C (230 °F).

NOTE: Coolant temperature compensation is disabled in emergency vehicles that require 100 percent power on demand.

Engine Crank Inhibit (ECI)

ECI will not allow the starting motor to crank when the engine is running or the automatic transmission is in gear. ECI is an optional system for vehicles with manual transmissions.

For additional information, see “ECI System” in Section 7 (page 366).

Change Engine Oil Interval Message

The change engine oil interval message can be programmed with the EST for mileage, hours, or amount of fuel used. The change oil message timer can be reset using the CRUISE ON and RESUME/ACCEL switches or EST.

Optional Features

Road Speed Limiting

Road speed limiting limits the speed to the maximum vehicle speed programmed by the customer.

Cruise Control

The ECM controls the cruise control feature. The cruise control system functions similarly for all electronic engines. Maximum and minimum allowable cruise control speeds will vary based on model. To operate cruise control, see appropriate truck model Operator’s Manual.

Engine Fuel Pressure (EFP) Monitor

The EFP monitors fuel pressure and indicates when the fuel filter needs to be serviced. For additional information, see “EFP Sensor” in Section 7 (page 406).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Traction Control

Traction control is a system that identifies when a wheel is going 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 Antilock Braking System (ABS) that supports traction control.

Diamond Logic® Engine Brake

International® now offers an optional engine brake. See “Diamond Logic® Engine Brake” in Section 1 (page 53) for feature description.

Diamond Logic® Exhaust Brake

International® now offers an optional integrated exhaust brake. This feature uses VGT to assist in braking.

Engine Warning Protection System (EWPS)

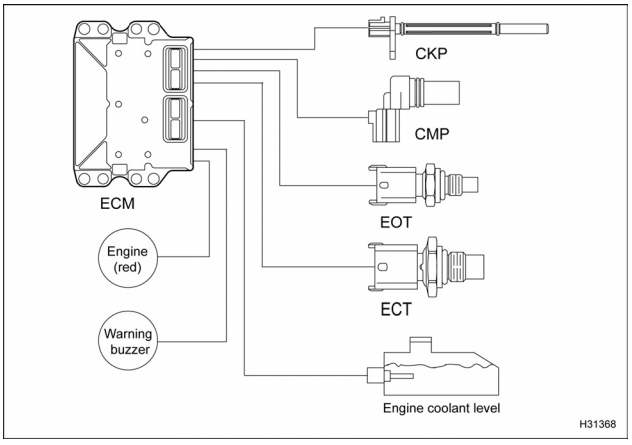


Figure 51 Engine Warning Protection System (EWPS)

The EWPS safeguards the engine from undesirable operating conditions to prevent engine damage and to prolong engine life. The ECM will illuminate the red ENGINE lamp and sound the warning buzzer when the ECM detects:

- High coolant temperature.
- Low oil pressure.
- Low coolant level (3–way system only).

When the protection feature is enabled and a critical engine condition occurs, the on-board electronics will shut the engine down. An event logging feature will record the event in engine hours and odometer readings. After the engine has shutdown, and the critical condition remains, the engine can be started for a 30 second run time.

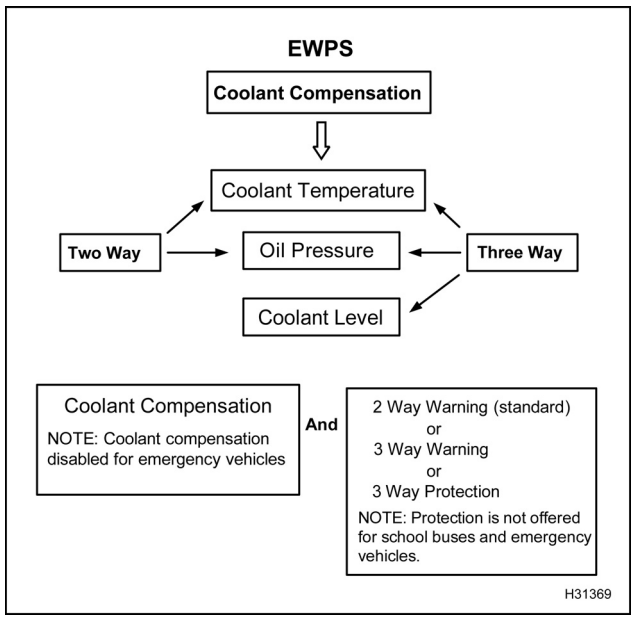


Figure 52 EWPS flowchart

Coolant Temperature Compensation and EWPS

Coolant temperature compensation reduces fuel delivery when the engine coolant temperature is above cooling system specifications.

The reduction in fuel delivery begins when engine coolant temperature reaches approximately 107 °C (225 °F). A reduction of 15% will be achieved as the temperature reaches approximately 110 °C (230 °F).

When the engine coolant temperature is *above* 110 °C (230 °F), the red ENGINE lamp is illuminated and an audible alarm sounds. After the alarm sounds, the engine will shutdown.

- When the coolant temperature is above 109 °C (228 °F), the red ENGINE lamp will be illuminated and DTC 321 will be set.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- When the coolant temperature is above 112 °C (234 °F), the red ENGINE lamp will flash, an audible alarm will sound, and DTC 322 will be set. If the vehicle has the warning protection feature enabled, the engine will shutdown after 30 seconds.

Fuel reduction is calibrated to a maximum of 30% before standard engine warning or optional EWPS is engaged. A DTC is stored in the ECM memory when a warning or shutdown occurs.

NOTE: Coolant temperature compensation is disabled in emergency vehicles that require 100% power on demand.

Idle Shutdown Timer (IST)

The IST feature allows the ECM to shutdown the engine when an extended idle condition occurs. The IST can be programmed for the customer to automatically shut the engine down for idle times that range from 2 to 120 minutes.

The red ENGINE lamp will illuminate before engine shutdown. The lamp will flash for 30 seconds to warn the operator engine shutdown is approaching. Idle time is measured from the last clutch or brake pedal transition. The engine must be out of gear for the IST to work.

For additional information and resets for engine shutdown timer, see “IST System” in Section 7 (page 497).

Electronic Fan (EFAN)

Engine electronics allow for the operation of an electronic fan or an air fan solenoid. For additional information, see “EFAN Control” in Section 7 (page 398).

Radiator Shutter Enable (RSE)

The RSE keeps the engine warm during cold weather operation. The RSE enables faster warm-up of the cab and faster windshield defrosting. For additional information, see “RSE” in Section 7 (page 514).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Table of Contents

Diagnostic Trouble Code Detection.....67
Continuous Monitor.....68

Diagnostic Trouble Codes 69
Using EST.....69
Accessing Diagnostic Trouble Codes (DTCs).....69
Reading DTCs.....69
Clearing DTCs.....69
Using Cruise Switches.....69
Accessing DTCs.....69
Reading DTCs.....70
Clearing DTCs.....70

Diagnostic Tests.....71
Key-On Engine-Off Tests.....71
Standard Test.....71
Standard Test Using EST.....71
Standard Test Using Cruise Switches.....72
Injector Test.....72
Continuous Monitor Test.....73
Output State Low Test.....74
Output State High Test.....75
Glow Plug/Inlet Air Heater Output State Test.....76
Key-On Engine-Running Tests.....77
Standard Test.....77
Continuous Monitor Test.....78
Air Management Test.....79
VGT Test.....83
Injector Disable Tests.....85
Automatic Test.....85
Manual Test - Engine Cold.....87
Manual Test - Engine Hot.....88
Relative Compression.....91

Reset Change Engine Oil Interval Message.....93
Using EST.....93
Using Cruise Switches.....97

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Diagnostic Trouble Code Detection

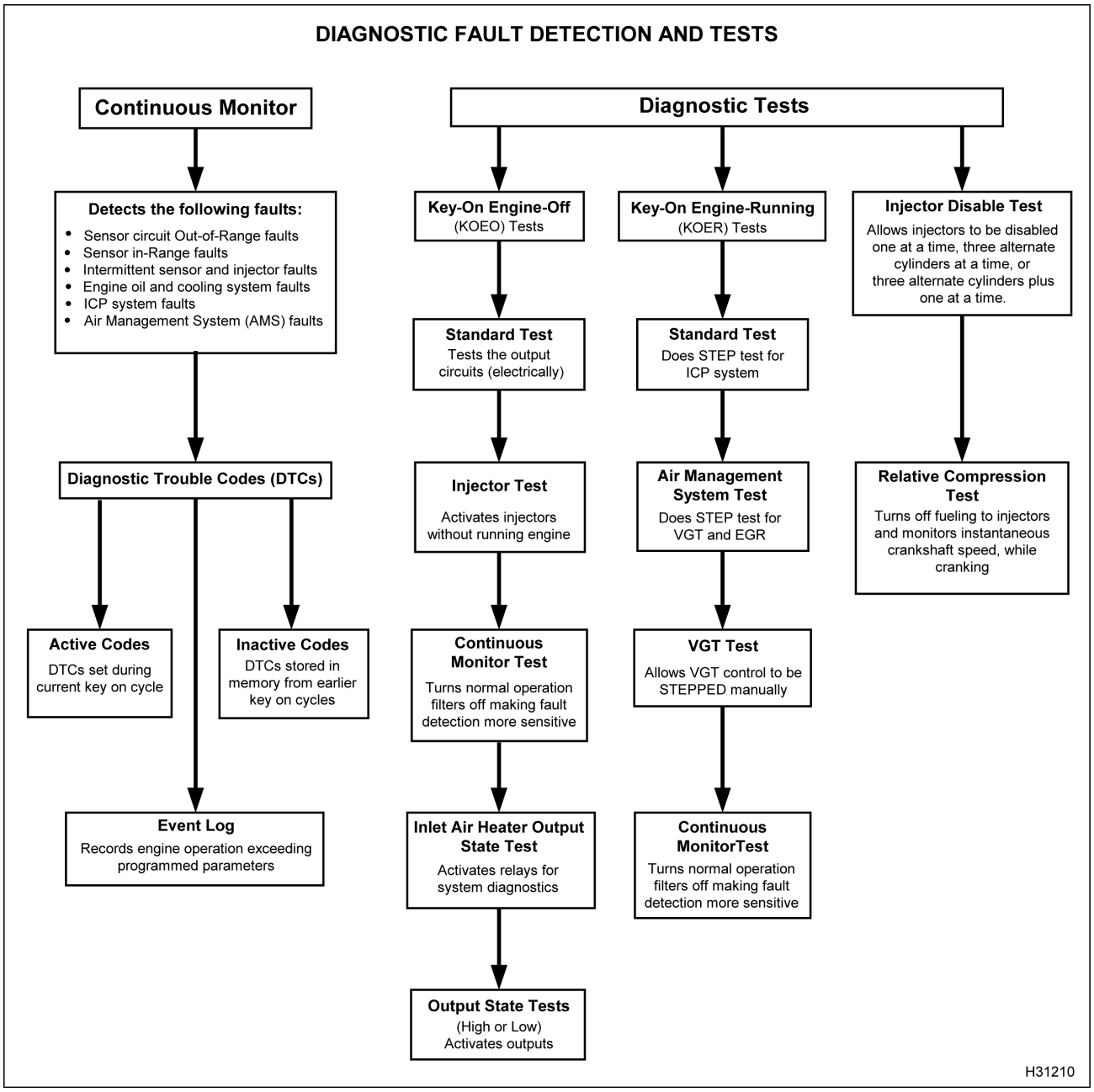


Figure 53

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Continuous Monitor

Continuous Monitor is a series of continuous diagnostic tests done by the Electronic Control Module (ECM) to detect failure modes (Out of Range, In Range, and System Faults). During Continuous Monitor the ignition switch is on.

- **Out of Range High** (Voltage over normal operating range)
- **Out of Range Low** (Voltage under normal operating range)
- **In Range** (In normal operating range but not correct for conditions)
- **System Malfunction** (System is not operating according to conditions)

If an input signal is out of range (over or under normal operating range), the ECM logs a fault and sets a Diagnostic Trouble Code (DTC). The ECM monitors the operation of systems for in range conditions to determine if systems are working in a normal operational range; If the ECM detects that a system falls outside a predetermined range, it will log a fault and set a DTC.

Each DTC has a three digit number to identify the source of a malfunction measured or monitored electronically. A fault is a malfunction measured or monitored electronically.

The ECM continuously monitors the Injection Control Pressure (ICP) system and the Air Management System (AMS). If the ECM detects that a system falls outside a predetermined range, the ECM logs a fault and sets a DTC.

During normal engine operation, the ECM automatically performs several tests to detect faults. When a fault is detected, the ECM often runs a fault management strategy to allow continued, though sometimes degraded, vehicle operation.

With the engine running, engine events are permanently recorded in the ECM; engine events can be retrieved with the Electronic Service Tool (EST).

Engine Events

Standard Engine Events

Standard engine events include excessive coolant temperature and engine rpm (over-speed).

Optional Engine Events

Optional engine events are monitored and recorded, if the engine is equipped with the optional Engine Warning Protection System (EWPS). Optional engine events recorded by the ECM include low coolant level and low oil pressure.

Engine Event Hours/Odometer

The ECM records engine events in two ways, hours and odometer readings.

Examples

- Overheat Hour 1
- Overheat Hour 2
- Overheat Odometer 1
- Overheat Odometer 2

The ECM stores the two most recent events. Two events could happen in the same hour, and two events could happen in the same mile.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Diagnostic Trouble Codes

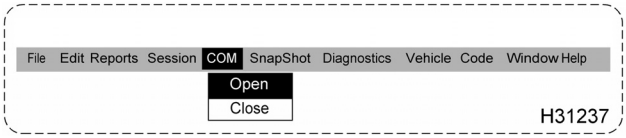
WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, make sure the transmission is in park or neutral, parking brake is set, and wheels are blocked before doing service bay diagnostics on engine or vehicle.

Using EST

Accessing Diagnostic Trouble Codes (DTCs)

NOTE: When opening VIN+ session to fill out form heading, the DTC window automatically appears.

1. Turn the ignition switch to ON.



2. Select Com from the menu bar in the main window, then select Open.

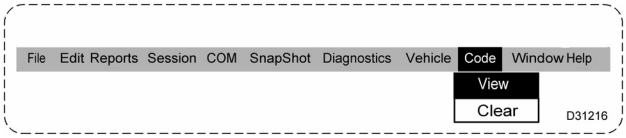


Figure 55 Menu bar Code/View

3. Select Code from the menu bar, then View for the Diagnostic Trouble Code window.

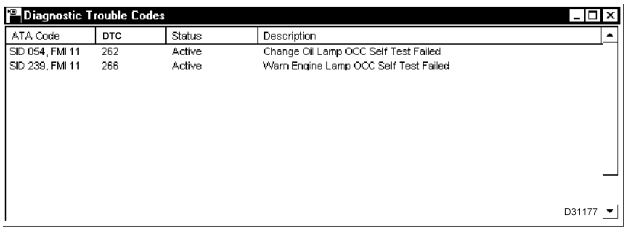


Figure 56 Diagnostic Trouble Code window

Reading DTCs

ATA code: Codes associated with a Subsystem Identifier (SID), Parameter Identifier (PID), and Failure Mode Indicator (FMI)

DTC: Diagnostic Trouble Code

Status: Indicates active or inactive DTCs

- **Active**: With the ignition switch on, active indicates a DTC for a condition currently in the system. When the ignition switch is turned off, an active DTC becomes inactive. (If a problem remains, the DTC will be active on the next ignition switch cycle and the EST will display active/inactive.)
- **Inactive**: With the ignition switch on, inactive indicates a DTC for a condition during a previous ignition switch cycle. When the ignition switch is turned to OFF, inactive DTCs from previous ignition switch on cycles remain in the ECM memory until cleared.
- **Active/Inactive:** With the ignition switch on, active/inactive indicates a DTC for a condition currently in the system and was present in a previous ignition switch cycle, if the code was not cleared.

Description: Defines each DTC

Clearing DTCs

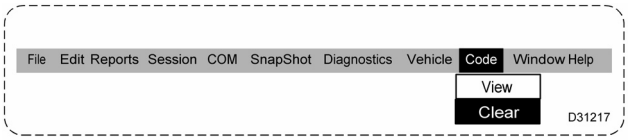


Figure 57 Menu bar Code/Clear

1. Select Code from the menu bar, then select Clear.

   NOTE: If unable to clear inactive DTCs, be sure Diagnostic Trouble Code window is active by clicking in the window area.

Using Cruise Switches

Accessing DTCs

NOTE: Read and be familiar with all steps and time limits in this procedure before starting.

1. Set parking brake for the correct signal from the Electronic System Controller (ESC).
2. Turn the ignition switch to ON. (Do not crank the engine.)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

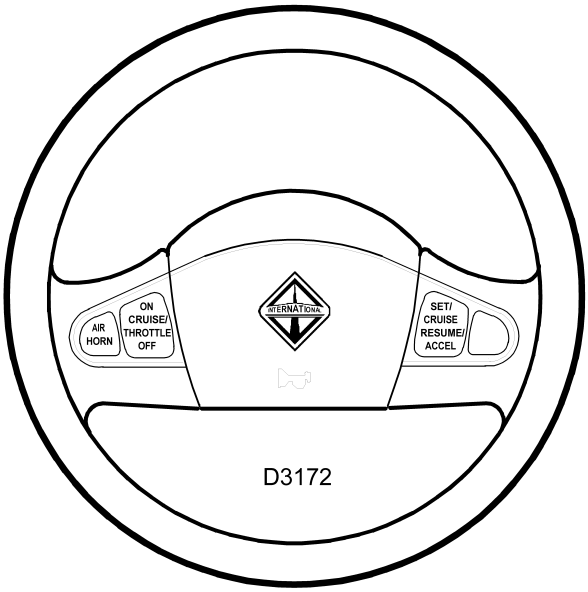


Figure 58 Cruise Switches

3. Press and release the CRUISE ON and RESUME/ACCEL switches at the same time within 3 seconds of the ignition switch on.

   NOTE: There could be as much as a 10 second delay from the time switches are pressed to the time DTCs are flashed.

Reading DTCs

1. The red ENGINE lamp will flash once to indicate the beginning of active DTCs.
2. The amber ENGINE lamp will flash repeatedly, signaling active DTCs.

   NOTE: All DTCs are three digits. For DTCs, see Appendix C in this manual or form CGE310-1. Code 111 indicates that no faults were detected.
3. Count the flashes of the amber ENGINE lamp in sequence. After each digit of the code a short pause will occur.

   - Two amber flashes, a pause; three amber flashes, a pause; and two amber flashes and a pause indicate code 232.
4. For more than one DTC, the red ENGINE lamp will flash once indicating the beginning of another active DTC.
5. After all active DTCs have flashed, the red ENGINE lamp will flash twice to indicate the start of inactive DTCs. Count the flashes from the amber ENGINE lamp. If there is more than one inactive code, the red ENGINE lamp will flash once between each DTC.
6. After all DTCs have been sent, the red ENGINE lamp will flash three times indicating end of DTC transmission.
7. To repeat DTC transmission, cycle the ignition switch and press and release the CRUISE ON and RESUME/ACCEL switches, at the same time, within 3 seconds of ignition switch on. The ECM will re-send stored DTCs.

Clearing DTCs

NOTE: Read and be familiar with all steps and time limits in this procedure before starting.

1. Set parking brake for the correct signal from the Electronic System Controller (ESC).
2. Turn the ignition switch to ON. (Do not crank the engine.)
3. Press and hold the CRUISE ON and RESUME/ACCEL switches at the same time.
4. Press and release the accelerator pedal three times within 6 seconds of the ignition switch on.
5. Release the cruise control switches to clear the inactive DTCs.

NOTE: Completing this procedure within 3 seconds of the ignition switch on, without turning the ignition switch off, will restart DTC transmission to the instrument panel.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Diagnostic Tests

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, make sure the transmission is in park or neutral, parking brake is set, and wheels are blocked before doing service bay diagnostics on engine or vehicle.

Key-On Engine-Off Tests

Standard Test

The KOEO Standard test is done by the ECM. The technician runs this test, using the EST or the CRUISE ON and RESUME/ACCEL switches.

During the KOEO Standard test, the ECM does an internal test of its processing components and memory followed by an Output Circuit Check (OCC). The OCC evaluates the electrical condition of the circuits, not mechanical or hydraulic performance of the systems. By operating the ECM output circuits and measuring each response, the Standard test detects shorts or opens in the harnesses, actuators, and ECM. If a circuit fails the test, a fault is logged and a DTC is set.

The ECM checks the following circuits:

- Injection Pressure Regulator (IPR)
- Brake shutoff valve (optional)
- Engine Fan (EFAN) (optional)
- Radiator Shutter Enable (RSE) (optional)

When the OCC is done, the DTC window will display DTCs, if there are problems.

Standard Test Using EST

1. Set parking brake to ensure the correct signal from the Electronic System Controller (ESC).
2. Turn the ignition switch to ON. (Do not crank the engine.)

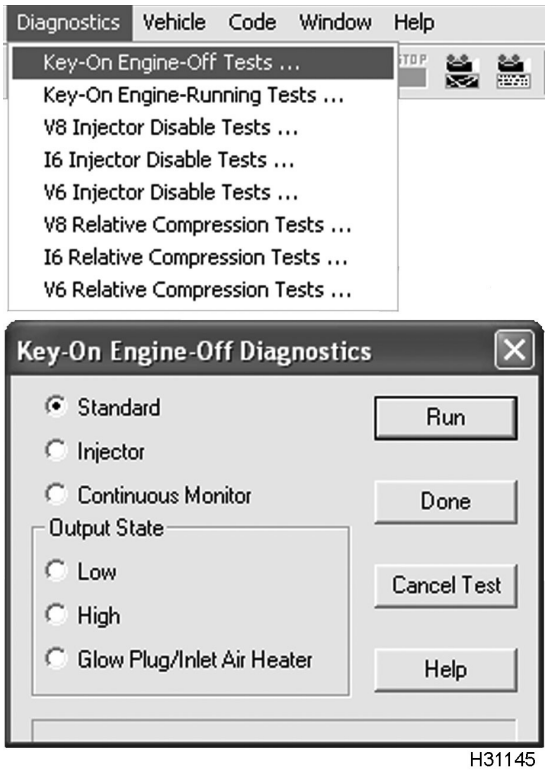


Figure 59 Standard test

3. Select Diagnostics from the menu bar.
4. Select Key-On Engine-Off tests from the drop down menu.
5. From the KOEO Diagnostics menu, select Standard and Run to start the test.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard test is always selected and run first. If the ignition switch is not cycled, the Standard test does not have to be run again.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Standard Test Using Cruise Switches

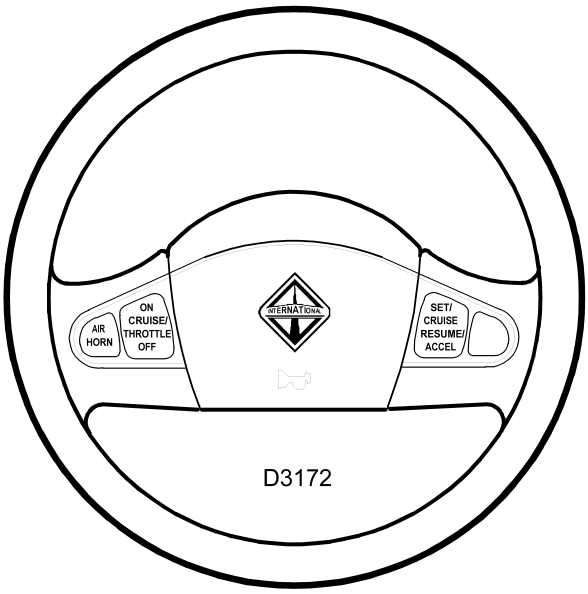


Figure 60 Cruise Switches

NOTE: Read and be familiar with all steps and time limits in this procedure before starting.

1. Set parking brake to ensure the correct signal from the Electronic System Controller (ESC).
2. Turn the ignition switch to ON. (Do not crank the engine.)
3. Press and release the CRUISE ON and RESUME/ACCEL switches at the same time, twice within 3 seconds of the ignition switch on.
   - The ECM will begin the Output Circuit Check (OCC).

     When the OCC is done, the ECM will flash the red ENGINE and amber ENGINE lamps to signal the DTCs.

NOTE: There could be as much as a 10 second delay from the time switches are pressed to the time DTCs are flashed.

Injector Test

NOTE: The Injector test can only be done with the EST; MasterDiagnostics® software is required. The Standard test must be done before doing the Injector test.

The Injector test diagnoses electrical problems in IDM wiring or injectors.

NOTE: Before doing the Injector test, DTCs should be accessed, noted, and cleared. This allows DTCs found to be displayed as Active DTCs.

During the Injector test, the ECM requests the IDM actuate the injectors in numerical order (1 through 6), not in firing order. The IDM monitors the electrical circuit for each injector, evaluates the performance of the injector coils, and checks the operation of the electrical circuit. If an electronic component in the injector drive circuit fails the expected parameters, the IDM sends a fault to the ECM. The ECM logs the fault, a DTC is set and sent to the EST.

NOTE: The technician can monitor injector operation by listening to the sound of each injector when activated by the IDM. During Hard Start and No Start conditions, when oil is very cold and thick, injectors may be hard to hear.

The DTC window will display DTCs, if there are problems.

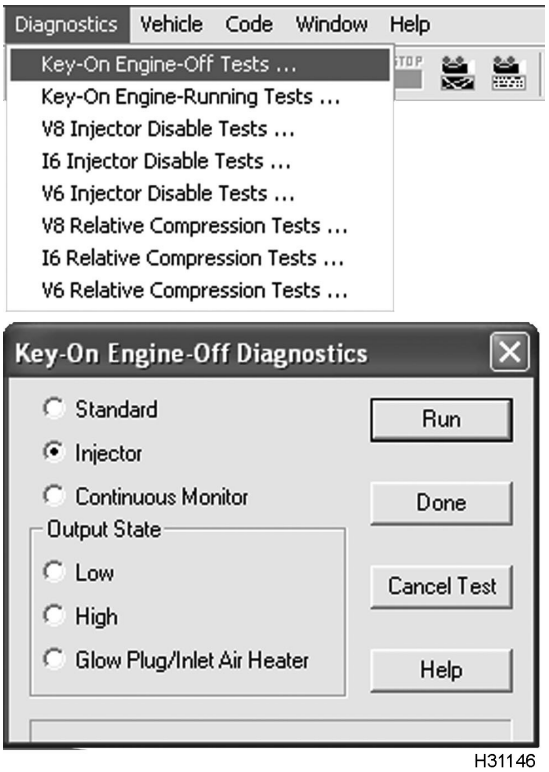


Figure 61 Injector test

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

1. Select Diagnostics from the menu bar.
2. Select Key-On Engine-Off Tests from the drop down menu.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard test is always selected and run first. If the ignition switch is not cycled, the Standard test does not have to be run again.

3. From the KOEO Diagnostics menu, select Injector and Run to start the test.

NOTE: During the Injector test, injector solenoids should click when actuated. If a series of clicks are not heard for each injector, one or more injectors are not activating.

Continuous Monitor Test

NOTE: This test can only be done with the EST; MasterDiagnostics® software is required.

The Continuous Monitor test troubleshoots intermittent connections between the ECM and sensors. The engine can be off or running.

The EST monitors the following circuits:

- Accelerator Position Sensor (APS)
- Barometric Absolute Pressure (BAP)
- Battery Voltage (V_{Batt})
- Brake Control Pressure (BCP) (optional)
- EGR Valve Position (EGRP)
- Exhaust Back Pressure (EBP)
- Engine Coolant Level (ECL)
- Engine Fuel Pressure (EFP) (optional)
- Engine Oil Pressure (EOP)
- Engine Oil Temperature (EOT)
- Intake Air Temperature (IAT)
- Injection Control Pressure (ICP)
- Manifold Air Temperature (MAT)
- Manifold Absolute Pressure (MAP)

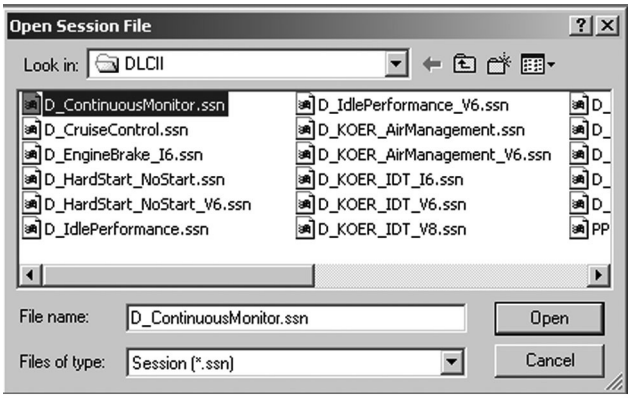


Figure 62 Continuous Monitor session

1. Select D_ContinuousMonitor.ssn from the open session file window and select OPEN to open the session.

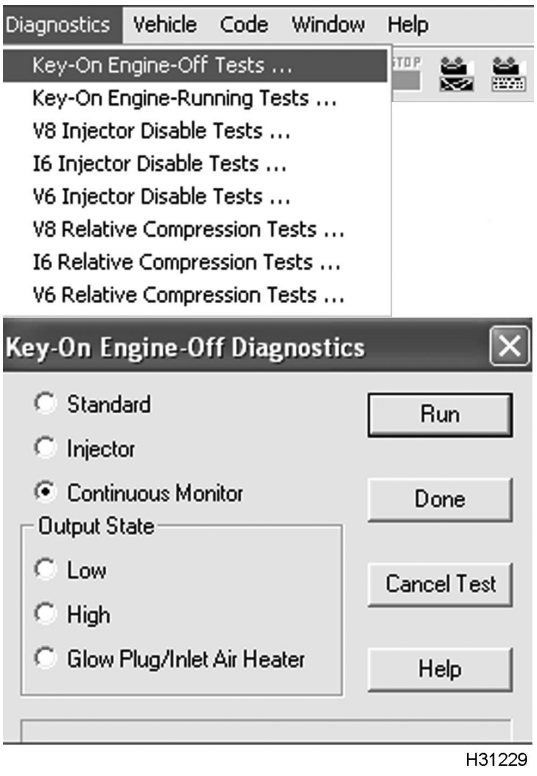


Figure 63 Continuous Monitor test

2. Select Diagnostics from the menu bar.
3. Select Key-On Engine-Off Tests from the drop down menu.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4. From the KOEO Diagnostics menu, select Continuous Monitor and select Run to start the test.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

5. Wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Correct problem causing active DTCs.
7. Clear DTCs.



Figure 64 Close session

8. When finished with this test, select Session from menu bar, then Close.

Output State Low Test

NOTE: This test can only be done with the EST; MasterDiagnostics® software is required.

The Output State Low test allows the technician to diagnose the operation of the output signals and actuators.

In the Output State Low test mode, the ECM pulls down the output voltage to the low state. This grounds the low side driver circuits and actuates the output components controlled by the ECM.

During Output State Low test, the output of the circuit in question can be monitored with a DMM. The DMM measures a low voltage state as the outputs are toggled. The actual voltage will vary with the circuit tested.

NOTE:

- A Breakout Box or Breakout Harness and a DMM are required to monitor the suspected circuit or actuator.
- DTCs are not set by the ECM during this test.

The following actuators are activated when toggled low during the test:

- Injection Pressure Regulator (IPR) (electrical circuit only)
- Engine Fan (EFAN) relay (optional) (electrical circuit and inspect if clutch is engaged)
- Radiator Shutter Enable (RSE) (optional) (electrical circuit, audible, and visual inspection of shutter position)
- EGR (audible and visual inspection only) continuous monitoring by EGR drive module
- VGT vanes full open (electrical circuit, audible, and visual inspection of actuator arm)

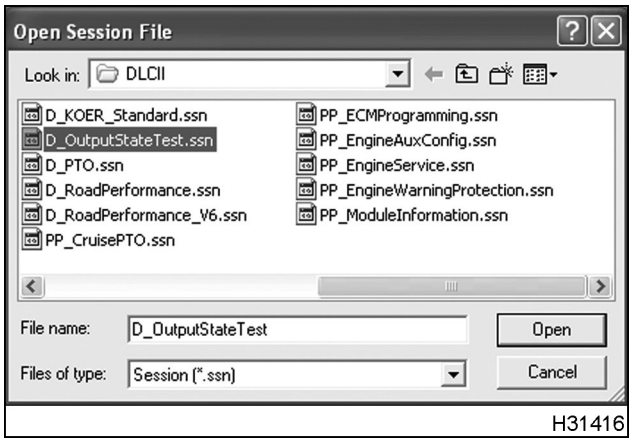


Figure 65 Output State Test Session

1. Select D_OutputStateTest.ssn from the open session file window.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

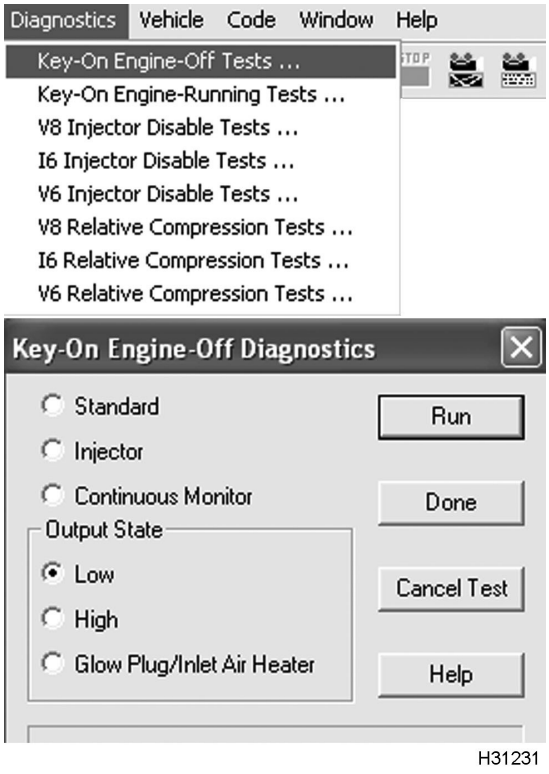


Figure 66 Output State Low test

2. Select Diagnostics from the menu bar.
3. Select Key-On Engine-Off Tests from the drop down menu.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard test is always selected and run first. If the ignition switch is not cycled, the Standard test does not have to be run again.

4. From the KOEO Diagnostics menu, select Output State Low and Run to start the test.
5. Toggle between the Low and High tests in the Output State Test. Listen and observe actuator control or circuit operation.

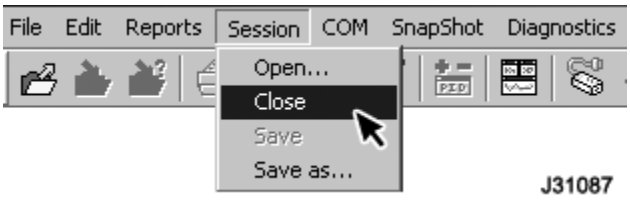


Figure 67 Close session

6. When finished with this test, select Session from menu bar, then Close.

Output State High Test

NOTE: This test can only be done with the EST; MasterDiagnostics® software is required.

The Output State High test allows the technician to diagnose the operation of the output signals and actuators.

In the Output State High test mode, the ECM pulls up the output voltage to the high state. This energizes the control high side driver circuits and actuates the output components controlled by the ECM.

During this test, the output of the circuit in question is monitored with a DMM. The DMM measures a high voltage state, as the outputs are toggled. The actual voltage will vary with the circuit tested.

NOTE:

- A Breakout Box or Breakout Harness and a DMM are required to monitor the suspected circuit or actuator.
- DTCs are not set by the ECM during this test.

The following actuators are activated when toggled high during the test:

- VGT vanes full closed (electrical circuit, audible, and visual inspection of actuator arm)
- Brake Shutoff valve (optional) (electrical circuit only)

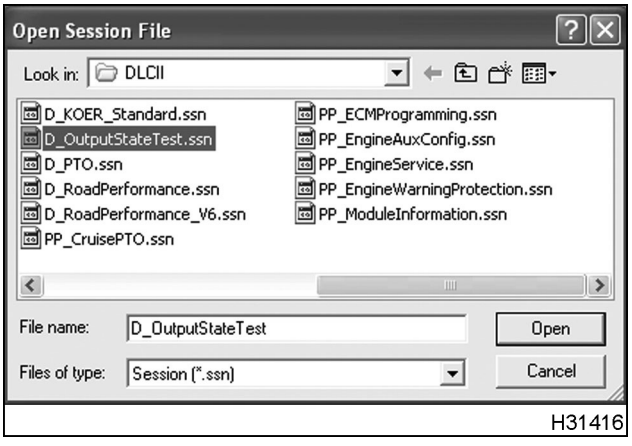


Figure 68 Output State Test Session

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

1. Select D_OutputStateTest.ssn from the open session file window.

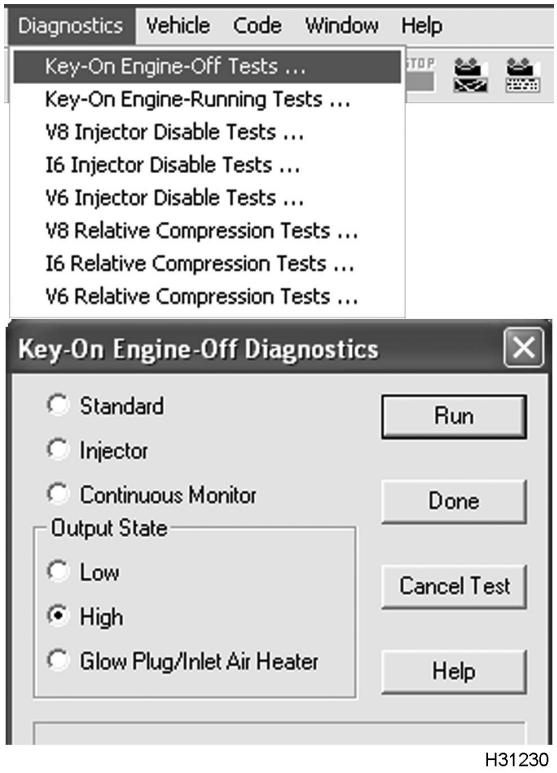


Figure 69 Output State High test

2. Select Diagnostics from the menu bar.
3. Select Key-On Engine-Off Tests from the drop down menu.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard test is always selected and run first. If the ignition switch is not cycled, the Standard test does not have to be run again.

4. From the KOEO Diagnostics menu, select Output State Test High and Run to start the test.
5. Toggle between the Output State Test Low and the Output State Test High. Listen and observe actuator control or circuit operation.

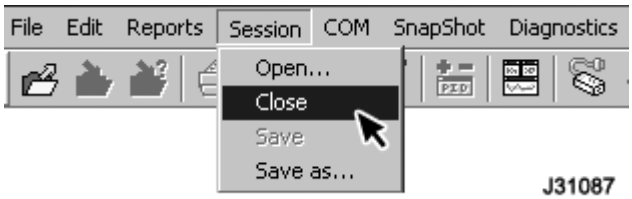


Figure 70 Close session

6. When finished with this test, select Session from menu bar, then Close.

Glow Plug/Inlet Air Heater Output State Test

NOTE: This test can only be done with the EST; MasterDiagnostics® software is required.

The Glow Plug/Inlet Air Heater Output State test allows the technician to determine if the Inlet Air Heater System is operating correctly.

The inlet air heater relay operation is activated for 30 seconds. A DMM and current clamp are used to measure the time the relay is on and the amperage that is drawn for the inlet air heater.

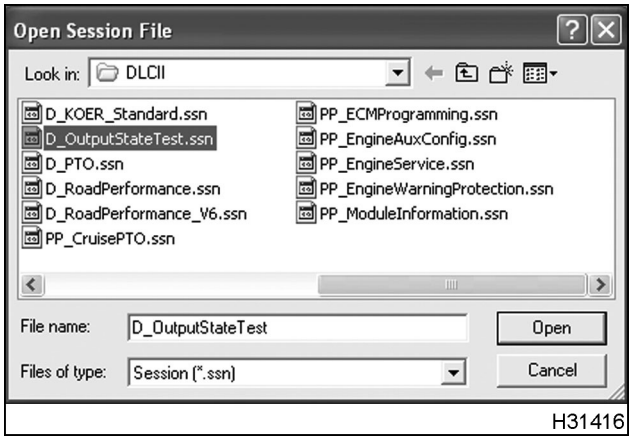


Figure 71 Output State Test Session

1. Select D_OutputStateTest.ssn from the open session file window.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

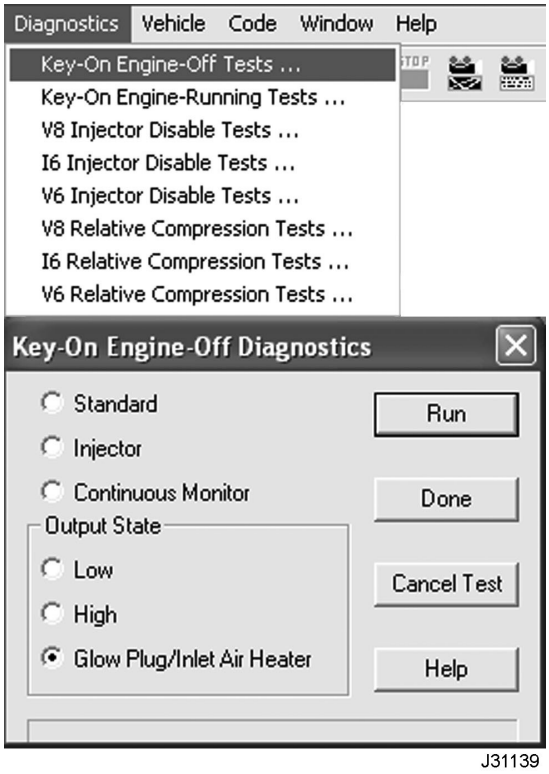


Figure 72 Glow Plug/Inlet Air Heater Output State test

2. Select Diagnostics from the menu bar.
3. Select Key-On Engine-Off Tests from the drop down menu.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard test is always selected and run first. If the ignition switch is not cycled, the Standard test does not have to be run again.

4. From the KOEO Diagnostics menu, select Glow Plug/Inlet Air Heater and Run to start the test.

NOTE: This test can only be run twice for each ignition switch cycle. Earlier calibration may not allow the test to be run, contact International® Technical Services.

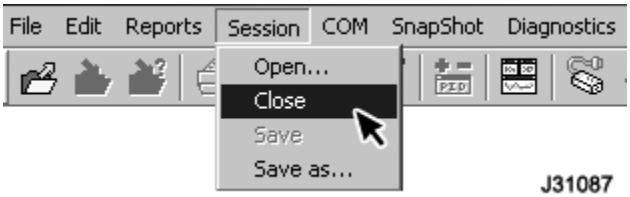


Figure 73 Close session

5. When finished with this test, select Session from menu bar, then Close.

Key-On Engine-Running Tests

Standard Test

NOTE: The KOER Standard test can only be done with the EST; MasterDiagnostics® software is required.

During the KOER Standard test, the ECM commands the IPR through a step test to determine if the ICP system is performing as expected. The ECM monitors signal values from the ICP sensor and compares those values to the expected values. When the Standard test is done, the ECM returns the engine to normal operation and transmits DTCs set during the test.

NOTE: Before doing this test, confirm the following conditions:

- Problems causing active DTCs were corrected, and active DTCs were cleared.
- Engine coolant temperature must be at least 70 °C (158 °F).
- Battery voltage must be higher than 10.5 volts.
- No signal from Vehicle Speed Sensor (VSS)
- Transmission in park or neutral

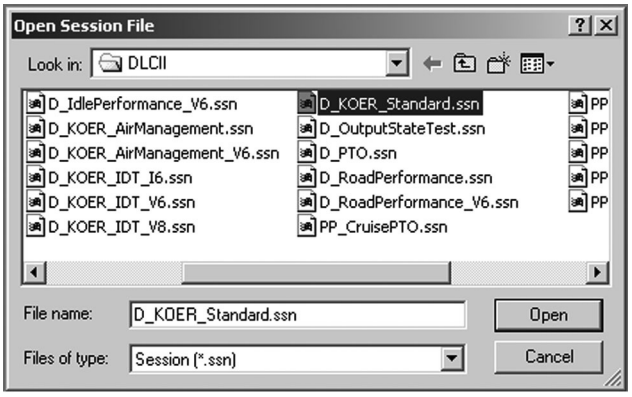


Figure 74 KOER Standard session

1. With the engine running, select D_KOER_Standard.ssn from the open session file window.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

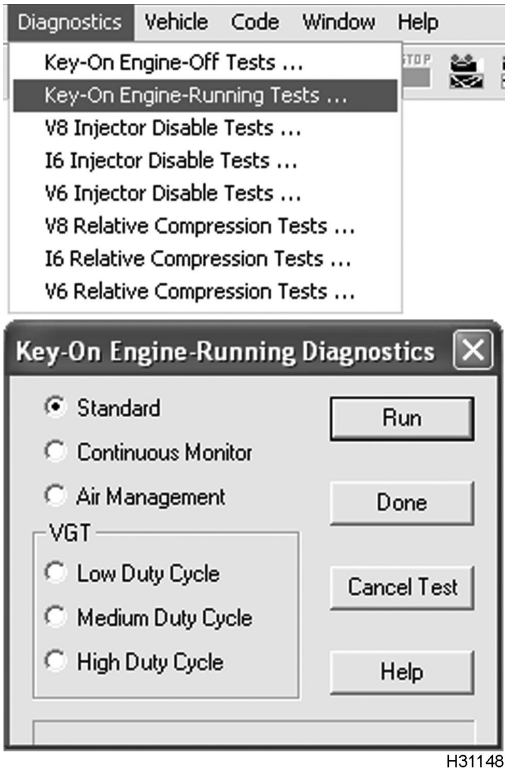


Figure 75 Standard test

2. Select Diagnostics from the menu bar.
3. Select Key-On Engine-Running Tests from the drop down menu.
4. From the KOER Diagnostics menu, select Standard and select Run to start the test.

The ECM increases engine idle to a predetermined value and commands the IPR valve to set ICP to rated speed pressure. If the performance of the ICP system is acceptable, the ECM will control the IPR valve and reduce the pressure in steps, while continuing to monitor the ICP system.

When the test is done, the ECM restores normal engine operation, and the Diagnostic Trouble Code window will display DTCs, if there are problems.

5. Correct problem causing active DTCs.
6. Clear DTCs.

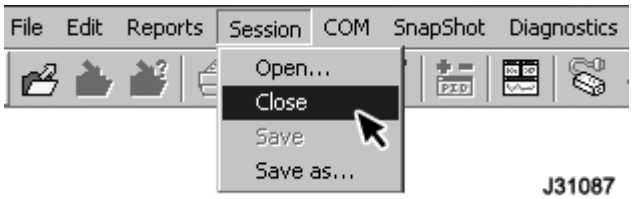


Figure 76 Close session

7. When finished with this test, select Session from menu bar, then Close.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard test is always selected and run first. If the ignition switch is not cycled, the Standard test does not have to be run again.

Continuous Monitor Test

NOTE: This test can only be done with the EST; MasterDiagnostics® software is required.

The Continuous Monitor test troubleshoots intermittent connections at sensors and actuators. The engine can be off or running.

The EST monitors the following circuits:

- Accelerator Position Sensor (APS)
- Barometric Absolute Pressure (BAP)
- Battery Voltage (V_{Batt})
- Brake Control Pressure (BCP) (optional)
- EGR Valve Position (EGRP)
- Exhaust Back Pressure (EBP)
- Engine Coolant Level (ECL)
- Engine Fuel Pressure (EFP) (optional)
- Engine Oil Pressure (EOP)
- Engine Oil Temperature (EOT)
- Intake Air Temperature (IAT)
- Injection Control Pressure (ICP)
- Manifold Air Temperature (MAT)
- Manifold Absolute Pressure (MAP)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

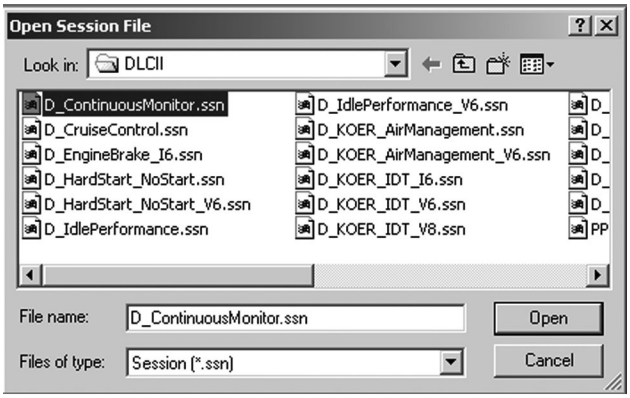


Figure 77 Continuous Monitor session

1. With the engine running, select D_ContinuousMonitor.ssn from the open session file window.

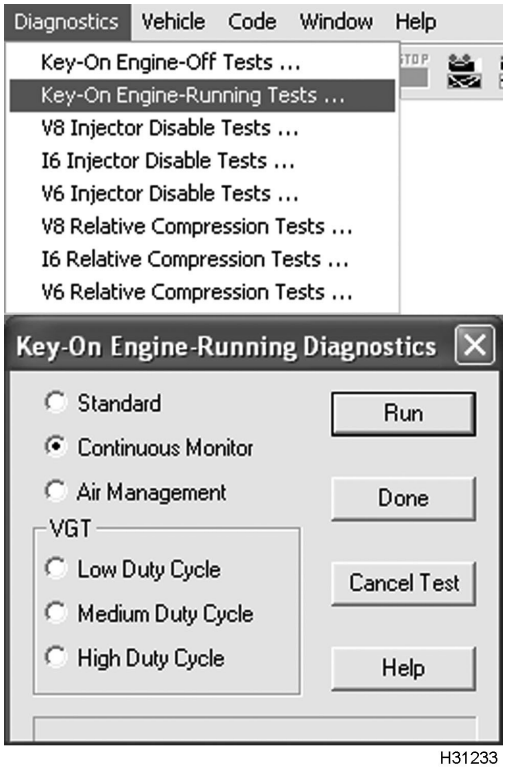


Figure 78 Continuous Monitor test

2. Select Diagnostics from the menu bar.
3. Select Key-On Engine-Running Tests from the drop down menu.
4. From the KOER Diagnostics menu, select Continuous Monitor and select Run to start the test.

⚠ WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

5. Wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Correct problem causing active DTCs.
7. Clear DTCs.

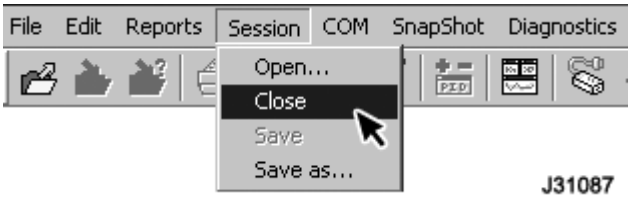


Figure 79 Close session

8. When finished with this test, select Session from menu bar, then Close.

Air Management Test

NOTE: Before doing this test, Performance Diagnostics tests 1 through 12 should be completed. Problems with other systems (injectors, fuel supply, etc.) can affect Air Management test results.

NOTE: The Air Management test can only be done with the EST; MasterDiagnostics® software is required. The Standard test must be done before doing the Air Management test.

The Air Management test checks the operation of the Air Management System and the following:

- EVRT® electronically controlled turbocharger - International's version of a Variable Geometry Turbocharger (VGT)
- Exhaust Gas Recirculation (EGR) valve

During the Air Management test, the ECM commands the VGT control actuator and EGR actuator through a step test sequence to determine if actuators and the Air Management System are performing as

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

expected. The ECM monitors the feedback signal values from the Exhaust Back Pressure (EBP) sensor and compares those values to the expected values.

If a fault is detected the test will end, engine operation will return to normal, and a DTC will be set.

If there are no faults, the test will be completed and engine operation will return to normal.

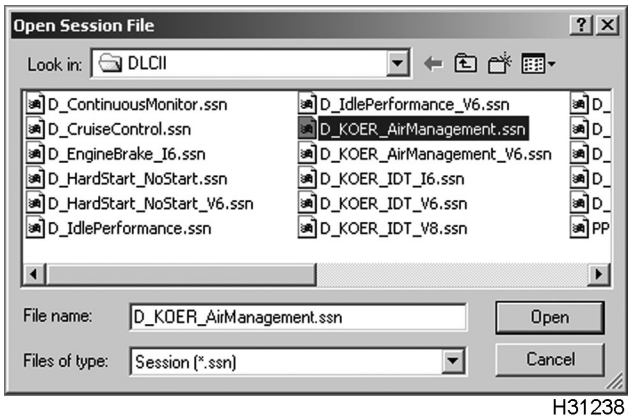


Figure 80 Air Management session

1. With the engine running, select D_KOER_AirManagement.ssn from the open session file window and select OPEN to open the session.

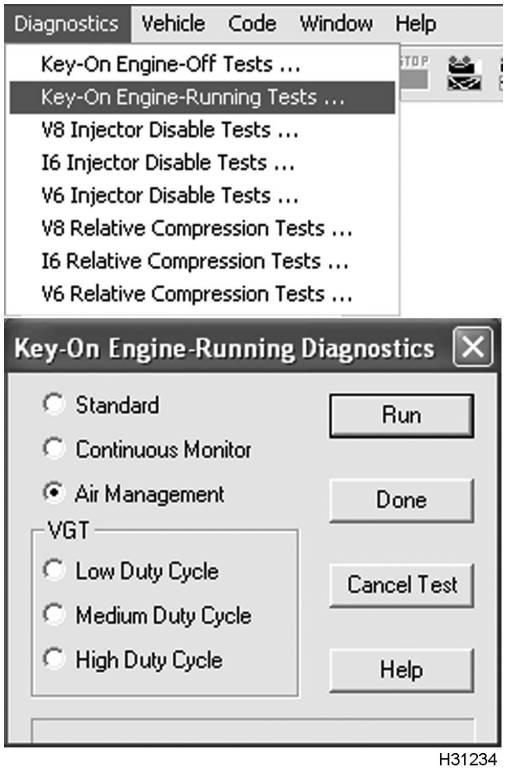


Figure 81 Air Management test

2. Select Diagnostics from the menu bar.
3. Select Key-On Engine-Running Tests from the drop down menu.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard test is always selected and run first. If the ignition switch is not cycled, the Standard test does not have to be run again.

4. From KOER Diagnostics menu, select Air Management and Run to start the test.
5. Correct problem causing active DTCs.
6. Clear DTCs.

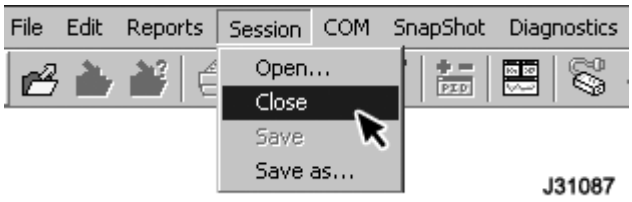


Figure 82 Close session

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

7. When finished with this test, select Session from menu bar, then Close.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Air Management Test

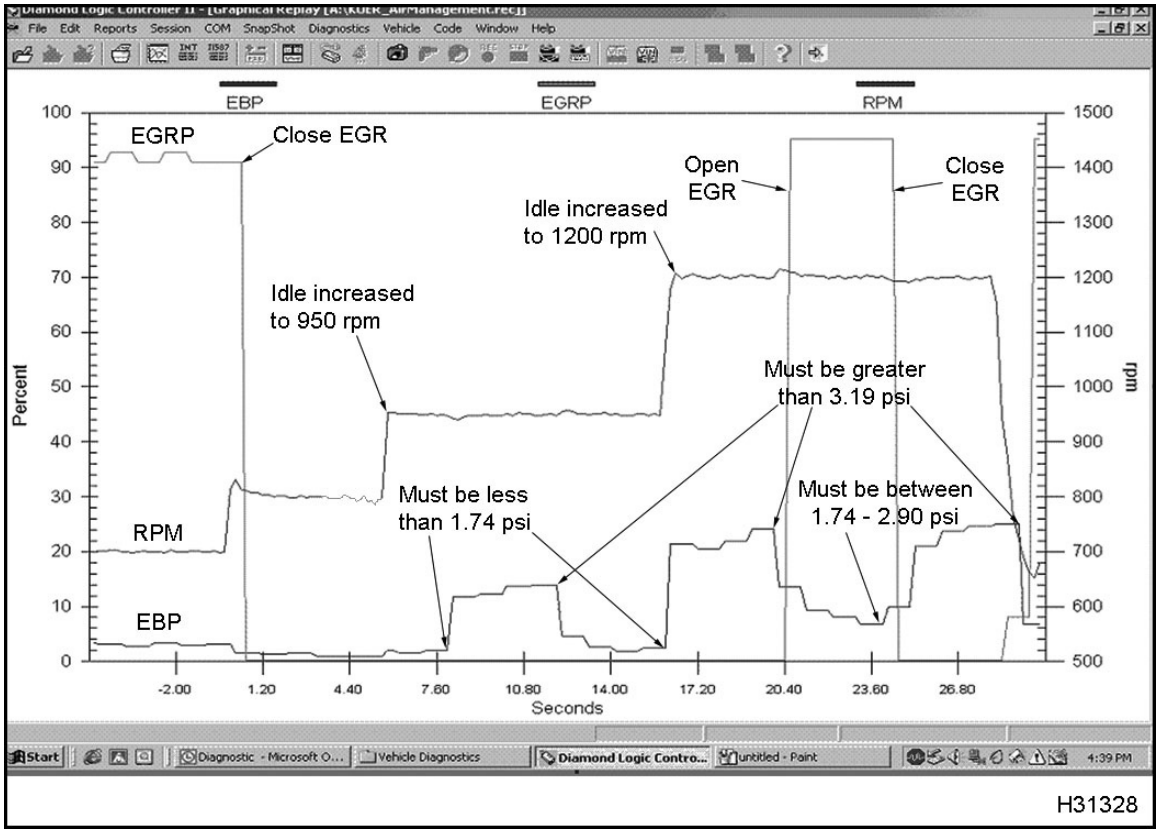


Figure 83 Air Management diagnostic readout

The ECM commands the EGR valve to close. The ECM then increases engine idle speed to 950 RPM and commands the VGT vanes to fully open. The ECM allows EBP to stabilize. The ECM monitors the EBP pressure and compares this pressure to the expected pressure; pressure is expected to drop. If EBP pressure does not match expected pressure, DTC 345 is set and the test is cancelled.

NOTE: Although commanding the EGR to close, it may be stuck partially open, which would cause EBP values to be lower than expected causing the test to fail during the VGT portion of this test. If this is suspected, the operation of the EGR valve should be visually inspected using the Output State tests.

With the EGR still closed, the ECM commands the VGT vanes to fully close. The ECM allows EBP to stabilize. The ECM monitors the EBP pressure and compares this pressure to the expected pressure; pressure is expected to increase. If EBP pressure does not match expected pressure, DTC 345 is set and the test is cancelled.

With the EGR still closed, the ECM commands the VGT vanes to fully open. The ECM allows EBP to stabilize. The ECM monitors EBP pressure and compares this pressure to the expected pressure; pressure is expected to drop. If EBP pressure does not match expected pressure, DTC 345 is set and the test is cancelled.

If all pressures matched the expected pressures, no DTC is set and the test will continue for EGR.

With the EGR still closed, the ECM increases engine RPM to 1200 rpm and commands the VGT vanes to fully close. The ECM allows EBP to stabilize. The ECM monitors the EBP pressure and compares this pressure to the expected pressure; pressure is expected to increase. If EBP pressure does not match expected pressure, DTC 346 is set and the test is cancelled.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

With the VGT vanes still closed, the ECM commands the EGR to open, and allows EBP to stabilize. The ECM monitors the EBP pressure and compares this pressure to the expected values; pressure is expected to drop. If EBP pressure does not match expected pressure, DTC 346 is set and the test is cancelled.

With the VGT still closed, the ECM then commands the EGR to close, and allows EBP to stabilize. The ECM monitors the EBP pressure and compares this pressure to the expected pressure; pressure is expected to increase. If EBP pressure does not match expected pressure, DTC 346 is set and the engine will return to normal operation.

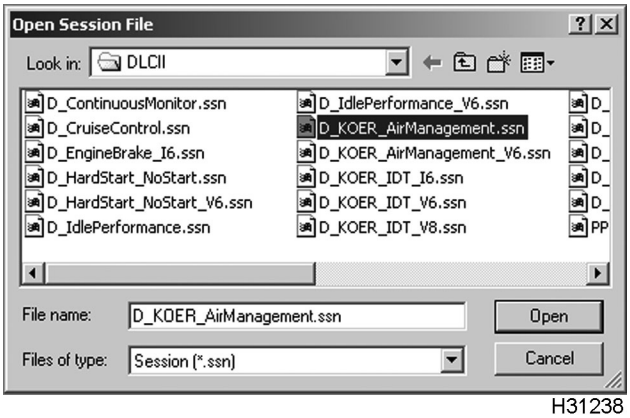
If all pressures matched the expected pressures, no DTC is set and the engine is returned to normal operation.

VGT Test

NOTE: The VGT test can only be done with the EST; MasterDiagnostics® software is required. The Standard test must be done before doing the VGT test.

The VGT test is a manual test that allows the technician to set the VGT duty to low, medium, or high and inspect the exhaust system for leaks.

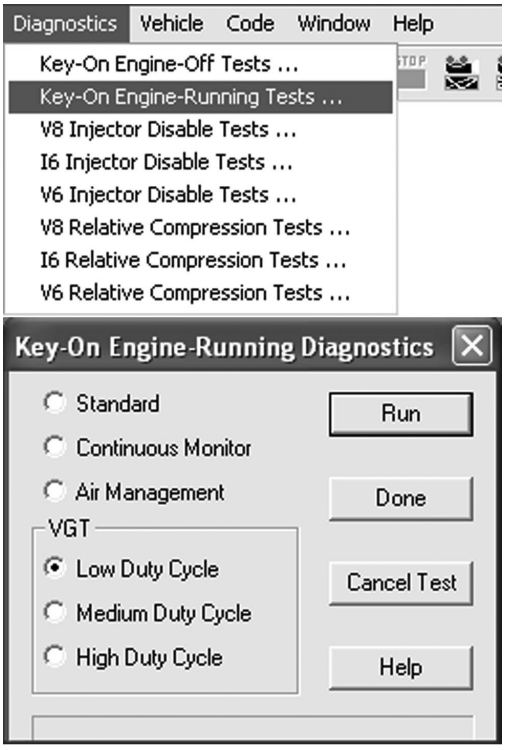
NOTE: Monitor EBP and MAP as VGT duty cycles are changed.



H31238

Figure 84 VGT session

1. With the engine running, select D_KOER_AirManagement.ssn from the open session file window and select OPEN to open the session.



H31232

Figure 85 VGT Low Duty cycle test

2. Select Diagnostics from the menu bar.
3. Select Key-On Engine-Running Tests from the drop down menu.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard test is always selected and run first. If the ignition switch is not cycled, the Standard test does not have to be run again.

4. From the KOER Diagnostics menu, select Low Duty Cycle from VGT, and select Run to start test:

   Use the suggested toggle sequence below, to check turbocharger operation from one duty cycle to the other.

   - Low to medium
   - Medium to high
   - High to low
   - Low to high

If the ECM does not receive a request from the EST, after about 40 seconds, the test will automatically end and the engine will return to normal operation.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

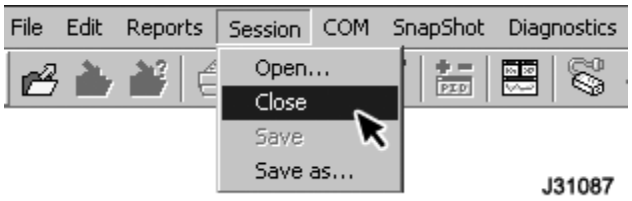


Figure 86 Close session

5. When finished with this test, select Session from menu bar, then Close.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Injector Disable Tests

NOTE: The Injector Disable tests can only be done with the EST; MasterDiagnostics® software is required.

The Injector Disable tests allows the technician to shut off injectors to determine if a specific cylinder is contributing to engine performance. Injectors can be shut off one at a time, alternative cylinders at a time or alternative cylinders plus one.

Alternate cylinders are every other cylinder in firing order.

Firing order: 1-5-3-6-2-4

When all cylinders are active, the contribution of each cylinder is 17% of its overall effect to maintain governed speed. When three cylinders are shut off, contribution of each remaining cylinder is 33% of its overall effect to maintain governed speed. The technician should monitor fuel rate and engine load.

NOTE: The Relative Compression test should be done after doing the Injector Disable test to distinguish between an injector or mechanical problem.

NOTE: Before doing the Auto test or Manual test for injector disable, make sure Performance Diagnostics tests 1 through 10 were completed and the following conditions are maintained:

- Make sure accessories are turned off (for example: engine fan and air conditioning). Items cycled during this test could corrupt the test results.
- Maintain engine idle.
- Keep EOT within a 2 °C (5 °F) range from the beginning to the end of the test. EOT affects injection timing; too much of a change in EOT temperature could corrupt the test results.

NOTE: If any injectors are removed and reinstalled or replaced, test drive vehicle for 20 miles before checking for misfire or rough idle.

Automatic Test

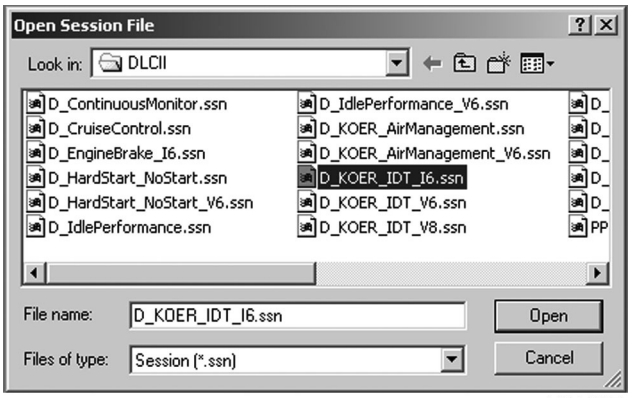
The Automatic test is best used when comparing cylinder to cylinder test data.

NOTE: If MasterDiagnostics® software does not have the Automatic test (auto run feature), see “Injector Disable - Manual test - Engine Hot” later in this section for procedure to compare cylinder to cylinder.

NOTE: Do KOER Standard test before doing this test.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle - comply with the following: When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral or park, and the wheels are blocked.

NOTE: If any injectors are removed and reinstalled or replaced, test drive vehicle for 20 miles before checking for misfire or rough idle.



H31235

Figure 87 KOER IDT I6 session

1. While engine is running, select D_KOER_IDT_I6.ssn from the open session file window and select OPEN to open the session.

©August 2008 Navistar, Inc.

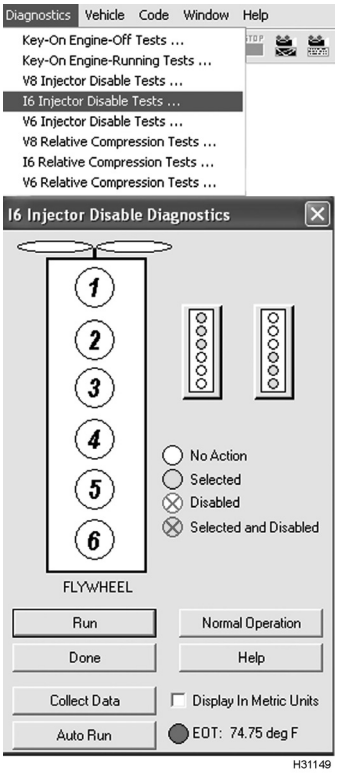


Figure 88 Injector Disable Tests

2. Select Diagnostics from menu bar.
3. Select I6 Injector Disable Tests from drop down menu.

   NOTE: The EOT indicator will change from red to green when engine temperature reaches 70 °C (158 °F) or higher.

   - If the EOT indicator is red, erroneous comparisons are likely from cylinder to cylinder.

     However, when diagnosing a cold misfire, a technician can listen to tone changes from cylinder-to-cylinder.

   - When the EOT indicator is green and the engine is at 70 °C (158 °F) or higher, fuel rate and timing are more stable, making comparisons from cylinder to cylinder more accurate. Overall engine operation is more stable.

4. Select Auto Run.

   NOTE: While running the engine listen for tone changes from cylinder-to-cylinder.

   NOTE: If any injectors are removed and reinstalled or replaced, test drive vehicle for 20 miles before checking for misfire or rough idle.

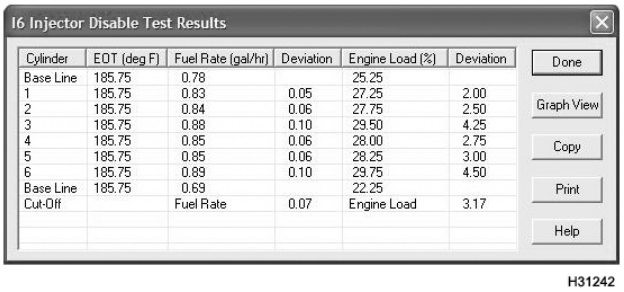


Figure 89 I6 Injector Disable test results (Auto Run - Text View)

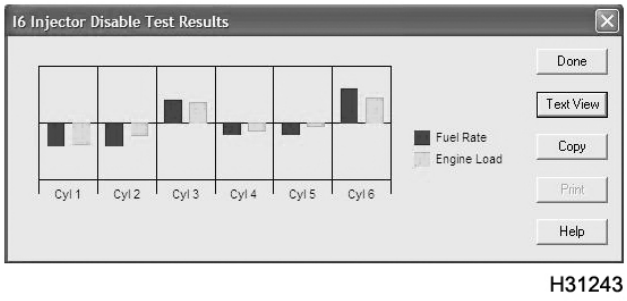


Figure 90 I6 Injector Disable test results (Auto Run - Graph View)

During Auto Run, injectors are shutoff one at a time (1 through 6 numerical sequence). Base line data and results for each cylinder is displayed in the window (Text View) for I6 Injector Disable test results. Test data for each cylinder can also be viewed by selecting the (Graph View). When finished the engine will return to normal operation.

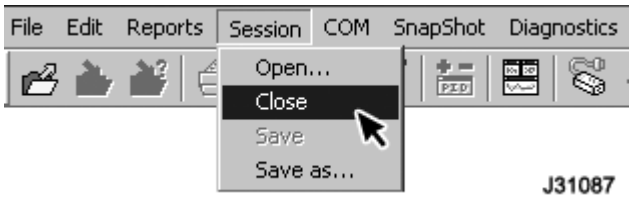


Figure 91 Close session

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

5. When finished with this test, select Session from menu bar, then Close.

Manual Test - Engine Cold

The Manual test is best used when diagnosing each cylinder for cold misfire, considering EOT changes.

The EOT indicator will change from red to green when engine temperature reaches 70 °C (158 °F) or higher.

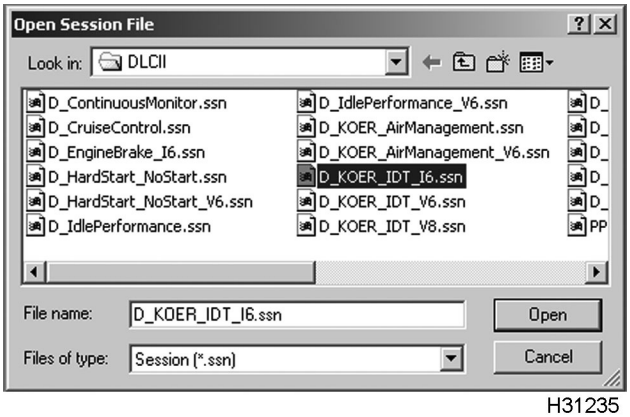
- If the EOT indicator is red, erroneous comparisons are likely from cylinder to cylinder.

  However, when diagnosing a cold misfire, a technician can listen to tone changes from cylinder-to-cylinder.

- When the EOT indicator is green and the engine temperature is 70 °C (158 °F) or higher, fuel rate and timing are more stable, making comparisons from cylinder to cylinder more accurate. Overall engine operation is more stable.

Shut off one injector at a time and listen for changes in exhaust tone.

NOTE: If any injectors are removed and reinstalled or replaced, test drive vehicle for 20 miles before checking for misfire or rough idle.



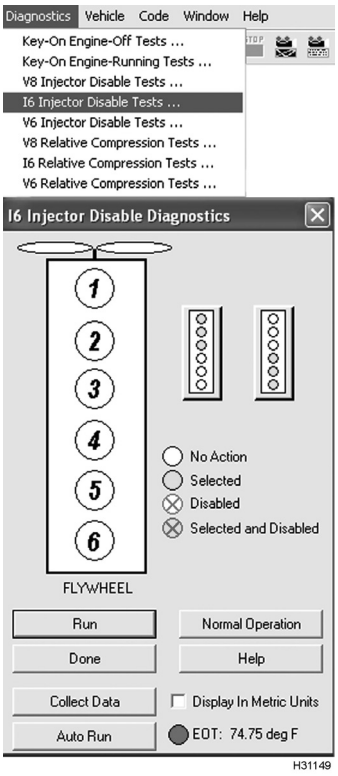
H31235

Figure 92 KOER IDT I6 session

1. While engine is running, select D_KOER_IDT_I6.ssn from the open session file window and select OPEN to open the session.

⚠ WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle - comply with the following: When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral or park, and the wheels are blocked.

2. Select Diagnostics from menu bar.



H31149

Figure 93 Injector Disable tests

3. Select I6 Injector Disable Tests from drop down menu.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NOTE: The EOT indicator will change from red to green when engine temperature reaches 70 °C (158 °F) or higher.

- If the EOT indicator is red, erroneous comparisons are likely from cylinder to cylinder.

  However, when diagnosing a cold misfire, a technician can listen to tone changes from cylinder-to-cylinder.

- When the EOT indicator is green and the engine temperature is 70 °C (158 °F) or higher, fuel rate and timing are more stable, making comparisons from cylinder to cylinder more accurate. Overall engine operation is more stable.

4. Select cylinder number and select Run. (Injector selected will be disabled and engine noise should change.)
5. Select Normal Operation. Injector will be enabled and engine noise should return to previous state of operation.
6. Repeat steps 4 and 5 for the remaining cylinders.

NOTE: Listen for tone changes from cylinder-to-cylinder.

NOTE: If any injectors are removed and reinstalled or replaced, test drive vehicle for 20 miles before checking for misfire or rough idle.

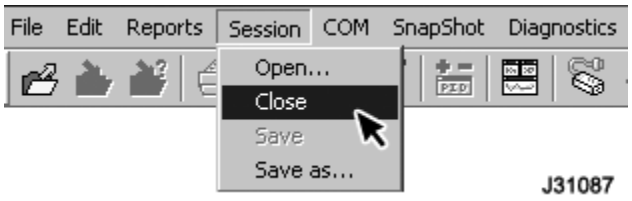


Figure 94 Close session

7. When finished with this test, select Session from menu bar, then Close.

Manual Test - Engine Hot

NOTE: This is an alternate method only. This Manual test should only be used when MasterDiagnostics® software does not have the Automatic test (auto run feature) and the engine is hot.

The EOT indicator will change from red to green when engine temperature reaches 70 °C (158 °F) or higher.

- If the EOT indicator is red, erroneous comparisons are likely from cylinder to cylinder.
- When the EOT indicator is green and the engine temperature is 70 °C (158 °F) or higher, fuel rate and timing are more stable, making comparisons from cylinder to cylinder more accurate. Overall engine operation is more stable.

Shut off one injector at a time and listen for changes in exhaust tone.

NOTE: Do KOER Standard test before doing the I6 Injector Disable test - Run.

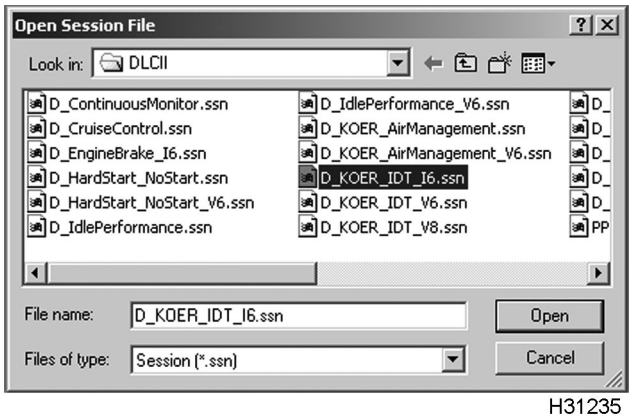


Figure 95 KOER IDT I6 session

1. While engine is running, select D_KOER_IDT_I6.ssn from the open session file window and select OPEN to open the session.

⚠ WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, when running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

2. Select Diagnostics from menu bar.

©August 2008 Navistar, Inc.

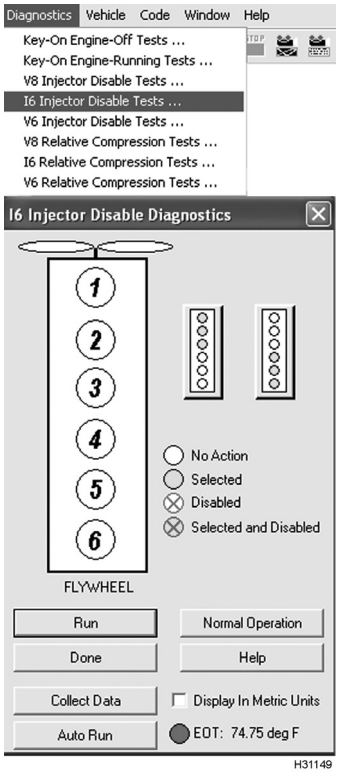


Figure 96 Injector Disable tests

3. Select I6 Injector Disable Tests from drop down menu.

NOTE: The EOT indicator will change from red to green when engine temperature reaches 70 °C (158 °F) or higher.

- If the EOT indicator is red, erroneous comparisons are likely from cylinder to cylinder.

  However, when diagnosing a cold misfire, a technician can listen to tone changes from cylinder-to-cylinder.

- When the EOT indicator is green and the engine temperature is 70 °C (158 °F) or higher, fuel rate and timing are more stable, making comparisons from cylinder to cylinder more accurate. Overall engine operation is more stable.

4. Select Collect Data from I6 Injector Disable Diagnostics window. (Baseline values will be shown.)

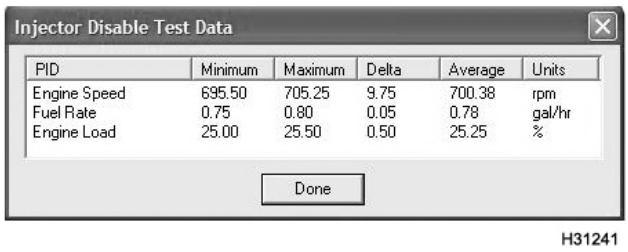


Figure 97 Injector Disable test data

5. Record baseline values for EOT, average fuel rate, and average engine load on Diagnostic Form.

NOTE: Listen for tone changes from cylinder-to-cylinder.

6. Select cylinder number and select Run. (Injector selected will be disabled and engine tone should change.)

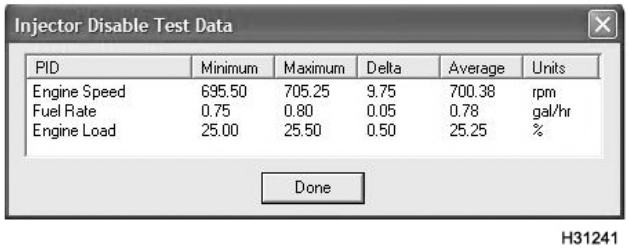


Figure 98 Injector Disable test data

7. Select Collect Data.
8. Record values for EOT, average fuel rate, and average engine load on Diagnostic Form.
9. Select Done to close Collect Data window.
10. Repeat steps 6 through 9 for the remaining cylinders.
11. Select Normal Operation
12. Subtract the baseline for (average fuel rate) from the (average fuel rate) for each injector and record the difference (deviation) on Diagnostic Form.
13. Add deviations for (average fuel rate) for all injectors and divide by 6. (Round to the nearest tenth - this is the cut off value for fuel rate.)
14. Record cut off value on Diagnostic Form.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

15. Subtract the baseline for (average engine load) from the (average engine load) for each injector and record the difference (deviation) on Diagnostic Form.
16. Add deviations for (average engine load) for all injectors and divide by 6. (Round to the nearest tenth - this is the cut off value for engine load.)
17. Record cut off value on Diagnostic Form.
    - If deviation values for average fuel rate and average engine load are less than the cut off values for fuel rate and engine load, the injector is suspect for weak cylinder contribution (fuel rate and engine load).
    - If only one deviation value is less than a cut off value, do not suspect that cylinder.
    - If a suspect cylinder(s) is identified, do Relative Compression test to distinguish between an injector or mechanical problems.
    - If the Relative Compression test shows that cylinders are mechanically sound but the Injector Disable test shows that one or more cylinders are bad, replace suspected injector.

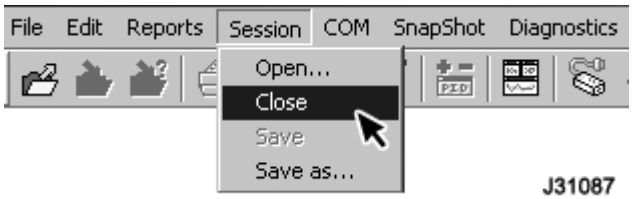


Figure 99 Close session

18. When finished with this test, select Session from menu bar, then Close.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Relative Compression

NOTE: During this test the IDM shuts off the injectors so no fueling occurs.

NOTE: The Relative Compression test can only be done with the EST; MasterDiagnostics® software is required.

NOTE: This test is used in conjunction with the Injector Disable test to distinguish between an injector problem or a mechanical problem.

The Relative Compression test provides the difference between the fastest and slowest crankshaft speed during the power stroke of each cylinder.

As the engine is cranked, the IDM uses the CMP and CKP sensor signals to measure crankshaft speed, as piston reaches two points: Top Dead Center (TDC) compression and about 30 degrees after TDC compression.

When the piston approaches TDC, crankshaft speed should be slower because of compression resistance. As the piston passes TDC, compression resistance dissipates and crankshaft speed increases.

At TDC compression, the cylinder reaches its highest compression and resistance to crankshaft rotation - Crankshaft speed is the slowest. A cylinder with low compression will have less resistance to crankshaft rotation. Crankshaft speed will be faster than normal.

About 30 degrees after TDC, crankshaft speed should be fastest because compression has dissipated. On a cylinder that has low compression, crankshaft speed will be close to, or less than crankshaft speed at TDC.

At TDC of each power cylinder, and about 30 degrees past TDC, the IDM collects data for crankshaft speed.

NOTE: If not cranked long enough to collect data, the EST will display 255. 255 represents an erroneous rpm value

The TDC value is subtracted from the value about 30 degrees after TDC and is recorded for each cylinder.

Example

200 rpm (30 degrees after TDC) - 180 rpm (TDC) = 20 rpm

The EZ-Tech® will display a value on the screen for each cylinder.

Example

Relative Compression Test	Value
Cylinder 1 Relative Compression	18
Cylinder 2 Relative Compression	22
Cylinder 3 Relative Compression	24
Cylinder 4 Relative Compression	20
Cylinder 5 Relative Compression	21
Cylinder 6 Relative Compression	22

H31310

Compare the compression values of each cylinder with the other cylinder values. A cylinder with compression lower than the other cylinders indicates a suspect cylinder. Test value of 18 for cylinder one indicates a suspect cylinder.

If a cylinder value is zero or a much lower than other cylinders and this cylinder is a non-contributor (identified in the Injector Disable Test), check for a mechanical problem.

Example

Relative Compression Test	Value
Cylinder 1 Relative Compression	5
Cylinder 2 Relative Compression	22
Cylinder 3 Relative Compression	24
Cylinder 4 Relative Compression	20
Cylinder 5 Relative Compression	21
Cylinder 6 Relative Compression	0

H31311

If TDC rpm is greater than rpm 30 degrees after TDC, the EST will display 0.

If the test value for a power cylinder is 0, the cylinder is suspect.

If the test value for a power cylinder is significantly below 15 rpm, the cylinder is suspect.

Test value 5 for cylinder 1 indicates a suspect cylinder. Test value 0 for cylinder 6 indicates a suspect cylinder.

When the Relative Compression test is done, the EST indicates, stop cranking the engine, and will display test values.

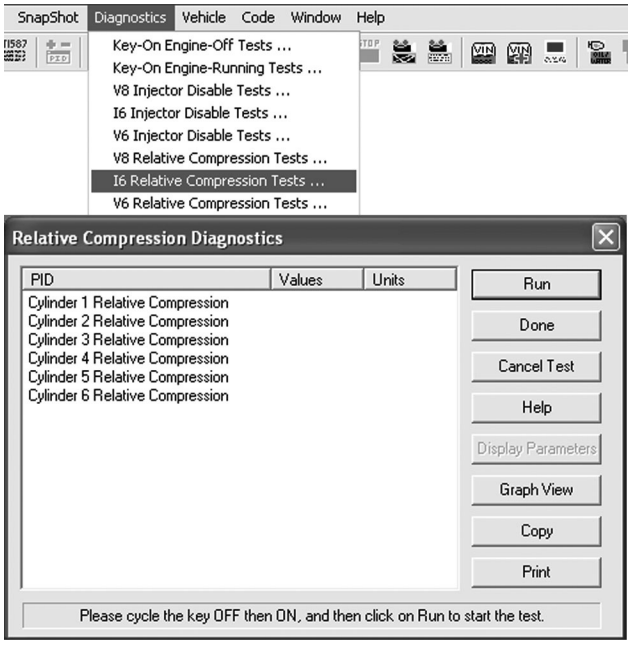
Test data displayed in this test should be compared with data collected from the Injector Disable test.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: Batteries must be fully charged before doing this test. Use battery charger during this test, if multiple tests are needed; battery drain can be extensive.

NOTE: Read and be familiar with all steps and time limits in this procedure before starting.



H31236

Figure 102 Relative Compression test

1. Select Diagnostics from the menu bar.
2. Select Relative Compression Tests from the drop down menu.
3. Follow the messages at the bottom of the window.
   - Turn the ignition switch to ON.
   - Select Run.

   WARNING: To avoid serious injury, possible death, or damage to the engine or vehicle, after clicking Run, turn the ignition switch, within 5 seconds, to crank the engine; if not done in 5 seconds, the IDM will cancel the test and the engine will start.

   - Within 5 seconds of selecting run, crank engine for 15 seconds. Another message will read Stop Cranking within 5 seconds. **Do not turn the ignition switch to OFF**. **If the ignition switch is turned to OFF, test results will be lost**.

   NOTE: If test results are identical to previous test results, the current test failed and the previous results were displayed.
4. Interpret results.
   - If a Relative Compression test and Injector Disable test identify a suspect cylinder, check for a mechanical problem.
   - If a Relative Compression test does not identify a suspect cylinder, but the Injector Disable test does, replace suspect injector(s).

©August 2008 Navistar, Inc.

Reset Change Engine Oil Interval Message

Using EST

1. Turn the ignition switch to ON.

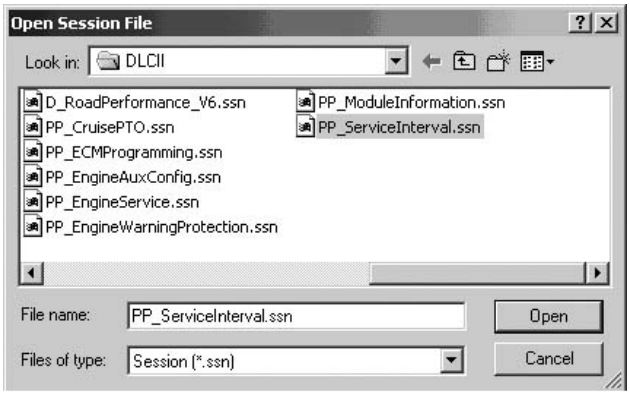
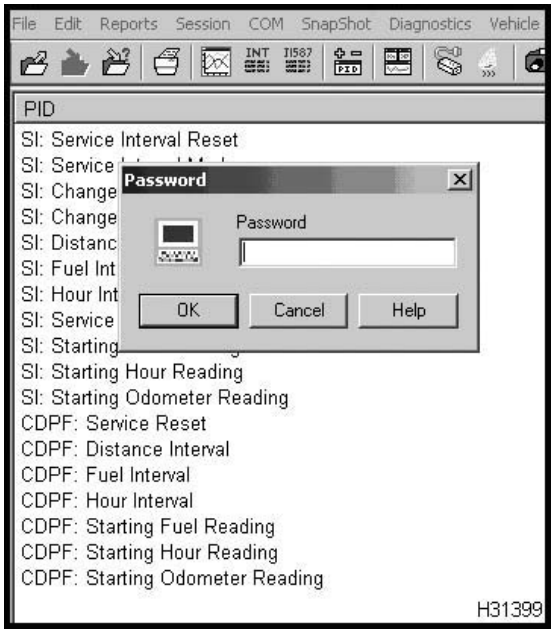


Figure 103 Select Service Interval session

2. Select PP_ServiceInterval.ssn from the Open Session File window, and select OPEN to open Vehicle Programming.



3. Click the right mouse button and select Enter Password.
4. Enter password in the dialog box, select OK.

   NOTE: If the password is not entered or is not entered correctly, you will get an error message indicating the password does not match, and the service interval will not reset.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

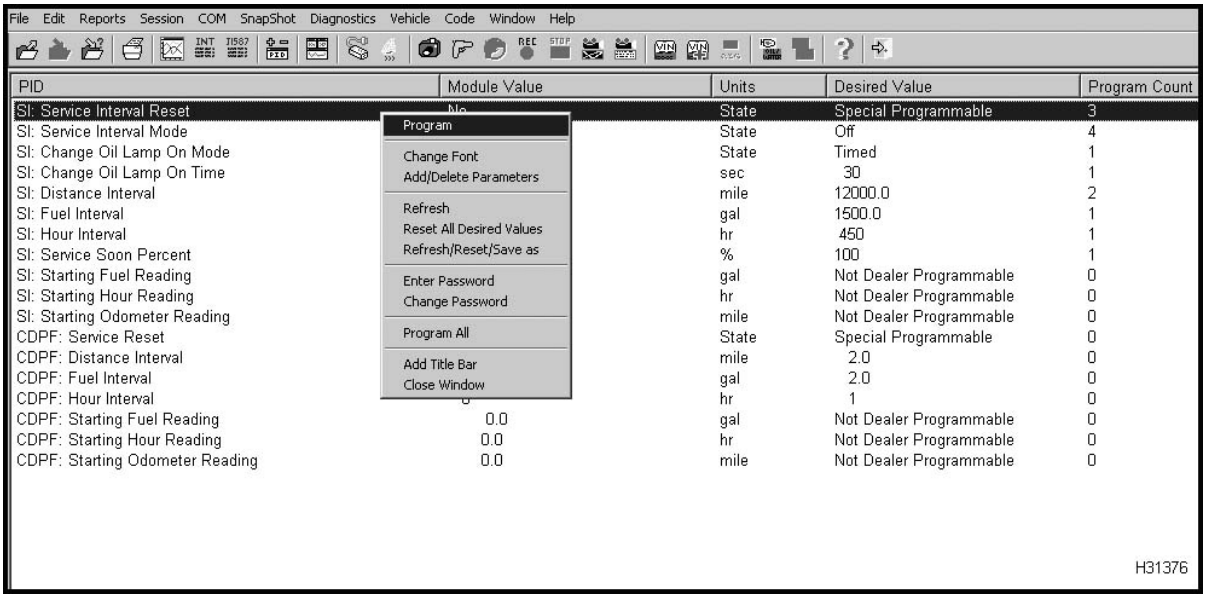


Figure 105 Select Parameter and Select Program

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

5. Select SI: Service Interval Reset, click the right mouse button and select Program.

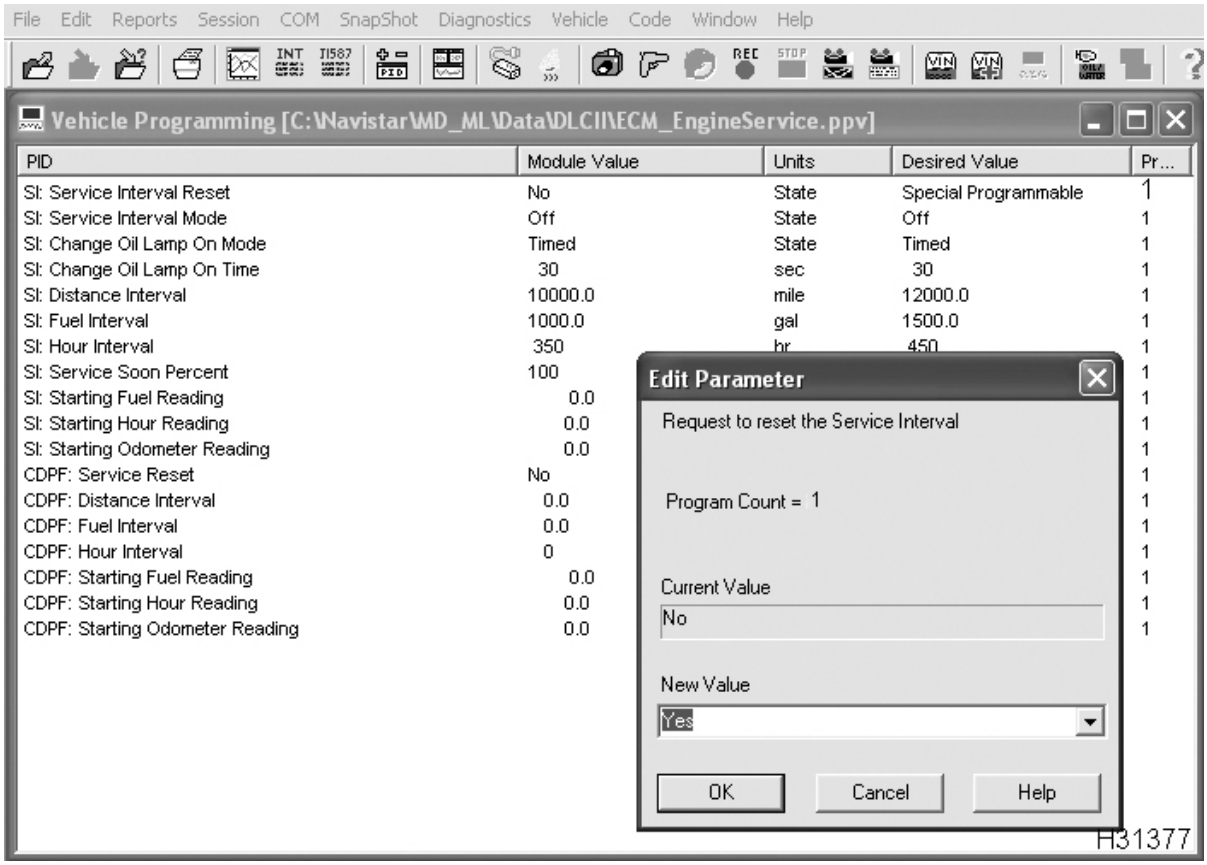
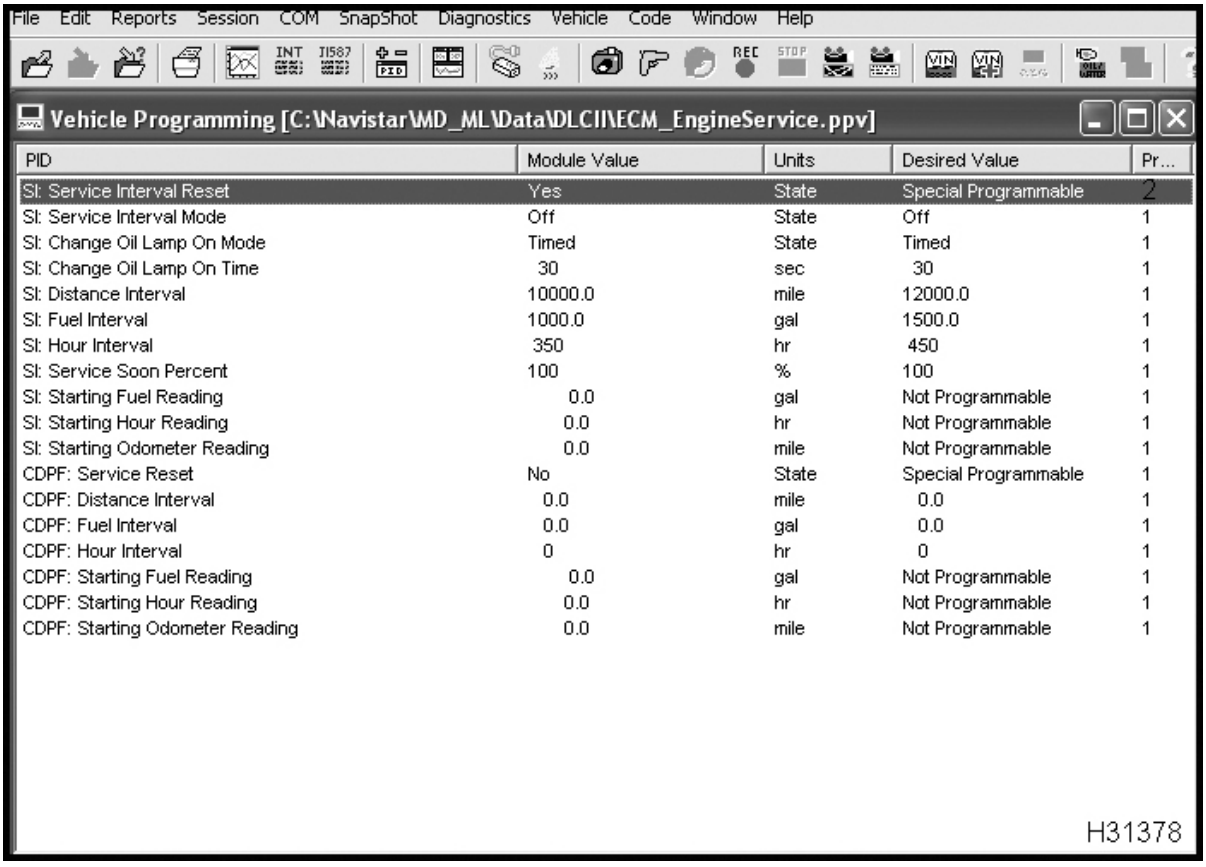


Figure 106 Change Edit Parameter to New

6. In the New Value box in the Edit Parameter dialog box click on the pull down arrow to select Yes, and select OK.

NOTE: If the password has not been entered or has not been entered correctly, an error message will indicate the password does not match, and the service interval will not reset.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.



PID	Module Value	Units	Desired Value	Pr...
SI: Service Interval Reset	Yes	State	Special Programmable	2
SI: Service Interval Mode	Off	State	Off	1
SI: Change Oil Lamp On Mode	Timed	State	Timed	1
SI: Change Oil Lamp On Time	30	sec	30	1
SI: Distance Interval	10000.0	mile	12000.0	1
SI: Fuel Interval	1000.0	gal	1500.0	1
SI: Hour Interval	350	hr	450	1
SI: Service Soon Percent	100	%	100	1
SI: Starting Fuel Reading	0.0	gal	Not Programmable	1
SI: Starting Hour Reading	0.0	hr	Not Programmable	1
SI: Starting Odometer Reading	0.0	mile	Not Programmable	1
CDPF: Service Reset	No	State	Special Programmable	1
CDPF: Distance Interval	0.0	mile	0.0	1
CDPF: Fuel Interval	0.0	gal	0.0	1
CDPF: Hour Interval	0	hr	0	1
CDPF: Starting Fuel Reading	0.0	gal	Not Programmable	1
CDPF: Starting Hour Reading	0.0	hr	Not Programmable	1
CDPF: Starting Odometer Reading	0.0	mile	Not Programmable	1

Figure 107 Module Value changed

7. Note that the Module Value has changed to Yes and Program Count number has increased.

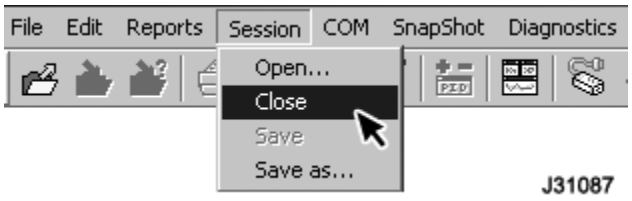


Figure 108 Close session

8. When finished, select Session from menu bar, then Close.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Using Cruise Switches

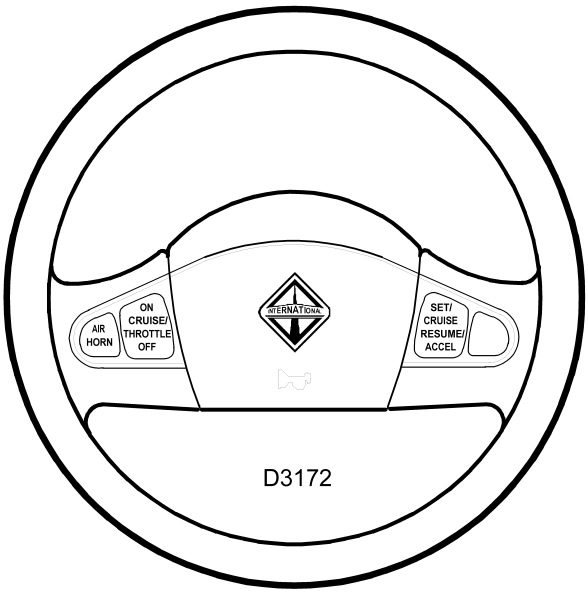


Figure 109 Switches for CRUISE ON and RESUME/ACCEL

Reset the change engine oil message feature as follows:

1. Set the parking brake (required for correct ESC signal).
2. Turn ignition switch to ON.

NOTE: The entire sequence must be completed within twelve seconds. The change engine oil message will now turn off and will activate when the next oil change is due.

3. Press and release both the CRUISE ON and RESUME/ACCEL switches four times within 6 seconds.
4. Press and hold both the CRUISE ON and RESUME/ACCEL switches for 3 seconds.
5. Release both Cruise buttons.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Table of Contents

Problems and Conditions.....101
Combustion Leaks to Coolant.....102
Aerated Fuel.....104
Aerated Fuel Inspection.....104
Alternate Fuel Source Supply to Fuel Pump.....106
Alternate Fuel Source Supply to Fuel Filter Housing.....107
Combustion Leaks to Fuel.....108
Coolant in Lube Oil.....109
Coolant System Inspection.....109
Air Compressor Leak Test.....110
Front Cover Inspection.....111
Cylinder Head Leak Test.....112
ECM Reset / IDM Reset (intermittent engine stumble).....113
Excessive Fuel Consumption.....114
Fuel in Coolant.....115
Coolant Leak to Exhaust.....117
Coolant Over-Temperature.....119
Coolant System Inspection.....119
Temperature Sensor Validation Test.....120
Cooling System Operating Pressure Test.....121
Lube Oil in Coolant.....122
Fuel in Lube Oil.....124
Low Oil Pressure.....128
Oil Inspection.....128
Oil Pressure Regulator Inspection.....129
Oil and Crankcase Inspection.....129
Oil Pump Inspection.....130
Front Cover Inspection.....131
Priming Fuel System.....132
Rough Idle.....135
Smoke.....137
Black Smoke.....137
White Smoke.....137
Low Power (Turbocharger Assembly and Actuator).....139

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Problems and Conditions

Diagnostic test procedures help technicians systematically find problems quickly to avoid unnecessary repairs. In this section, diagnostic and test procedures help identify causes for known problems and conditions.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the foreword of this manual. Follow all warnings, cautions, and notes.

©August 2008 Navistar, Inc.

Combustion Leaks to Coolant

Symptom

Combustion leaks can be identified by coolant overflowing from deaeration tank or air bubbles in the coolant.

Cause

- Failed injector sleeve
- Failed air compressor
- Failed head gasket
- Failed EGR cooler
- Porous or cracked cylinder sleeve

The likely cause of combustion gas leakage to the cooling system is past the injector sleeve in the cylinder head. A failed cylinder head gasket or porous / cracked cylinder sleeve is possible. However, this should not be considered unless there is evidence of engine overheating or high engine mileage without proper coolant conditioning.

Tools

- Radiator pressure testing kit
- Plastic surge tank cap adapter
- Cylinder head test plate
- Water supply housing pressure adapter
- Thermostat opening pressure adapter (cylinder head)
- Hose pinch-off pliers (2)

Procedure

1. Is the engine equipped with an air compressor?
   - If yes, do step 2.
   - If no, do step 3.

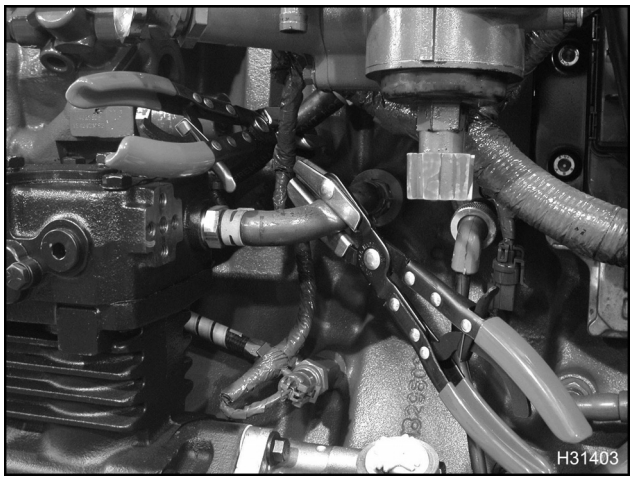


Figure 110 Air compressor coolant hoses

2. Close off both coolant hoses for the air compressor with hose pinch-off pliers. Test the system again.
   - If coolant continues overflowing from the deaeration tank, do step 3.
   - If coolant stops overflowing from deaeration tank, repair or replace the air compressor.
3. Remove injectors following the procedure in the *Engine Service Manual*.

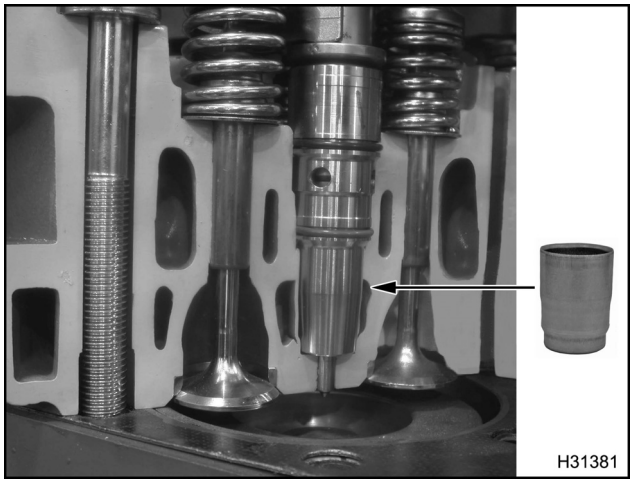


Figure 111 Cylinder head cut-away with injector sleeve

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4. Install radiator pressure tester with the appropriate adapter.

   WARNING: To avoid serious personal injury, possible death and damage to the engine:

   - **Always allow the engine to cool for 15 minutes.**
   - **Wrap a thick cloth around the cap.**
   - **Loosen cap slowly a quarter to half turn.**
   - **Pause for a moment to avoid water or steam scalding.**
   - **Continue to turn the cap and remove.**
   - **Never add cold coolant to a hot engine. This can result in a cracked cylinder head or crankcase.**
   - **Never use water as a coolant substitute.**

5. Pressurize cooling system to 96 kPa (14 psi).
6. Look for coolant leaking around the injector sleeve and into the cylinder bore.
   - If a leak is noticed, replace the leaking injector sleeve and test again.
   - If no leak is noticed, replace all six injector sleeves and test again.
   - If coolant continues to flow into cylinders after all injector sleeves were replaced, do step 7.
7. Remove cylinder head from engine, perform all inspections, and pressure test cylinder head to verify leak path. Follow the procedure in the *Engine Service Manual*.
   - Inspect cylinder head gasket for coolant leaks.
   - Verify crankcase and cylinder head surface flatness using a straight edge and feeler gauge.
   - Check cylinder liner protrusion.
8. Test the cylinder head with pressure test plate to validate the repair.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Aerated Fuel

Symptom

Fuel aeration will exhibit one or more of the following characteristics:

- Engine stall during operation
- White to black smoke during cranking
- Rough running engine
- Extended engine crank time (hard start)
- Fuel pressure slow to build while cranking
- Excessive fuel pressure while cranking
- Pulsating fuel pressure during crank or engine running at idle.
- Difficulty priming fuel system

Cause

- Leaks in fuel supply to fuel pump
- Loose fuel injector hold down
- Missing/damaged stainless steel injector gasket

Tools

- Fuel Pressure Test Gauge
- 1 to 5 gallon bucket
- Fuel pump supply line
- Fuel filter housing supply line fitting (Part No. 3533425C2)
- Fuel Pressure Test Adapter
- Fuel/Oil Pressure Test Coupler

Aerated Fuel Inspection

NOTE: If directed to this procedure from “Hard Start and No Start Diagnostics” section, go to “Alternate Fuel Source Supply to Fuel Pump” (page 106) in this section.

CAUTION: Be sure to place a rag or suitable container under the fuel pressure test valve when bleeding the fuel rail. Dispose of fuel in a correct container clearly marked DIESEL FUEL according to local regulations.

NOTE: Engine fuel can be a threat to the environment. Never dispose of engine fuel by putting it in the trash, pouring on the ground, in the sewers, in streams, or bodies of water.

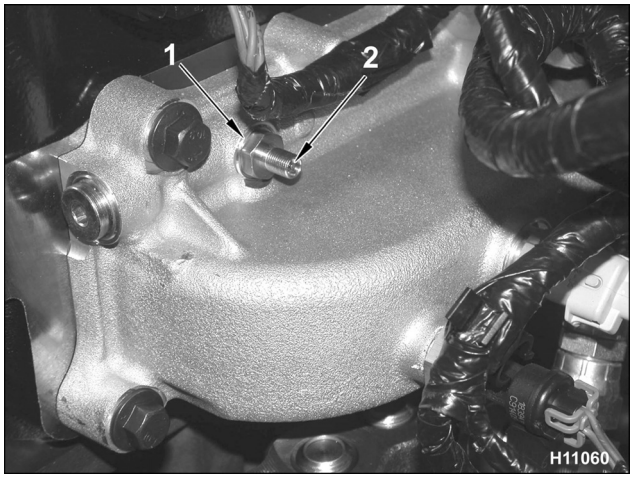


Figure 112 Shrader valve assembly

1. Valve
2. Center stem

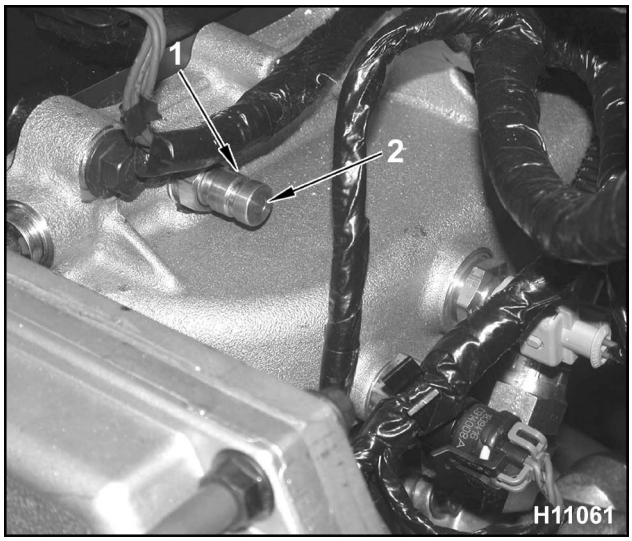


Figure 113 Diagnostic coupling

1. Valve
2. Center section

©August 2008 Navistar, Inc.

NOTE: Engines are equipped with a fuel pressure test valve in the form of either a Shrader valve or a diagnostic coupling.

1. Check fuel pressure and aeration from fuel pressure test valve located at the front of the intake manifold.
2. Check fuel pressure and aeration from fuel pressure test valve located at the front of the intake manifold.

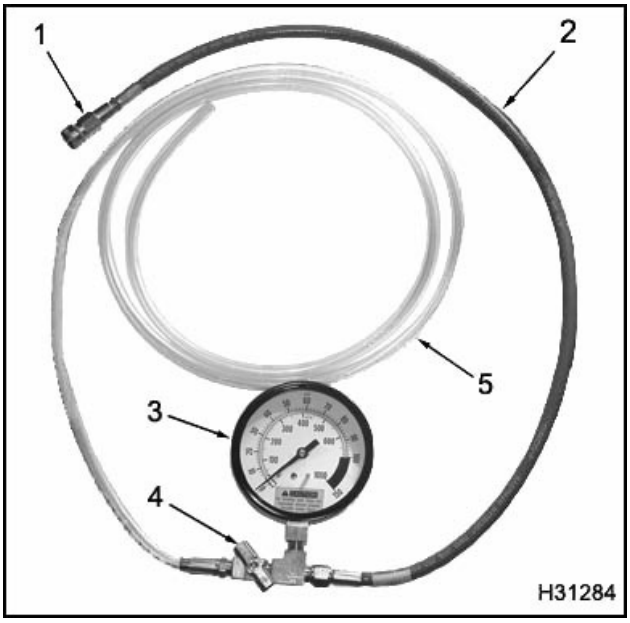


Figure 114 Fuel Pressure Gauge

1. Quick disconnect check valve
2. Fuel test line
3. Fuel Pressure Gauge
4. Inline shut-off valve
5. Clear test line



Figure 115 Fuel Pressure Test Adapter

NOTE: If the engine is equipped with a Shrader valve, use the Fuel Pressure Test Adapter.



Figure 116 Fuel/Oil Pressure Test Coupler

NOTE: If the engine is equipped with a diagnostic coupling, adapt the Fuel/Oil Pressure Test Coupler to the Fuel Pressure Gauge.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

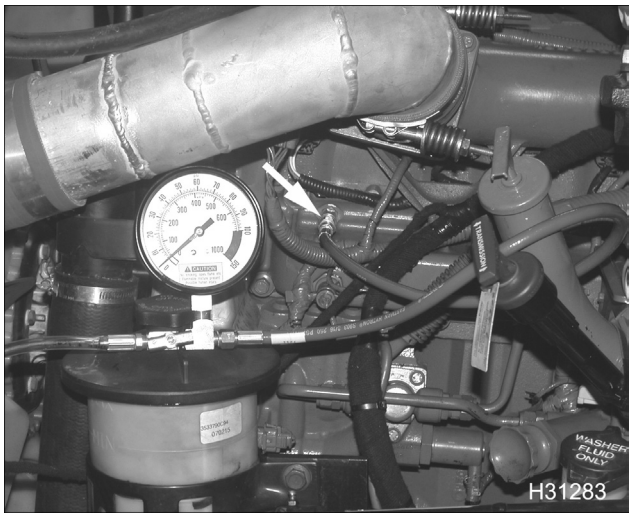


Figure 117 Fuel Pressure Gauge to fuel pressure test adapter

3. Connect Fuel Pressure Gauge with shut-off valve and clear 3/8” diameter hose to test valve.
4. Route the clear hose into a drain pan.
5. Start or crank the engine for 20 seconds. Measure fuel pressure with the shut-off valve closed. Open the shut-off valve to check for aeration.

   NOTE: Breaking any fuel system joint will induce air into the fuel system. The air should pass in a short period of time. As fuel pressure is relieved, a steady stream of fuel without air bubbles indicates the fuel is not aerated.

   - If fuel pressure is in specification and fuel is not aerated, do not continue with this test.
   - If the fuel is aerated, go to “Alternate Fuel Source Supply to Fuel Pump” (page 106) in this section.

Alternate Fuel Source Supply to Fuel Pump

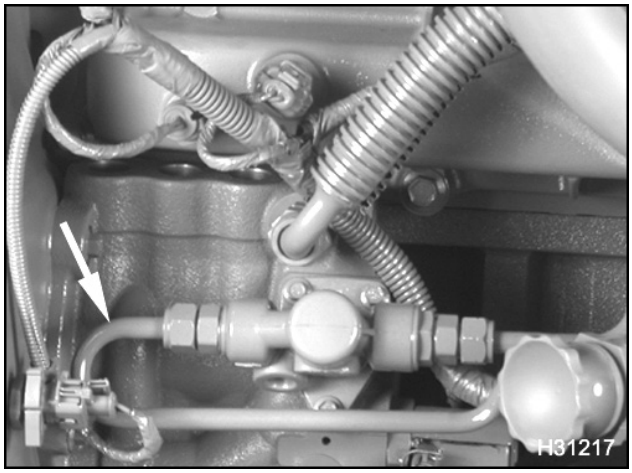


Figure 118 Fuel supply line

1. Remove fuel pump supply line.

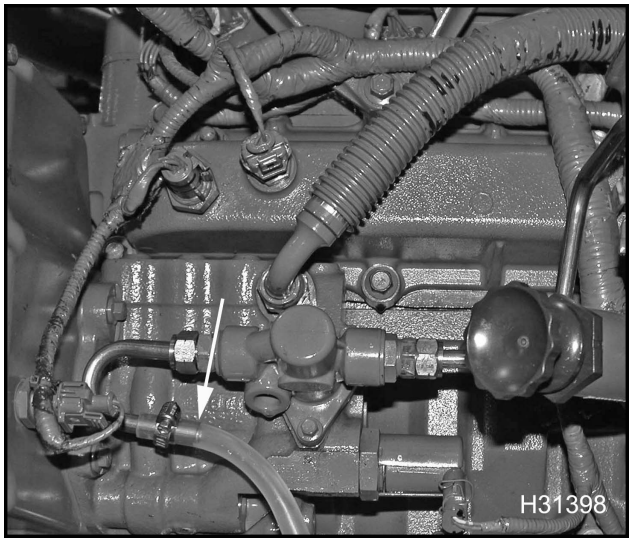


Figure 119 Fuel test line

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

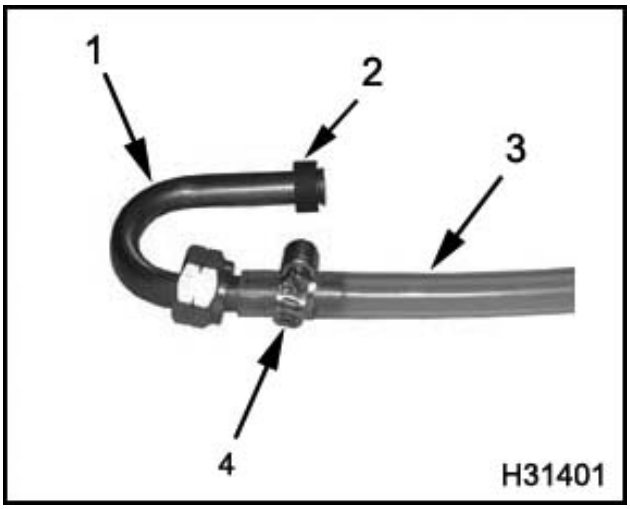


Figure 120 Test fuel line

1. Fuel line
2. Sleeve seal
3. Clear plastic tube
4. Clamp

2. Make a test fuel line.

   - Use spare fuel line. (Make sure the sleeve seal is in good condition.) Cut the line in half. Use the test fuel line portion that supplies the fuel pump. Install clear plastic line in place of removed section and secure plastic line with a clamp.

   NOTE: The mechanic is expected to keep the fuel test line for future diagnostics. Expense the fuel test line as an essential tool and keep it with other diagnostic tools. Warranty will not cover the cost of the fuel test line.

3. Connect the fuel test line between the fuel pump inlet and an alternate fuel source.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

When routing test line, do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces.

4. Start or crank the engine for 20 seconds. Measure fuel pressure with the shut-off valve closed. Open the shut-off valve to check for aeration.

   NOTE: Breaking any fuel system joint will induce air into the fuel system. The air should pass in a short period of time. As fuel pressure is relieved, a steady stream of fuel without air bubbles indicates the fuel is not aerated.

   - If the fuel is aerated, go to “Combustion Leaks to Fuel” (page 108) in this section.
   - If the fuel is not aerated, remove test setup from the fuel pump inlet. Connect the fuel pump supply line. Go to “Alternate Fuel Source Supply to Fuel Filter Housing” in this section.

Alternate Fuel Source Supply to Fuel Filter Housing

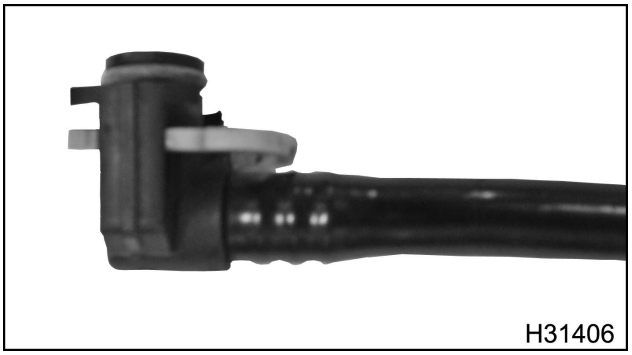


Figure 121 Fuel filter inlet test line

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

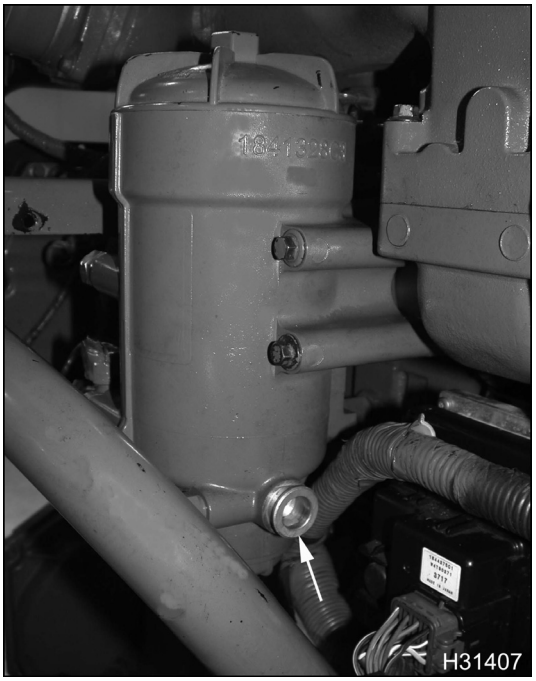


Figure 122 Fuel filter housing inlet

1. Disconnect the supply line from the fuel filter housing.
2. Make a test fuel line.
   - Use a 90° fuel line male fitting and install a clear plastic line that is long enough to reach an alternative fuel source.

   NOTE: The mechanic is expected to keep the fuel test line for future diagnostics. Expense the fuel test line as an essential tool and keep it with other diagnostic tools. Warranty will not cover the cost of the fuel test line.
3. Connect the alternate fuel source to the fuel filter housing inlet.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

When routing test line, do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces.

4. Start or crank the engine for 20 seconds. Measure fuel pressure with the shut-off valve closed. Open the shut-off valve to check for aeration.

   NOTE: Breaking any fuel system joint will induce air into the fuel system. The air should pass in a short period of time. As fuel pressure is relieve, a steady stream of fuel without air bubbles indicates the fuel is not aerated.

   NOTE: If a fuel pressure gauge with shut-off valve and clear 3/8” diameter hose is not available, refer to the alternative test “Checking for Aerated Fuel using Spare Fuel Line.”

   - If the fuel pressure is in specification and the fuel is not aerated, repair the leak between the fuel filter housing and the fuel tank.
   - If the fuel is aerated, repair or replace the fuel filter housing.

Combustion Leaks to Fuel

1. Remove the valve cover following the procedure in the *Engine Service Manual*.
2. Check all injector hold-down clamps for correct torque.
3. Remove any loose injectors. Inspect and clean following the procedure in the *Engine Service Manual*. Replace injector O-rings and install injectors following the procedure in the *Engine Service Manual*.
4. Test for fuel aeration to validate the repair. Go to “Aerated Fuel Inspection” (page 105) in this section.

©August 2008 Navistar, Inc.

Coolant in Lube Oil

Symptom

When the crankcase lube oil is contaminated with coolant, the oil will have a dark-gray or black sludgy appearance. The crankcase may also be overfilled.

Cause

- Accessory leak (water cooled air compressor)
- Injector sleeve leak
- Cylinder head cup plug failure
- Crevice seal (liner O-ring)
- Cylinder head gasket leak
- Front cover gasket damage
- Front cover, cylinder head or crankcase porosity

Tools

- Radiator pressure testing kit
- Plastic surge tank cap adapter
- Cylinder head test plate
- Water supply housing pressure adapter
- Thermostat opening pressure adapter (cylinder head)
- Straightedge
- Feeler gauge

Coolant System Inspection

Procedure

1. Check oil level to verify oil contamination complaint.
   - The presence of coolant in the oil will generally give the oil a dark-gray or black sludgy appearance.
   - If coolant in the oil is not verified, an oil sample can be taken for analysis.
2. When oil contamination is verified, plug in cylinder block heater to warm coolant.
3. Is the engine equipped with an air compressor?
   - If yes, do step 4.
   - If no, do step 8.

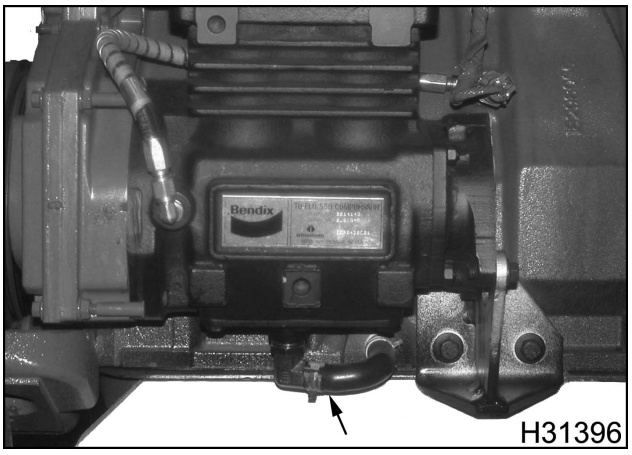


Figure 123 Air compressor oil drain-back hose

4. Remove air compressor oil drain-back hose from the bottom of compressor.
5. Install radiator pressure tester with the appropriate adapter.

   WARNING: To avoid serious personal injury, possible death and damage to the engine:
   - **Always allow the engine to cool for 15 minutes.**
   - **Wrap a thick cloth around the cap.**
   - **Loosen cap slowly a quarter to half turn.**
   - **Pause for a moment to avoid water or steam scalding.**
   - **Continue to turn the cap and remove.**
   - **Never add cold coolant to a hot engine. This can result in a cracked cylinder head or crankcase.**
   - **Never use water as a coolant substitute.**
6. Pressurize the cooling system to 96 kPa (14 psi).
7. Look for coolant leaking from the air compressor oil drain-back port.
   - If coolant is leaking from air compressor, repair or replace air compressor.
   - If coolant is not leaking from the air compressor oil drain-back port, do step 8.
8. Drain engine oil and remove the oil filter.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

9. Remove the oil pan following the procedure in the *Engine Service Manual*.
10. Install radiator pressure tester with the appropriate adapter.

WARNING: To avoid serious personal injury, possible death and damage to the engine:

- **Always allow the engine to cool for 15 minutes.**
- **Wrap a thick cloth around the cap.**
- **Loosen cap slowly a quarter to half turn.**
- **Pause for a moment to avoid water or steam scalding.**
- **Continue to turn the cap and remove.**
- **Never add cold coolant to a hot engine. This can result in a cracked cylinder head or crankcase.**
- **Never use water as a coolant substitute.**

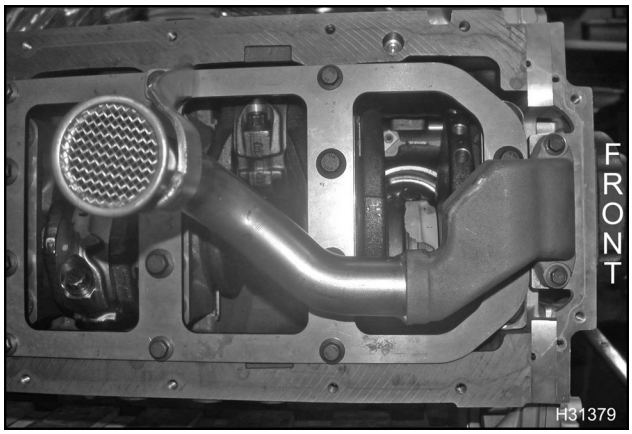


Figure 124 Bottom of engine

11. Pressurize cooling system to 96 kPa (14 psi). Look for coolant leaks.
    - If the engine is equipped with an air compressor, and is leaking from the compressor oil drain-back hose or from the left side of the front cover, do “Air Compressor Leak Test.”
    - If the engine does not have an air compressor, and is leaking from the front cover area or the oil pick-up tube, do “Front Cover Inspection” (page 111).
    - If a leak is noticed between the cylinder sleeve and piston, replace the injector sleeve for that cylinder. Follow the procedure in the *Engine Service Manual*.
    - If a leak is noticed between the cylinder sleeve and the engine block, replace the cylinder sleeve crevice seal for that cylinder. Follow the procedure in the *Engine Service Manual*.
    - If a leak is noticed from the oil drain-back ports (camshaft side), do “Cylinder Head Leak Test” (page 112).
    - If no leak is noticed, leave pressure on cooling system overnight and check the following day.
    - If no leak is noticed after overnight pressure test, do the following sequential tests until problem is found:
        A. “Front Cover Inspection” (page 111)
        B. “Cylinder Head Leak Test” (page 112)
12. After any repairs are complete, test the cooling system again to validate the repair.

Air Compressor Leak Test

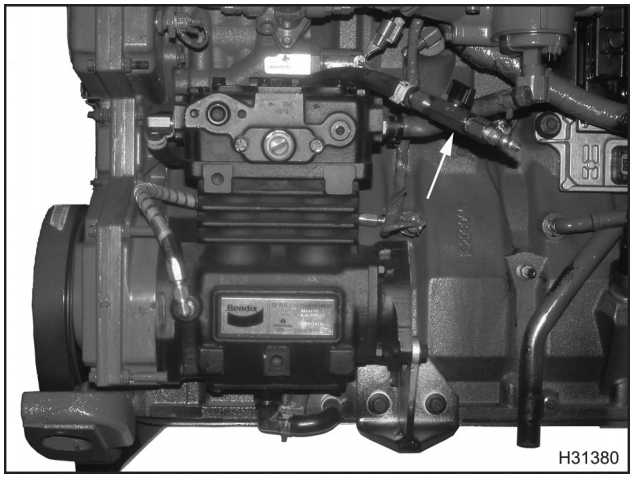


Figure 125 Air compressor test setup

1. Drain coolant from the system.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

2. Remove the coolant inlet and outlet hoses for the air compressor from the crankcase.
3. Fill air compressor coolant passage and hoses with coolant.
4. Adapt air pressure fitting and regulator to one of the coolant hoses and block opposite hose.
5. Pressurize air compressor coolant hoses to 96 kPa (14 psi).
6. Inspect for coolant leakage from oil drain-back hose or left side of front cover. Listen for air escaping.
   - If a leak is noticed, repair or replace the air compressor.
   - If coolant is not leaking, do “Front Cover Inspection” (page 111).
7. Test the cooling system again after any repair to validate the repair.

Front Cover Inspection

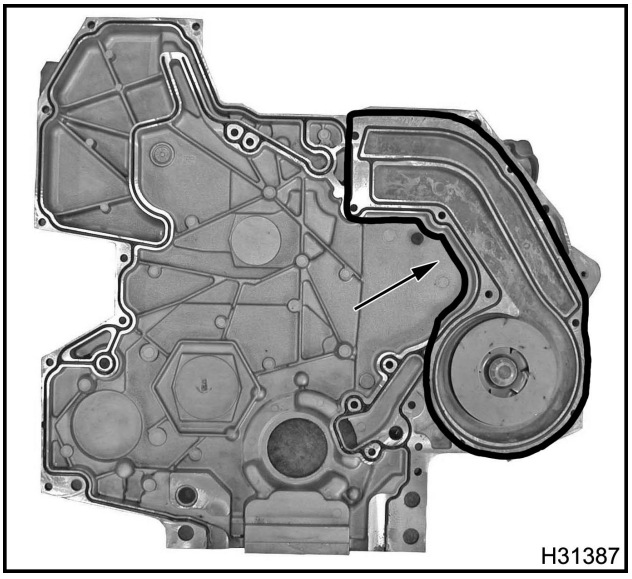


Figure 126 Front cover coolant leak location

1. Remove front cover and inspect gaskets and sealing surfaces following the procedure in the *Engine Service Manual*. Check front cover and crankcase with straight edge and feeler gauge. Repair or replace as required.
2. Test the cooling system again after any repair to validate the repair.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Cylinder Head Leak Test

1. Remove the valve cover following the procedure in the *Engine Service Manual*.

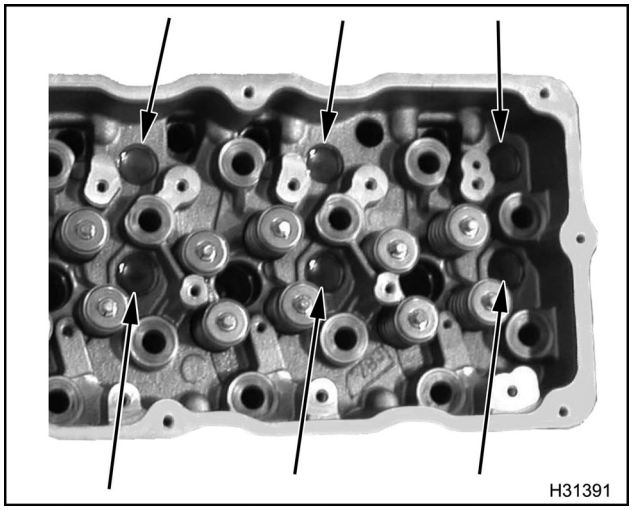


Figure 127 Cylinder head (top) cup plugs

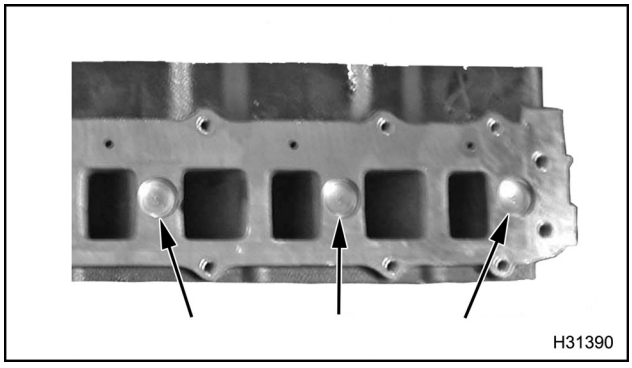


Figure 128 Cylinder head (intake side) cup plugs

2. Pressurize the cooling system to 96 kPa (14 psi)
3. Inspect the entire cylinder head for cracks or leaks at the cup plugs.
   - If a leak is noticed, repair or replace.
   - If no leaks are noticed, do step 4.
4. Drain coolant from system.
5. Remove cylinder head from engine following the procedures in the *Engine Service Manual*.
6. Inspect and pressure test the cylinder head following the procedures in the *Engine Service Manual*.
   - Inspect cylinder head gasket for damage at sealing points that may have caused a leak. Verify crankcase and cylinder head surface flatness using a straightedge and feeler gauge. Replace the head gasket. Repair or replace the cylinder head if necessary.
   - Inspect the cylinder head for cracks in the coolant passages. Repair or replace.
7. If cylinder head is in good condition, remove cylinder sleeve crevice seals following the procedures in the *Engine Service Manual*.
   - Inspect the engine block for cracks in the coolant passages. Repair or replace.
   - Inspect for damaged cylinder liners and seals. Repair or replace.
8. Test the cooling system again after any repair to validate the repair.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM Reset / IDM Reset (intermittent engine stumble)

Symptom

An Electronic Control Module (ECM) reset occurs when the ECM momentarily reboots or is turned OFF and ON while the engine is operating. Symptoms of this include the following:

- Wait to start lamp cycles ON while engine running
- Engine stumbles and may die
- Loss of accelerator pedal authority
- Miles driven are not logged if ECM reset occurs during current key cycle

If a reset occurs, the engine will momentarily stumble and the ECM will go through a normal KEY ON cycle. This includes the following:

- Illuminate the WAIT TO START lamp
- Validate the accelerator pedal position

If the pedal is not at idle position when the reset occurs, a DTC is set and engine speed goes to low idle. The ECM will not allow accelerator pedal authority until the Accelerator Pedal Sensor (APS) is released.

An Injector Drive Module (IDM) reset will occur if power is lost to the circuits for IDM Logic or IDM Main Power while the engine is operating. If power is lost, the engine will miss and recover or stall. The APS will not be affected by this fault.

Cause

Momentary loss of power to the ECM or IDM may be caused by the following:

- Failed fuses
- Intermittent open circuit
- Failed battery power feed harness
- Poor ground connection
- Failed power relay
- Shorted or open harness

Procedure

1. Using the EST, check for DTCs for both the engine and chassis modules.
   - If DTC 626 (unexpected reset fault) or 534 (IDM relay voltage low) are present as active or inactive codes, continue with next step.
   - If any other engine DTCs are active, perform appropriate diagnostics and repairs before continuing with these procedures.
   - If any chassis DTCs are active when checking the Electronic System Controller (ESC), perform appropriate diagnostics and repairs before continuing.

NOTE: See Section 7 in this manual, the *Chassis Electrical Circuit Diagram Manual and Electrical System Troubleshooting Guide* for the model and year of the vehicle when performing the following steps.

2. Check all ECM and IDM related fuses.
3. Check all Battery, V_{IGN} and ground connections for the ECM and IDM.
4. Monitor ECM powers and grounds with breakout box under operator complaint conditions.
5. Monitor IDM powers and grounds with 12-pin Breakout Harness under operator complaint conditions.
6. If root cause has not been identified in previous steps, continue diagnosis by performing the remaining steps on the Performance Diagnostics form or Section 6 of this manual.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Excessive Fuel Consumption

Symptom

Occasionally, it may be noticed that more fuel is required to perform the same task as before.

Cause

Operator effect

- Inaccurate record keeping or tank filling
- Winter blend or No. 1 fuel

Application effect

- Heavy loading Gross Vehicle Weight (GVW)
- Low rear axle ratio
- Large frontal area
- Accessory usage (Power Takeoff, etc.)
- Additional equipment drawing fuel from vehicle fuel tanks
- Extended idle applications
- Tire size, tire condition, air pressure

Chassis effect

- Brake drag
- Cooling fan clutch locked ON
- Transmission slippage/shifting
- Fuel tank plumbing or venting
- Intake or exhaust restriction

Engine effect

- Incorrect or failed thermostat
- Failed Variable Geometry Turbocharger (VGT) operation
- Oil aeration
- Fuel system leaks
- Base engine performance loss

Procedure

1. Review operator records and fueling procedures. Measurement errors are common. Fuel consumption taken only from one tank of use is susceptible to significant error because of filling procedures and vehicle application differences during operation. Accurate fuel consumption must be measured over time with a record of what the vehicle was doing during the measurement period.
2. Loss of fuel economy is normal if winter blend fuel or No. 1 diesel fuel is being used.
3. Review vehicle specifications to determine if fuel consumption is normal for type of application and use of vehicle. (Compare consumption with similar vehicles in the same application and Truck Computer Analysis of Performance and Economy (TCAPE) report.
4. Do all tests on Performance Diagnostic form or in Section 6 of this manual. These tests will verify the operating condition of the following engine and chassis systems:
   - Intake system
   - Exhaust system
   - Fuel delivery and filtration
   - High-pressure oil system
   - Injector operation
   - VGT operation
   - Oil aeration
   - Base engine condition
   - Electronic control system condition

   If all tests are passed, the engine is operating normally.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel in Coolant

Symptom

Coolant contaminated with diesel fuel will have a diesel fuel odor.

Cause

- Leaking or cracked injector sleeve with injector O-ring failure
- Cracked or porous head casting in fuel rail cross-drillings.

Tools

- Regulated compressed air
- Fuel Test Fitting
- Fuel/Oil Pressure Test Coupler
- Cylinder head test plate
- Water supply housing pressure adapter
- Thermostat opening pressure adapter (cylinder head)

Procedure

1. Verify coolant contamination.
   - Check for diesel fuel odor in coolant.
   - Coolant may be discolored if diesel fuel is present.

   CAUTION: Be sure to place a rag or suitable container under the fuel pressure test valve when bleeding the fuel rail. Dispose of fuel in a correct container clearly marked DIESEL FUEL according to local regulations.

   NOTE: Engine fuel can be a threat to the environment. Never dispose of engine fuel by putting it in the trash, pouring on the ground, in the sewers, in streams, or bodies of water.
2. Plug in the cylinder block heater to warm coolant.

WARNING: To avoid serious personal injury, possible death and damage to the engine:

- **Always allow the engine to cool for 15 minutes.**
- **Wrap a thick cloth around the cap.**
- **Loosen cap slowly a quarter to half turn.**
- **Pause for a moment to avoid water or steam scalding.**
- **Continue to turn the cap and remove.**
- **Never add cold coolant to a hot engine. This can result in a cracked cylinder head or crankcase.**
- **Never use water as a coolant substitute.**

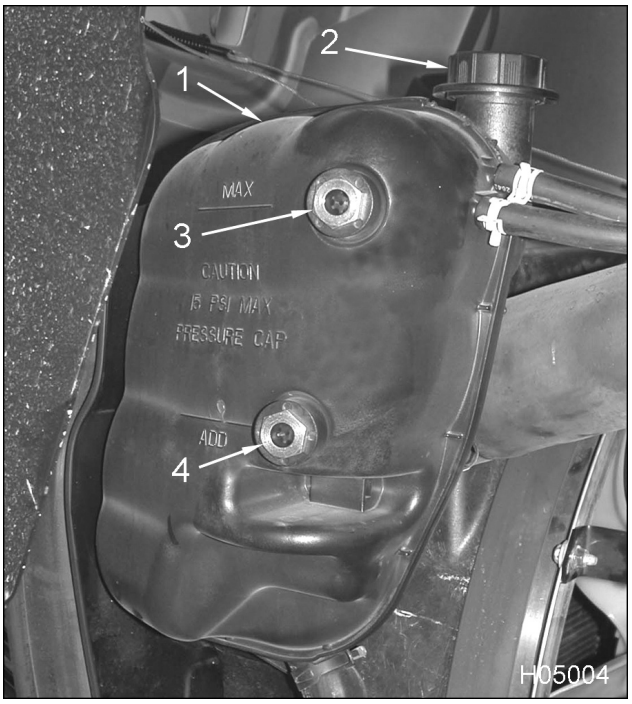


Figure 129 Deaeration tank fill position

1. Deaeration tank cap
2. Deaeration tank
3. MAXIMUM coolant level mark
4. ADD coolant level mark

3. Remove cap from deaeration tank and fill with coolant to a level above the deaeration inlet line to tank.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.



Figure 130 Shrader valve assembly

1. Valve
2. Center stem

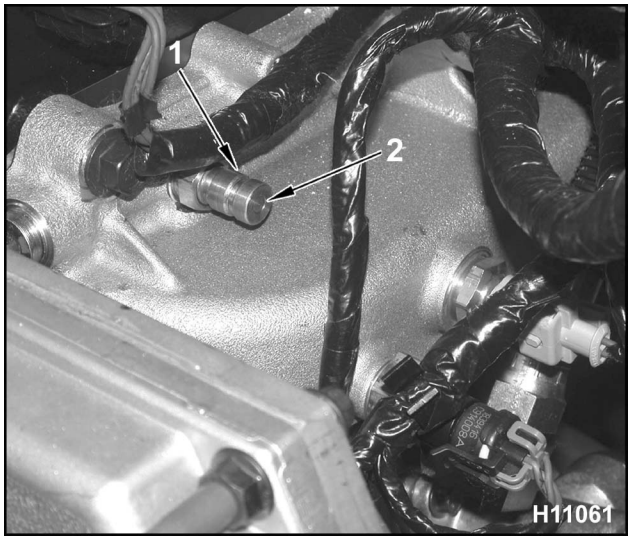


Figure 131 Diagnostic coupling

1. Valve
2. Center section

NOTE: Engines are equipped with a fuel pressure test valve in the form of either a Shrader valve or a diagnostic coupling.

4. Pressurize fuel rail with air from the fuel pressure test valve on the intake manifold to 550 kPa to 690 kPa (80 psi to 100 psi) using the fuel line test adapter. Observe deaeration tank for air bubbles.
   - If air bubbles appear in deaeration tank, do step 5.
   - If air bubbles do not appear in deaeration tank, do step 6.

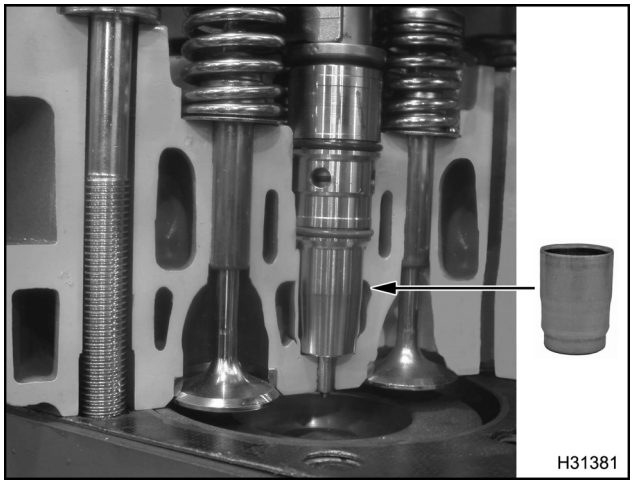


Figure 132 Injector cut-away with injector sleeve

5. Remove all injectors and inspect O-rings and injector sleeves for damage.
   - If any injector O-ring or injector sleeve appears damaged, clean the injector and replace O-rings or injector sleeves. Test the system again. Do step 4.
   - If injector O-rings or injector cups are not damaged, do step 6.
6. Remove, inspect, and pressurize the cylinder head following the procedure in the *Engine Service Manual*.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Coolant Leak to Exhaust

Symptom

- Coolant residue at exhaust manifold flanges
- Observation of coolant loss without engine overheating
- Excessive white smoke from exhaust pipe on start up (hot or cold)
- Coolant smell in exhaust
- Coolant leaking from muffler
- Severe case – engine hydraulic lock

Cause

- Failed EGR cooler
- Injector cup and gasket leak
- Intake side of cylinder head cup plugs leaking
- Porosity in cylinder head casting

Tools

- Regulated compressed air
- Water supply housing pressure adapter
- Radiator pressure testing kit and plastic surge cap adapter
- EGR cooler pressure test plates (2)

Procedure

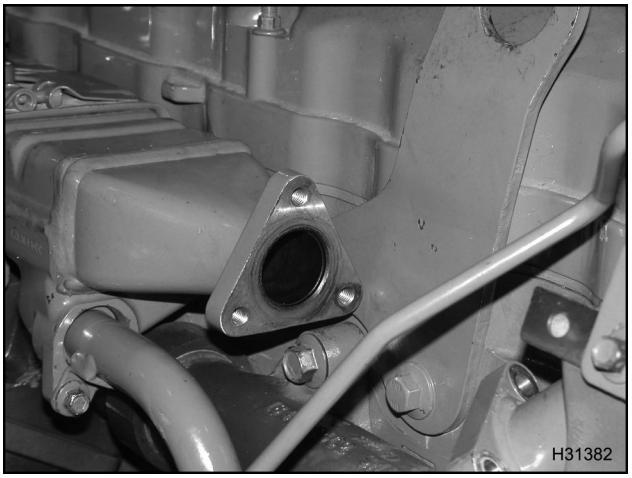


Figure 133 EGR cooler without cross-over tube

1. Remove EGR crossover tube assembly following the procedure in the *Engine Service Manual*.
2. Check for presence of coolant in EGR cooler and tube.
3. Plug in the cylinder block heater to warm coolant.
4. Install radiator pressure tester with the appropriate adapter.

   WARNING: To avoid serious personal injury, possible death and damage to the engine:

   - **Always allow the engine to cool for 15 minutes.**
   - **Wrap a thick cloth around the cap.**
   - **Loosen cap slowly a quarter to half turn.**
   - **Pause for a moment to avoid water or steam scalding.**
   - **Continue to turn the cap and remove.**
   - **Never add cold coolant to a hot engine. This can result in a cracked cylinder head or crankcase.**
   - **Never use water as a coolant substitute.**
5. Pressurize cooling system to 96 kPa (14 psi).
6. Check EGR cooler for the presence of coolant.
   - If coolant is present, replace EGR cooler following the procedure in the *Engine Service Manual*.
   - If no leak is found, do step 7.

     If pressure is dropping rapidly, coolant may be leaking from the EGR cooler into the exhaust manifold or tail pipe.
7. Drain coolant from the system.
8. Remove EGR cooler following the procedure in the *Engine Service Manual*.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

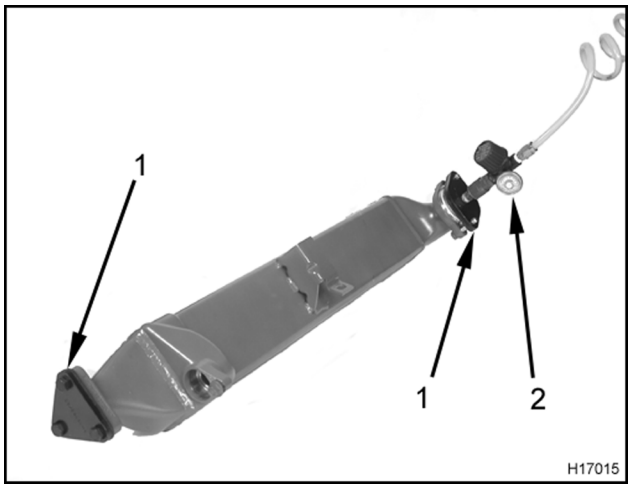


Figure 134 EGR cooler pressure test

1. EGR cooler pressure test plates (2)
2. Air pressure regulator

9. Bolt EGR cooler pressure test plates to each end of the cooler assembly.
10. Use regulated air pressure and apply no more than 207 kPa (30 psi) to the EGR cooler assembly.
11. Submerge the EGR cooler assembly into a tank of water. Watch for air bubbles leaving the cooler.
    - If a leak is noticed, replace the EGR cooler.
    - If a leak is not noticed, install the EGR cooler.
12. Fill cooling system.
13. Pressurize cooling system to 96 kPa (14 psi).
14. Inspect cylinder head (removing components as required) for cracks, porosity, and leaking cup plugs.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Coolant Over-Temperature

Symptom

When the coolant temperature is above 107 °C (224 °F), DTC 325 will be set and the control system will command less fueling. A power loss may also occur.

When the coolant temperature is above 109 °C (228 °F), the red ENGINE lamp will be illuminated and DTC 321 will be set.

When the coolant temperature is above 112 °C (234 °F), the red ENGINE lamp will flash, an audible alarm will sound, and DTC 322 will be set. If the vehicle has the warning protection feature enabled, the engine will shutdown after 30 seconds.

Cause

- Low engine coolant level
- External coolant leaks
- Internal or external radiator blockage
- Broken/worn accessory drive belt
- Accessory belt tensioner failure
- Coolant thermostat stuck (closed)
- Slipping cooling fan drive clutch
- Water pump failure
- Cooling fan blade assembly wrong/damaged
- Inoperative electric cooling fan
- Instrument panel gauge error
- Engine Coolant Temperature (ECT) sensor biased
- Incorrect radiator
- Missing coolant thermostat
- Internal coolant leak
- Chassis effects, transmission, after-market equipment

Tools

- Radiator pressure test kit and adapter
- Regulated compressed air
- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM) with thermocouple

Coolant System Inspection

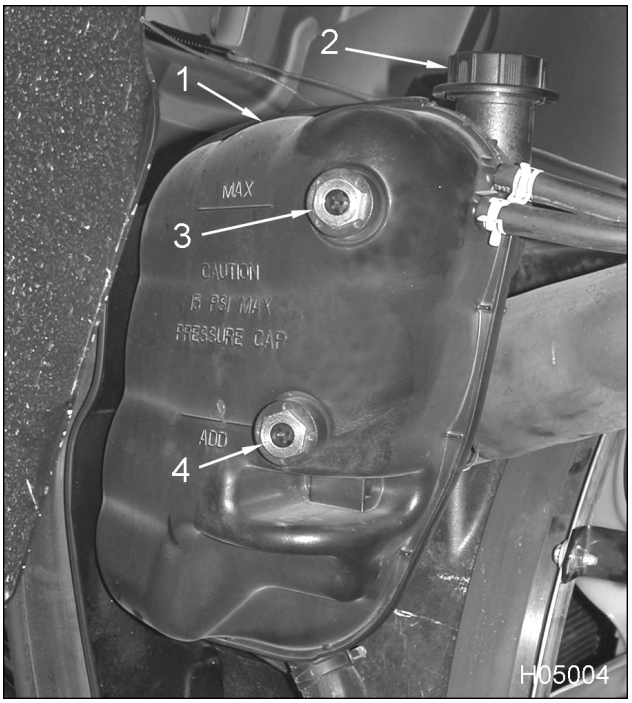


Figure 135 Deaeration tank components

1. Deaeration tank cap
2. Deaeration tank
3. MAXIMUM coolant level mark
4. ADD coolant level mark

1. Check coolant deaeration tank for contamination and correct fill level.
   - If coolant level is low, do step 2.
   - If coolant level is correct, do step 6.
   - If coolant is contaminated with oil, go to “Lube Oil in Coolant” (page 122).
2. Inspect for coolant leaks. Check for external leaks from coolant hoses, radiator, heater core, engine, or cylinder head cup plugs. Check for coolant in oil.
   - If any external leaks are found, repair and fill cooling system. Test again for over-temperature condition.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- If oil is contaminated with coolant, go to “Coolant in Lube Oil” (page 109) in this section.
- If no leaks are found, do step 3.

WARNING: To avoid serious personal injury, possible death and damage to the engine:

- **Always allow the engine to cool for 15 minutes.**
- **Wrap a thick cloth around the cap.**
- **Loosen cap slowly a quarter to half turn.**
- **Pause for a moment to avoid water or steam scalding.**
- **Continue to turn the cap and remove.**
- **Never add cold coolant to a hot engine. This can result in a cracked cylinder head or crankcase.**
- **Never use water as a coolant substitute.**

3. Fill cooling system to the maximum coolant level mark.



Figure 136 Coolant crossover pipe drain valve

4. Start the engine.
5. Purge all air out of system by opening the coolant crossover pipe drain valve. Close the port when coolant appears.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, use extreme caution when purging air out of the cooling system.

6. Test again for over-temperature condition
   - If the engine is not running over-temperature, do step 7.
   - If the engine continues overheating, do step 9.
7. Install radiator pressure tester with the appropriate adapter.
8. Pressurize the cooling system to 96 kPa (14 psi)
   - If coolant is leaking externally, identify the leak and repair.
   - If coolant is not leaking externally, but the pressure is dropping, see “Coolant Leak to Exhaust” (page 117) and “Coolant in Lube Oil” (page 109) in this section.
9. Inspect the condition of the following items: cooling fan blade, shroud, accessory drive belt, accessory drive belt tensioner, cooling fan drive clutch, operation of electric or air fan, and radiator.

   CAUTION: To avoid radiator damage, when using high pressure washer, be careful not to damage radiator fins with wand.
   - If vehicle is new or recently repaired, verify the correct part number for any component related to the cooling system.
   - If the radiator cooling fins are blocked due to a build-up of dirt or debris, use a power washer to clean blockage from radiator fins or any debris on the cooling fan and fan drive clutch.
   - If no problems are identified, go to “Temperature Electrical System Test” (page 120) in this section.

Temperature Sensor Validation Test

1. Install EST and check for active and inactive DTCs related to engine coolant over-temp conditions.
   - If any DTCs remain relating to coolant over-temp condition, correct DTC before continuing.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- If no DTCs exist, do step 2.

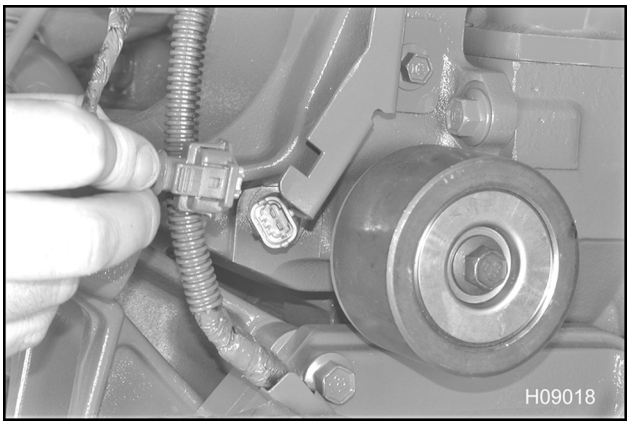


Figure 137 ECT sensor location

2. Using the EST, compare Engine Coolant Temperature (ECT), Engine Oil Temperature (EOT), and Manifold Air Temperature (MAT) with Key On Engine Off. All of the sensors should read within 2° C (5° F) of each other.

   NOTE: This is only accurate if done after a cold soak of at least 8 hours on the engine.

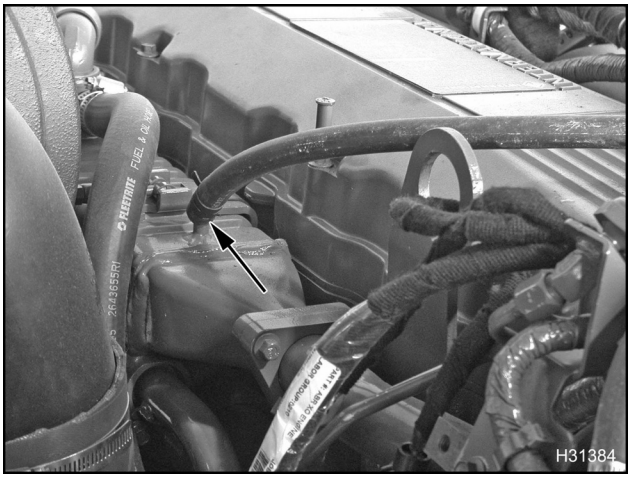


Figure 138 EGR coolant outlet port

3. Install a manual gauge or DMM with a thermocouple in the EGR cooler inlet port, operate the engine, and use the EST to monitor ECT.
4. Run engine up to an operating temperature of at least 70° C (158° F). While monitoring ECT using the EST, instrument panel coolant temperature gauge and the mechanical or electrical gauge. Attempt to duplicate the operator's concern of coolant over-temp.
   - If instrument panel coolant temperature gauge reads a different temperature than the EST and test gauge, refer to the *Electrical System Troubleshooting Guide* for the appropriate model and year of vehicle.
   - If test gauge and EST read values with a difference greater than +/- 3° C (+/- 5° F), do Electronic Control Systems Diagnostics for ECT circuit found in Section 7 of this manual.
   - If the gauge is reading correctly and the engine is running over-temperature, go to "Cooling System Operating Pressure Test" (page 121) in this section.

Cooling System Operating Pressure Test

1. Install the radiator pressure tester on the deaeration tank and run engine at elevated idle. Monitor the pressure in the system using the tester gauge to see if pressure rises above normal value of deaeration tank cap.
   - If pressure is higher than the pressure rating of the cooling system cap, go to "Combustion Leaks to Coolant" (page 102) in this section.
   - If pressure gauge reading is below pressure rating of system, replace the thermostat.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Lube Oil in Coolant

Symptom

Coolant contaminated with lube oil will have oil in the deaeration tank.

Cause

- Oil cooler

Tools

- Oil cooler pressure test plate
- Air pressure regulator

Procedure

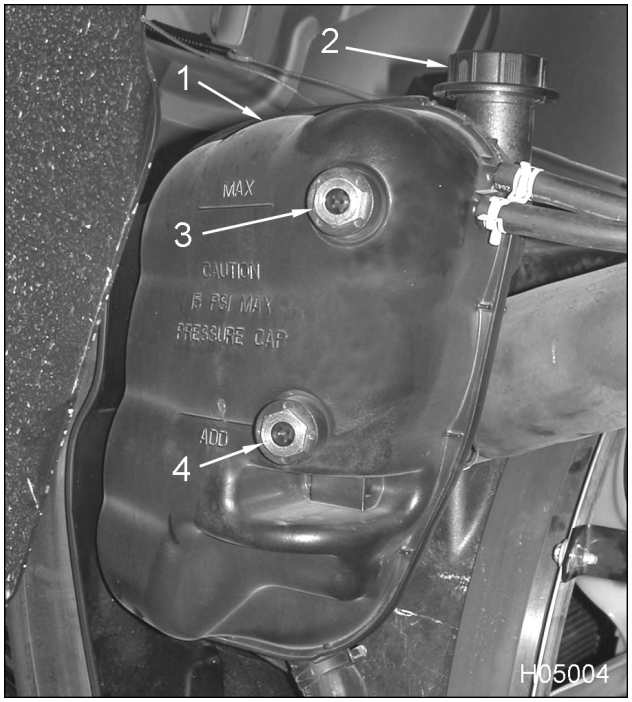


Figure 139 Deaeration tank fill position

1. Deaeration tank cap
2. Deaeration tank
3. MAXIMUM coolant level mark
4. ADD coolant level mark

WARNING: To avoid serious personal injury, possible death and damage to the engine:

- **Always allow the engine to cool for 15 minutes.**
- **Wrap a thick cloth around the cap.**
- **Loosen cap slowly a quarter to half turn.**
- **Pause for a moment to avoid water or steam scalding.**
- **Continue to turn the cap and remove.**
- **Never add cold coolant to a hot engine. This can result in a cracked cylinder head or crankcase.**
- **Never use water as a coolant substitute.**

1. Verify if coolant is contaminated by inspecting deaeration tank for presence of oil.
2. Place a coolant drain pan under the oil system module.

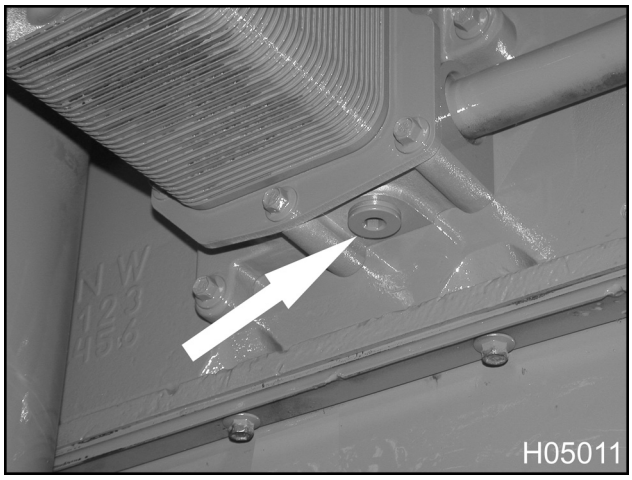


Figure 140 Coolant drain plug

3. Remove the coolant drain plug located at the bottom of the oil system module. Drain coolant

   NOTE: Replace O-ring with a new O-ring when installing the coolant drain plug.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

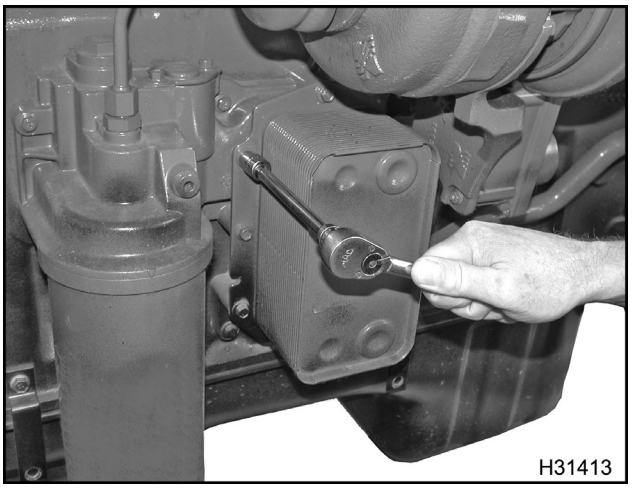


Figure 141 Removing oil cooler

4. Remove the eight bolts (M8 x 20) securing the oil cooler to the oil cooler housing. Separate the oil cooler from the oil cooler housing.

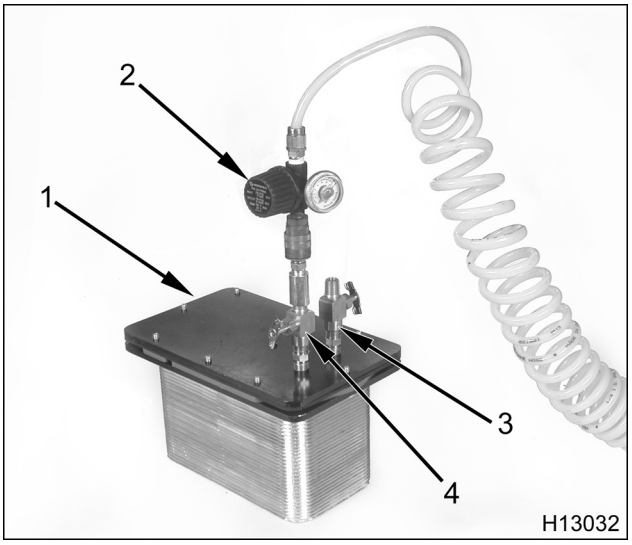


Figure 142 Checking the oil cooler for internal leakage

1. Test plate set
2. Air pressure regulator
3. Coolant port (open)
4. Oil port

5. Pressure test the oil cooler following the procedure in the *Engine Service Manual*. If a leak is noticed, replace the oil cooler.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel in Lube Oil

Symptom

Oil contaminated with diesel fuel will cause the oil level in engine to increase.

Cause

- Leaking fuel injector or injector O-ring (A leaking injector sleeve or injector tip could cause contaminated engine oil, but would most likely be identified as a performance problem.)
- Cracked or porous cylinder head casting in fuel rail area cross-drillings

Tools

- 2 oz of fuel dye
- UV Leak Detection Kit (black light)
- Fuel pressure gauge kit
- Fuel pressure test adapter
- Fuel/Oil Pressure Test Coupler
- 1 to 5 gallon bucket
- Inspection mirror

Procedure

NOTE: The black light requires warm-up time. Turn on the black light

1. Verify oil contamination.

   NOTE: Other issues that may contribute to fuel dilution beside fuel injectors, include the following:

   - Hard starting
   - Running rich (strong fuel odor)
   - Valve related issue

   If the engine is mechanically sound and the oil has been changed, diagnose for fuel in the oil with dye.

2. Remove the fuel filter housing cap.

   NOTE: If the fuel filter housing cap is out of the system for an extended time, the O-ring will swell and needs to be replaced.

3. Add 2 oz fuel dye to the fuel filter housing.

   NOTE: Use only recommended dye, manufactured by Balkamp, Inc., available at local NAPA Auto Parts stores, part number 765-2661.

4. Install the fuel filter housing cap.

CAUTION: Be sure to place a rag or suitable container under the fuel pressure test valve when bleeding the fuel rail. Dispose of fuel in a correct container clearly marked DIESEL FUEL according to local regulations.

NOTE: Engine fuel can be a threat to the environment. Never dispose of engine fuel by putting it in the trash, pouring on the ground, in the sewers, in streams, or bodies of water.



Figure 143 Shrader valve assembly

1. Valve
2. Center stem

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

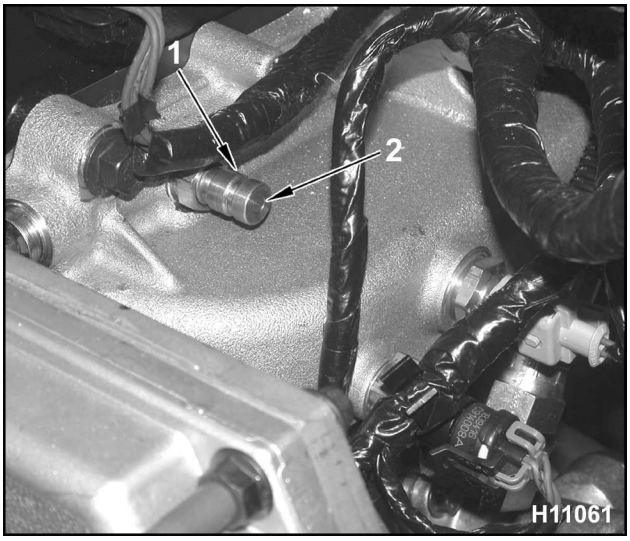


Figure 144 Diagnostic coupling

1. Valve
2. Center section

NOTE: Engines are equipped with a fuel pressure test valve in the form of either a Shrader valve or a diagnostic coupling.

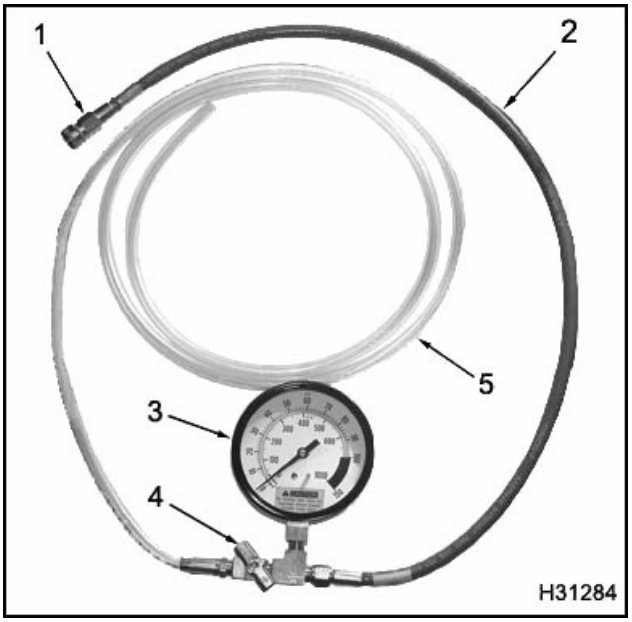


Figure 145 Fuel Pressure Gauge

1. Quick disconnect check valve
2. Fuel test line
3. Fuel Pressure Gauge
4. Inline shut-off valve
5. Clear test line



Figure 146 Fuel Pressure Test Adapter

NOTE: If the engine is equipped with a Shrader valve, use the Fuel Pressure Test Adapter.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.



Figure 147 Fuel/Oil Pressure Test Coupler

NOTE: If the engine is equipped with a diagnostic coupling, adapt the Fuel/Oil Pressure Test Coupler to the Fuel Pressure Gauge.

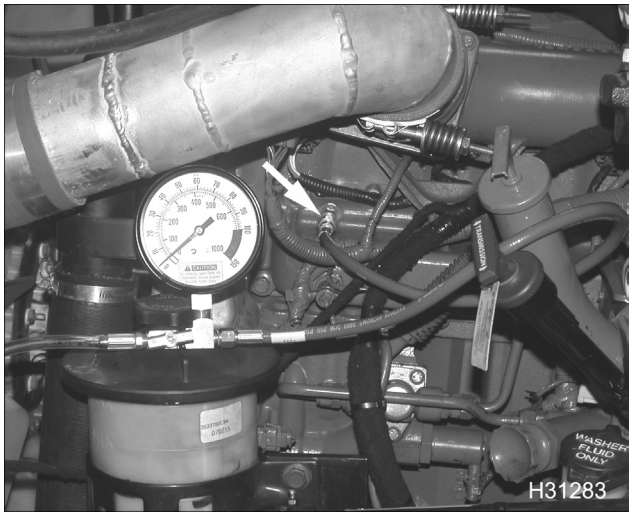


Figure 148 Fuel Pressure Gauge to fuel pressure test adapter

5. Connect a fuel pressure gauge with shut-off valve and clear 3/8” diameter hose to test valve.
6. Route the clear hose into a drain pan.
7. Open the gauge setup shut-off valve
8. Shine the black light at the fuel pressure gauge clear line. The dyed fuel will have a yellow-green fluorescent glow.
9. Using the priming pump, purge the fuel until the dyed fuel begins to flow from the pressure gauge clear hose.
10. Close the shut-off valve.
11. Remove the valve cover following the procedure in the *Engine Service Manual*.
12. Start and run the engine at low idle for 3 to 5 minutes.

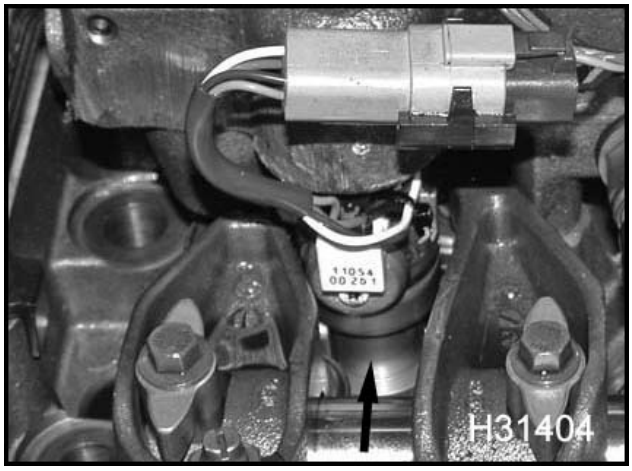


Figure 149 High-pressure oil rail with injector

13. While the engine is running, use the black light to inspect for yellow-green streams of dye running between the valve spring seats at each injector. A small mirror can aid in hard to reach areas.

    Inspection should take no longer than 5 minutes. Because disbursement of dye in the fuel, the amount of dye seen does not indicate severity of failure, only that a failure exists.

    NOTE: If no dye or leak is found after running engine, verify there is fuel dilution issue by oil analysis or observing an oil level increase.

    - If a leak is found, turn off the engine. Do steps 14 through 17.
    - If a leak is not found, turn off the engine. Continue with step 18.
14. Remove the high-pressure oil rail following the procedure in the *Engine Service Manual*.
15. Inspect remaining injectors for leaks. Failed injectors will have a solid yellow-green color around the intensifier body area (weep hole).
16. Relieve the pressure in the fuel system to avoid further contamination of oil.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

17. Replace leaking fuel injector following the procedure in the *Engine Service Manual*.

    NOTE: If a set (six) of injectors must be replaced, contact International® Technical Services to start a case file.

18. Remove the high-pressure oil rail following the procedure in the *Engine Service Manual*.

19. Use the black light to inspect between each injector and hold-down clamp. Do not remove the injectors.

    - If a leak is found, do steps 20 and 21.
    - If no leak is found, do steps 22 through 24.

20. Relieve the pressure in the fuel system to avoid further contamination of oil.

21. Replace leaking fuel injector following the procedure in the *Engine Service Manual*.

    NOTE: If a set of injectors (six) must be replaced, contact International® Technical Services to start a case file.

22. Relieve the pressure in the fuel system to avoid further contamination of oil.

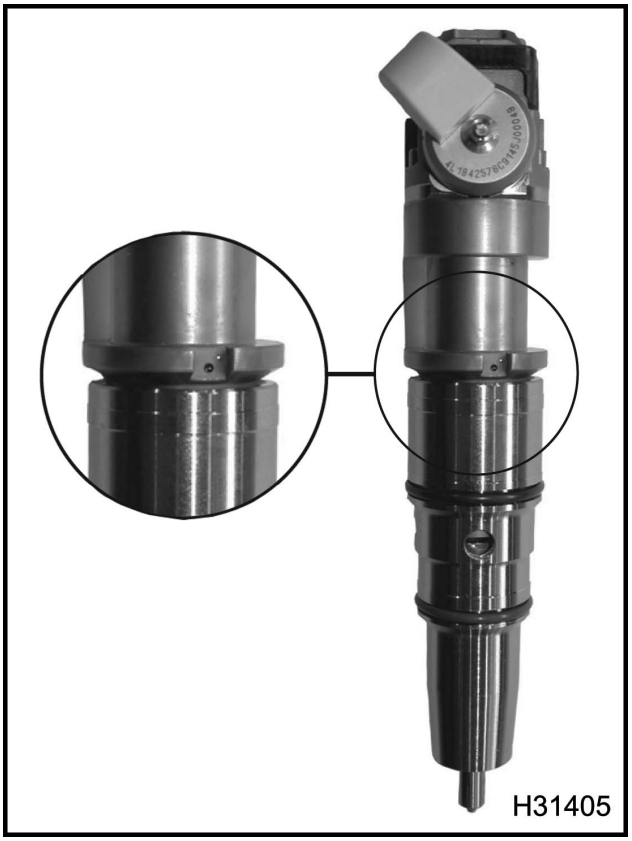


Figure 150 Fuel injector weep hole

23. Remove each injector (one at a time) following the procedure in the *Engine Service Manual*. Hold each fuel injector over their respective injector opening for several seconds to allow fuel to drain from injector. Inspect each injector.

24. Replace leaking fuel injector following the procedure in the *Engine Service Manual*.

    NOTE: If a set of injectors (six) must be replaced, contact International® Technical Services to start a case file.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Low Oil Pressure

Symptom

Low oil pressure can cause any or all of the following:

- Red ENGINE lamp
- DTC 313 – Engine oil pressure below warning level
- DTC 314 – Engine oil pressure below critical level
- Engine knock
- Engine hard start or no start condition
- Engine loss of power
- DTC 335 – ICP unable to build pressure during cranking
- DTC 333 – Injection control pressure above/below desired level

Cause

- Instrument panel gauge error
- Low oil level: oil leak, oil consumption or incorrect servicing
- High oil level: incorrect servicing, fuel in oil or coolant in oil
- Incorrect oil viscosity
- Incorrect EOP sensor
- Stuck oil pressure regulator
- Scored/damaged oil pump
- EOP sensor biased
- Broken, missing or loose piston cooling tube(s)
- Missing, damaged or worn bearing inserts or camshaft bushings
- Aeration (cracked pickup tube or pickup tube gasket)

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Gauge bar tool
- Air Regulator
- Shut-off valve

Oil Inspection

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. Park vehicle on level ground.
2. Check oil level with oil level gauge.

   NOTE: Never check the oil level when the engine is running or immediately after the engine is shut down; the reading will be inaccurate. Allow 15 minute drain down time, before checking oil level.

   NOTE: If the oil level is too low, the fuel injectors will not work correctly. If the oil level is above the operating range, the engine has been incorrectly serviced, fuel is in the oil, or coolant is in the oil.

   - Engine oil level will vary depending on temperature of engine
   - If oil level is low, fill to the correct level and retest.
   - If oil level is at the correct level and not contaminated, do step 4.
3. Inspect oil for thickening and odor.

   NOTE: When the crankcase lube oil is contaminated with coolant, the oil will have a dark-gray or black sludgy appearance. The crankcase may also be overfilled.

   - If oil is contaminated, go to "Fuel in Lube Oil" (page 124) or "Coolant in Lube Oil" (page 109) test procedures located in this section.
   - If oil level is at the correct level and not contaminated, do step 4.
4. Measure pressure at low and high idle. The engine must be at operating temperature.

   - If oil pressure does not read within the specification listed in Appendix A in this Manual, go to "Oil Pressure Regulator Inspection" (page 129) in this section.
   - If oil pressure reads within specification listed in Appendix A in this Manual, compare mechanical gauge readings with instrument panel gauge and Engine Oil Pressure (EOP) value on the Electronic Service Tool (EST).

©August 2008 Navistar, Inc.

- If mechanical gauge and EST read values with a difference greater than +/- 14 kPa (+/-2 psi), perform Electronic Control Systems Diagnostics for the EOP circuit as described in Section 7 in this Manual.
- If instrument panel engine oil pressure gauge reads a different value than the EST and mechanical gauge refer to the *Electrical System Troubleshooting Guide* for the model and year of vehicle.

Oil Pressure Regulator Inspection

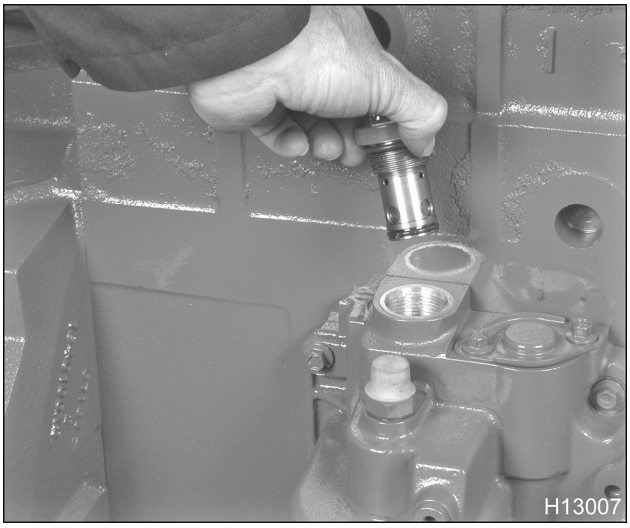


Figure 151 Oil pressure regulator

1. Remove and inspect oil pressure regulator as described in the *Engine Service Manual*.
   - The oil pressure regulator piston should move freely in its bore.
   - If oil pressure regulator is functional and passes inspection, install regulator following the procedure in the *Engine Service Manual*. Go to “Oil and Crankcase Inspection” (page 129) in this section.

Oil and Crankcase Inspection

1. Drain oil from engine. Inspect oil drain plug magnet, drained oil and oil filter for foreign debris.
   - An oil sample should be taken to determine level of engine wear metals and contaminants in the oil.

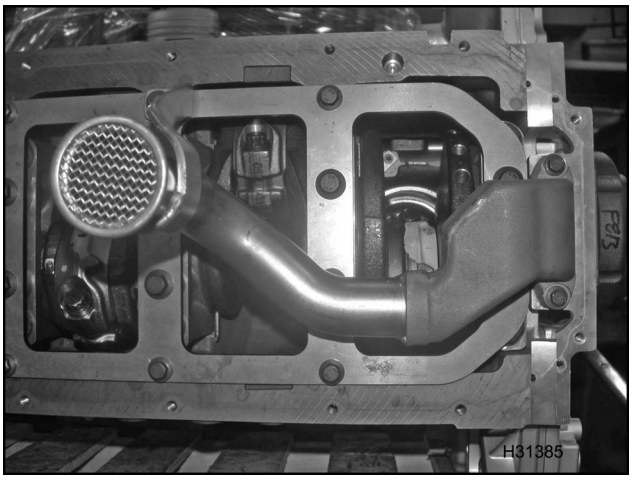


Figure 152 Bottom of engine

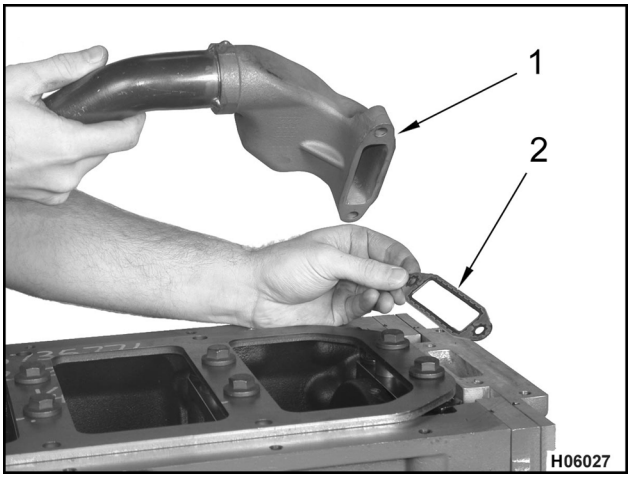


Figure 153 Oil pickup tube assembly and gasket

1. Oil pickup tube assembly
2. Gasket

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

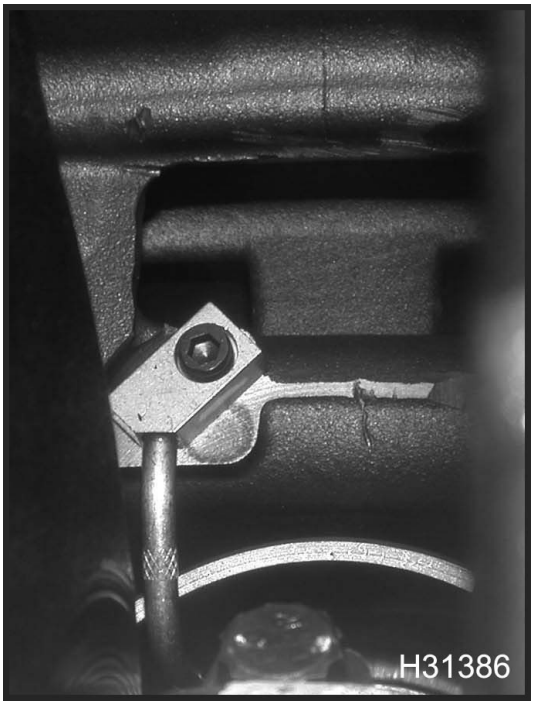


Figure 154 Piston cooling tube

2. Remove oil pan following the procedure in the *Engine Service Manual*.
3. Inspect for missing, loose, plugged or damaged oil pickup tube, pickup tube gasket, piston cooling tubes, bearing inserts, and cam bushings.
   - If unable to identify any damaged parts, Go to “Pressurized Oil System Leak Inspection” in this section.

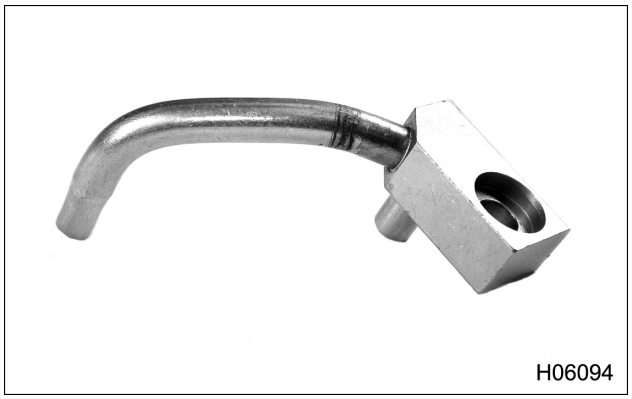


Figure 155 Old piston cooling tube

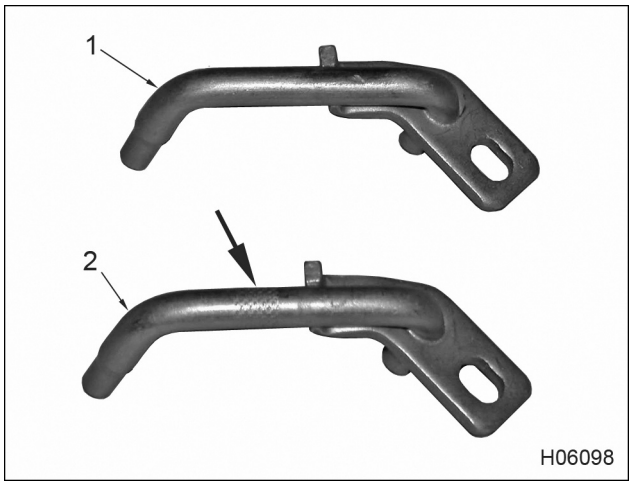


Figure 156 New piston cooling tubes

1. New piston cooling tube (unknurled) – DT 466 engines
2. New piston cooling tube (knurled) – DT 570 and HT 570 engines

NOTE: The piston cooling tube was redesigned. The new piston cooling tube is lighter and structurally stronger. The piston cooling tubes with knurling are used on the HT 570 and DT 570 engine. The piston cooling tubes without knurling are used on the DT 466 engine.

Oil Pump Inspection

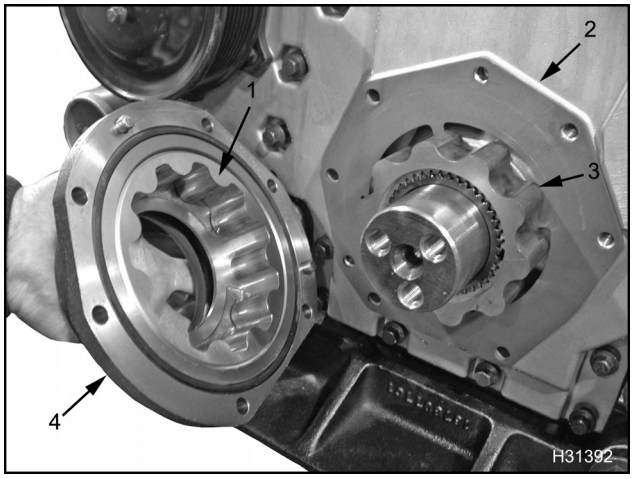


Figure 157 Oil pump housing cover

1. Outer gerotor
2. Oil pump housing plate
3. Inner gerotor
4. Oil pump housing

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

1. Remove and inspect the lube oil pump as described in the *Engine Service Manual*.
   - Inspect the lube oil pump housing and plate for gouging, deep scratches, or a discolored hot-scored appearance.
   - Inspect the gerotor gears for excessive wear or damage.
   - If no excessive damage is found, go to “Front Cover Inspection” (page 131) in this section.

Front Cover Inspection

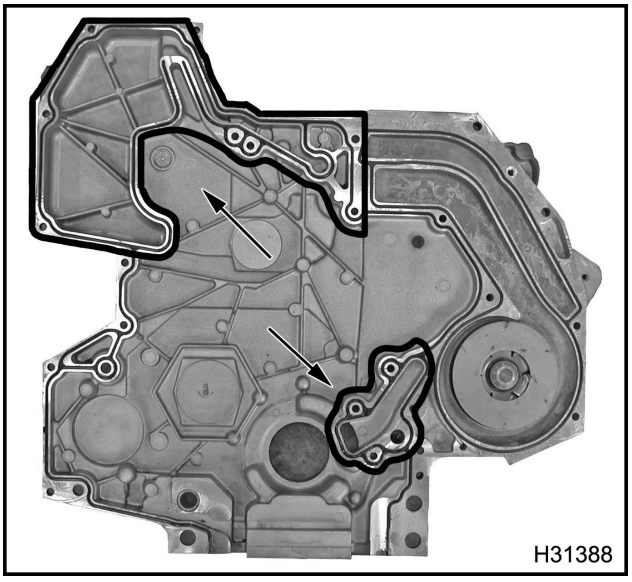


Figure 158 Front cover oil pressure leak locations

1. Remove the front cover assembly (front half) from the engine following the procedure in the *Engine Service Manual*. Inspect the front cover and front cover gasket for damage. Repair or replace and test.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Priming Fuel System

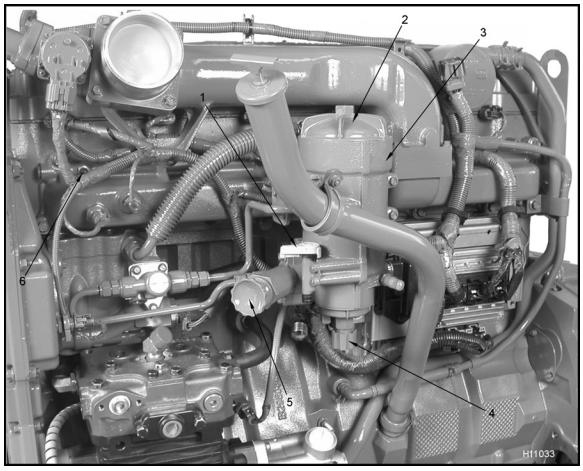


Figure 159 Fuel system components

1. Water drain valve
2. Fuel filter cover
3. Fuel filter header
4. Drain valve (fuel)
5. Fuel primer pump assembly
6. Fuel Pressure Test Valve

WARNING: To avoid personal injury, possible death or damage to the engine or vehicle, make sure the transmission is in neutral, parking brake is set and wheels are blocked before doing diagnostic or service procedures on engine or vehicle.

WARNING: To avoid serious personal injury or possible death, make sure that the engine has cooled down sufficiently before attempting to prime the fuel system.

WARNING: To avoid serious personal injury or possible death: do not allow engine fuel to stay on your skin. Clean your skin and nails with soap and water, or a good hand cleaner. Wash or properly throw away clothing or rags containing used engine fuel. Used engine fuel contains certain elements that may be unhealthy for skin.

CAUTION: Do not add fuel to the fuel filter header. This can add contaminates to the fuel.

Tools

- Fuel Pressure Gauge
- Fuel pressure test adapter
- Fuel Test Fitting
- Fuel/Oil Pressure Test Coupler
- 1 to 5 gallon bucket

If the engine runs out of fuel, do the following:

1. Set parking brake and place transmission control lever to NEUTRAL or PARK.
2. Verify that there is at least 15 liters to 19 liters (4 gallons to 5 gallons) of fuel in the tank.

NOTE: If your vehicle is equipped with dual fuel tanks, fill each tank with 15 liters to 19 liters (4 gallons to 5 gallons) of fuel.

3. Unlock the fuel primer pump assembly by turning the knob counter-clockwise.
4. Fill the fuel filter header and fuel rail by pumping the fuel primer pump.
5. Pump the system until enough pressure is built up. Typically, 20 to 30 pumps will build enough pressure. At this point, the pump plunger will become difficult to pump. Make sure the pump plunger is pushed in when finished. It is not necessary to lock the fuel primer knob at this time.
   - If the pump is working correctly and the pressure is built up, do step 11.
   - If the pump plunger does not pump on the first attempt, the fuel system may be full of compressed air. Do step 6.
   - If little pressure is felt after pushing the knob of the fuel primer pump several times, air must be bled from the fuel rail. Do step 8.

WARNING: To avoid serious personal injury or possible death, wear safety glasses with side shields when performing the following procedure.

©August 2008 Navistar, Inc.

CAUTION: Be sure to place a rag or suitable container under the fuel pressure test valve when bleeding the fuel rail. Dispose of fuel in a correct container clearly marked DIESEL FUEL according to local regulations.

NOTE: Engine fuel can be a threat to the environment. Never dispose of engine fuel by putting it in the trash, pouring on the ground, in the sewers, in streams, or bodies of water.

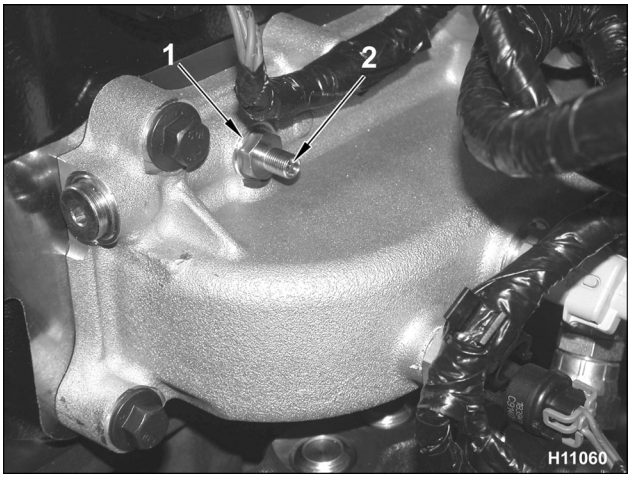


Figure 160 Shrader valve assembly

1. Valve
2. Center stem

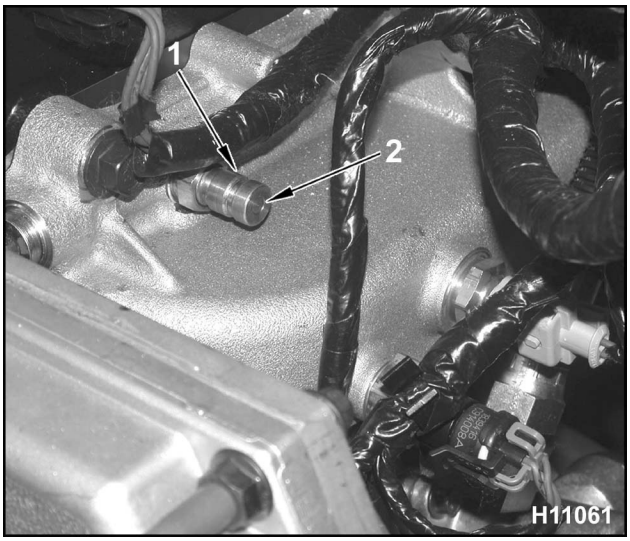


Figure 161 Diagnostic coupling

1. Valve
2. Center section

NOTE: Engines are equipped with a fuel pressure test valve in the form of either a Shrader valve or a diagnostic coupling.

6. Place either a shop rag or suitable container under the fuel pressure test valve.

NOTE: It is recommended to use the Fuel Pressure Test Adapter to avoid bending the needle in the Shrader valve. The Fuel Pressure Test Adapter is part of Fuel Pressure Test Kit ZTSE4657.

7. Depress the fuel pressure test valve center section.
   - If air is released, and you can now pump the primer hand pump, go to “Aerated Fuel” (page 104) in this section.
   - If unable to work the pump after releasing pressure from the fuel test valve, repair the fuel pump primer.

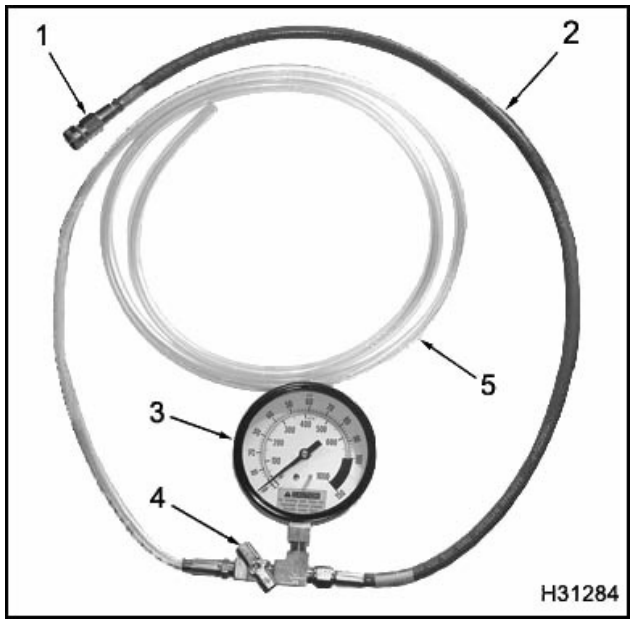


Figure 162 Fuel Pressure Gauge

1. Quick disconnect check valve
2. Fuel test line
3. Fuel Pressure Gauge
4. Inline shut-off valve
5. Clear test line

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.



Figure 163 Fuel Pressure Test Adapter

NOTE: If the engine is equipped with a Shrader valve, use the Fuel Pressure Test Adapter.



Figure 164 Fuel/Oil Pressure Test Coupler

NOTE: If the engine is equipped with a diagnostic coupling, adapt the Fuel/Oil Pressure Test Coupler to the Fuel Pressure Gauge.

8. Install the Fuel Pressure Gauge with shut-off valve into the test port at the front of the intake manifold. Run the discharge hose into a bucket.
9. Open the shut-off valve. Pump the fuel primer pump knob until a steady stream of fuel flows out of the clear hose.
   - If fuel has air bubbles, go to “Aerated Fuel” (page 104) in this section.
   - If fuel flows without air bubbles, close shut-off valve. Do step 10.
10. Pump the fuel primer pump again to build pressure in the system. Lock down the knob.
11. Start the engine.
12. If the engine does not start in 20 seconds, repeat the priming procedure.
13. Once the engine starts, let it run for five to 10 seconds, then shut-off the engine. Turn the fuel primer pump knob clockwise to lock in place.
14. Remove fuel pressure test fitting (if used) and dispose of any fuel in correct container clearly marked DIESEL FUEL according to local regulations.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Rough Idle

Cause

- Engine oil (aerated, incorrect grade, low oil level, extended drain interval)
- Poor fuel quality
- Low fuel pressure
- Aerated fuel
- Electronic control system faults (ECM and IDM)
- Injection control pressure system problems
- Fuel injectors not working properly
- EGR valve stuck open
- Power cylinder problems
- Valve train problems
- Engine or flywheel balance problems
- Exhaust system to cab/chassis contact
- Loose/worn engine mounts

Procedure

1. Verify complaint. Confirm conditions when complaint is present.

   When does engine rough idle occur?

   - Hot – operating temperature
   - Cold
   - After high speed operation
   - Over entire engine speed range
   - Combination of the above conditions
   - Is there chassis vibration or any other conditions/observations present when engine idles rough.

2. Inspect exhaust system for contact with cab, frame or body of vehicle.

   Engine exhaust pipe contact with cab may transmit engine vibrations to cab, especially on acceleration or engine shifts. This condition may be incorrectly diagnosed as a rough idle complaint.

Complete the following tests on the Performance Diagnostic form. See “Performance Diagnostics” – Section 6 (page 205) in this manual for specific details on each test.

3. Do Test 1 (Diagnostic Trouble Codes) on Performance Diagnostics form. Intermittent sensor, injector or wiring harness faults can affect engine idle conditions. The ECM may have detected and recorded these conditions.
4. Do Test 2 (KOEO Standard Test) on Performance Diagnostics form. This test will verify electrical operation of actuators.
5. Do Test 3 (KOEO Injector Test) on Performance Diagnostics form. This test will verify that the injectors are working electronically.
6. Do Test 4 (Engine Oil) on Performance Diagnostics form. Check engine oil level. Verify correct oil grade for ambient temperature. See *Engine Operation and Maintenance Manual*, Engine Lubrication Requirements section. Confirm oil meets correct API specification for your model and year of engine.
7. Do Test 5 (Fuel) on Performance Diagnostics form. Verify quality and quantity of diesel fuel. Poor quality fuel or low cetane rating can cause white smoking, engine misfire, and low power. See *Engine Operation and Maintenance Manual*, Fuel Requirements section for your model and year of engine to determine minimum necessary fuel grade and cetane rating.
8. Do Test 6 (Fuel Pressure and Aerated Fuel) on Performance Diagnostics form. Measure fuel pressure at fuel rail (intake manifold). Low fuel pressure, aerated fuel, and fuel inlet restriction will cause the engine to misfire and a loss of power.
9. Do Test 9 (KOER Standard Test) on Performance Diagnostics form. This test will verify the functionality of the injection control pressure system. The engine must be at operating temperature 70 °C (158 °F) to do this test.
10. Do Test 10 (Injection Control Pressure) on Performance Diagnostics form. This test will confirm if the injection control pressure system is functioning properly and verify injection control pressure stability.
11. Do Test 11 (Injector Disable) on Performance Diagnostics form. The primary function of this test is to show the contributions of the individual

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

power cylinders. The test will detect a weak cylinder which could be the result of an injector or base engine problem.

- Test 11 is used in conjunction with Test 12 (Relative Compression) to distinguish between an injector or mechanical problem.

12. Do Test 12 (Relative Compression) on Performance Diagnostics form. This will verify base engine compression.
    - Test 12 is used in conjunction with Test 11 (Injector Disable) to distinguish between an injector or mechanical problem.
13. Do Test 16 (Crankcase Pressure) on Performance Diagnostics form. This test will determine the condition of the power cylinders and base engine.
14. Inspect for engine and flywheel balance. Engine roughness at idle that gets worse with a no load acceleration may be caused by an out of balance condition.

    WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, support the vibration damper during mounting bolt removal. The damper can slide off the nose of the crankshaft very easily.

    - Following the procedure in the *Engine Service Manual* remove the vibration damper and inspect the elastomer layer for cracks and misalignment. If no problem is found, install vibration damper following the assembly procedure found in the *Engine Service Manual*. Verify that locating dowel on the end of the crankshaft pulley is aligned with locating hole in the balancer for proper installation.
    - Isolate the engine from transmission by removing the transmission, clutch and pressure plate or torque converter. Start the engine and evaluate for roughness. If the engine runs smooth, replace the torque converter or replace clutch and pressure plate.
    - Following the procedure in the *Engine Service Manual*, remove the flywheel and verify proper orientation. If orientation is correct, replace or rebalance flywheel. When removing/installing the flywheel, ensure that the locating dowel is in the right place and that the flywheel is located properly on the dowel.
    - For new engines only remove the oil pan following the procedure in the *Engine Service Manual*. Inspect the crankshaft counterweights to ensure balance holes exist.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Smoke

Two types of smoke conditions can occur, black and white. Dark-gray smoke is considered black smoke. Light-blue smoke is considered white smoke.

Refer to the following corresponding smoke condition for symptom, cause, and diagnostic procedure.

Black Smoke

Cause

- Air intake or exhaust restriction
- Turbocharger failure, turbocharger blade damage or turbocharger wheel stuck
- Loose or failed injector
- Altitude (black smoke on hard acceleration or snap acceleration may be more pronounced at higher elevations)
- Failed Manifold Absolute Pressure (MAP) sensor
- Failed Exhaust Back Pressure (EBP) sensor
- Failed Injection Control Pressure (ICP) sensor

Procedure

1. If engine has fuel knock or there is evidence of fuel in the exhaust, remove exhaust manifolds and inspect for fuel in the exhaust ports. (Suspect loose injectors, missing or damaged O-ring and gasket on bottom of injector).
2. Inspect air inlet system and exhaust system for possible sources of restriction.
3. Inspect turbocharger for oil leakage or failure of blades.
4. Do Test 7 (Intake Restriction) on Performance Diagnostics form or in Section 6 of this manual.
5. Do Test 8 (Exhaust Restriction) on Performance Diagnostics form or in Section 6 of this manual.

White Smoke

Cause

- Cold engine
- No Intake Air Heater (IAH) operation
- Poor quality fuel
- EGR stuck open on startup
- EGR cooler leaking coolant into exhaust
- Loose or failed injector
- Bent connecting rods
- Worn piston rings
- Low compression
- Coolant leaking into the intake manifold through the cylinder head cup plugs
- Coolant leaking into combustion chamber
- Aerated fuel

Procedure

1. In cold ambient temperatures, some white smoke is normal until the engine is up to operating temperature.
   - Ensure that engine is up to operating temperature 88 °C (190 °F) prior to verifying a white smoke complaint.
   - If the engine is unable to obtain operating temperature during a road test, verify thermostat opening temperature 88 °C (190 °F).
2. Do Test 15 (Inlet Air Heater System) on Hard Start and No Start Diagnostics form to verify inlet air heater operation.
3. Do Test 5 (Fuel) on Performance Diagnostics form. Verify quality and quantity of diesel fuel. Poor quality fuel or low cetane rating can cause white smoking, engine misfire and low power. See *Engine Operation and Maintenance Manual*, Fuel Requirements section for model and year of engine to determine minimum necessary fuel grade and cetane rating.
4. Do Test 6 (Fuel Pressure and Aerated Fuel) on Performance Diagnostics form to verify aerated fuel.
5. Do Test 11 (Injector Disable) and Test 12 (Relative Compression) on Performance Diagnostics form to identify failed injector or weak power cylinder.
6. Do Test 16 (Crankcase Pressure) to measure condition of power cylinders.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

7. If there is coolant loss without engine overheating, check for coolant in exhaust.
   - If coolant is leaking from exhaust or can be smelled in the exhaust, go to “Coolant Leak to Exhaust” (page 117) in this section.
8. If engine has fuel knock or evidence of fuel in exhaust, remove exhaust manifolds and inspect for fuel in the exhaust ports. (Suspect loose injectors, missing or damaged O-ring and copper gasket on bottom of injector).
9. Inspect air induction system for evidence of water ingestion or evidence of unfiltered air entering the engine.
   - Water ingestion could have caused a hydraulic lock and bent connecting rods. If water ingestion is suspected, identify smoking cylinders by removing exhaust manifolds and running engine.
   - Unfiltered air entering the engine can cause excessive power cylinder wear and turbocharger compressor blade damage. If power cylinder wear is suspected, identify smoking cylinder(s) by removing exhaust manifolds and running engine.
   - If coolant is found in the intake manifold, check cylinder head cup plugs and intake manifold. Go to “Coolant Leak to Exhaust” (page 117) in this section.
10. If engine is overheating with coolant loss, and cylinder head gasket or injector sleeve is suspected for leaking, go to “Combustion Leaks to Coolant” (page 102) in this section.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Low Power (Turbocharger Assembly and Actuator)

Symptom

Excessive low power on take-off or intermittent low power from drive cycle to drive cycle

Cause

- Electrical power or ground issue
- Inoperative turbocharger assembly
- Failed turbocharger actuator

Tools

- Digital Multimeter (DMM)
- Turbo Breakout Harness
- 12-pin Breakout Harness

Procedure

1. Turn the ignition switch to OFF.
   a. Move turbocharger linkage through its full range of motion by hand. Linkage should move smoothly and not chatter or hesitate.
   b. Do a bounce test by moving turbocharger linkage all the way out towards frame rail and let it go. Linkage should move towards engine, bounce, and stay there.
      - If linkage moves smoothly, do step 2.
      - If linkage does not move smoothly, remove turbocharger actuator and move linkage through its full range of motion.
        — If linkage moves smoothly, replace turbocharger actuator.
        — If linkage does not move smoothly, replace turbocharger assembly.
2. Turn the ignition switch to ON. Watch turbocharger linkage during pre-cycle movement. Linkage should move all the way out towards frame rail, move all the way back in towards engine, and move back out about half way.

   Check pre-cycle three times with at least three seconds of key-off time between tests. Linkage should move through pre-cycle smoothly and not chatter, vibrate, hesitate or slow down during pre-cycle. Each pre-cycle should be completed in less than one second.

   NOTE: When pre-cycle is complete with key-on engine-off, the linkage should not move by hand.

   - If pre-cycle fails, do step 3.
   - If pre-cycle passes, the turbocharger or actuator may not be cause of low power.
     — Verify that all tests on Performance Diagnostic form do not indicate another cause.
     — If the low power complaint is intermittent, and all tests on Performance Diagnostic form do not indicate another cause, do step 3.
3. Connect turbocharger breakout harness between engine harness and actuator harness. Measure voltage between actuator power and ground terminals with key-on engine-off.
   - If pre-cycle fails, and voltage is 10 V or more, replace the actuator.
   - If low power complaint is intermittent, and voltage is 10 V or more, inspect turbocharger power and ground wires for corroded or loose connections.
     — If power and ground wires are properly connected, not corroded, and performance diagnostic tests do not indicate another cause of low power, replace the actuator.
   - If voltage is low, repair low voltage problem. See “VGT Actuator” in Section 7 (page 524).
     — Go to step 2 and test again.

   NOTE: The turbocharger actuator can be tested again with a known good power and ground supplied directly through turbocharger actuator breakout harness.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Table of Contents

Description.....143
Diagnostic Form Information.....143

Test Procedures.....144
1. Initial Ignition Switch ON (Do not start).....144
2. Engine Cranking.....146
3. Diagnostic Trouble Codes.....148
Vehicle Information for Form Heading.....148
Entering Vehicle Information without using the EST.....148
Entering Vehicle Information using the EST.....149
Accessing DTCs.....151
Reading DTCs.....152
4. KOEO Standard Test.....153
5. KOEO Injector Test.....155
6. EST Data List.....157
Monitoring Engine Systems using an EST.....157
Monitoring ICP using VC Gasket Breakout Harness.....159
Monitoring BCP using VC Gasket Breakout Harness.....161
Monitoring EOP at EOT Sensor Port.....163
Monitoring Engine Systems using Breakout Box.....164
7. Fuel.....166
8. Engine Systems.....170
9. Engine Oil.....171
10. Intake and Exhaust Restriction.....172
11. Main Power Relay to ECM.....174
Voltage Measurement with Breakout Harness at Main Power Relay.....174
Voltage Measurement at ECM with Breakout Box.....175
12. Main Power Relay to IDM.....177
Voltage Measurement at 12–Pin Connection with Breakout Harness.....177
Voltage Measurement with Breakout Harness at Main Power Relay.....179
13. Fuel Pressure and Aerated Fuel.....180
Fuel Pressure.....180
Checking for Aerated Fuel using Spare Fuel Line.....183
Operation of Fuel Pump.....185
14. Low ICP System Pressure.....186
14.1 – System Function.....186
14.2 – Oil Reservoir Level.....188
14.3 – IPR and High-pressure Pump Operation.....188
14.4 – Under Valve Cover Leak Test.....191
14.5 – IPR Function.....194
15. Inlet Air Heater System.....197
15.1 – Current Amperage Draw.....197
15.2 – Voltage at Element Terminal.....198
15.3 – Element Terminal Continuity.....199
15.4 – Wiring Harness Continuity and Resistance.....200
15.5 – Relay Operation.....200

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Description

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, make sure the transmission is in neutral, parking brake is set, and wheels are blocked before doing diagnostic or service procedures on engine or vehicle.

The Diagnostic Form (Hard Start and No Start side) directs technicians to systematically troubleshoot a hard start or no start condition and avoid unnecessary repairs.

This section shows detailed instructions of the tests on the form. The manual should be used with the form and referenced for supplemental test information. Use the form as a worksheet to record all test results.

Do all tests in sequence, unless otherwise stated. Doing a test out of sequence can cause incorrect results. If a problem was found and corrected, it is not necessary to complete the remaining tests.

See appendices for Diagnostic Trouble Codes (DTCs) and engine specifications.

Diagnostic Form Information



Figure 165 Diagnostic Form EGED-290-1 (Hard Start and No Start Diagnostics side)

Diagnostic Form EGED-290-1 is available in 50 sheet pads. To order technical service literature, contact your International dealer.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Test Procedures

1. Initial Ignition Switch ON (Do not start)

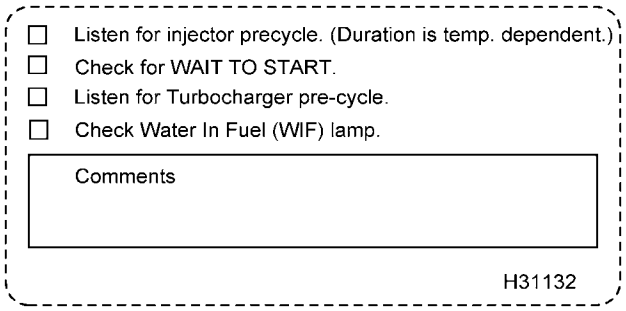


Figure 166

Purpose

To determine the following:

- Is the Injector Drive Module (IDM) powered up?
- Is the Electronic Control Module (ECM) powered up?
- Is water in the fuel?

Tools

- None

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. Turn ignition switch to ON. (Do not start the engine.) Check or listen for the following:
   - WAIT TO START lamp
   - WATER IN FUEL lamp (If the Water In Fuel lamp comes on, check for water in fuel filter housing.)
   - Injector pre-cycle (Shop noise can drown out the sound of injector pre-cycle.)
   - Turbocharger pre-cycle

   NOTE: Do not mistake the sound of the instrument panel cycle self-test or the Antilock Brake System (ABS) self-check for injector or turbocharger pre-cycle.
2. If pre-cycle noise was not heard or missed, cycle the ignition switch and listen again.
   - If pre-cycle noise is still not heard, the ECM may not be powered up. Check for DTCs. If the EST is not communicating with the ECM, see Electronic Control Module Power (ECM PWR) in Section 7 (page 381).
   - If injectors did not pre-cycle, the IDM may not be powered up. Check DTCs and 12–way connector.
   - If the water in fuel light is on, check for water in the fuel system. Drain water from the fuel filter housing. Verify that the fuel source is not contaminated.
   - If the turbocharger did not pre-cycle, there may be an open circuit. Check the engine 12–way connector. Check for DTCs.
   - If the turbocharger and injector pre-cycle, and the WAIT TO START lamp and WATER IN FUEL lamp come on and off, continue to the next diagnostic test.

Possible Causes

No injector pre-cycle

- No key power (v_{IGN})
- Failed IDM ground circuit
- No power from main power relay to IDM.
- ICP sensor bias high (above 3.45 MPa [500 psi])
- Failed ECM ground circuit
- No power from main power relay to ECM
- CAN 2 link is not working.
- IDM failure
- ECM failure

WAIT TO START lamp does not illuminate

- No key power (v_{IGN})
- Failed ECM ground circuit
- No power from main power relay to ECM
- ECM failure
- Amber WAIT TO START lamp is out (will not cause hard start or no start).

©August 2008 Navistar, Inc.

- CAN 1 link to instrument panel is not working (will not cause hard start or no start).

No turbocharger pre-cycle

- No key power (v_{IGN})
- No power from ECM main power relay
- Failed actuator power circuit (will not cause hard start or no start)
- Failed actuator power ground circuit (will not cause hard start or no start)
- Failed Variable Geometry Turbocharger (VGT) actuator (will not cause hard start or no start)
- Failed VGT turbocharger (will not cause hard start or no start)

WATER IN FUEL lamp illuminates

- Water in fuel
- Electrical circuit failure

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

2. Engine Cranking

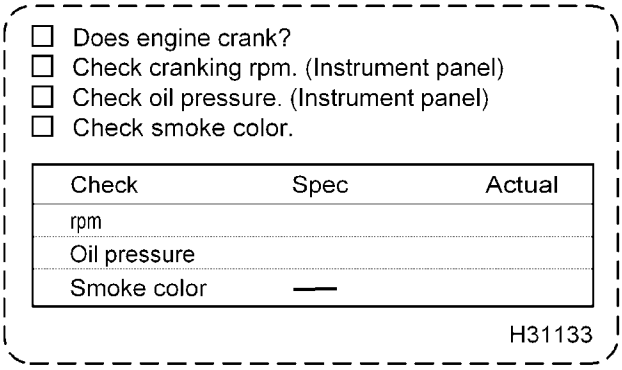


Figure 167

Purpose

To determine the following:

- Does the crankshaft rotate?
- Does the instrument panel receive a signal from the Electronic Control Module (ECM) and is rpm sufficient?
- Is oil pressure sufficient?
- Is fuel getting into the cylinders?

Tools

- None

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) for specifications, and enter data in spec column for rpm and oil pressure on Diagnostic Form.
2. Turn the ignition switch to START.

   NOTE: If equipped, push optional push button to crank engine.
3. Check rpm on instrument panel. Record results on Diagnostic Form.
   - If engine speed is below specification, the engine will not start. Check batteries and DTCs if engine seems to be turning over fast enough to start and no rpm is noticed on instrument panel.
4. Check oil pressure (instrument panel). Record results on Diagnostic Form.
   - If oil pressure does not build while cranking the engine, oil may not be feeding the high-pressure oil system. Check oil level.
5. Check for exhaust smoke and record color on Diagnostic Form.

   NOTE: Typically smoke indicates that fuel is getting into the cylinders. However, fuel pressure should be measured to ensure sufficient fuel supply.
   - If there is no smoke from the exhaust during engine crank, fuel may not be getting to the engine cylinders. See "Priming the Fuel System" in Section 4 (page 132) for procedure.

Possible Causes

Engine will not turn over

- Low or no battery power
- No key power (v_{IGN})
- Insufficient power to ECM
- Starting system failure
- Circuit fault for Engine Crank Inhibit (ECI)
- Cylinder hydraulic lock

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- Cylinder mechanical lock (timing incorrect; valve/piston contact)

Insufficient rpm

- Low battery power
- Starter motor problem
- Incorrect oil viscosity
- Cold temperature

Insufficient oil pressure

- Oil gauge error on instrument panel (will not cause hard start or no start)
- Low oil level: oil leak, oil consumption, or incorrect servicing
- High oil level: incorrect servicing, fuel in oil, coolant in oil
- Incorrect oil viscosity
- Stuck oil pressure regulator
- Scored or damaged oil pump/front cover
- Engine Oil Pressure (EOP) sensor biased
- Incorrect EOP sensor
- EOP circuit or sensor problems
- Broken, missing, or loose piston cooling tubes
- Missing, damaged, or worn bearing inserts
- Missing, damaged, or worn camshaft bushings
- Lifter missing (will also have performance problems)

Excessive exhaust smoke with hard start or no start concern

- Poor fuel quality
- Insufficient cylinder temperature
- Loose injector
- Low compression
- Inoperable inlet air heater system – if equipped
- Excessive air inlet or exhaust restriction
- Damaged injector – split tip
- Base engine timing incorrect
- Combustion leak to fuel

No exhaust smoke / cylinders not receiving fuel

- Fuel supply system concern
- ECM and IDM communication failure
- ICP sensor bias high (above 3.45 MPa [500 psi])
- Combustion leak to fuel supply (fuel rail)
- Base engine timing incorrect

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

3. Diagnostic Trouble Codes

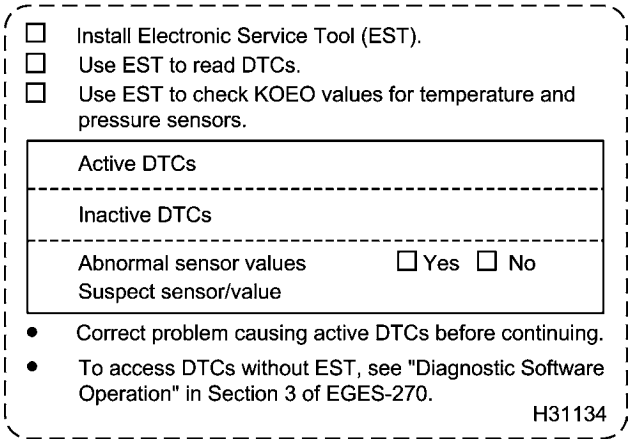


Figure 168

Purpose

- To determine if the ECM has detected Diagnostic Trouble Codes (DTCs) indicating conditions that could cause engine problems
- To fill out Diagnostic Form heading
- To check for abnormal sensor readings

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

Vehicle Information for Form Heading

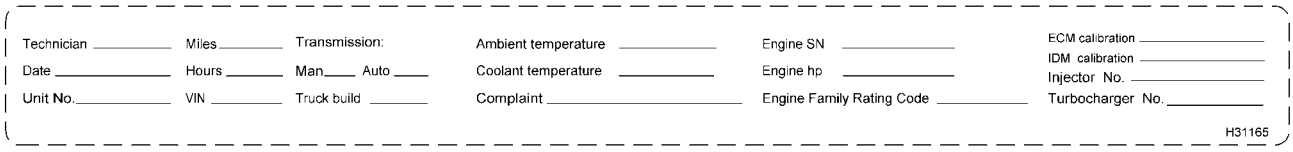


Figure 169

NOTE: Before continuing diagnostic tests, fill out the form heading on Diagnostics Form EGED-290.

Entering Vehicle Information without using the EST

1. Enter the following information in the form heading:
   - Technician
   - Date (for warranty)
   - Unit No (dealer's quick reference for customer's vehicle identification)
   - Truck build (date)
   - Complaint (for warranty)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

2. Do the following procedure “Entering Vehicle Information using the EST” to complete the rest of the form heading:

Entering Vehicle Information using the EST



Figure 170 American Trucking Association (ATA) connector



Figure 171 EZ-Tech® interface cable



Figure 172 EZ-Tech® interface cable

⚠ WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the “Safety Information” section of this manual.

1. Connect the EZ-Tech® interface cable to the EST and the ATA connector.
2. Boot-up EST.

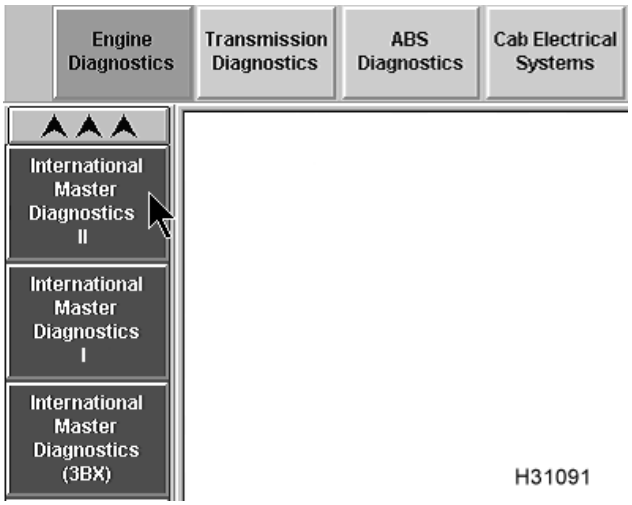


Figure 173 International® launchpad

3. Select Engine Diagnostics, then International® MasterDiagnostics® II.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4. Turn the ignition switch to ON.

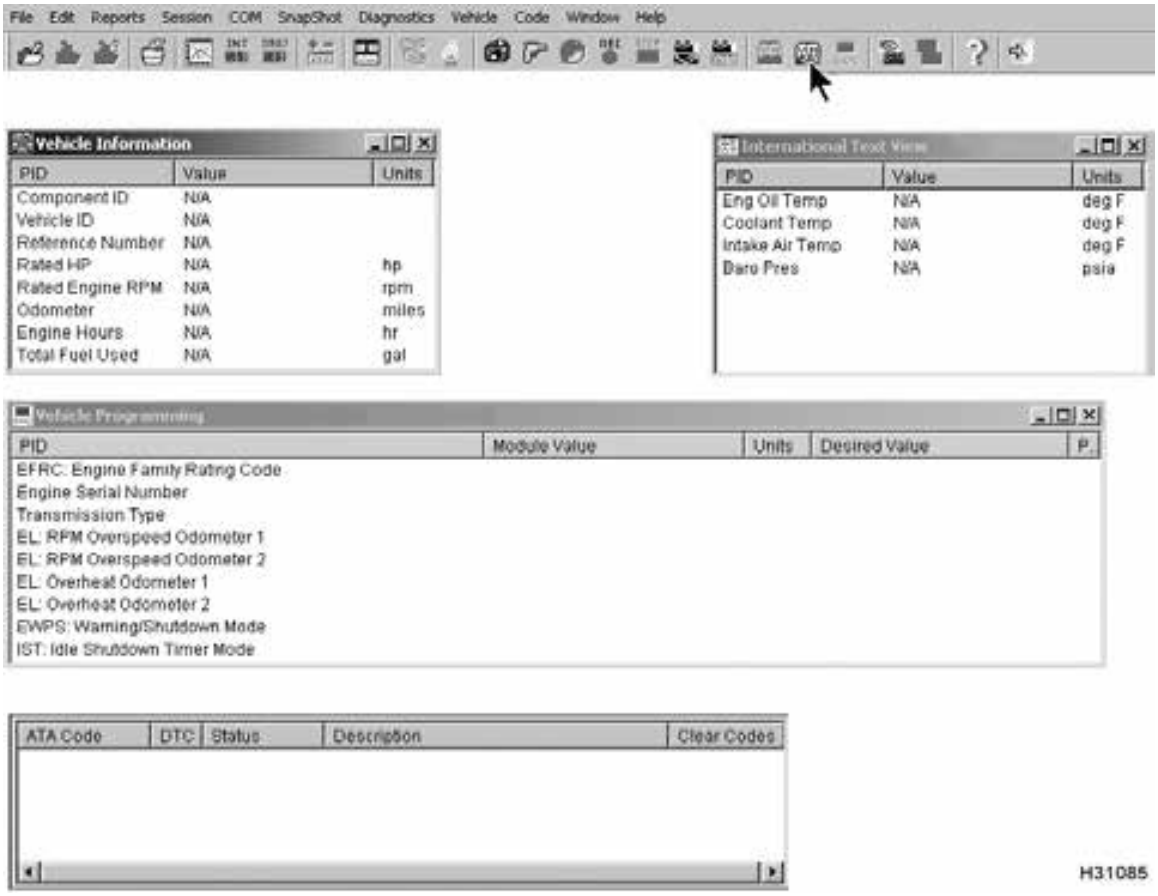


Figure 174 Open VIN+ session

©August 2008 Navistar, Inc.

5. Select VIN+ icon to open VIN+ session.
6. Use the on-screen information and the following “Information List” to complete the form heading.

Table 1

Heading Information	VIN+ session PID
Miles	Odometer
Hours	Engine Hours
VIN	Vehicle ID
Transmission	Transmission Type
	Manual Non-Isochronous
	Manual Isochronous
	Allison AT/MT
	Allison MD
Ambient temperature	Intake Air Temp
Coolant temperature.	Coolant Temp
Engine SN	Engine Serial Number
Engine HP	Rated HP
Engine Family Rating Code	EFRC: Engine Family Rating Code
ECM calibration	Reference Number
(Example for reference only)	PRE1PJ02
	(First group)
IDM calibration	Reference Number
(Example for reference only)	ANZKLA02
	(Second group)

Information List

- Miles (for warranty)
- Hours (for warranty)
- VIN (for warranty, ordering parts, and service information) The Vehicle Identification Number is also on the door jamb on the operators side.
- Transmission: Manual/Auto
- Ambient temperature
- Coolant temperature
- Engine SN (for ordering parts and service information)

  The engine serial number is stamped on a crankcase pad on the right side of the crankcase below the cylinder head. The engine serial number is also on the engine emission label on the valve cover.

  Compare the Engine SN in the Vehicle Programming window of the VIN+ session with the Engine SN on the engine. The engine could have been replaced without a programming change to the ECM to upgrade the Engine SN.
- Engine HP (for correct engine application)
- Engine Family Rating Code (for warranty)
- ECM calibration
- IDM calibration

NOTE: Fill in the Turbocharger No. and Injector No. if a mismatch of components is suspected.

- Injector No. (requires removal of valve cover and high-pressure oil rail)
- Turbocharger No. (Check for plate on turbocharger – may require removal of paint from plate)

Accessing DTCs

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the “Safety Information” section of this manual.

NOTE: When opening VIN+ session to fill out form heading, the DTC window automatically appears.

NOTE: If an EST is not available, see “Accessing DTCs” in Section 3 .



Figure 175 DTC window

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

1. Record all DTCs from DTC window on Diagnostic Form. See “Diagnostic Trouble Codes” – Appendix C (page 643) for DTCs.
2. Correct problem causing active DTCs before continuing.
3. Clear DTCs.
4. Use EST to check KOEO values for temperature and pressure sensors. Record results on Diagnostic Form.
    - If engine has not been run for 8 to 12 hours, the Engine Coolant Temperature (ECT), Engine Oil Temperature (EOT), and Manifold Air Temperature (MAT) should be within 2 °C (5 °F) of each other. The Intake Air Temperature (IAT) could be a few degrees higher or lower due to faster outside engine temperature change.
    - The Injection Control Pressure (ICP) and Brake Control Pressure (BCP) values may fluctuate as much as 345 kPa (50 psi). Electromagnetic Interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem.
    - Engine Oil Pressure (EOP), Manifold Air Pressure (MAP), and Exhaust Back Pressure (EBP) values may fluctuate as much as 7 kPa (1 psi). Electromagnetic Interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem.
    - Barometric Absolute Pressure (BAP) values should equal the barometric reading for your region.
    - Are values normal?
    - If abnormal values are suspected, record on Diagnostic Form and see Operational Voltage tables in Section 7 (page 283) for applicable sensor.
5. Continue with KOEO Standard Test.

Reading DTCs

ATA code: Codes associated with a Subsystem Identifier (SID), Parameter Identifier (PID), and Failure Mode Indicator (FMI)

DTC: Diagnostic Trouble Code

Status: Indicates active or inactive DTCs

- **Active**: With the ignition switch on, active indicates a DTC for a condition currently in the system. When the ignition switch is turned off, an active DTC becomes inactive. (If a problem remains, the DTC will be active on the next ignition switch cycle and the EST will display active/inactive.)
- **Inactive**: With the ignition switch on, inactive indicates a DTC for a condition during a previous key cycle. When the ignition switch is turned to OFF, inactive DTCs from a previous ignition switch cycle, remain in the ECM memory until cleared.
- **Active/Inactive:** With the ignition switch on, active/inactive indicates a DTC for a condition currently in the system and was present in previous key cycles, if the codes were not cleared.

Description: Defines each DTC

Possible Causes

- Electronics failure
- Failure of the ICP sensor or ICP system
- Failure of the Air Management System (AMS)
- Failure of Diamond Logic® engine brake

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4. KOEO Standard Test

☐ Use EST to run KOEO Standard Test.

Active DTCs

- Correct problem causing active DTCs before continuing.
- To do KOEO Standard Test without EST, see "Diagnostic Software Operation" in Section 3 of EGES-270.

H31135

Figure 176

Purpose

To determine electrical malfunctions detected by the ECM self-test and Output Circuit Check (OCC)

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

NOTE: If an EST is not available, see “Standard Test Using Cruise Switches” in Section 3 (page 72).

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the “Safety Information” section of this manual.

1. Set parking brake to ensure the correct signal from the Electronic System Controller (ESC).
2. Turn the ignition switch to ON. (Do not crank engine.)

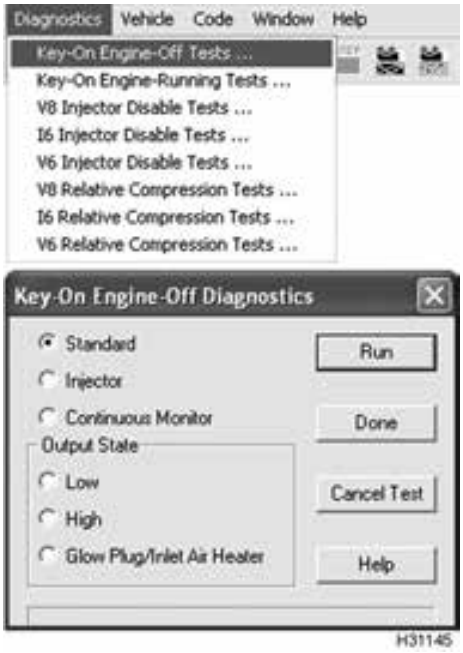


Figure 177 KOEO Standard Test

3. Select Diagnostics from the menu bar.
4. Select Key-On Engine-Off Tests from the drop down menu.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard Test is always selected and run first. If the ignition switch is not cycled, the Standard Test does not have to be run again.

5. From the KOEO Diagnostics menu, select Standard, then select Run to start the test.

   The ECM will complete an internal self-test and an OCC. When the OCC is over, the DTC window will show DTCs, if there is a problem.

   NOTE: This test takes less than 5 seconds. While the test is running, the MasterDiagnostics® screen displays message Diagnostics Running .
6. Record all DTCs on Diagnostic Form. See “Diagnostic Trouble Codes” – Appendix C (page 643) for DTCs.
7. Correct problem causing active DTCs.
8. Clear DTCs.

Possible Causes

- Failed electrical components or circuitry

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- OCC fault for the IPR valve or brake shut-off valve (if equipped)
- Inlet Air Heater (IAH)
  - — For initial calibrations, if the system voltage is less than 13 volts, DTC 251 may become active.
  - — Later calibrations and current hardware levels do not support DTC 251.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

5. KOEO Injector Test

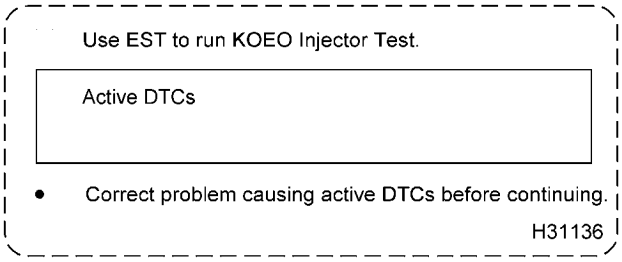


Figure 178

Purpose

To determine if fuel injectors are working (electronically) by energizing injectors in a programmed sequence. The ECM monitors the IDM results from this test and transmits DTCs, if injectors or injector circuits are not working correctly.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: The KOEO Injector Test can only be done with the EST using MasterDiagnostics® software.

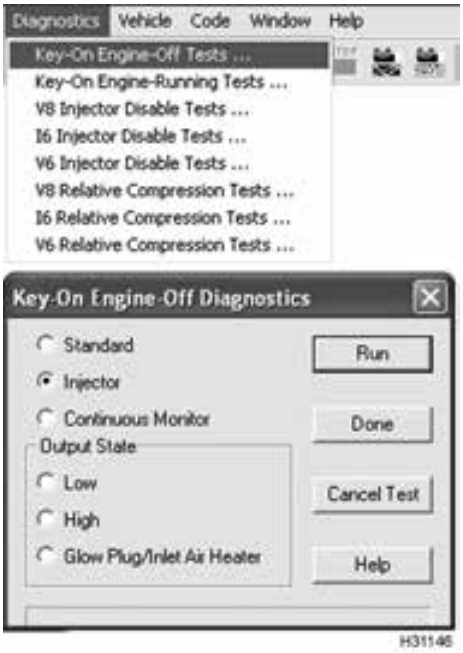


Figure 179 KOEO Injector Test

1. Select Diagnostics from the menu bar.
2. Select Key-On Engine-Off Tests from the drop down menu.

   NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard Test is always selected and run first. If the ignition switch is not cycled, the Standard Test does not have to be run again.
3. From the KOEO Diagnostics menu, select Injector, then select Run to start the test.

   NOTE: During this test, injector solenoids should click in a numerical sequence, not the firing order, when actuated. If a series of clicks are not heard for each injector, one or more injectors are not activating.

   The DTC window will show DTCs for electrical problems.
4. Record DTCs on Diagnostic Form. See "Diagnostic Trouble Codes" – Appendix C (page 643) for DTCs.
5. Correct problem causing active DTCs.
6. Clear DTCs.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

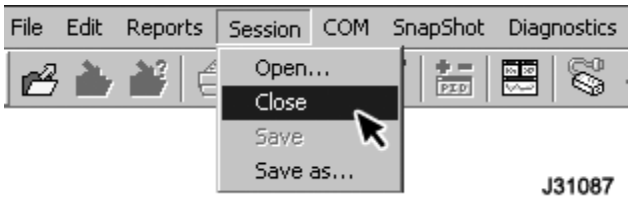


Figure 180 Close session

7. When finished with this test, close the VIN+ session. Select Session from menu bar, then Close.

Possible Causes

- Injector wiring harness open or shorted
- Under Valve Cover (UVC) wiring
- Valve cover gasket
- Faulty wiring harness connection on injector coil
- Failed injector coil
- Failed Injector Drive Module (IDM)
- Failed ECM (not sending test request to IDM)

Hard Start and No Start Only

- Faulty wiring CAN2 datalink
- Faulty wiring IDM power and ground
- Faulty wiring IDM main power relay

©August 2008 Navistar, Inc.

6. EST Data List

☐ Monitor KOEO values and enter in KOEO column.
☐ Enter data in the Cranking Spec column.
☐ Crank engine and monitor DATA for 20 seconds. (See note 4.)
☐ Enter data in the Cranking Actual column.

PID	KOEO	Cranking Spec	Cranking Actual
VBAT			
RPM			
ICP			
EOP			
EGRP			
BCP (if equipped)			

- If voltage is below spec, see "ECM Self Diagnostics" - Section 7.
- If no rpm is noted, check DTCs.
- If ICP is below spec, do "Low ICP System Pressure" - Test 14.
- If EOP is below spec, see "Engine Symptoms Diagnostics" - Section 4.
- EGRP should equal 0.
- If BCP is out of range, see "BCP Sensor" - Section 7.

H31138

Figure 181

Purpose

To determine if engine systems meet operating specifications to start engine

Monitoring Engine Systems using an EST

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: If an EST is not available, see alternate test procedures following this test.

Batteries must be fully charged before doing the following steps.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) for specifications, and record on Diagnostic Form.



Figure 182 D_HardStart_ NoStart.ssn

2. Open D_HardStart_NoStart.ssn to monitor engine operation.
3. Turn the ignition switch to ON.
4. Record KOEO readings on Diagnostic Form.
5. Crank engine for 20 seconds and read EST to measure VBAT, RPM, ICP, EOP, EGRP, and BCP.
6. Record readings on Diagnostic Form.
   - Battery voltage must be 7 V or more. If voltage to the ECM drops below 7 V, the ECM will not remain powered up.

     Note: If the battery volt (VBAT) PID is less than actual battery voltage or the EST is not communicating with the ECM, see Electronic Control Module Power (ECM PWR) in Section 7 (page 381).
   - Engine cranking speed must generate the required injection control pressure to operate the fuel injectors and create required compression to ignite the fuel.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- If the EST shows 0 rpm during engine cranking, the ECM may not be receiving a signal from the Crankshaft Position (CKP) sensor or Camshaft Position (CMP) sensor. The ECM will not send the fueling command to the IDM without a correct CKP or CMP signal. See CKP sensor (page 351) and CMP sensor (page 355) in Section 7.
- If the EST indicates low or no injection control pressure, do Test 14 – “Low ICP System Pressure” (page 186).

  If the ICP sensor is biased high, see “ICP Sensor” in Section 7 (page 457).
- If oil pressure is low, the ICP system may not be receiving enough oil.
- If EGR valve is open at start-up it can disrupt the air fuel mixture enough to inhibit engine operation.
- BCP values may fluctuate as much as 345 kPa (50 psi). Electromagnetic interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem. If above 7 MPa (1000 psi), brake actuation may occur. If over 345 kPa (50 psi), ICP operation may be inhibited for fuel injectors.

Possible Causes

Low battery voltage

- Failed batteries
- High-resistance at battery cable connections or in wiring to the ECM
- Failed ECM main power relay
- Blown inline fuse (in battery box) that supplies voltage to the ECM
- Blown fuse in power distribution box

Low cranking rpm

- Electrical system malfunctions, incorrect oil, or long oil change intervals in cold ambient temperatures
- No rpm indication on the EST while cranking the engine: Failed CKP sensor, CMP sensor, or circuit to the ECM. Check DTCs after cranking engine for 20 seconds.

Low Injection Control Pressure

- A leak in the high-pressure oil system
- Failed ICP sensor
- Low oil level in the high-pressure oil reservoir
- Failed IPR valve or electronic controls for the regulator
- Failed high-pressure oil pump or pump drive

Low oil pressure

- Failed oil pressure regulator relief valve
- Failed gerotor oil pump or front cover
- Failed pickup tube or gasket
- Internal lube oil pressure leak

EGR valve

- Stuck or inoperative valve

BCP

- Inoperative brake shut-off valve
- Failed BCP sensor
- Failed BCP sensor wiring
- Porosity or sand hole in high-pressure oil rail (injector oil gallery to brake oil gallery)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Monitoring ICP using VC Gasket Breakout Harness

NOTE: Do this procedure, if an EST is not available. This is an alternate method.

Tools

- VC Gasket Breakout Harness
- Digital Multimeter (DMM)

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle - comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) and Section 7 for specifications, operational voltages, and values. Record on Diagnostic Form.

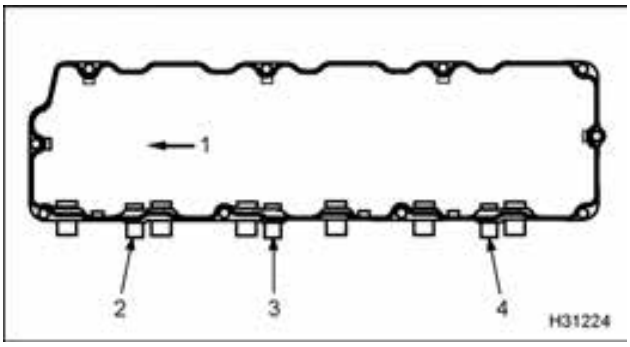


Figure 183 Valve cover gasket

1. Front of engine
2. Pass-through connector for BCP sensor
3. Pass-through connector for brake shut-off valve
4. Pass-through connector for ICP sensor

2. Disconnect engine harness connector from pass-through connector for ICP sensor.

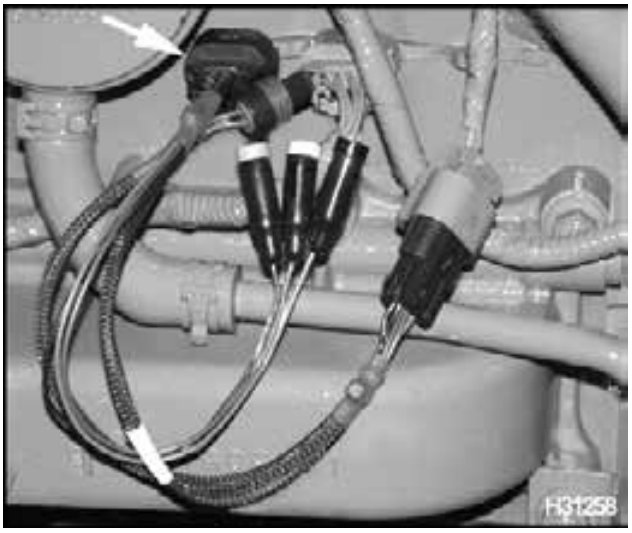


Figure 184 VC Gasket Breakout Harness connector to pass-through connector for ICP sensor

3. Connect VC Gasket Breakout Harness to pass-through connector and engine harness.

   WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

   When routing DMM leads, do not crimp the leads, run the leads too close to moving parts, or let the leads touch hot engine surfaces.

4. Use DMM to measure injection control pressure (ICP signal voltage) KOEO.
   - Connect POS to green (signal circuit) and NEG to black (signal ground).
5. Record KOEO reading on Diagnostic Form.
6. Take another measurement while cranking the engine for 20 seconds.
7. Record reading on Diagnostic Form.
   - If ICP voltage is out of specification at KOEO only, see "ICP Sensor" in Section 7 (page 457).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- If ICP voltage is out of specification at engine crank only, do Test 14 – “Low ICP System Pressure” (page 186).
- If ICP voltage is in specification at KOEO and builds to cranking voltage during engine crank, continue to “Monitoring BCP using VC Gasket Breakout Harness” test

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Monitoring BCP using VC Gasket Breakout Harness

NOTE: Do this procedure, if an EST is not available. This is an alternate method.

Tools

- VC Gasket Breakout Harness
- Digital Multimeter (DMM)

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

NOTE: BCP should be zero, when engine brake is inactive. BCP values may fluctuate as much as 50 psi. Electromagnetic Interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem. This should be equal to KOEO BCP signal voltage.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) and Section 7 for specifications, operational voltages, and values. Record on Diagnostic Form.

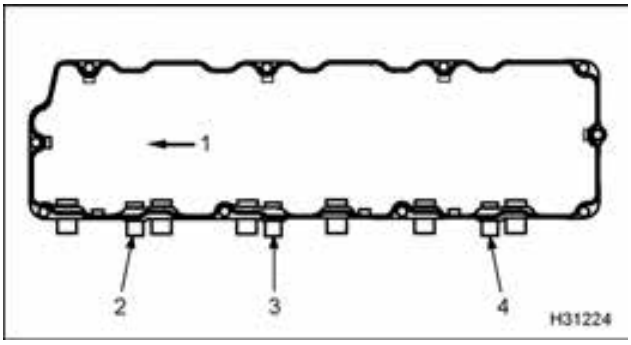


Figure 185 Valve cover gasket

1. Front of engine
2. Pass-through connector for BCP sensor
3. Pass-through connector for brake shut-off valve
4. Pass-through connector for ICP sensor

2. Disconnect engine harness connector from the pass-through connector for the BCP sensor.



Figure 186 VC Gasket Breakout Harness to pass-through connector for BCP sensor

3. Connect VC Gasket Breakout Harness to pass-through connector and engine harness.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

When routing DMM leads, do not crimp the leads, run the leads too close to moving parts, or let the leads touch hot engine surfaces.

4. Use DMM to measure brake control pressure (BCP signal voltage) KOEO.
   - Connect POS to green (signal circuit) and NEG to black (signal ground).
5. Record KOEO reading on Diagnostic Form.
6. Take another measurement while cranking engine for 20 seconds.
7. Record reading on Diagnostic Form and compare KOEO reading.
   - If BCP cranking signal voltage is significantly more than KOEO BCP signal voltage, when engine brake is inactive, diagnose BCP sensor, circuit, and engine brake components.
   - If BCP cranking signal voltage is equal to KOEO BCP, signal voltage BCP is not a problem.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Monitoring EOP at EOT Sensor Port

NOTE: Do this procedure, if an EST is not available. This is an alternate method.

Tool

- Gauge bar (0 - 160 psi gauge)
- ICP system test adapter (VT 365)
- Test hose assembly
- Socket or wrench (EOT sensor removal and installation)

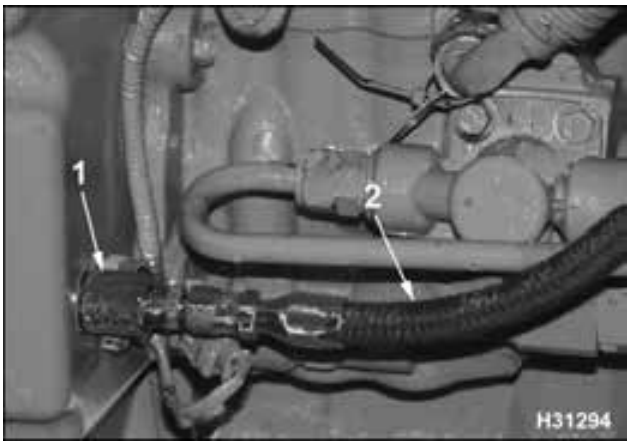


Figure 187 ICP test adapter and test hose assembly

1. ICP system test adapter
2. Test hose assembly

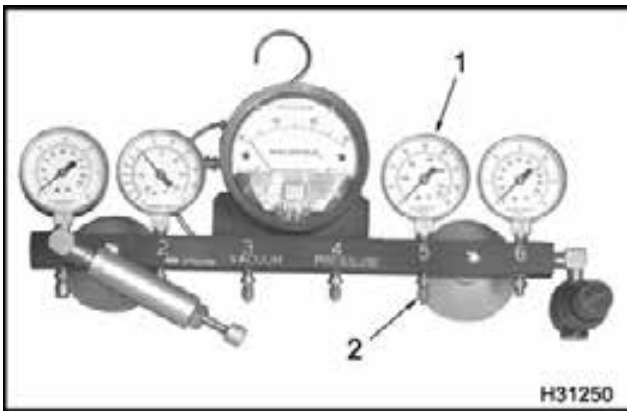


Figure 188 Test hose connection to 0 - 160 psi gauge

1. 0 - 160 psi gauge
2. Test hose connection

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) and Section 7 for specifications, operational voltages, and values. Record on Diagnostic Form.
2. Make a test hose that will connect the ICP system test adapter to the gauge bar or equivalent gauge.
3. Connect test hose to ICP adapter.
4. Remove the EOT sensor from the front cover. **Oil will spill out. Catch oil in container. Quickly install ICP system adapter and test hose assembly. Position hose so oil will not drain out.** If oil does not spill out of the EOT port, oil supply is the problem.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

When routing test line, do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces.

5. Connect test hose to gauge bar (0-160 psi gauge) or equivalent gauge.
6. Crank engine for 20 seconds and monitor EOP.
7. Record pressure on Diagnostic Form.
   - If oil pressure is below specification, diagnose lube oil pressure system, see Section 4 – "Engine Symptoms Diagnostics" (page 101).
   - If oil pressure is at specification, remove test hose and gauge bar. Quickly remove ICP system adapter and test hose assembly. **Oil will spill out. Catch oil in container** and install EOT sensor. Follow the procedure in *Engine Service Manual*.

©August 2008 Navistar, Inc.

Monitoring Engine Systems using Breakout Box

NOTE: Do this procedure, if an EST is not available. This is an alternate method.

Tools

- Breakout Box
- Digital Multimeter (DMM)

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) and Section 7 for specifications, operational voltages, and values. Record on Diagnostic Form.
2. Turn the ignition switch to OFF and ensure all accessories are turned off.
3. Remove X1, X2 and X3, X4 connectors from ECM.

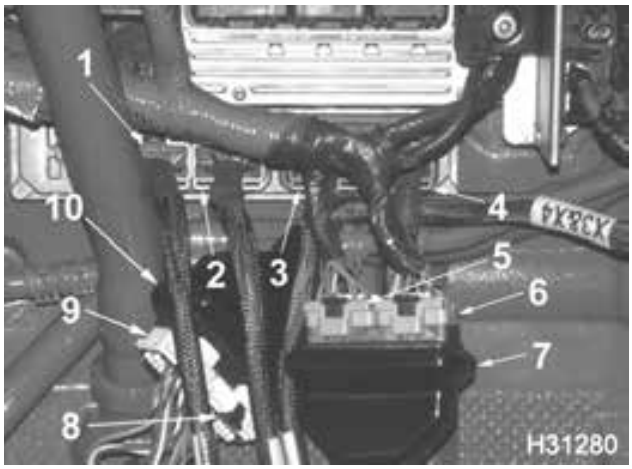


Figure 189 Engine and chassis breakout box connections

1. Breakout box connector X4 to ECM
2. Breakout box connector X3 to ECM
3. Breakout box connector X2 to ECM
4. Breakout box connector X1 to ECM
5. Engine wiring harness ECM connector X2 to breakout box header
6. Engine wiring harness ECM connector X1 to breakout box header
7. Breakout box header X1 and X2 engine to breakout box
8. Chassis wiring harness connector to breakout box header
9. Chassis wiring harness connector to breakout box header
10. Breakout box header X3 and X4 breakout box to chassis

4. Connect breakout box connectors X1, X2 and X3, X4 to ECM.
5. Connect wiring harness connectors to breakout box headers X1, X2 and X3, X4.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.



Figure 190 Breakout box

6. Connect DMM leads to breakout box.

   WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

   When routing DMM leads, do not crimp the leads, run the leads too close to moving parts, or let the leads touch hot engine surfaces.

7. Use DMM to measure KOEO values for the following:
   - V_{BAT} (DMM set to DC V)
     - — POS X3–3 to NEG X3–7 (V_{IGN} Pwr)
     - — POS X4–1 to NEG X3–6 (ECM PWR)
     - — POS X4–2 to NEG X3–7 (ECM PWR)
   - rpm (DMM set to DC mV Hz)
     - — POS X1–1 to NEG X3–7 (CKP)
   - rpm (DMM set to DC mV rpm^2)
     - — POS X1–9 to NEG X3–7 (CMP)
   - ICP (DMM set to DC V)
     - — POS X1–20 to NEG X1–6
   - EOP (DMM set to DC V)
     - — POS X2–7 to NEG X1–6
   - BCP (DMM set to DC V)
     - — POS X2 –11 to NEG X1– 6
8. Record KOEO reading on Diagnostic Form.
9. Take another measurement while cranking engine for 20 seconds.
   - If ECM voltage is below specification, see “Electronic Control Module Power (ECM PWR)” in Section 7 (page 381).
   - If CKP DCmV Hz is not in specification during crank, see “CKP Sensor” in Section 7 (page 351).
   - If CMP DCmV RPM2 is not in specification during crank, see “CMP Sensor” in Section 7 (page 355).
   - If EOP is not in specification during crank, see “Low Oil Pressure” in Section 4 (page 128).
   - If BCP is not in specification during crank, see “BCP” Sensor” in Section 7 (page 457).
   - If all measurements are in specification, continue with the next diagnostic test.
10. Record readings on Diagnostic Form.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

7. Fuel

☐ Fuel level in tank
☐ Free of water, icing, and clouding
☐ Free of contaminants
☐ Correct fuel grade
☐ Check water in fuel lamp

Note: If unit was run out of fuel, see "Priming the Fuel System" in Section 4.

Comments

H31128

Figure 191

Purpose

To check fuel level and quality for efficient engine operation

- Ask the operator if the amber WATER IN FUEL lamp was on during vehicle operation.
- If engine has an optional Engine Fuel Pressure (EFP) sensor, ask the operator if the amber FUEL FILTER lamp was on during vehicle operation. If the lamp was on, change the fuel filter and retest for poor engine operation.

Tools

- Clear container (approximately 1 liter or 1 quart US)
- Fuel pressure test adapter
- Pocket screw driver

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following when taking fuel a sample:

- **Do not smoke.**
- **Keep away from open flames and sparks.**

1. Check fuel level in fuel tank and for odors other than diesel fuel – kerosene and gasoline, for example.

CAUTION: Be sure to place a rag or suitable container under the fuel pressure test valve when bleeding the fuel rail. Dispose of fuel in a correct container clearly marked DIESEL FUEL according to local regulations.

NOTE: Engine fuel can be a threat to the environment. Never dispose of engine fuel by putting it in the trash, pouring on the ground, in the sewers, in streams, or bodies of water.



Figure 192 Shrader valve assembly

1. Valve
2. Center stem

©August 2008 Navistar, Inc.

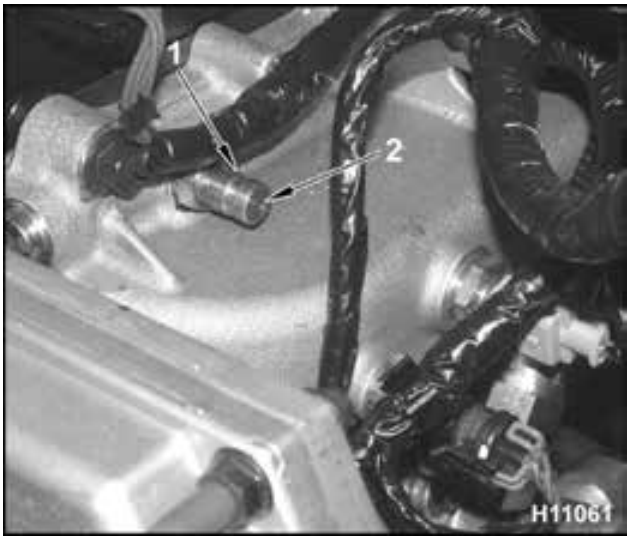


Figure 193 Diagnostic coupling

1. Valve
2. Center section

NOTE: Engines are equipped with a fuel pressure test valve in the form of either a Shrader valve or a diagnostic coupling.

2. Check for indications of aerated fuel in the fuel system. Relieve pressure from the fuel rail using the fuel pressure test valve.
   - As fuel pressure is relieved, a steady stream of fuel, without air from the fuel pressure test valve, means that air is not in the fuel system.
   - An erratic air/fuel mixture surge suggests that air is in the fuel system.



Figure 194 Fuel pressure test adapter

NOTE: It is recommended to use the fuel pressure test adapter to avoid bending the needle in the fuel pressure test valve.



Figure 195 Fuel test fitting

NOTE: Some engines will have a diagnostic coupling instead of a Shrader valve. Press end of coupling with a pocket screwdriver to relieve pressure.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.



Figure 196 Water drain valve

1. Water drain valve
2. Plastic tube



Figure 197 Fuel strainer drain valve

3. Open water drain valve and collect a fuel sample using a clear container. Check for the following conditions:
   - Fuel must be the correct grade, clean, and undiluted.
   - Gasoline, kerosene or other chemicals in the diesel fuel

     (If diesel fuel is contaminated, correct the condition and retest.)
   - If the fuel filter was not serviced or drained for a long time, some sediment or water could be in the fuel filter housing.

   NOTE: Cold weather can cause fuel waxing in some grades of diesel fuel. Waxing will restrict or stop fuel flow through the fuel filter.
4. Open fuel strainer drain valve. Collect a fuel sample using a clear container. If fuel is contaminated do the following:
   a. Pull drain valve down and out of bowl.
   b. Remove strainer bowl and check strainer for sediment, debris, or rust. Clean and replace as required.
   c. Check fuel tanks and fuel lines. Clean and flush if necessary.
5. Prime fuel system. See “Priming the Fuel System” in Section 4 (page 132) for procedure.

Possible Causes

- Low fuel level in fuel tank.
- Inline fuel valve (if equipped) could be shut-off.
- Fuel supply line could be broken or crimped.
- The fuel tank pickup tube could be clogged or cracked.
- Supplemental filters or water separators may be plugged or leaking allowing air to enter the fuel system.
- Failed seal for inlet fitting in fuel filter housing
- Water or contaminants in fuel tank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- Ice in fuel lines
- Debris in fuel tank
- Cloudy fuel indicates unsuitable fuel grade for cold temperatures.
- Fuel could be waxed or jelled. (usually Grade 2-D)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

8. Engine Systems

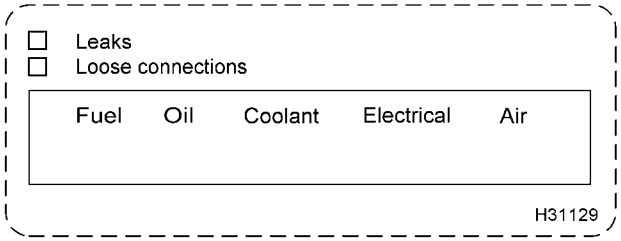


Figure 198

Purpose

To inspect engine and control system for damage (leaks, open connections, or harness chaffing)

Tools

- Inspection lamp

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. Inspect fuel supply system (including tank and lines) for leaks and damage.
2. Check high-pressure oil line from high-pressure pump to supply manifold for major leaks.
3. Check engine for oil leaks.
4. Inspect cooling system for leaks.
5. Check sensor, relay, and control module connections. All connections must be seated, in good condition, and free of damage or corrosion.

   NOTE: The engine will not start if the following components are disconnected or damaged:

   - Injection Pressure Regulator (IPR) valve
   - Camshaft Position (CMP) sensor
   - Crankshaft Position (CKP) sensor
   - Electronic Control Module (ECM)
   - Injector Driver Module (IDM)
6. Inspect battery cable and fuse connections for corrosion. All connections must be seated, in good condition, and free of damage or corrosion.
7. Inspect engine wiring harness for correct routing and protection against rubbing or chaffing.
8. Check the following components of the air induction system for leaks:

   - Inspect air filter housing for damage or distortion that could allow unfiltered air into the engine.
   - Inspect air filter housing for end seal movement. End seal movement is indicated if the seal contact area is polished. A polished contact area indicates that unfiltered air has passed by the filter element and into the engine.
   - Inspect air filter element for end cap dents, holes, damaged seals, and soot.
   - Inspect air intake hoses and clamps for tightness and positioning over sealing beads.
   - Inspect the chassis mounted Charge Air Cooler (CAC) and piping.

   NOTE: Unfiltered air will cause accelerated engine wear.
9. Record identified problems on Diagnostic Form.

   - If problems were identified, repair as necessary and verify if a hard start and no start condition still exists.
   - If no problems were identified, continue with the next diagnostic test.

Possible Causes

- Loose or leaking fuel supply lines could cause fuel system to lose prime.
- Kinked or blocked fuel supply lines can restrict fuel flow.
- Massive or excessive fuel or oil leaks
- Coolant leaks could indicate serious engine damage.
- Damaged or incorrectly installed electronic connectors
- Blockage in the air induction system

©August 2008 Navistar, Inc.

9. Engine Oil

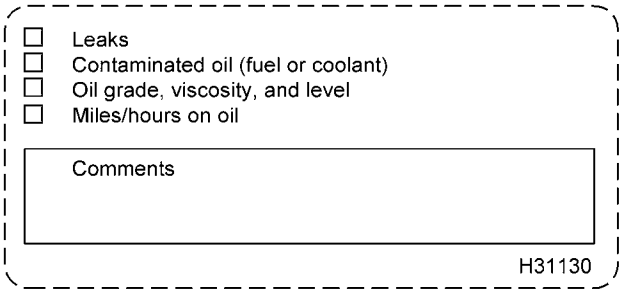


Figure 199

Purpose

To determine if crankcase oil level and oil quality are correct to ensure operation of the Injection Control Pressure (ICP) system

Tools

- None

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. Park vehicle on level ground.
2. Check oil level with oil level gauge.

   NOTE: Never check the oil level when the engine is running or immediately after the engine is shut down; the reading will be inaccurate. Allow 15 minute drain down time, before checking oil level.

   NOTE: If the oil level is too low, the fuel injectors will not work correctly. If the oil level is above the operating range, the engine has been incorrectly serviced, fuel is in the oil, or coolant is in the oil.
3. Inspect oil for thickening.

   NOTE: When the crankcase lube oil is contaminated with coolant, the oil will have a dark-gray or black sludgy appearance.

   - Engine oil level will vary depending on temperature of engine.
   - If oil is contaminated, see "Fuel in Lube Oil" (page 124) or "Coolant in Lube Oil" (page 109) in Section 4.
   - If oil level is low, fill to correct level and test again.
4. Check engine service records for correct oil grade and viscosity for ambient operating temperatures. **Do not use 15W-40 oil below -7 °C (20 °F)**. Long oil drain intervals can increase oil viscosity; thicker oil will make engine cranking and starting more difficult below freezing temperatures. See "Lubrication Requirements" in the *Engine Operation and Maintenance Manual* (for this engine's model number and model year). Confirm that oil meets correct API category.
5. Record concerns on Diagnostic Form.

Possible Causes

Low oil level

- Oil leak
- Oil consumption
- Incorrect servicing

High oil level

- Incorrect servicing
- Fuel in oil
- Coolant in oil
- Incorrect oil level gauge

Coolant in oil

- Cylinder head gasket leak
- Failed cup plug in cylinder head
- Injector sleeve leak
- Front cover gasket leak
- Front cover, cylinder head, or crankcase porosity
- Accessory leak (water cooled air compressor)
- Failed crevice seal (piston sleeve)

Fuel in oil

- Injector O-ring leak
- Cylinder head porosity
- Leaking injector

©August 2008 Navistar, Inc.

10. Intake and Exhaust Restriction

☐ Hoses and piping
☐ Filter minder
☐ Intake and exhaust restriction

Comments

H31131

Figure 200

Purpose

To determine if intake or exhaust restriction is causing hard start or no start conditions

NOTE: High intake or exhaust restriction can cause a large amount of black smoke when starting the engine.

Tools

- None

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. Inspect the following parts for restriction, damage, or incorrect installation:
   - Air filter inlet and duct (could include hood, cowling, etc.)
   - Hoses and clamps
   - Air filter housing, filter element, and gaskets
   - Exhaust pipes
   - Chassis mounted CAC and piping
   - Air filter restriction indicator or gauge

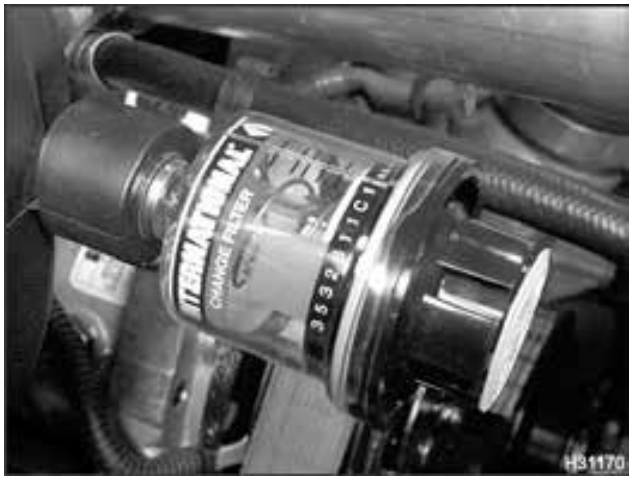


Figure 201 Low-restriction



Figure 202 High-restriction

NOTE: Intake restriction should be below 25 in H_2O. When the filter element reaches maximum allowable restriction, the yellow indicator will reach the top of window and automatically lock in this position.

2. Record concerns on Diagnostic Form.

©August 2008 Navistar, Inc.

Possible Causes

- Air filter element clogged or dirty
- Snow in air filter inlet
- Ice in air filter inlet
- Plastic bags or other foreign material in air filter inlet
- Collapsed air filter
- Collapsed inlet piping or hoses
- On engines recently repaired, rags or cap plugs may have been left in the intake system.
- Tailpipe or muffler may be damaged or collapsed.
- Exhaust restriction (muffler or catalytic converter)
- Restricted or plugged Catalyzed Diesel Particulate Filter (CDPF) – if equipped

©August 2008 Navistar, Inc.

11. Main Power Relay to ECM

☐ Connect breakout harness between ECM main power relay and power distribution center.

☐ Crank engine and use DMM to measure voltage to ECM (Min 130 rpm for 20 seconds. See note 4.)

☐ Check voltage between connector pin 87 and ground.

Instrument	Spec	Actual
DMM	7V (min)	

H31139

Figure 203



Figure 204 Relay Breakout Harness to power distribution center

Purpose

To determine correct power supplied to operate the ECM

The ECM requires 7 V minimum for correct operation.

Voltage Measurement with Breakout Harness at Main Power Relay

Tools

- Relay Breakout Harness
- DMM

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: Batteries must be fully charged before doing the following steps.

1. Turn the ignition switch to OFF and ensure all accessories are turned off.
2. Connect Relay Breakout Harness between ECM main power relay and power distribution center or chassis harness depending on application.

   NOTE: Depending on application, the relay could be one of two kinds. Check power distribution center or cab cowl.
3. Connect DMM POS to lead 87 and NEG to ground terminal on cowl.
4. Crank engine for 20 seconds and measure voltage.
5. Record the lowest voltage on Diagnostic Form.
   - If the voltage is below 7 V, the ECM main power relay may be resetting, due to low voltage and current from the batteries, or problems in the ignition circuit and power feed circuits. See Electronic Control Module Power (ECM PWR) in Section 7 (page 381).
   - If the voltage is above 7 V, continue with Hard Start and No Start Diagnostic tests.

   NOTE: Results can be above 7 V, but there may be a problem between the main power relay and the ECM. If a Hard Start / No Start problem remains after all Diagnostic Form tests are complete, do Voltage Measurement at ECM with Breakout Box.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Possible Causes

Low battery voltage

- Failed batteries
- High-resistance at battery cable connections
- Wiring to the ECM

Low or no battery voltage to the ECM

- High-resistance or an open power feed circuit to the ECM or ECM main power relay.
- The ECM power circuit fuse in battery box may be open.
- ECM main power relay may have failed.
- V_{IGN} circuit problem
- Failed ECM

Voltage Measurement at ECM with Breakout Box

NOTE: If the breakout box was used to do Test 6 – EST Data List, the following procedures do not have to be done.

Use the following procedures when any of the following situations exist:

- A Relay Breakout Harness is not available
- Expected voltages were not to spec, when using the Relay Breakout Harness
- Voltages were to spec, using the Relay Breakout Harness and Hard Start No Start Diagnostics is complete – but a concern remains

Tools

- Breakout Box
- Digital Multimeter (DMM)

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: Batteries must be fully charged before doing the following steps.

1. Turn the ignition switch to OFF and ensure all accessories are turned off.
2. Remove two white connectors (X3 and X4) from ECM.

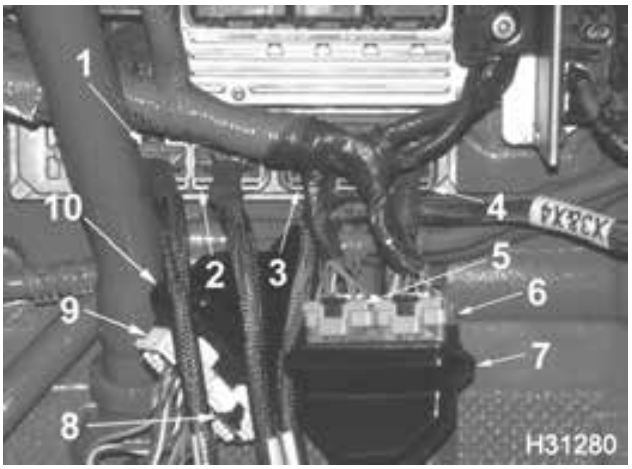


Figure 205 Engine and chassis breakout box connections

1. Breakout box connector X4 to ECM
2. Breakout box connector X3 to ECM
3. Breakout box connector X2 to ECM
4. Breakout box connector X1 to ECM
5. Engine wiring harness ECM connector X2 to breakout box header
6. Engine wiring harness ECM connector X1 to breakout box header
7. Breakout box header X1 and X2 engine to breakout box
8. Chassis wiring harness connector to breakout box header
9. Chassis wiring harness connector to breakout box header
10. Breakout box header X3 and X4 breakout box to chassis

3. Connect breakout box connectors (X3 and X4) to connections on ECM.
4. Connect chassis harness connectors to breakout box header (X3 and X4).

©August 2008 Navistar, Inc.



Figure 206 Breakout box

5. Connect leads of the DMM to the following test points on the breakout box:
   - POS X3–3 to NEG X3–7 (V_{IGN} Pwr)
   - POS X4–2 to NEG X3–7 (ECM PWR)
   - POS X4–1 to NEG X3–7 (ECM PWR)
6. Crank engine for 20 seconds and measure voltage.
7. Record the lowest voltage on Diagnostic Form.
   - If the voltage is below 7 V, the ECM power relay may be resetting, resulting from low voltage and current from the batteries, or problems in the ignition circuit and power feed circuits. See “ECM PWR, Electronic Control Module Power” in Section 7 (page 381).
   - If the voltage is above 7 V, continue with Hard Start and No Start Diagnostic tests.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

12. Main Power Relay to IDM

☐ Connect 12 - Pin Breakout Harness between engine and chassis harness.

☐ Crank engine and use DMM to measure voltage to IDM. (Min. 130 rpm for 20 seconds. See note 4.)

☐ Check voltage between connector Pin 12 and Pin 1.

Instrument	Spec	Actual
DMM	7V (min)	

H31140

Figure 207

Purpose

To determine correct power supplied to operate the IDM

The IDM requires 7 V minimum for correct operation.

Voltage Measurement at 12–Pin Connection with Breakout Harness

Tools

- 12-Pin Breakout Harness
- Digital Multimeter (DMM)

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: Batteries must be fully charged before doing the following steps.

1. Turn the ignition switch to OFF and ensure all accessories turned off.
2. Disconnect 12-pin connector above the ECM and IDM.

CAUTION: When disconnecting the 12-pin connector, the lock can come loose. Put the lock back in the correct place before reconnecting the connector.

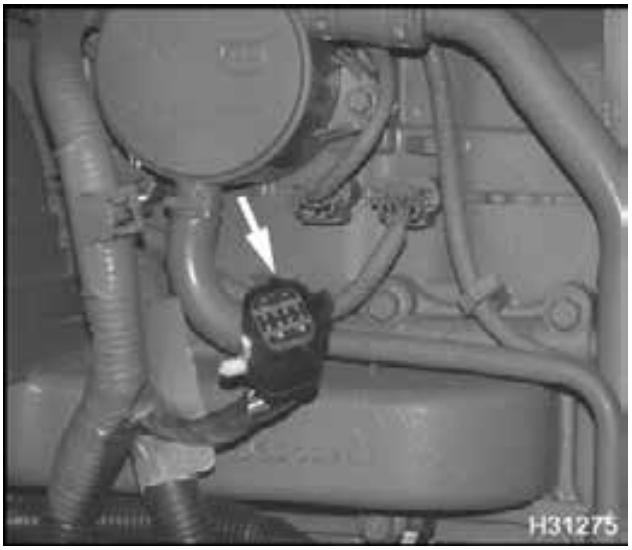


Figure 208 12-pin Engine Harness Connector

3. Connect 12-pin Breakout Harness between both engine and chassis connectors.
4. Connect leads of the DMM to each of the following test points:
   - POS 12 to NEG 1 (IDM PWR to IDM GND)
   - POS 9 to NEG 1 (V_{IGN} to IDM GND)
   - POS 9 to NEG 8 (V_{IGN} to MPR)
   - POS 6 to NEG 1 (IDM Logic PWR to IDM GND)
5. Crank engine for 20 seconds and measure voltage.
6. Record the lowest voltage on Diagnostic Form.
   - If the voltage is below 7 V, the IDM main power relay may be resetting, resulting from low voltage and current from the batteries or problems in the ignition circuit or power feed circuits. See "IDM PWR, Injector Drive Module Power" (page 479) in Section 7.
   - If the voltage is above 7 V, continue with Hard Start And No Start diagnostic tests.

   NOTE: Results can be above 7 V, but there may be a problem between the 12-pin connector and the IDM. If a Hard Start / No Start problem remains after all Diagnostic Form tests are complete, check voltage at IDM connector.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Possible Causes

Low battery voltage

- Failed batteries
- High-resistance at battery cable connections
- Wiring to the IDM

Low or no battery voltage to the IDM main power relay

- High-resistance or an open power feed circuit to the IDM or IDM main power relay.
- The IDM power circuit fuse in battery box may be open.
- IDM main power relay may have failed.
- V_{IGN} circuit problem
- Failed IDM

©August 2008 Navistar, Inc.

Voltage Measurement with Breakout Harness at Main Power Relay

NOTE: This is an alternate procedure for any of the following:

- A 12-pin Breakout Harness is not available
- Expected voltages were not to spec, when using the 12-pin Breakout Harness

Tools

- Relay Breakout Harness
- Digital Multimeter (DMM)

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: Batteries must be fully charged before doing the following steps.

1. Turn the ignition switch to OFF and ensure all accessories are turned off.



Figure 209 Relay Breakout Harness

2. Connect Relay Breakout Harness between IDM main power relay and power distribution center or chassis harness depending on application.

   NOTE: Depending on application, the relay could be one of two kinds. Check power distribution center or cab cowl.

3. Connect DMM POS lead to 87 and NEG to ground terminal on cowl.
4. Crank engine for 20 seconds and measure voltage.
5. Record the lowest voltage on Diagnostic Form.
   - If the voltage is below 7 V, the IDM main power relay may be resetting, resulting from low voltage and current from the batteries or problems in the ignition circuit or power feed circuits. See "IDM PWR, Injector Drive Module Power" in Section 7 (page 479).
   - If the voltage is above 7 V, continue with Hard Start and No Start tests.

   NOTE: Results can be above 7 V, but there may be a problem between the main power relay and IDM. If a Hard Start / No Start problem remains after all Diagnostic Form tests are complete, check voltage at 12-pin connector and IDM connector.

©August 2008 Navistar, Inc.

13. Fuel Pressure and Aerated Fuel

☐ Measure pressure at fuel rail (intake manifold).
☐ Minimum cranking speed 130 rpm for 20 seconds. (See note 4.)
☐ Check for Aerated fuel.

Instrument	Spec	Actual
0-100 psi Gauge		
Visual	Aerated fuel	Yes____ No ____
Vacuum gauge	> 12 in Hg	_____

Note: If unit was run out of fuel, see "Priming the Fuel System" in Section 4.

- If fuel pressure is below spec, replace fuel filter, clean strainer, and retest.
- Correct for aerated fuel before continuing.
- If still below spec, check fuel pump operation

H31141

Figure 210

Purpose

To check for correct fuel pressure and aerated fuel

NOTE: Do the following:

- Ask the operator if the amber WATER IN FUEL lamp was on during vehicle operation.
- If engine has an optional Engine Fuel Pressure (EFP) sensor, ask the operator if the amber FUEL FILTER lamp was on during vehicle operation. If the lamp was on, change the fuel filter and retest for poor engine operation.
- If unit was run out of fuel, make sure the fuel system was primed. See “Priming the Fuel System” in Section 4 (page 132) for procedure.
- See “Combustion Leaks to Fuel” in Section 4 (page 104) if all three of the following conditions are noted:
  - Fuel system will not prime
  - White to black exhaust smoke
  - Pulsating fuel pressure

Tools

- Fuel pressure test gauge
- Fuel Pressure Test Kit
- 1 to 5 gallon bucket
- Fuel/Oil Pressure Test Coupler

Fuel Pressure

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the “Safety Information” section of this manual.

1. See “DT 466 Performance Specifications” – Appendix A (page 595) or “DT 570 and HT 570 Performance Specifications” – Appendix B (page 619) for fuel pressure specifications and record on Diagnostic Form.

NOTE: If engine is equipped with optional Engine Fuel Pressure (EFP) sensor, use EST with MasterDiagnostics® software to monitor fuel pressure. Compare the EST values to gauge readings.

CAUTION: Be sure to place a rag or suitable container under the fuel pressure test valve when bleeding the fuel rail. Dispose of fuel in a correct container clearly marked DIESEL FUEL according to local regulations.

NOTE: Engine fuel can be a threat to the environment. Never dispose of engine fuel by putting it in the trash, pouring on the ground, in the sewers, in streams, or bodies of water.



Figure 211 Shrader valve assembly

1. Valve
2. Center stem

©August 2008 Navistar, Inc.

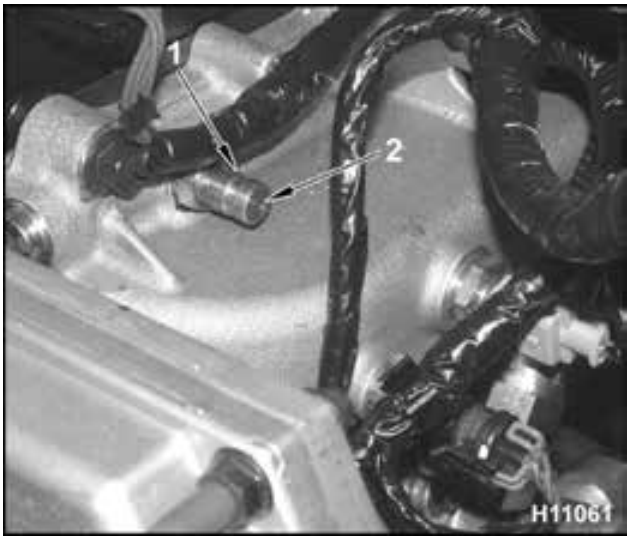


Figure 212 Diagnostic coupling

1. Valve
2. Center section

NOTE: Engines are equipped with a fuel pressure test valve in the form of either a Shrader valve or a diagnostic coupling.

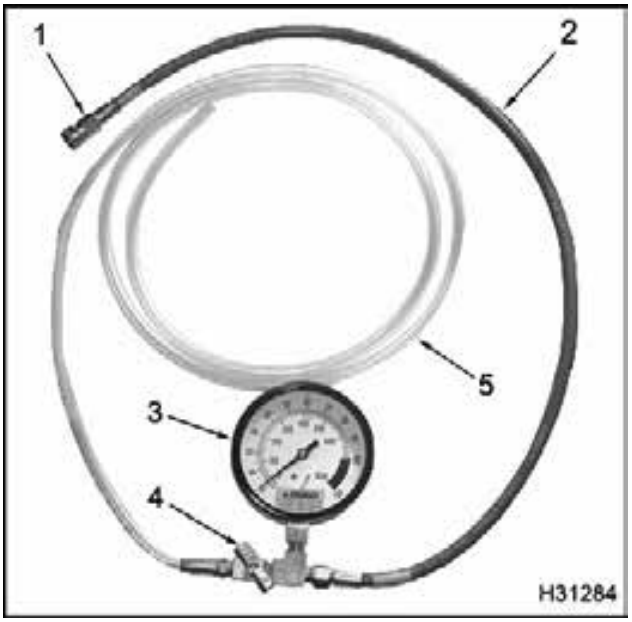


Figure 213 Fuel Pressure Gauge

1. Quick disconnect check valve
2. Fuel test line
3. Fuel Pressure Gauge
4. Inline shut-off valve
5. Clear test line



Figure 214 Fuel Pressure Test Adapter

NOTE: If the engine is equipped with a Shrader valve, use the Fuel Pressure Test Adapter.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.



Figure 215 Fuel/Oil Pressure Test Coupler

NOTE: If the engine is equipped with a diagnostic coupling, adapt the Fuel/Oil Pressure Test Coupler to the Fuel Pressure Gauge.



Figure 216 Fuel Pressure Gauge to fuel pressure test adapter

2. Connect Fuel Pressure Gauge with shut-off valve and clear 3/8” diameter hose to test valve.
3. Route the clear hose into a drain pan.

   WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

   When routing test line, do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces.

4. Start or crank the engine for 20 seconds. Measure the fuel pressure with the shut-off valve closed. Open the shut-off valve to check for aeration.

   NOTE: Breaking any fuel system joint will induce air into the fuel system. The air should pass in a short period of time. As fuel pressure is relieved, a steady stream of fuel without air bubbles indicates the fuel is not aerated.

   NOTE: If a Fuel Pressure Gauge with shut-off valve and clear 3/8” diameter hose is not available to check for aeration, see alternative test “Checking for Aerated Fuel using Spare Fuel Line.”

5. Record results on Diagnostic Form.
   - If fuel pressure is below specification and fuel is not aerated, replace the fuel filter and clean the strainer. Test the fuel pressure again.
   - If fuel is aerated, see “Aerated Fuel” in Section 4.
   - If fuel pressure is still low and fuel is not aerated after replacing the fuel filter and cleaning the strainer, do “Operation of the Fuel Pump Test.”
   - If fuel pressure is in specification and the fuel is not aerated, do not continue testing the fuel system. Continue to the next diagnostic test.

Possible Causes

No fuel

- Low fuel level in fuel tank
- Debris in tank can cause high-restriction and low fuel pressure.
- Inline fuel valve (if equipped) could be shut-off
- Failed seals or fuel lines between fuel tanks
- Ice in fuel lines
- Inoperative fuel tank transfer pump
- Fuel tank pickup tube cracked

Low fuel pressure

- Dirty filter element
- Debris or rust in fuel strainer

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- Restriction from the fuel tank to the fuel filter housing inlet can cause high-restriction and low fuel pressure.
- Plugged supplemental filters or water separators can cause high-restriction and low fuel pressure.
- Debris in tank can cause high-restriction and low fuel pressure.
- A kinked or bent fuel supply line or a blocked pickup tube can cause high-restriction and low fuel pressure.
- Waxed or jelled fuel in the fuel filter will cause high-restriction and low fuel pressure. (Usually Grade 2-D)
- Ice in fuel lines.
- A restriction between the fuel inlet fitting, strainer, and fuel pump can cause high-restriction and low fuel pressure.
- Debris in the fuel regulator valve
- Failed fuel pressure regulator valve.
- Failed fuel pump
- Failed high-pressure oil pump (can not operate fuel pump)

Aerated fuel

- Failed seal for inlet fitting in fuel filter housing
- Supply filter or water separator leaking
- A loose fuel line on the suction side of the fuel system can ingest air into the system and cause low fuel pressure (most noticeable under load).
- Strainer drain valve loose or damaged
- Strainer bowl warped or damaged
- Missing O-ring from strainer bowl
- Damaged seals on steel inlet tube to fuel pump
- Primer pump seals damaged

Fuel restriction

- Dirty filter element
- Debris or rust in fuel strainer
- Restriction from the low-pressure fuel filter housing inlet to the fuel tank can cause high-restriction and low fuel pressure.
- Plugged supplemental filters or water separators can cause high-restriction and low fuel pressure.
- Debris in tank can cause high-restriction and low fuel pressure.
- A kinked or bent fuel supply line or a blocked pickup tube can cause high-restriction and low fuel pressure.
- Waxed or jelled fuel in the fuel filter will cause high-restriction and low fuel pressure. (Usually Grade 2-D)
- Ice in fuel lines.
- A restriction between the fuel inlet fitting, strainer, and fuel pump can cause high-restriction and low fuel pressure.

High fuel pressure (pulsating fuel pressure)

- Debris in the fuel regulator valve
- Inoperative fuel pressure regulator valve.
- Combustion gases leaking into fuel system

Checking for Aerated Fuel using Spare Fuel Line

NOTE: This is an alternative test. Do this procedure, only if Fuel Pressure Gauge with shut-off valve is not available.

Tools

- Spare fuel line (filter housing to fuel supply pump)
- Clear plastic line
- Hose clamp (2)

Procedure

 **WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the “Safety Information” section of this manual.**

©August 2008 Navistar, Inc.

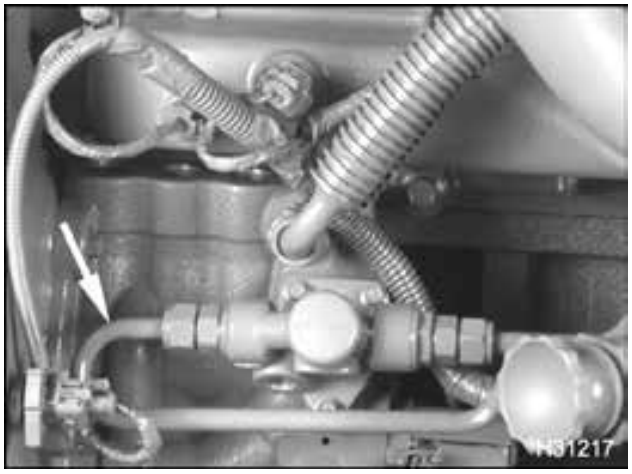


Figure 217 Fuel supply line

1. Remove fuel supply line from suction side of fuel pump and fuel filter housing.

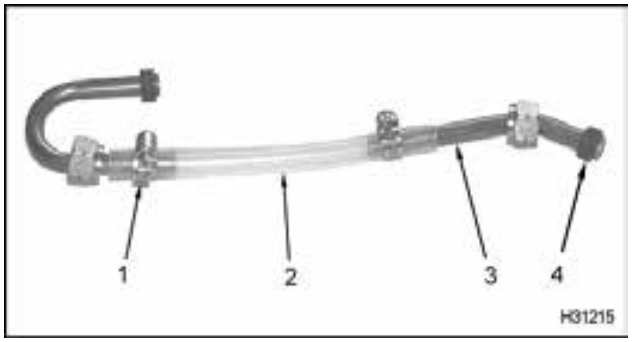


Figure 218 Test fuel line

1. Clamp (2)
2. Clear plastic tube
3. Spare fuel line (half)
4. Sleeve seal (2)

2. Make a test fuel line.
   - Use spare fuel line. (Make sure both sleeve seals are good.) Cut a 3 inch section from the center of the fuel line. Install clear plastic line in place of removed section and secure plastic line with clamps.

   NOTE: The mechanic is expected to keep the fuel test line for future diagnostics. Expense the fuel test line as an essential tool and keep it with other diagnostic tools. Warranty will not cover the cost of the fuel test line.

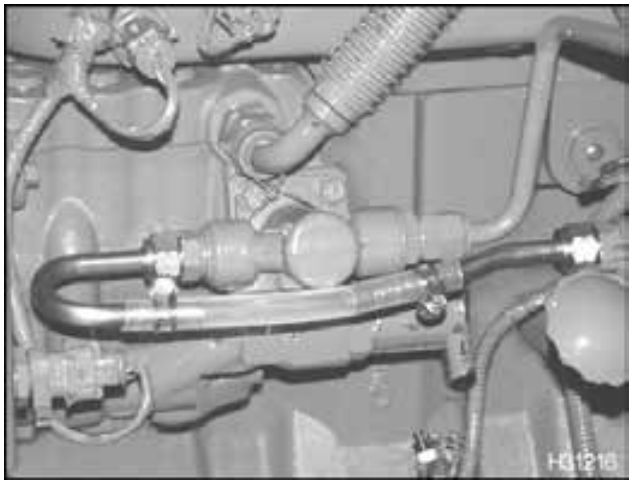


Figure 219 Test line installed

3. Install test fuel line.

   NOTE: Verify that sleeve seals are in good condition.

4. Do one of the following:
   - For **Hard Start and No Start Diagnostics**, crank engine for 20 seconds and check for air bubbles in the clear plastic line.
   - For **Performance Diagnostics**, run engine at high idle, no load and check for air bubbles in the clear plastic line.

5. Record results on Diagnostic Form.

   NOTE: Initially, fuel will be aerated due to draining fuel from filter housing and strainer in previous test.
   - If fuel is aerated check for a leak in the suction side of fuel system. See “Aerated Fuel” in Section 4.
   - If fuel is not aerated and fuel pressure is good, continue with next test.
   - If fuel is not aerated and fuel pressure is low, do “Operation of Fuel Pump”.

6. Remove fuel test line and install original fuel line.

   NOTE: Verify that sleeve seals are in good condition.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Operation of Fuel Pump

Tools

- Vacuum Pump And Gauge (kit)
- Hose clamp
- Fuel pressure test gauge
- Fuel Pressure Test Kit
- Fuel/Oil Pressure Test Coupler
- 1 to 5 gallon bucket

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.



Figure 220 Test hose to fuel line

1. Fuel line (suction side)
2. Hose clamp
3. Test hose

NOTE: The fuel pressure gauge with the inline shut-off valve is still connected to the fuel pressure test valve. If shut-off valve is not opened, test will result in false readings. Do the following procedure:

1. Open the shut-off valve.
2. Disconnect fuel line (suction side) from fuel filter housing.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When routing test line, do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces.

3. Slide test hose onto fuel line and secure with hose clamp or use cone adapter (vacuum pump kit) that fits into end of fuel line.

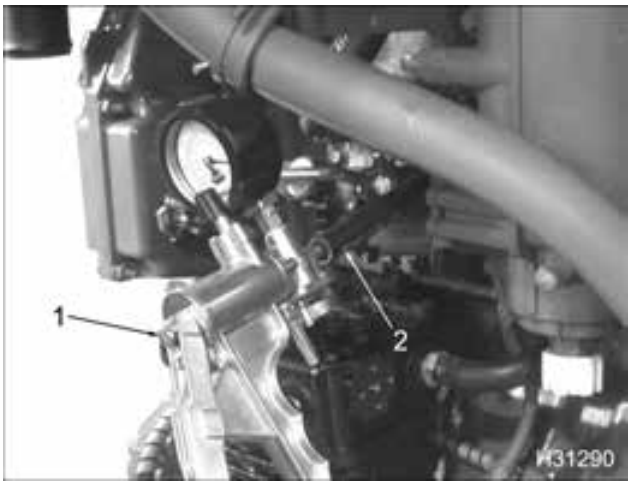


Figure 221

4. Insert vacuum pump nozzle into test hose.
5. Crank engine, check gauge reading, and record on Diagnostic Form.
   - If less than 12 in Hg., check steel line and test connections between the air vacuum test gauge and fuel pump. Verify integrity of test hose adapter
   - If vacuum is still below specification, replace the fuel pump following procedures in the *Engine Service Manual*.
   - If greater than 12 in Hg., the fuel pump is working. Replace fuel regulator and retest fuel pressure.
   - If fuel pressure is still low after replacing the fuel pump and regulator, check for restriction between the filter housing and fuel tank.

©August 2008 Navistar, Inc.

14. Low ICP System Pressure

☐ Do only the low ICP tests below, if ICP was not to spec during Test 6.
☐ Start and continue Test 14.1 System Function, if lube oil pressure is not a concern and terminals on IPR valve and engine harness are not damaged or corroded.
☐ If test result is yes for 14.1 System Function, **do not do tests 14.2 through 14.5 for low ICP**.

Low ICP Tests

Test	Question	Result
14.1 - System Function	IPR connectors: Corroded, bent or pushed back pins	☐ Yes ☐ No
	Greater than 28 Mpa (4061 psi) 4.45 V?	☐ Yes ☐ No
14.2 - Oil Reservoir Level	Oil level full?	☐ Yes ☐ No
14.3 - IPR and High-pressure Pump Operation	Greater than 28 Mpa (4061 psi) 4.45 V?	☐ Yes ☐ No
14.4 - UVC Leak Test	Audible air leak? If equipped with engine brake, it is normal to have air passing through the system.	☐ Yes ☐ No
14.5 - IPR Function	Audible crankcase air leak?	Unplugged ☐ Yes ☐ No B+ and gnd applied ☐ Yes ☐ No

H31175

Figure 222

Purpose

To determine the cause of low injection control pressure that prevents engine starting

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Actuator Breakout Harness
- Jumper harness (from Terminal Test Kit)
- Pressure Sensor Breakout Harness
- Socket or wrench (EOT sensor)
- Compressed air source 689 kPa (100 psi)
- Spare VT 365 ICP sensor (Part No. -1845274C92 or equivalent)
- Spare high-pressure hose (Part No.-1842571C91 or equivalent)

NOTE: The mechanic is expected to keep the spare ICP sensor and high-pressure hose for future diagnostics. Expense the spare ICP sensor and high-pressure hose as essential tools and keep it with other diagnostic tools. Warranty will not cover the cost of the spare ICP sensor and high-pressure hose.

Possible Causes

- ICP system leakage
- Failed ICP sensor circuit
- Failed ICP sensor
- Failed IPR wiring (power and control)
- Failed IPR valve
- Low or no lube oil pressure
- Inoperative high-pressure oil pump
- Failed BCP sensor circuit
- Failed BCP sensor
- Inoperative brake shut-off valve of Diamond Logic® engine brake
- BCP system leakage
- If ECM detects low boost pressure, an incorrect feedback signal from APS or the ICP sensor, the ECM commands the IPR valve to reduce ICP.

14.1 – System Function

Start Test 14.1 System Function – continue Low ICP System Pressure diagnostics, if no concerns are found with the following:

- Lube oil pressure system has the ability to build engine oil pressure while the engine is cranking.
- Inspect Injection Pressure regulator (IPR) valve and engine wiring harness connector for corrosion.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

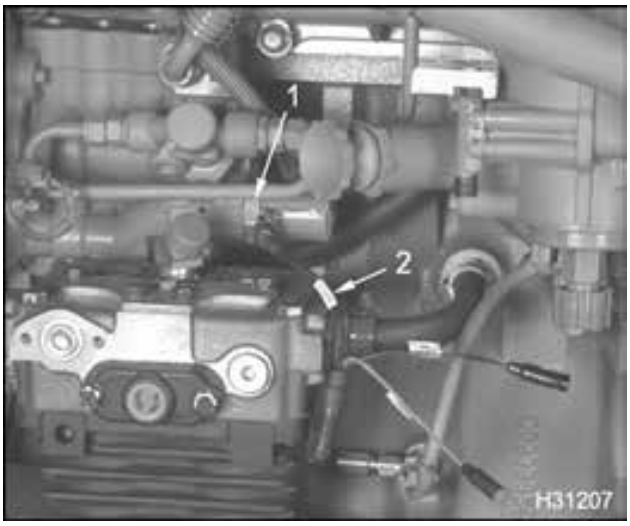


Figure 223 Actuator Breakout Harness to IPR

1. IPR valve
2. Actuator Breakout Harness

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. Disconnect engine wiring harness connector from IPR valve and inspect engine harness terminals and IPR valve for corrosion, bent pins, or pins pushed back.
   - If the harness connector or the IPR valve is corroded, replace the harness connector and IPR valve. Retest injection control pressure.
   - If pins are bent or pushed back, repair as necessary. Retest injection control pressure.
   - If the wiring harness connector and the IPR valve are not corroded or damaged, continue with step 2.
2. Connect Actuator Breakout Harness to IPR. **Do not connect engine harness**.

CAUTION: If the engine harness is connected to the actuator breakout harness, the ignition switch fuse will blow or cause damage to wiring harness.



Figure 224 B+ on power distribution terminal



Figure 225 Ground to terminal on cowl

3. Apply B+ volts and ground to the IPR valve.

©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

While cranking the engine, the engine could start.

- **Set the parking brake**
- **Put transmission in neutral**
- **Block wheels.**

CAUTION: Do not leave the IPR valve energized longer than 120 seconds — this can damage the IPR valve.

NOTE: If the engine starts, disconnect ground and B+ at the Actuator Breakout Harness.

4. Using the EST, monitor injection control pressure while cranking the engine for 20 seconds.

   NOTE: If an EST is not available, use alternate method – Measuring Voltage on ICP Sensor using a Pressure Sensor Breakout Harness.

5. Record results on Diagnostic Form.

   - If injection control pressure increases above 28 MPa (4061 psi) (4.45 V), the mechanical system is operating correctly for the engine to start. **Either the ECM is not controlling the IPR or the IPR circuit has failed. Do not continue with Low ICP System Tests.**

     Check DTCs found during Test 8 (KOEO Standard Test). Make sure problems were corrected.

   - For problems in the electrical circuit, see “IPR (Injection Pressure Regulator)” in Section 7 (page 494).
   - If 28 MPa (4061 psi) (4.45 V) can not be reached. Continue with the next test, 14.2 – Oil Reservoir Level.

14.2 – Oil Reservoir Level

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the “Safety Information” section of this manual.



Figure 226 EOT sensor

1. Disconnect engine harness connector from EOT sensor installed in the rear of the front cover, left of the high-pressure oil pump assembly.
2. Slowly loosen the EOT sensor from the EOT port until oil flows out, indicating that the oil level is above the sensor. **Oil will spill out, if the sensor is removed. Catch oil in a container.**If oil does not flow out remove sensor.

   - If the oil level was above the EOT sensor, tighten sensor and reconnect the harness.

     Do test 14.3 – IPR and High-pressure Pump Operation.

   - If oil level is low, place container under port to catch oil. Crank engine and check if oil flows out.
   - If oil does not flow out while cranking, the lube oil pump may not be supplying oil to the reservoir. See “Low Oil Pressure” in Section 4 (page 128).

14.3 – IPR and High-pressure Pump Operation

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the “Safety Information” section of this manual.

©August 2008 Navistar, Inc.

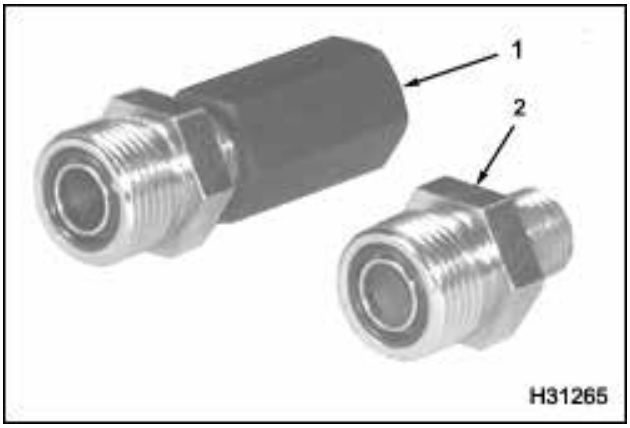


Figure 227 ICP Test Kit

1. ICP sensor adapter
2. Fitting, 13/16-16 NPT

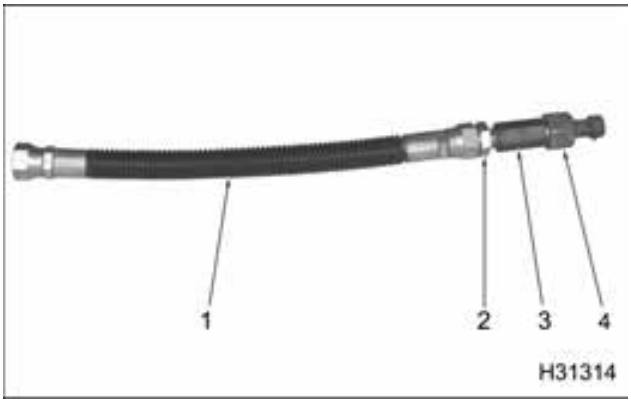


Figure 228 High-pressure oil hose assembly

1. High-pressure hose
2. Fitting, 13/16-16 NPT
3. ICP sensor adapter
4. ICP sensor

1. Make test hose assembly with the following components:
   - ICP sensor adapter
   - High-pressure hose (Part No. - 1842571C91 or equivalent)
   - VT 365 ICP sensor (Part No. - 1845274C92 or equivalent)

   NOTE: The mechanic is expected to keep the spare ICP sensor and high-pressure hose for future diagnostics. Expense the spare ICP sensor and high-pressure hose as essential tools and keep both with other diagnostic tools. Warranty will not cover the cost of the spare ICP sensor and high-pressure hose.

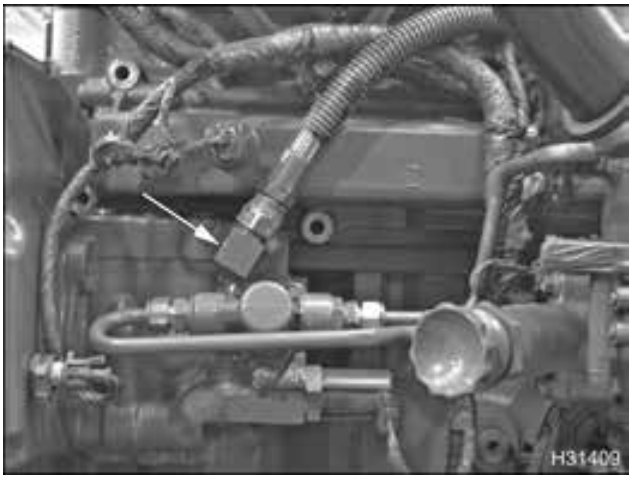


Figure 229 High-pressure pump fitting

2. Disconnect high-pressure oil hose from high-pressure pump fitting.

   NOTE: Oil will spill from hose. Position the high-pressure oil hose so oil will not spill.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

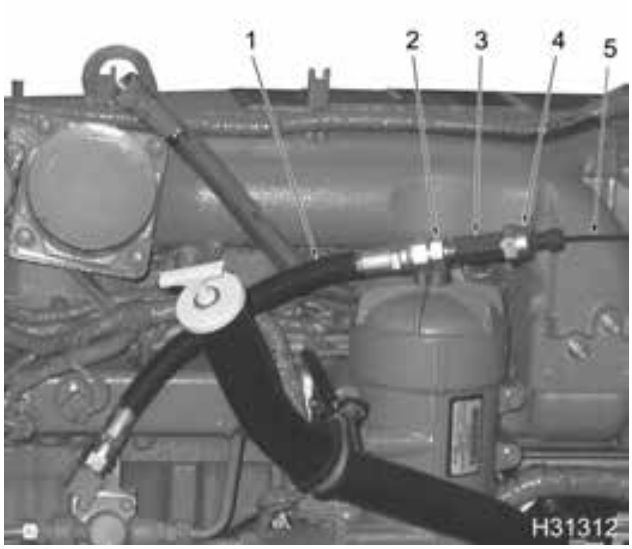


Figure 230 High-pressure oil hose, ICP Test Kit, sensor, and Pressure Sensor Breakout Harness

1. High-pressure hose
2. Fitting, 13/16-16 NPT
3. ICP sensor adapter
4. ICP sensor
5. VC Gasket Breakout Harness

3. Install test hose assembly to high-pressure pump.

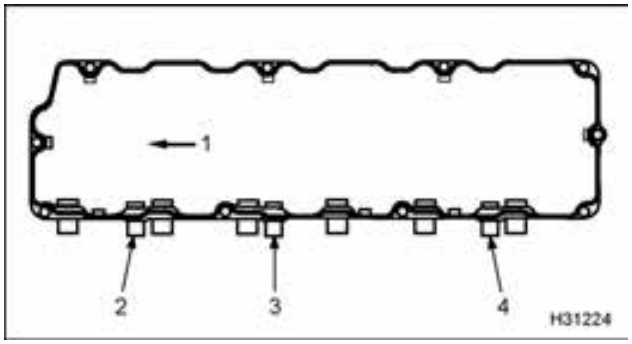


Figure 231 Valve cover gasket

1. Front of engine
2. Pass-through connector for BCP sensor
3. Pass-through connector for brake shut-off valve
4. Pass-through connector for ICP sensor

4. Disconnect engine wiring harness from valve cover gasket (ICP connector).

5. Connect VC Gasket Breakout Harness between high-pressure hose assembly and engine wiring harness only.

   NOTE: If connected to the valve cover, gasket connector – readings will be wrong, because the harness will be connected to the ICP sensor under the valve cover.

6. Connect Actuator Breakout Harness to IPR. **Do not connect engine harness**.

   CAUTION: If the engine harness is connected to the actuator breakout harness, the ignition switch fuse will blow or cause damage to wiring harness.



Figure 232 B+ on power distribution terminal



Figure 233 Ground to terminal on cowl

7. Apply B+ volts and ground to the IPR valve.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

8. Using the EST or DMM, monitor injection control pressure while cranking engine for 20 seconds.
9. Record results on Diagnostic Form.
   - If injection control pressure increases above 28 MPa (4061 psi) (4.45 V), the high-pressure pump and IPR are operating correctly for the engine to start. Remove test hose assembly from high-pressure pump. Do test 14.4 – Under Valve Cover Leak Test.
   - If 28 MPa (4061 psi) (4.45 V) can not be reached, continue with test 14.5 - IPR Function.

14.4 – Under Valve Cover Leak Test

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

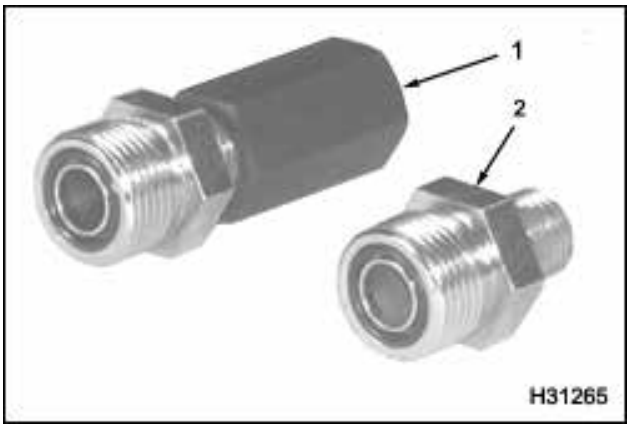


Figure 234 ICP Test Kit

1. ICP sensor adapter
2. Fitting, 13/16-16 NPT

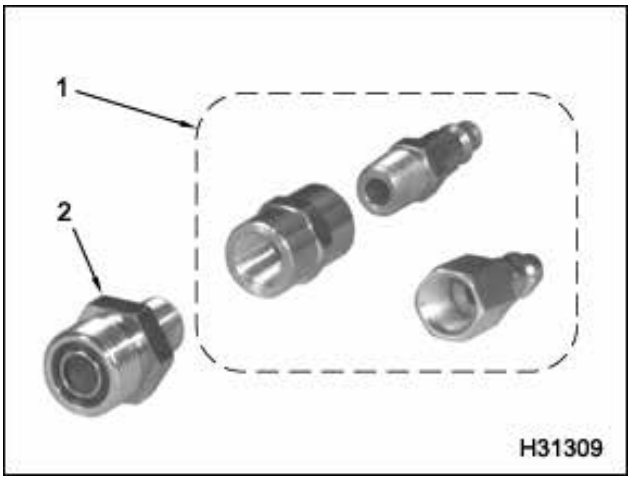


Figure 235 13/16-16 NPT fitting and air chuck adapters

1. Air chuck adapters
2. Fitting, 13/16-16 NPT

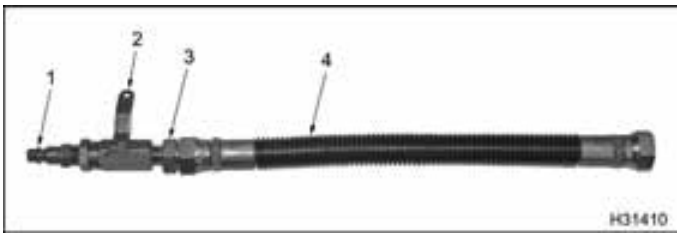


Figure 236 High-pressure oil hose, fitting, and air chuck

1. Air chuck
2. Shut-off valve
3. Fitting, 13/16-16 NPT
4. High-pressure hose

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

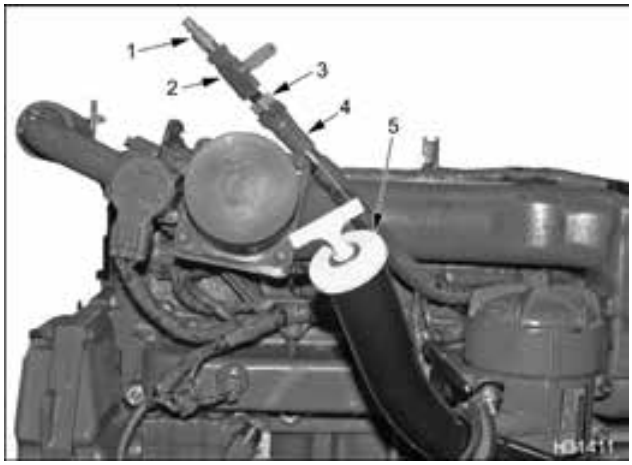


Figure 237 High-pressure oil hose with test fittings installed

1. Air chuck
2. Shut-off valve
3. Fitting, 13/16-16 NPT
4. High-pressure hose
5. Oil level gauge

1. Install 13/16-16 NPT fitting, shut-off valve, and air chuck fitting to high-pressure oil hose connected to cylinder head.

   WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, do the following:

   - **Install an inline shut-off valve.**

     If system does not leak when air is applied, the system will maintain pressure.

     When hose is removed, oil will be released with air pressure.

   - **Use inline shut-off valve to control and contain bleed-off pressure mixture (air and oil).**

2. Remove oil level gauge from oil fill tube.
3. Close shut-off valve.
4. Connect shop air supply line to test hose.
5. Apply 689 kPa (100 psi) of pressure. Slowly open the shut-off valve.
6. Listen for an air leak in the crankcase through the oil fill tube.

   NOTE: Engines with engine brake option will have a small amount of air passing through the system. Air will pass through brake shut-off valve into the brake oil gallery. The air will leak off through the actuator pistons and the relief valve at the end of the rail.

7. Record results on Diagnostic Form.

   - If a leak is not heard, check previous test results.
   - If a leak is heard, check components under the valve cover. Continue with step 8.

8. Close inline shut-off valve to stop air flow.
9. Remove the valve cover following procedures in the *Engine Service Manual*.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

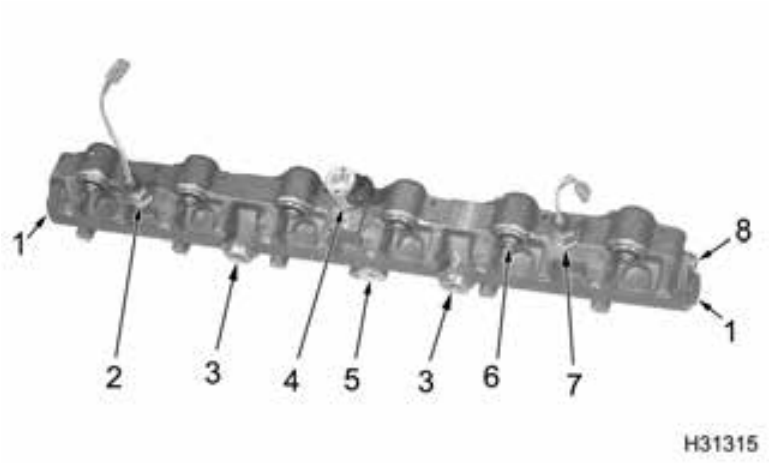


Figure 238 High-pressure oil rail with engine brake (leak locations)

1. End plug (2)
2. ICP sensor
3. Attenuator assembly (2)
4. Brake shut-off valve
5. Machined surface (oil inlet to cylinder head)
6. Inlet adapter (6)
7. BCP sensor
8. Brake pressure relief valve

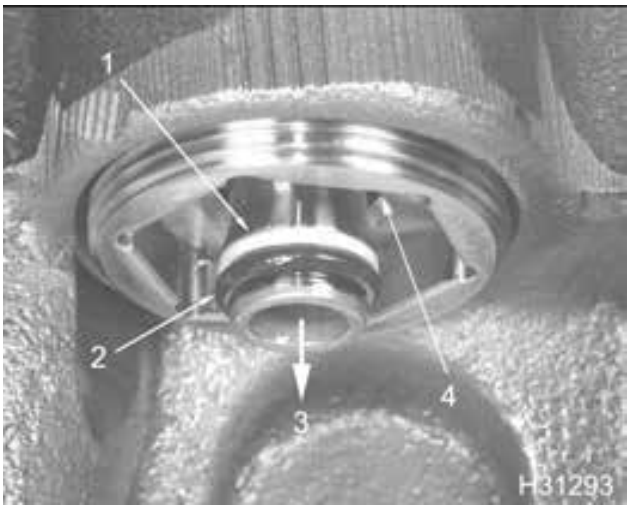


Figure 239 Injector oil inlet adapter in high-pressure oil rail

1. Backup ring
2. Seal
3. To injectors
4. O-ring



Figure 240 O-ring for high-pressure oil manifold

1. O-ring
2. Oil inlet fitting

10. Open inline shut-off valve and listen for leaks. Check the following components:
    - Injector oil inlet adapter O-rings (Figure 239)
    - Injector oil inlet adapter (Figure 239)
    - ICP sensor (Figure 238)
    - O-ring for high-pressure oil rail (Figure 240)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- End plugs in high-pressure oil rail (Figure 238)
- Loose brake shut-off valve (optional) (Figure 238)

11. Replace or repair components, if necessary.
12. Install the valve cover following the procedures in the *Engine Service Manual*.

    NOTE: Make sure all under valve cover wiring is routed correctly. Follow procedures in the *Engine Service Manual*.

    - If engine is equipped with Diamond Logic® Engine Brake, and the high-pressure oil manifold has been removed, adjust the engine brake lash. Follow the procedure in Section 6 - Performance Diagnostics, Brake Lash.

14.5 – IPR Function

⚠ WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. Remove ICP sensor adapter and spare ICP sensor from test hose assembly.

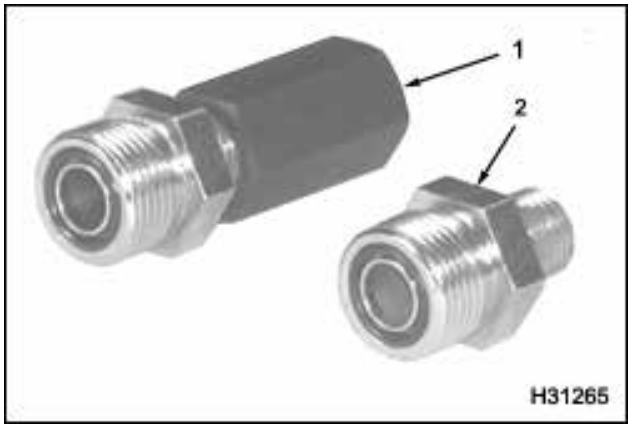


Figure 241 ICP Test Kit

1. ICP sensor adapter
2. Fitting 13/16-16 NPT

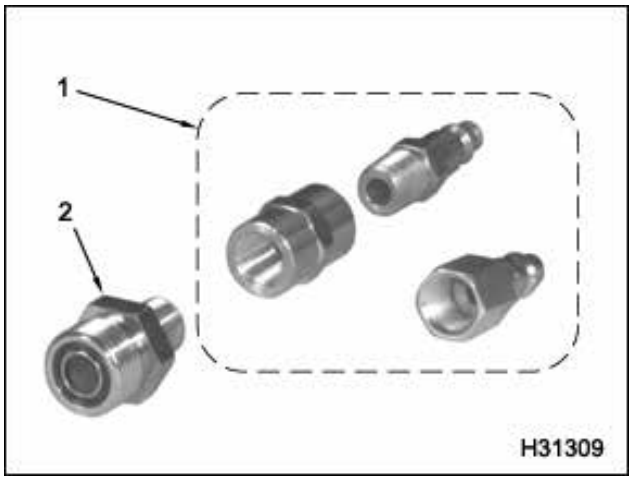


Figure 242 13/16-16 NPT fitting and air chuck adapters

1. Air chuck adapters
2. Fitting, 13/16-16 NPT

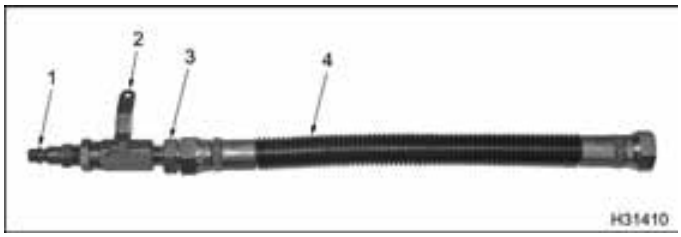


Figure 243 High-pressure oil hose, fitting, and air chuck

1. Air chuck
2. Shut-off valve
3. 13/16-16 NPT fitting
4. High-pressure hose

©August 2008 Navistar, Inc.

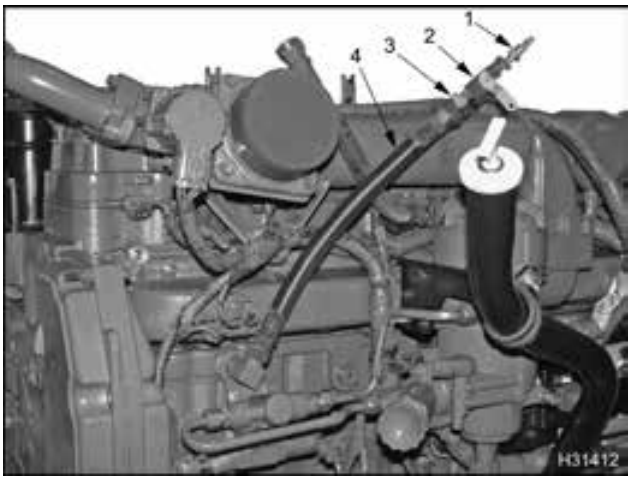


Figure 244 High-pressure oil hose with test fittings installed

1. Air chuck
2. Shut-off valve
3. 13/16-16 NPT fitting
4. High-pressure hose

2. Install 13/16-16 NPT fitting, shut-off valve, and air chuck fitting to test hose.
3. Remove oil level gauge from oil fill tube.
4. Close the shut-off valve.
5. Connect shop air supply line to test hose.
6. Apply 689 kPa (100 psi) of pressure. Slowly open the shut-off valve.
7. Listen for an air leak in the crankcase through the oil fill tube.
   - A leak should be heard through the IPR valve when the IPR valve is not energized.

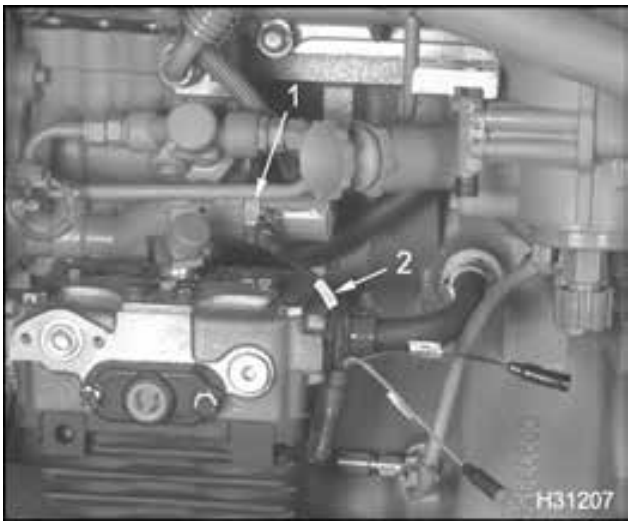


Figure 245 Actuator Breakout Harness to IPR

8. Connect Actuator Breakout Harness to IPR. **Do not connect engine harness**.

   CAUTION: If the engine harness is connected to the actuator breakout harness, the ignition switch fuse will blow or cause damage to wiring harness.

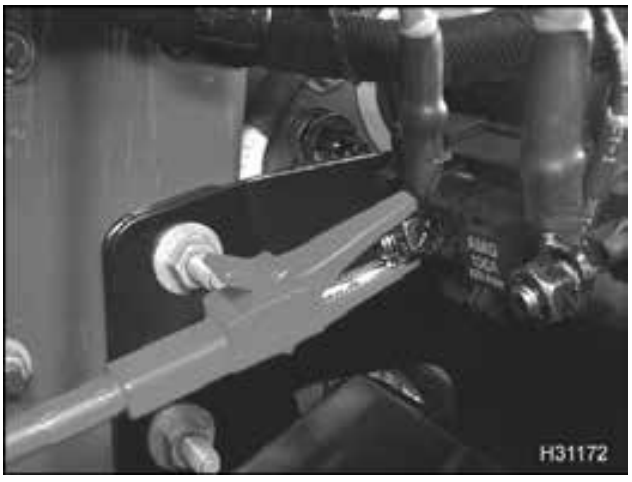


Figure 246 B+ on power distribution terminal

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.



Figure 247 Ground to terminal on cowl

CAUTION: Do not leave the IPR valve energized longer than 120 seconds — this can damage the IPR valve.

9. Apply B+ volts and ground to the IPR valve. Listen for air leak in crankcase.
10. Record results on Diagnostic Form.
    - If the IPR valve is energized, the air leak should stop.
    - If the air leak does not stop, replace the IPR valve following the procedures in the *Engine Service Manual*. Repeat test 14.3 - IPR and High-pressure Pump Operation.
    - If the air leak stops the IPR is functioning. The high-pressure pump is suspect because injection control pressure does not increase. Continue with next step.
11. Remove the high-pressure pump following procedures in the *Engine Service Manual*
    - If high-pressure pump gear is loose, tighten, and reinstall high-pressure pump. Retest injection control pressure.

      If ICP pressure is still below specification, replace the high-pressure pump.
    - If high-pressure pump gear is tight, but the high-pressure pump cam does not rotate, suspect damage in the high-pressure pump. Replace the high-pressure pump and test.

      Note: To inspect high-pressure pump cam, the fuel pump must be removed.

©August 2008 Navistar, Inc.

15. Inlet Air Heater System

☐ Install Amp Clamp around one of the two feed wires and do the Output State Test. After 2 seconds, measure amperage for each air heater wire.

☐ If amperage reading is not to spec for Test 15.1, do tests 15.2, 15.3, 15.4, and 15.5 for that circuit.

Test	Air Heater Wire Circuit 1	Spec	Circuit 2
15.1 - Amperage draw		125 ± 10 amps	
15.2 - Voltage at element		BAT V	
15.3 - Element continuity	☐ Yes ☐ No		☐ Yes ☐ No
15.4 - Wiring Harness continuity and resistance		< 5 ohms	
15.5 - Relay operation Battery feed Relay output		 B+ B+	

H31144

Figure 248

Purpose

To determine if the Inlet Air Heater assembly is operating correctly

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Amp Clamp

15.1 – Current Amperage Draw

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: Inspect for damaged, loose or corroded terminals. Repair if necessary.

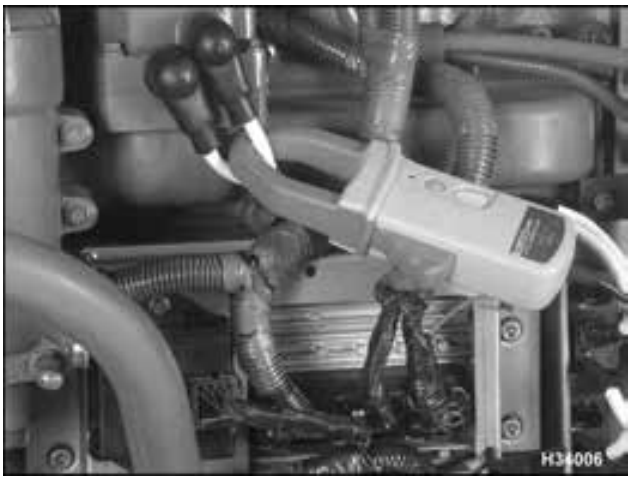


Figure 249 Amp Clamp

1. Install Amp Clamp around one of the two feed wires.
2. Turn the ignition switch to ON.

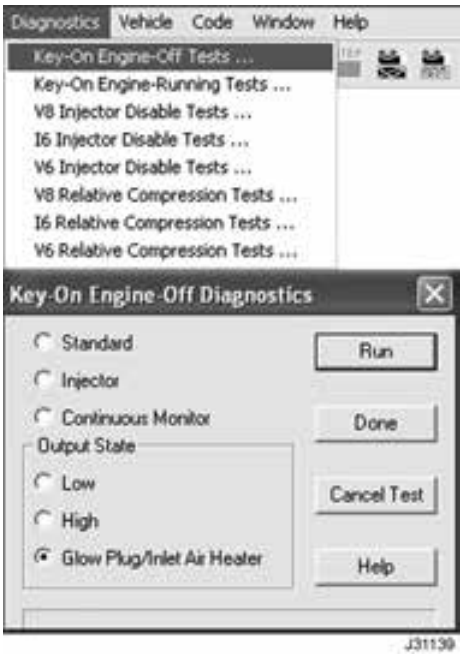


Figure 250 Inlet Air Heater Output State Test

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard Test is always selected and run first. If the ignition switch is not cycled, the Standard Test does not have to be run again.

3. Select Diagnostics from the menu bar.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4. Select Key-On Engine-Off Tests from the drop down menu.
5. From the KOEO Diagnostics menu, select Glow Plug/Inlet Air Heater, then select Run to start the test.
6. Use the DMM and Amp Clamp to measure amperage. Record results on Diagnostic Form.
7. Repeat the above procedure for other feed wire circuit. Record results on Diagnostic Form.
   - If amperage draw for both circuits meets specifications, do not continue with test. The Inlet Air Heater system is working correctly.
   - If both circuits are not operational, confirm that the ECM is programmed and enabled for the Inlet Air Heater.
   - When a failed circuit has been identified, check that circuit only.
   - If amperage draw does not meet specification, continue with test 15.2 – Voltage at Element.

15.2 – Voltage at Element Terminal

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.



Figure 251 Element terminal

1. Connect DMM positive lead to the element terminal that is out of specification.



Figure 252 Ground terminal (left side of crankcase)

2. Connect DMM negative lead to the ground terminal.
3. Turn the ignition switch to ON.



Figure 253 Inlet Air Heater Output State Test

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4. Select Diagnostics from the menu bar.
5. Select Key-On Engine-Off Tests from the drop down menu.

   NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard Test is always selected and run first. If the ignition switch is not cycled, the Standard Test does not have to be run again.
6. From the KOEO Diagnostics menu, select Glow Plug/Inlet Air Heater, then select Run to start the test.
7. Use the DMM to measure voltage.
8. Record results on Diagnostic Form.
   - If voltage is B+, do 15.3 Element Terminal Continuity.
   - If voltage is not B+, do 15.4 - Wiring Harness Continuity and Resistance.

15.3 – Element Terminal Continuity

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

When the voltage at element is B+, check the continuity of the element terminal to ground.

1. Turn the ignition switch to OFF.
2. Use DMM to check resistance.



Figure 254 Element terminal

3. Connect DMM positive lead to the element terminal that is not to specification.



Figure 255 Ground terminal (left side of crankcase)

4. Connect DMM negative lead to the ground terminal.
5. Record results on Diagnostic Form.
   - If the element does not have continuity to ground, replace the element.
   - If the element has continuity, verify the previous Inlet Air Heater test.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

15.4 – Wiring Harness Continuity and Resistance

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

When the voltage at element is not B+, measure the resistance (continuity) between the element and relay.

1. Turn the ignition switch to OFF.
2. Use the DMM to check wiring harness continuity and measure resistance.



Figure 256 Element terminal

3. Connect DMM negative lead to the element terminal that is not B+.

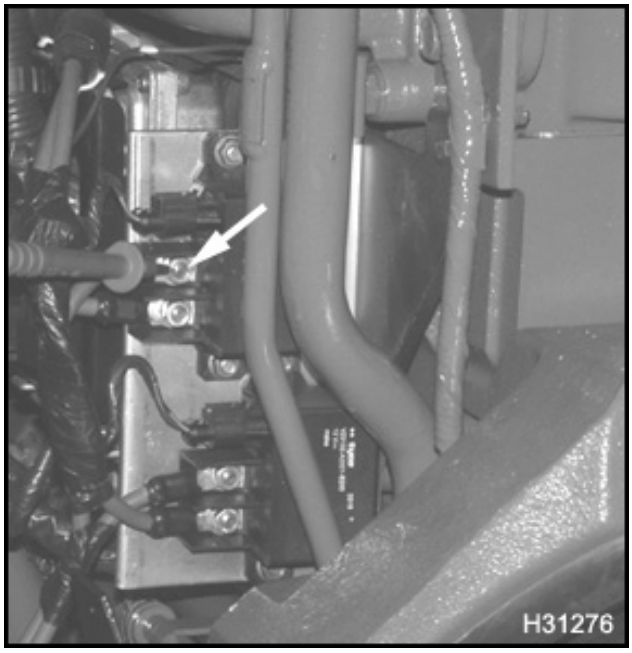


Figure 257 Relay terminal

NOTE: Engines could be wired differently, having wiring harness connectors secured to different relay terminals. Trace wiring harness from element to the relay, to be sure that the correct relay terminal is being tested.

4. Contact DMM positive lead to relay terminal.
5. Record results on Diagnostic Form.
   - If wiring resistance is > 5 Ω, repair or replace, if necessary.
   - If wiring resistance is < 5 Ω, continue with test 15.5 - Relay Operation.

15.5 – Relay Operation

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

©August 2008 Navistar, Inc.



Figure 258 Ground terminal (left side of crankcase)

1. Connect DMM negative lead to the ground terminal, on the left side of crankcase or known, good ground in the cab.

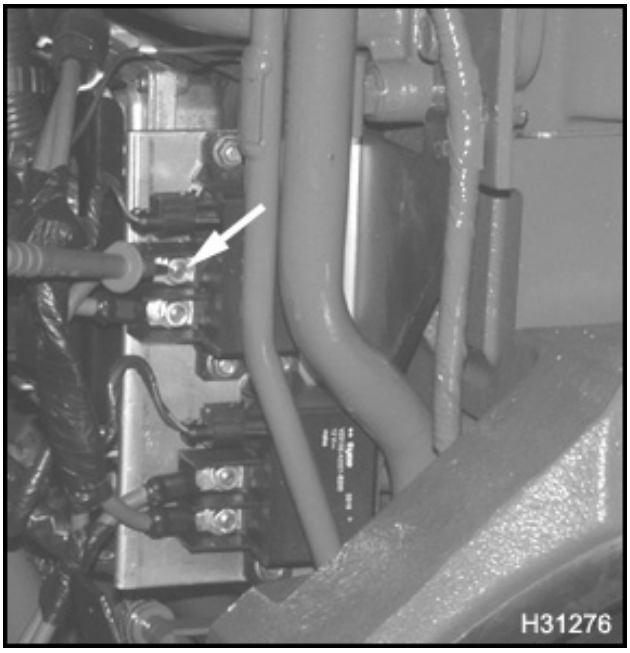


Figure 259 Relay terminal

NOTE: Engines could be wired differently, having wiring harness connectors secured to different relay terminals. Trace wiring harness from battery to the relay, to be sure that the correct relay terminal is being tested.

2. Contact DMM positive lead to relay terminal of battery feed to relay.
3. Record results on Diagnostic Form.
   - If DMM voltage at relay terminal is B+, continue with step 4 and measure relay output to element.
   - If voltage of relay terminal is less than B+, repair or replace wire from starter to relay. Retest to verify repair.
4. Turn the ignition switch to ON.
5. Contact DMM positive lead to relay output terminal, relay to element.



Figure 260 Glow Plug/Inlet Air Heater Output State Test

6. Select Diagnostics from the menu bar.
7. Select Key-On Engine-Off Tests from the drop down menu.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard Test is always selected and run first. If the ignition switch is not cycled, the Standard Test does not have to be run again.

8. From the KOEO Diagnostics menu, select Glow Plug/Inlet Air Heater, then select Run to start the test.
9. Record results on Diagnostic Form.
   - If both relays are not operational, confirm that the ECM is programmed and enabled for the Inlet Air Heater.
   - If both relays are not operational and the ECM programming is correct, do the following checks in “IAH System” – Section 7:
     — Actuator Voltage Checks at ECM (page 449)
     — Harness Resistance Checks – Relay to ECM (page 450)
     — Harness Resistance Checks – Relay to 12–pin Connector (page 450)
   - If voltage is not B+, do the following checks in “IAH System” – Section 7:
     — Harness Resistance Checks – Relay to ECM (page 450)
     — Harness Resistance Checks – Relay to 12–pin Connector (page 450)

     If the control circuit wiring to the relay is correct, replace relay.
   - If voltage is B+, verify previous test results.

     Check wiring from the relay to element. The wiring may have continuity and low resistance. However, a poor crimp, loose connector, or corrosion could prevent ability to handle circuit load.

Possible Causes

- Failed wiring harness or connection
- Poor ground connection
- Failed relay
- Failed element
- Failed ECM
- ECM not programmed (inlet air heater)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Table of Contents

Description.....205
Diagnostic Form Information.....205

Test Procedures.....207
1. Diagnostic Trouble Codes.....207
Vehicle Information for Form Heading.....207
Entering Vehicle Information without using the EST.....207
Entering Vehicle Information using the EST.....208
Accessing DTCs.....211
Reading DTCs.....212
2. KOEO Standard Test.....213
3. KOEO Injector Test.....215
4. Engine Oil.....217
5. Fuel.....218
6. Fuel Pressure and Aerated Fuel.....222
Fuel Pressure.....222
Checking for Aerated Fuel using Spare Fuel Line.....226
Operation of Fuel Pump.....228
7. Intake Restriction 229
8. Exhaust Restriction.....231
Monitoring EBP using EST.....231
Monitoring EBP using Pressure Sensor Breakout Harness 232
9. KOER Standard Test.....234
10. Injection Control Pressure.....236
Monitoring ICP and BCP using EST.....236
Monitoring ICP using VC Gasket Breakout Harness.....239
Monitoring BCP using VC Gasket Breakout Harness.....242
11. Injector Disable Test.....244
Automatic Test – Auto Run.....244
Manual Test.....246
12. Relative Compression.....248
13. Air Management.....251
14. VGT Test.....253
15. Torque Converter Stall (Automatic only).....255
16. Crankcase Pressure.....256
17. Test Drive (Full load, rated speed).....258
Monitoring Engine Parameters using EST and Fuel Pressure Gauge.....258
Fuel Inlet Restriction.....266
Monitoring Boost Pressure using Pressure Sensor Breakout Harness.....268
Monitoring ICP using VC Gasket Breakout Harness.....269
Monitoring BCP using VC Gasket Breakout Harness.....272
18. Valve Lash and Brake Lash.....274
Adjusting Valve Lash 274
Brake Lash.....277

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Description

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, make sure the transmission is in neutral, parking brake is set, and wheels are blocked before doing service bay diagnostics on engine or vehicle.

The Diagnostic Form (Performance side) directs technicians to systematically troubleshoot a performance condition and avoid unnecessary repairs.

This section shows detailed instructions of the tests on the form. The manual should be used with the form and referenced for supplemental test information. Use the form as a worksheet to record all test results.

Do all tests in sequence, unless otherwise stated. Doing a test out of sequence can cause incorrect results. If a problem was found and corrected, it is not necessary to complete the remaining tests.

See appendices for Diagnostic Trouble Codes (DTCs) and engine specifications.

Diagnostic Form Information

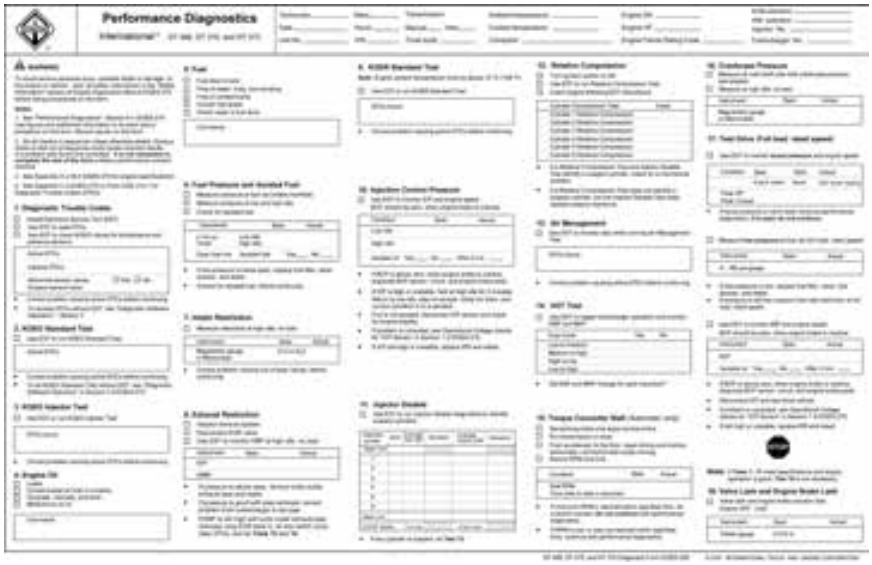


Figure 261 Diagnostic Form EGED-290-1 (Performance Diagnostics side)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Diagnostic Form EGED-290–1 is available in 50 sheet pads. To order technical service literature, contact your International dealer.

©August 2008 Navistar, Inc.

Test Procedures

1. Diagnostic Trouble Codes

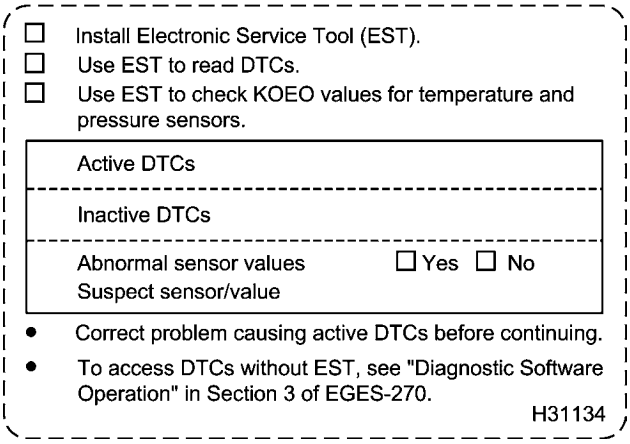


Figure 262

Purpose

- To determine if the ECM has detected Diagnostic Trouble Codes (DTCs) indicating conditions that could cause engine problems
- To fill out Diagnostic Form heading
- To check for abnormal sensor readings

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

Vehicle Information for Form Heading

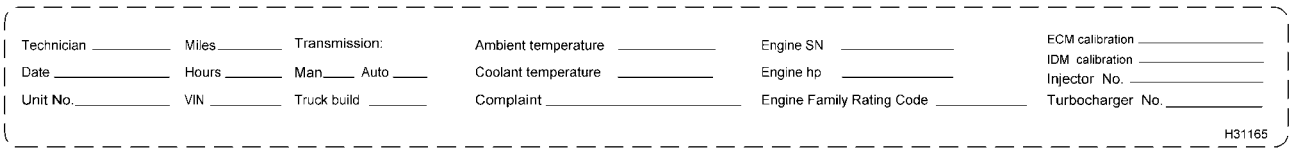


Figure 263

NOTE: Before continuing diagnostic tests, fill out the form heading on Diagnostics Form EGED-290.

Entering Vehicle Information without using the EST

1. Enter the following information in the form heading:
   - Technician
   - Date (for warranty)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- Unit No (dealer's quick reference for customer's vehicle identification)
- Truck build (date)
- Complaint (for warranty)

2. Do the following procedure "Entering Vehicle Information using the EST" to complete the rest of the form heading:

Entering Vehicle Information using the EST



Figure 264 American Trucking Association (ATA) connector



Figure 265 EZ-Tech® interface cable



Figure 266 EZ-Tech® interface cable

⚠ WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

©August 2008 Navistar, Inc.

1. Connect the EZ-Tech® interface cable to the EST and the ATA connector.
2. Boot-up EST.
3. Select Engine Diagnostics, then International® MasterDiagnostics® II.
4. Turn the ignition switch to ON.

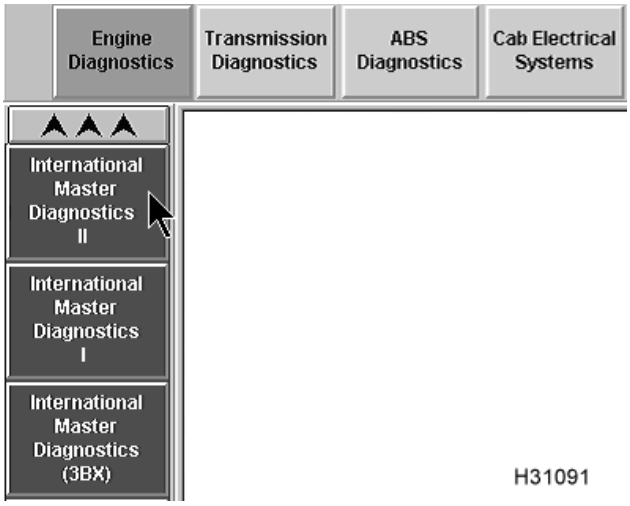


Figure 267 International® launchpad

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

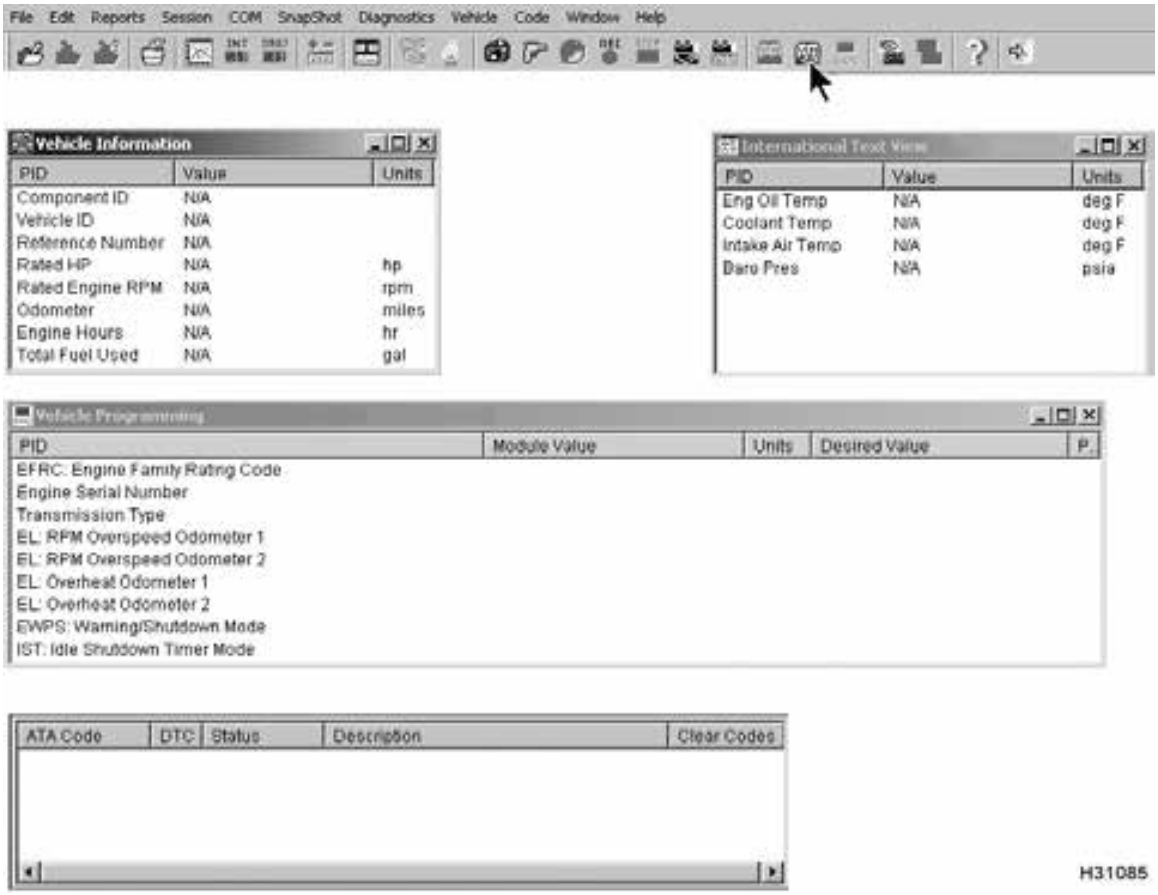


Figure 268 Open VIN+ session

©August 2008 Navistar, Inc.

5. Select VIN+ icon to open VIN+ session.
6. Use the on-screen information and the following “Information List” to complete the form heading.

Table 2

Heading Information	VIN+ session PID
Miles	Odometer
Hours	Engine Hours
VIN	Vehicle ID
Transmission	Transmission Type
	Manual Non-Isochronous
	Manual Isochronous
	Allison AT/MT
	Allison MD
Ambient temperature	Intake Air Temp
Coolant temperature.	Coolant Temp
Engine SN	Engine Serial Number
Engine HP	Rated HP
Engine Family Rating Code	EFRC: Engine Family Rating Code
ECM calibration	Reference Number
(Example for reference only)	PRE1PJ02
	(First group)
IDM calibration	Reference Number
(Example for reference only)	ANZKLA02
	(Second group)

Information List

- Miles (for warranty)
- Hours (for warranty)
- VIN (for warranty, ordering parts, and service information) The Vehicle Identification Number is also on the door jamb on the operators side.
- Transmission: Manual/Auto
- Ambient temperature
- Coolant temperature
- Engine SN (for ordering parts and service information)

  The engine serial number is stamped on a crankcase pad on the right side of the crankcase below the cylinder head. The engine serial number is also on the engine emission label on the valve cover.

  Compare the Engine SN in the Vehicle Programming window of the VIN+ session with the Engine SN on the engine. The engine could have been replaced without a programming change to the ECM to upgrade the Engine SN.
- Engine HP (for correct engine application)
- Engine Family Rating Code (for warranty)
- ECM calibration
- IDM calibration

NOTE: Fill in the Turbocharger No. and Injector No. if a mismatch of components is suspected.

- Injector No. (requires removal of valve cover and high-pressure oil rail)
- Turbocharger No. (Check for plate on turbocharger – may require removal of paint from plate)

Accessing DTCs

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the “Safety Information” section of this manual.

NOTE: When opening VIN+ session to fill out form heading, the DTC window automatically appears.

NOTE: If an EST is not available, see “Accessing DTCs” in Section 3 .



Figure 269 DTC window

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

1. Record all DTCs from DTC window on Diagnostic Form. See “Diagnostic Trouble Codes” – Appendix C (page 643) for DTCs.
2. Correct problem causing active DTCs before continuing.
3. Clear DTCs.
4. Use EST to check KOEO values for temperature and pressure sensors. Record results on Diagnostic Form.
    - If engine has not been run for 8 to 12 hours, the Engine Coolant Temperature (ECT), Engine Oil Temperature (EOT), and Manifold Air Temperature (MAT) should be within 2 °C (5 °F) of each other. The Intake Air Temperature (IAT) could be a few degrees higher or lower due to faster outside engine temperature change.
    - The Injection Control Pressure (ICP) and Brake Control Pressure (BCP) values may fluctuate as much as 345 kPa (50 psi). Electromagnetic Interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem.
    - Engine Oil Pressure (EOP), Manifold Air Pressure (MAP), and Exhaust Back Pressure (EBP) values may fluctuate as much as 7 kPa (1 psi). Electromagnetic Interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem.
    - Barometric Absolute Pressure (BAP) values should equal the barometric reading for your region.
    - Are values normal?
    - If abnormal values are suspected, record on Diagnostic Form and see Operational Voltage tables in Section 7 (page 283) for applicable sensor.
5. Continue with KOEO Standard Test.

Reading DTCs

ATA code: Codes associated with a Subsystem Identifier (SID), Parameter Identifier (PID), and Failure Mode Indicator (FMI)

DTC: Diagnostic Trouble Code

Status: Indicates active or inactive DTCs

- **Active**: With the ignition switch on, active indicates a DTC for a condition currently in the system. When the ignition switch is turned off, an active DTC becomes inactive. (If a problem remains, the DTC will be active on the next ignition switch cycle and the EST will display active/inactive.)
- **Inactive**: With the ignition switch on, inactive indicates a DTC for a condition during a previous key cycle. When the ignition switch is turned to OFF, inactive DTCs from a previous ignition switch cycle, remain in the ECM memory until cleared.
- **Active/Inactive:** With the ignition switch on, active/inactive indicates a DTC for a condition currently in the system and was present in previous key cycles, if the codes were not cleared.

Description: Defines each DTC

Possible Causes

- Electronics failure
- Failure of the ICP sensor or ICP system
- Failure of the Air Management System (AMS)
- Failure of Diamond Logic® engine brake

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

2. KOEO Standard Test

☐ Use EST to run KOEO Standard Test.

Active DTCs

- Correct problem causing active DTCs before continuing.
- To do KOEO Standard Test without EST, see "Diagnostic Software Operation" in Section 3 of EGES-270.

H31135

Figure 270

Purpose

To determine electrical malfunctions detected by the ECM self-test and Output Circuit Check (OCC)

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

NOTE: If an EST is not available, see “Standard Test Using Cruise Switches” in Section 3 (page 72).

Procedure

⚠ WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the “Safety Information” section of this manual.

1. Set parking brake to ensure the correct signal from the Electronic System Controller (ESC).
2. Turn the ignition switch to ON. (Do not crank engine.)

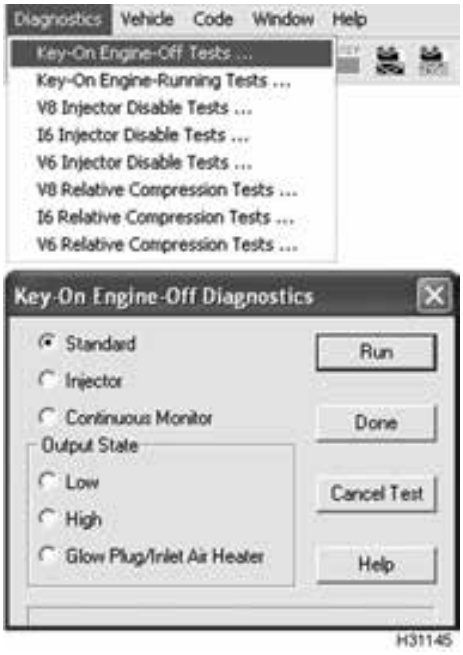


Figure 271 KOEO Standard Test

3. Select Diagnostics from the menu bar.
4. Select Key-On Engine-Off Tests from the drop down menu.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard Test is always selected and run first. If the ignition switch is not cycled, the Standard Test does not have to be run again.

5. From the KOEO Diagnostics menu, select Standard, then select Run to start the test.

   The ECM will complete an internal self-test and an OCC. When the OCC is over, the DTC window will show DTCs, if there is a problem.

   NOTE: This test takes less than 5 seconds. While the test is running, the MasterDiagnostics® screen displays message Diagnostics Running .
6. Record all DTCs on Diagnostic Form. See “Diagnostic Trouble Codes” – Appendix C (page 643) for DTCs.
7. Correct problem causing active DTCs.
8. Clear DTCs.

Possible Causes

- Failed electrical components or circuitry

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- OCC fault for the IPR valve or brake shut-off valve (if equipped)
- Inlet Air Heater (IAH)
  - — For initial calibrations, if the system voltage is less than 13 volts, DTC 251 may become active.
  - — Later calibrations and current hardware levels do not support DTC 251.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

3. KOEO Injector Test

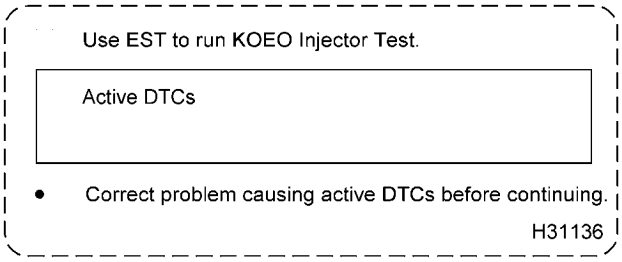


Figure 272

Purpose

To determine if fuel injectors are working (electronically) by energizing injectors in a programmed sequence. The ECM monitors the IDM results from this test and transmits DTCs, if injectors or injector circuits are not working correctly.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: The KOEO Injector Test can only be done with the EST using MasterDiagnostics® software.

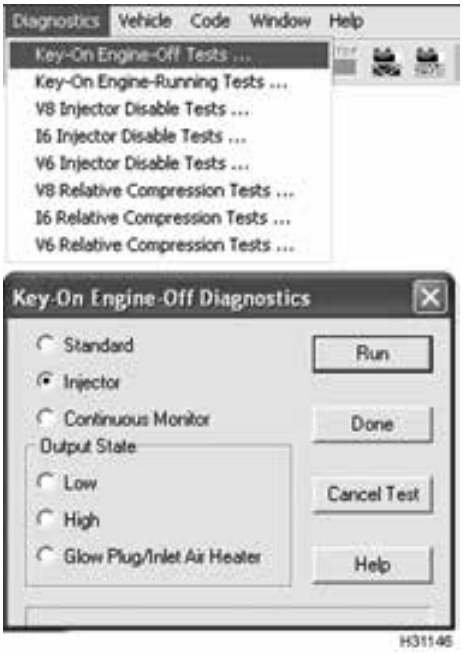


Figure 273 KOEO Injector Test

1. Select Diagnostics from the menu bar.
2. Select Key-On Engine-Off Tests from the drop down menu.

   NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard Test is always selected and run first. If the ignition switch is not cycled, the Standard Test does not have to be run again.
3. From the KOEO Diagnostics menu, select Injector, then select Run to start the test.

   NOTE: During this test, injector solenoids should click in a numerical sequence, not the firing order, when actuated. If a series of clicks are not heard for each injector, one or more injectors are not activating.

   The DTC window will show DTCs for electrical problems.
4. Record DTCs on Diagnostic Form. See "Diagnostic Trouble Codes" – Appendix C (page 643) for DTCs.
5. Correct problem causing active DTCs.
6. Clear DTCs.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

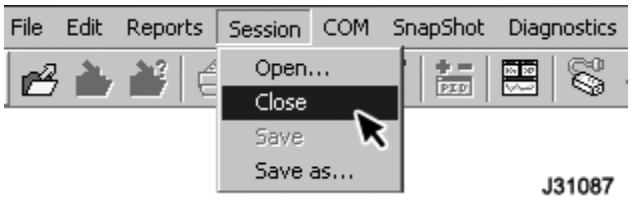


Figure 274 Close session

7. When finished with this test, close the VIN+ session. Select Session from menu bar, then Close.

Possible Causes

- Injector wiring harness open or shorted
- Under Valve Cover (UVC) wiring
- Valve cover gasket
- Faulty wiring harness connection on injector coil
- Failed injector coil
- Failed Injector Drive Module (IDM)
- Failed ECM (not sending test request to IDM)

Hard Start and No Start Only

- Faulty wiring CAN2 datalink
- Faulty wiring IDM power and ground
- Faulty wiring IDM main power relay

©August 2008 Navistar, Inc.

4. Engine Oil

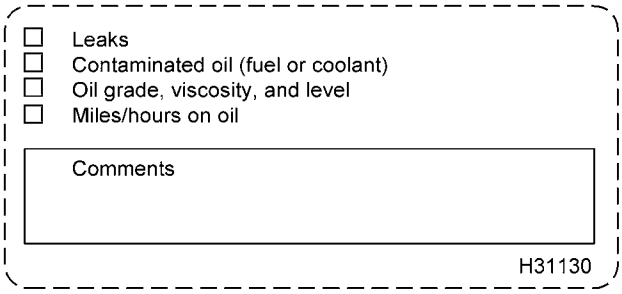


Figure 275

Purpose

To determine if crankcase oil level and oil quality are correct to ensure operation of the Injection Control Pressure (ICP) system

Tools

- None

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. Park vehicle on level ground.
2. Check oil level with oil level gauge.

   NOTE: Never check the oil level when the engine is running or immediately after the engine is shut down; the reading will be inaccurate. Allow 15 minute drain down time, before checking oil level.

   NOTE: If the oil level is too low, the fuel injectors will not work correctly. If the oil level is above the operating range, the engine has been incorrectly serviced, fuel is in the oil, or coolant is in the oil.
3. Inspect oil for thickening.

   NOTE: When the crankcase lube oil is contaminated with coolant, the oil will have a dark-gray or black sludgy appearance.

   - Engine oil level will vary depending on temperature of engine.
   - If oil is contaminated, see "Fuel in Lube Oil" (page 124) or "Coolant in Lube Oil" (page 109) in Section 4.
   - If oil level is low, fill to correct level and test again.
4. Check engine service records for correct oil grade and viscosity for ambient operating temperatures. **Do not use 15W-40 oil below -7 °C (20 °F)**. Long oil drain intervals can increase oil viscosity; thicker oil will make engine cranking and starting more difficult below freezing temperatures. See "Lubrication Requirements" in the *Engine Operation and Maintenance Manual* (for this engine's model number and model year). Confirm that oil meets correct API category.
5. Record concerns on Diagnostic Form.

Possible Causes

Low oil level

- Oil leak
- Oil consumption
- Incorrect servicing

High oil level

- Incorrect servicing
- Fuel in oil
- Coolant in oil
- Incorrect oil level gauge

Coolant in oil

- Cylinder head gasket leak
- Failed cup plug in cylinder head
- Injector sleeve leak
- Front cover gasket leak
- Front cover, cylinder head, or crankcase porosity
- Accessory leak (water cooled air compressor)
- Failed crevice seal (piston sleeve)

Fuel in oil

- Injector O-ring leak
- Cylinder head porosity
- Leaking injector

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

5. Fuel

☐ Fuel level in tank
☐ Free of water, icing, and clouding
☐ Free of contaminants
☐ Correct fuel grade

Comments

H31169

Figure 276

Purpose

To check fuel level and quality for efficient engine operation

- Ask the operator if the amber WATER IN FUEL lamp was on during vehicle operation.
- If engine has an optional Engine Fuel Pressure (EFP) sensor, ask the operator if the amber FUEL FILTER lamp was on during vehicle operation. If the lamp was on, change the fuel filter and retest for poor engine operation.

Tools

- Clear container (approximately 1 liter or 1 quart US)
- Fuel pressure test adapter
- Pocket screw driver

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following when taking fuel a sample:

- **Do not smoke.**
- **Keep away from open flames and sparks.**

1. Check fuel level in fuel tank and for odors other than diesel fuel – kerosene and gasoline, for example.

CAUTION: Be sure to place a rag or suitable container under the fuel pressure test valve when bleeding the fuel rail. Dispose of fuel in a correct container clearly marked DIESEL FUEL according to local regulations.

NOTE: Engine fuel can be a threat to the environment. Never dispose of engine fuel by putting it in the trash, pouring on the ground, in the sewers, in streams, or bodies of water.



Figure 277 Shrader valve assembly

1. Valve
2. Center stem

©August 2008 Navistar, Inc.

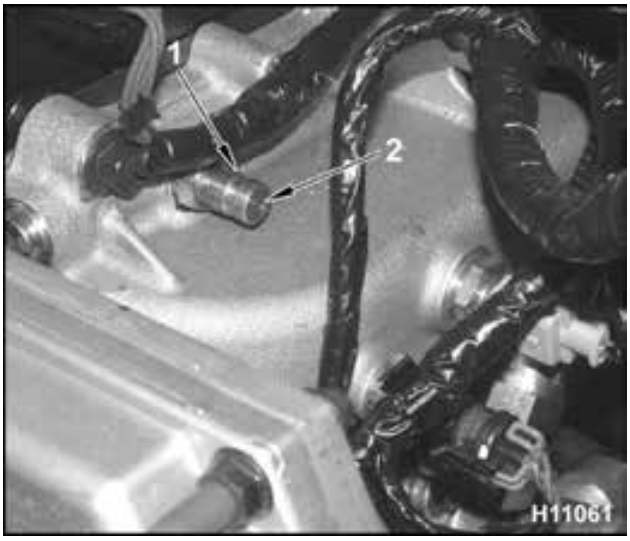


Figure 278 Diagnostic coupling

1. Valve
2. Center section

NOTE: Engines are equipped with a fuel pressure test valve in the form of either a Shrader valve or a diagnostic coupling.

2. Check for indications of aerated fuel in the fuel system. Relieve pressure from the fuel rail using the fuel pressure test valve.
   - As fuel pressure is relieved, a steady stream of fuel, without air from the fuel pressure test valve, means that air is not in the fuel system.
   - An erratic air/fuel mixture surge suggests that air is in the fuel system.



Figure 279 Fuel pressure test adapter

NOTE: It is recommended to use the fuel pressure test adapter to avoid bending the needle in the fuel pressure test valve.



Figure 280 Fuel test fitting

NOTE: Some engines will have a diagnostic coupling instead of a Shrader valve. Press end of coupling with a pocket screwdriver to relieve pressure.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.



Figure 281 Water drain valve

1. Water drain valve
2. Plastic tube



Figure 282 Fuel strainer drain valve

3. Open water drain valve and collect a fuel sample using a clear container. Check for the following conditions:
   - Fuel must be the correct grade, clean, and undiluted.
   - Gasoline, kerosene or other chemicals in the diesel fuel

     (If diesel fuel is contaminated, correct the condition and retest.)
   - If the fuel filter was not serviced or drained for a long time, some sediment or water could be in the fuel filter housing.

   NOTE: Cold weather can cause fuel waxing in some grades of diesel fuel. Waxing will restrict or stop fuel flow through the fuel filter.
4. Open fuel strainer drain valve. Collect a fuel sample using a clear container. If fuel is contaminated do the following:
   a. Pull drain valve down and out of bowl.
   b. Remove strainer bowl and check strainer for sediment, debris, or rust. Clean and replace as required.
   c. Check fuel tanks and fuel lines. Clean and flush if necessary.
5. Prime fuel system. See “Priming the Fuel System” in Section 4 (page 132) for procedure.

Possible Causes

- Low fuel level in fuel tank.
- Inline fuel valve (if equipped) could be shut-off.
- Fuel supply line could be broken or crimped.
- The fuel tank pickup tube could be clogged or cracked.
- Supplemental filters or water separators may be plugged or leaking allowing air to enter the fuel system.
- Failed seal for inlet fitting in fuel filter housing
- Water or contaminants in fuel tank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- Ice in fuel lines
- Debris in fuel tank
- Cloudy fuel indicates unsuitable fuel grade for cold temperatures.
- Fuel could be waxed or jelled. (usually Grade 2-D)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

6. Fuel Pressure and Aerated Fuel

☐ Measure pressure at fuel rail (intake manifold).
☐ Measure pressure at low and high idle.
☐ Measure pressure under load.
(automatic only – torque converter stall)
☐ Check for Aerated fuel.

Instrument		Spec	Actual
0-100 psi Gauge	Low idle		
	High idle		
	Auto only (converter stall)		
Clear fuel line	Aerated fuel	Yes____ No ____	

- If fuel pressure is below spec, replace fuel filter, clean strainer, and retest.
- Correct for aerated fuel, before continuing

H31168

Figure 283

Purpose

To check for correct fuel pressure and aerated fuel

- Ask the operator if the amber WATER IN FUEL lamp was on during vehicle operation.
- If engine has an optional Engine Fuel Pressure (EFP) sensor, ask the operator if the amber FUEL FILTER lamp was on during vehicle operation. If the lamp was on, change the fuel filter and retest for poor engine operation.

Tools

- Fuel pressure test gauge
- Fuel Pressure Test Kit
- 1 to 5 gallon bucket
- Fuel/Oil Pressure Test Coupler

Fuel Pressure

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) for fuel pressure specifications and record on Diagnostic Form.

NOTE: If engine is equipped with optional Engine Fuel Pressure (EFP) sensor, use EST with MasterDiagnostics® software to monitor fuel pressure. Compare the EST values to gauge readings.

CAUTION: Be sure to place a rag or suitable container under the fuel pressure test valve when bleeding the fuel rail. Dispose of fuel in a correct container clearly marked DIESEL FUEL according to local regulations.

NOTE: Engine fuel can be a threat to the environment. Never dispose of engine fuel by putting it in the trash, pouring on the ground, in the sewers, in streams, or bodies of water.



Figure 284 Shrader valve assembly

1. Valve
2. Center stem

©August 2008 Navistar, Inc.

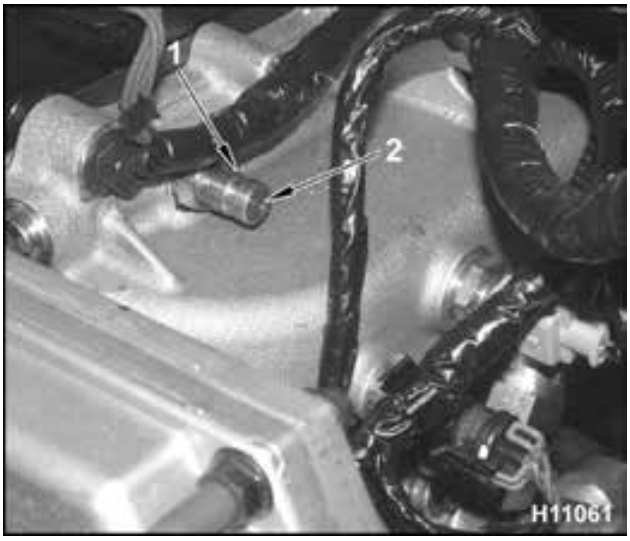


Figure 285 Diagnostic coupling

1. Valve
2. Center section

NOTE: Engines are equipped with a fuel pressure test valve in the form of either a Shrader valve or a diagnostic coupling.

CAUTION: Be sure to place a rag or suitable container under the fuel pressure test valve when bleeding the fuel rail. Dispose of fuel in a correct container clearly marked DIESEL FUEL according to local regulations.

NOTE: Engine fuel can be a threat to the environment. Never dispose of engine fuel by putting it in the trash, pouring on the ground, in the sewers, in streams, or bodies of water.



Figure 286 Shrader valve assembly

1. Valve
2. Center stem

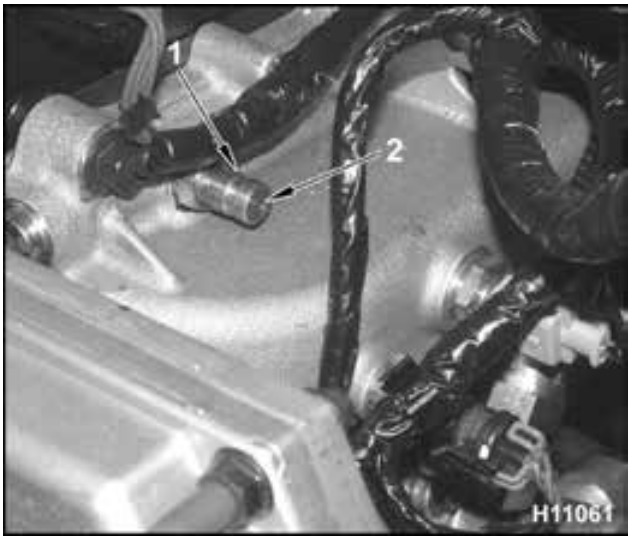


Figure 287 Diagnostic coupling

1. Valve
2. Center section

NOTE: Engines are equipped with a fuel pressure test valve in the form of either a Shrader valve or a diagnostic coupling.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

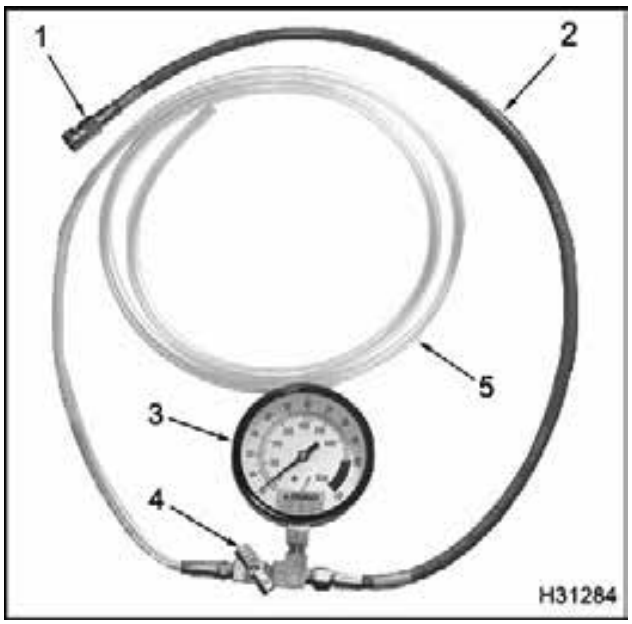


Figure 288 Fuel Pressure Gauge

1. Quick disconnect check valve
2. Fuel test line
3. Fuel Pressure Gauge
4. Inline shut-off valve
5. Clear test line



Figure 289 Fuel Pressure Test Adapter

NOTE: If the engine is equipped with a Shrader valve, use the Fuel Pressure Test Adapter.



Figure 290 Fuel/Oil Pressure Test Coupler

NOTE: If the engine is equipped with a diagnostic coupling, adapt the Fuel/Oil Pressure Test Coupler to the Fuel Pressure Gauge.



Figure 291 Fuel Pressure Gauge to fuel pressure test adapter

2. Connect Fuel Pressure Gauge with shut-off valve and clear 3/8” diameter hose to test valve.
3. Route the clear hose into a drain pan.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When routing test line, do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces.

©August 2008 Navistar, Inc.

4. Start the engine and measure fuel pressure with the shut-off valve closed. Open the shut-off valve to check for aeration.

   NOTE: Breaking any fuel system joint will induce air into the fuel system. The air should pass in a short period of time. As fuel pressure is relieved, a steady stream of fuel without air bubbles indicates the fuel is not aerated.

   NOTE: If a Fuel Pressure Gauge with shut-off valve and clear 3/8" diameter hose is not available to check for aeration, see alternative test "Checking for Aerated Fuel using Spare Fuel Line."

5. Record results on Diagnostic Form.
   - If fuel pressure is below specification and fuel is not aerated, replace the fuel filter and clean the strainer. Test the fuel pressure again.
   - If fuel is aerated, see "Aerated Fuel" in Section 4.
   - If fuel pressure is still low and fuel is not aerated after replacing the fuel filter and cleaning the strainer, do "Operation of the Fuel Pump."
   - If fuel pressure is in specification and fuel is not aerated, continue with step 6.
6. Run the engine at high idle. Measure the fuel pressure with the shut-off valve closed. Open the shut-off valve to check for aeration.
7. Record results on Diagnostic Form.
   - If fuel pressure is below specification, replace the fuel filter and clean the strainer. Test the fuel pressure again.
   - If fuel pressure is still low after replacing the fuel filter and cleaning the strainer, do the "Operation of the Fuel Pump Test."
   - If fuel pressure stays in specification, continue to step 8
8. Does the vehicle have an automatic transmission?
   - If yes, continue to step 9.
   - If no, continue to the next diagnostic test.
9. Set the parking brake and apply service brake.

   WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, make sure brakes are correctly adjusted and in good condition. This procedure should be done in an open lot.

   CAUTION: Avoid damage to the drive train. Do not do this test for more than 10 seconds at a time or more than twice back to back. (If doing twice – wait 2 minutes between tests.)
10. Put transmission in drive.
11. Press accelerator to the floor for no longer than 10 seconds.
12. Record results on Diagnostic Form.
    - If fuel pressure is below specification, replace fuel filter and clean the strainer. Test the fuel pressure again.
    - If fuel pressure is still low after replacing the fuel filter and cleaning the strainer, do the "Operation of the Fuel Pump Test."
    - If fuel pressure is in specification, continue to the next diagnostic test.

Possible Causes

No fuel

- Low fuel level in fuel tank
- Debris in tank can cause high-restriction and low fuel pressure.
- Inline fuel valve (if equipped) could be shut-off
- Failed seals or fuel lines between fuel tanks
- Ice in fuel lines
- Inoperative fuel tank transfer pump
- Fuel tank pickup tube cracked

Low fuel pressure

- Dirty filter element
- Debris or rust in fuel strainer
- Restriction from the fuel tank to the fuel filter housing inlet can cause high-restriction and low fuel pressure.
- Plugged supplemental filters or water separators can cause high-restriction and low fuel pressure.

©August 2008 Navistar, Inc.

- Debris in tank can cause high-restriction and low fuel pressure.
- A kinked or bent fuel supply line or a blocked pickup tube can cause high-restriction and low fuel pressure.
- Waxed or jelled fuel in the fuel filter will cause high-restriction and low fuel pressure. (Usually Grade 2-D)
- Ice in fuel lines.
- A restriction between the fuel inlet fitting, strainer, and fuel pump can cause high-restriction and low fuel pressure.
- Debris in the fuel regulator valve
- Failed fuel pressure regulator valve.
- Failed fuel pump
- Failed high-pressure oil pump (can not operate fuel pump)

Aerated fuel

- Failed seal for inlet fitting in fuel filter housing
- Supply filter or water separator leaking
- A loose fuel line on the suction side of the fuel system can ingest air into the system and cause low fuel pressure (most noticeable under load).
- Strainer drain valve loose or damaged
- Strainer bowl warped or damaged
- Missing O-ring from strainer bowl
- Damaged seals on steel inlet tube to fuel pump
- Primer pump seals damaged

Fuel restriction

- Dirty filter element
- Debris or rust in fuel strainer
- Restriction from the low-pressure fuel filter housing inlet to the fuel tank can cause high-restriction and low fuel pressure.
- Plugged supplemental filters or water separators can cause high-restriction and low fuel pressure.
- Debris in tank can cause high-restriction and low fuel pressure.
- A kinked or bent fuel supply line or a blocked pickup tube can cause high-restriction and low fuel pressure.
- Waxed or jelled fuel in the fuel filter will cause high-restriction and low fuel pressure. (Usually Grade 2-D)
- Ice in fuel lines.
- A restriction between the fuel inlet fitting, strainer, and fuel pump can cause high-restriction and low fuel pressure.

High fuel pressure (pulsating fuel pressure)

- Debris in the fuel regulator valve
- Inoperative fuel pressure regulator valve.
- Combustion gases leaking into fuel system

Checking for Aerated Fuel using Spare Fuel Line

NOTE: This is an alternative test. Do this procedure, only if Fuel Pressure Gauge with shut-off valve is not available.

Tools

- Spare fuel line (filter housing to fuel supply pump)
- Clear plastic line
- Hose clamp (2)

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the “Safety Information” section of this manual.

©August 2008 Navistar, Inc.



Figure 292 Fuel supply line

1. Remove fuel supply line from suction side of fuel pump and fuel filter housing.

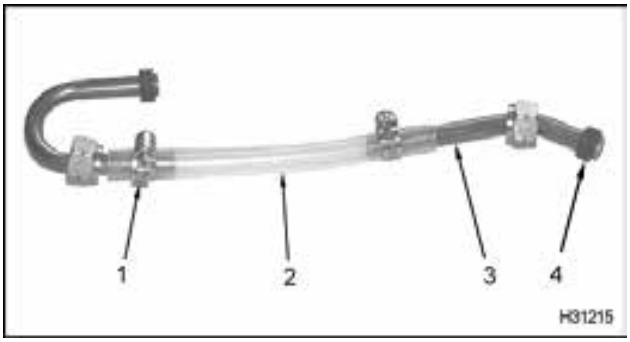


Figure 293 Test fuel line

1. Clamp (2)
2. Clear plastic tube
3. Spare fuel line (half)
4. Sleeve seal (2)

2. Make a test fuel line.

   - Use spare fuel line. (Make sure both sleeve seals are good.) Cut a 3 inch section from the center of the fuel line. Install clear plastic line in place of removed section and secure plastic line with clamps.

   NOTE: The mechanic is expected to keep the fuel test line for future diagnostics. Expense the fuel test line as an essential tool and keep it with other diagnostic tools. Warranty will not cover the cost of the fuel test line.

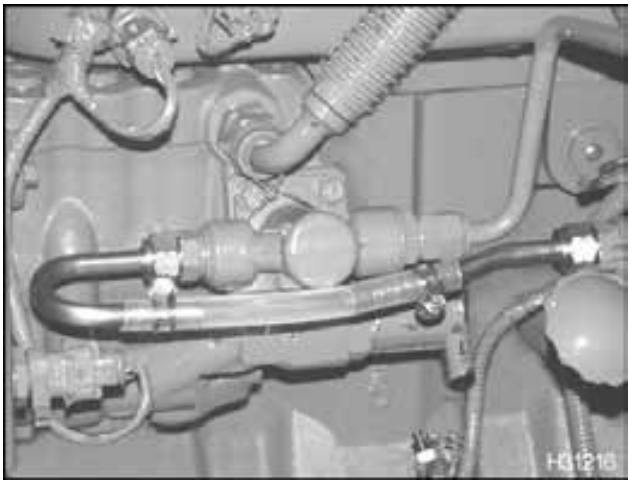


Figure 294 Test line installed

3. Install test fuel line.

   NOTE: Verify that sleeve seals are in good condition.

4. Do one of the following:

   - For **Hard Start and No Start Diagnostics**, crank engine for 20 seconds and check for air bubbles in the clear plastic line.
   - For **Performance Diagnostics**, run engine at high idle, no load and check for air bubbles in the clear plastic line.

5. Record results on Diagnostic Form.

   NOTE: Initially, fuel will be aerated due to draining fuel from filter housing and strainer in previous test.

   - If fuel is aerated check for a leak in the suction side of fuel system. See “Aerated Fuel” in Section 4.
   - If fuel is not aerated and fuel pressure is good, continue with next test.
   - If fuel is not aerated and fuel pressure is low, do “Operation of Fuel Pump”.

6. Remove fuel test line and install original fuel line.

   NOTE: Verify that sleeve seals are in good condition.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Operation of Fuel Pump

Tools

- Vacuum Pump And Gauge (kit)
- Hose clamp
- Fuel pressure test gauge
- Fuel Pressure Test Kit
- Fuel/Oil Pressure Test Coupler
- 1 to 5 gallon bucket

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.



Figure 295 Test hose to fuel line

1. Fuel line (suction side)
2. Hose clamp
3. Test hose

NOTE: The fuel pressure gauge with the inline shut-off valve is still connected to the fuel pressure test valve. If shut-off valve is not opened, test will result in false readings. Do the following procedure:

1. Open the shut-off valve.
2. Disconnect fuel line (suction side) from fuel filter housing.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When routing test line, do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces.

3. Slide test hose onto fuel line and secure with hose clamp or use cone adapter (vacuum pump kit) that fits into end of fuel line.

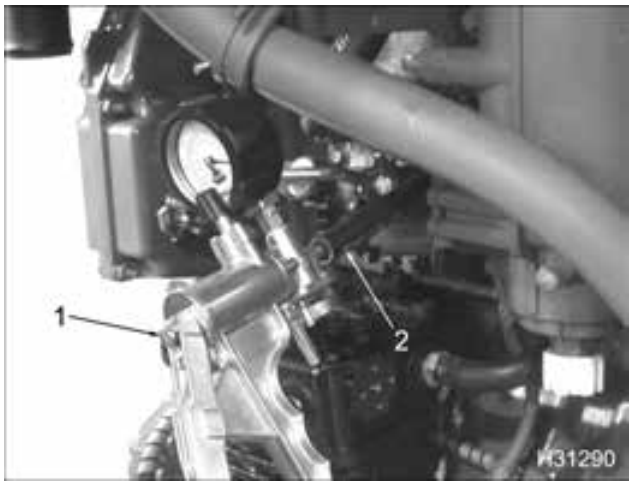


Figure 296

4. Insert vacuum pump nozzle into test hose.
5. Crank engine, check gauge reading, and record on Diagnostic Form.
   - If less than 12 in Hg., check steel line and test connections between the air vacuum test gauge and fuel pump. Verify integrity of test hose adapter
   - If vacuum is still below specification, replace the fuel pump following procedures in the *Engine Service Manual*.
   - If greater than 12 in Hg., the fuel pump is working. Replace fuel regulator and retest fuel pressure.
   - If fuel pressure is still low after replacing the fuel pump and regulator, check for restriction between the filter housing and fuel tank.

©August 2008 Navistar, Inc.

7. Intake Restriction

☐ Measure restriction at high idle, no load.

Instrument	Spec	Actual
Magnehelic gauge or Manometer	12.5 in H_2O	

- Correct problem causing out of spec values, before continuing.

H31160

Figure 297

Purpose

To check for restriction in the air intake system likely to cause engine performance problems.

NOTE: High intake or exhaust restriction can cause a large amount of black smoke.

Tools

- Gauge Bar (magnehelic)
- Test line

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. Inspect the following parts for restriction, damage or incorrect installation:
   - Air filter inlet and ducting (includes hood)
   - Air inlet hoses and clamps
   - Air filter housing, filter element, and gaskets
   - Chassis mounted CAC and piping
   - Air filter restriction indicator or gauge

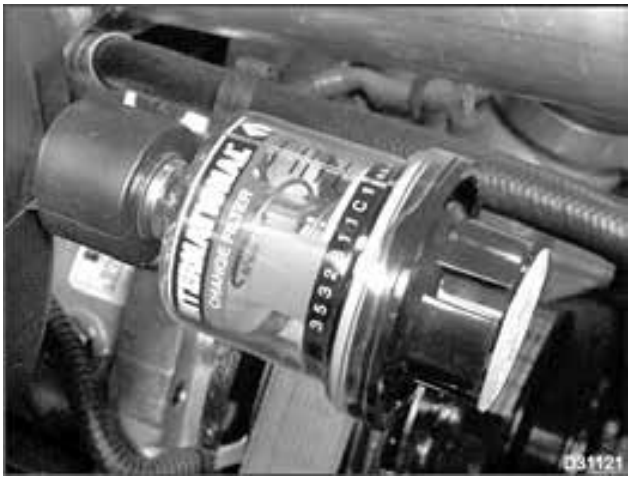


Figure 298 Low restriction



Figure 299 High restriction

NOTE: Intake restriction should be below 25 in H_2O. When the filter element reaches maximum allowable restriction, the yellow indicator will reach the top of window and automatically lock in this position.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

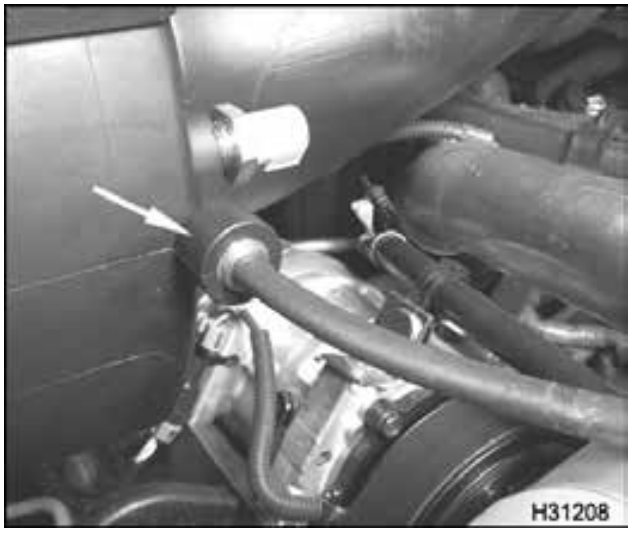


Figure 300 Air filter housing tap

2. Remove air intake restriction indicator or remove line to instrument panel restriction gauge from air filter housing.
3. Attach test line to tap for air filter housing.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When routing test line, do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces.

4. Connect line to magnehelic gauge or manometer.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

5. Run engine at high idle, no load.
6. Record reading on Diagnostic Form.
   - If restriction is more than 3.13 kPa (12.5 in H_2O), replace air filter element.
   - If restriction is more than 3.13 kPa (12.5 in H_2O), and a new filter is in place, check for obstructions in air inlet.
   - If restriction is less than 3.13 kPa (12.5 in H_2O), continue with Performance Diagnostics.

NOTE: An equivalent test, using the instrument mounted restriction indicator, can only be done while operating the engine at full load and rated horsepower. The true maximum air filter restriction for this test is 6.22 kPa (25 in H_2O).

Possible Causes

- Clogged air filter element (dust, dirt, or debris)
- Snow in air filter inlet
- Ice in air filter inlet
- Plastic bags or other foreign material in air filter inlet
- Collapsed air filter
- On engines recently repaired, rags or cap plugs may have been left in the intake system.

©August 2008 Navistar, Inc.

8. Exhaust Restriction

☐ Inspect exhaust system.
☐ Disconnect EGR valve.
☐ Use EST to monitor EBP at high idle, no load.

Instrument	Spec	Actual
EST		

- If pressure is above spec, remove turbo outlet exhaust pipe and retest.
- If pressure is good with pipe removed, correct problem from turbocharger to tail pipe.
- If EBP is still high with turbo outlet exhaust pipe removed, plug EGR back in, dokey cycle, clear codes, and do **Tests 13** and **14**.

H31159

Figure 301

Purpose

To check for restrictions in the exhaust system likely to cause engine performance problems

NOTE: High intake or exhaust restriction can cause a large amount of black smoke.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

Monitoring EBP using EST

NOTE: If an EST is not available, use alternate method – "Monitoring EBP using Pressure Sensor."

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) for specifications and record on Diagnostic Form.
2. Inspect the exhaust system for damage and restriction.
3. Disconnect the EGR control valve. If EGR control valve is plugged in during the test, results will be incorrect.

   NOTE: When the EGR control valve is disconnected, the ECM will set DTC 163 (Position signal out of range low) and possibly DTC 365 (Position above/below desired level) for the EGR control valve. Ignore and clear DTC 163 and DTC 365, after the test is complete.

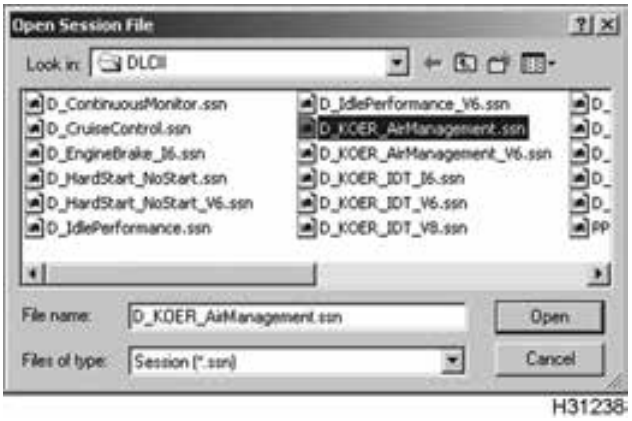


Figure 302 KOER Air Management.ssn

4. Open D_KOER_AirManagement.ssn to monitor EBP at high idle, no load.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

5. Run engine at high idle, no load.

   NOTE: Do not run KOER Air Management test. The session is open to monitor EBP at high idle and to clear DTC after it is set.
6. Record results on Diagnostic Form.
   - If restriction is to specification, do the following:
     a. Turn ignition switch to OFF.
     b. Reconnect EGR control valve.
     c. Turn ignition switch to ON.
     d. Clear all DTCs.
     e. Continue Performance Diagnostics.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- If restriction is above specification, remove exhaust pipe from turbocharger outlet and retest.
- If restriction is to specification with exhaust pipe removed, do the following:
    a. Turn ignition switch to OFF.
    b. Reconnect EGR control valve.
    c. Turn ignition switch to ON.
    d. Clear all DTCs.
    e. Correct problem from turbocharger outlet to tail pipe.
- If exhaust back pressure is still high with pipe removed from turbocharger outlet, do the following:
    a. Turn ignition switch to OFF.
    b. Reconnect EGR control valve.
    c. Turn ignition switch to ON.
    d. Clear all DTCs.
    e. An inoperative turbocharger is suspect. Do Test 13 Air Management and Test 14 VGT Test.

Possible Causes

- Restricted exhaust pipe
- Collapsed exhaust pipe
- Damaged muffler
- Turbocharger malfunction
- Clogged catalytic converter
- Clogged Catalyzed Diesel Particulate Filter (CDPF) – dependent on application

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Monitoring EBP using Pressure Sensor Breakout Harness

NOTE: Do this procedure, if an EST is not available. This is an alternate method.

Tools

- Pressure sensor breakout harness
- Digital Multimeter (DMM)

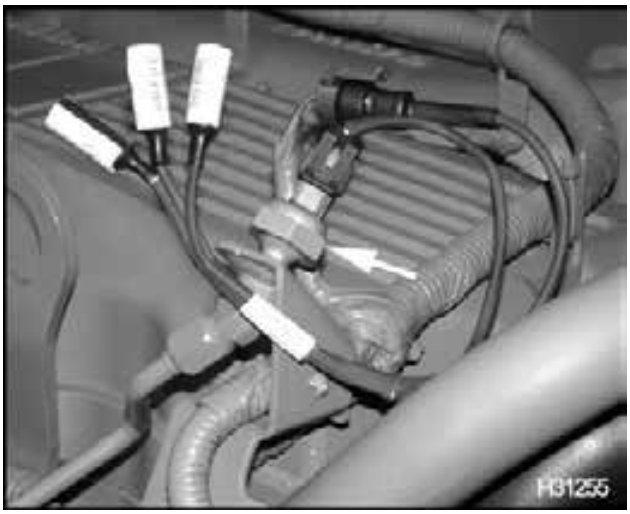


Figure 303 Pressure Sensor Breakout Harness to EBP sensor

1. See “DT 466 Performance Specifications” – Appendix A (page 595) or “DT 570 and HT 570 Performance Specifications” – Appendix B (page 619) for specifications and record on Diagnostic Form.
2. Connect Pressure Sensor Breakout Harness to engine harness and EBP sensor.
3. Use DMM to measure EBP at high idle, no load.
    - Connect POS to green (signal circuit) and NEG to black (signal ground).

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

4. Run engine at high idle, no load.
5. Record results on Diagnostic Form.
    - If restriction is to specification, do the following:
        a. Turn ignition switch to OFF.
        b. Reconnect EGR control valve.
        c. Turn ignition switch to ON.
        d. Clear all DTCs.
        e. Continue Performance Diagnostics.
    - If restriction is above specification, remove exhaust pipe from turbocharger outlet and retest.
    - If restriction is to specification with exhaust pipe removed, do the following:
        a. Turn ignition switch to OFF.
        b. Reconnect EGR control valve.
        c. Turn ignition switch to ON.
        d. Clear all DTCs.
        e. Correct problem from turbocharger outlet to tail pipe.
    - If exhaust back pressure is still high with pipe removed from turbocharger outlet, do the following:
        a. Turn ignition switch to OFF.
        b. Reconnect EGR control valve.
        c. Turn ignition switch to ON.
        d. Clear all DTCs.
        e. An inoperative turbocharger is suspect. An EST is needed to run Test 13 Air Management and Test 14 VGT Test.

©August 2008 Navistar, Inc.

9. KOER Standard Test

Note: Engine coolant temperature must be 70 °C (158 °F) or higher.

☐ Use EST to run KOER Standard Test.

DTCs found

- Correct problem causing active DTCs before continuing.

H31163

Figure 304

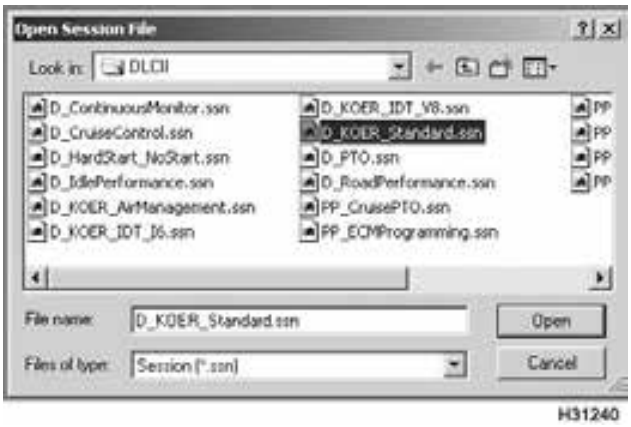


Figure 305 KOER Standard.ssn

Purpose

To verify that the engine sensors and IPR are operating correctly within specified operating ranges

The ECM will actuate the IPR and monitor ICP sensor feedback signals. If an ICP system problem exists, the ECM will transmit DTCs to the EST.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: The KOER Standard test can only be done with the EST; MasterDiagnostics® software is required.

1. Open D_KOER_Standard.ssn to monitor engine operation.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

2. Start and run engine to reach minimum operating temperature 70 °C (158 °F) or higher.

   NOTE: Engine coolant temperature must reach 70 °C (158 °F) minimum for the ECM to accurately test engine actuators and sensors. If engine coolant temperature is below self test range, the EST will display – Coolant temperature is out of range.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.



Figure 306 KOER Standard Test

3. Select Diagnostics from menu bar.
4. Select Key-On Engine-Running Tests from the drop down menu.

   NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard test is always selected and run first. If the ignition switch is not cycled, the Standard test does not have to be run again.
5. From the KOER Diagnostics Menu, select Standard Test and select Run to start the test.
6. The ECM will start the Key-On Engine-Running Standard Test and command the engine to accelerate to a predetermined rpm.

   During the test, the ECM commands the IPR through a Step Test to determine if the ICP system is performing as expected. The ECM monitors signal values from the ICP sensor and compares those values to the expected values. When the test is done, the ECM returns the engine to the normal operating mode and transmits any DTCs set during the test.
7. Record DTCs on Diagnostic Form. See “Diagnostic Trouble Codes” – Appendix C (page 643) for DTCs.
8. Correct problems causing active DTCs.
9. Clear DTCs.

Possible Causes

- Oil leakage in injection control pressure system
- Loose or corroded engine wiring harness for ICP sensor or IPR valve
- Open or shorted wiring harness to ICP sensor or IPR valve
- Failed ICP sensor
- Inoperative IPR valve
- Inoperative high-pressure oil pump
- Not enough oil from lube oil system to high-pressure pump

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

10. Injection Control Pressure

☐ Use EST to monitor ICP and engine speed.
BCP should be zero, when engine brake is inactive.

Condition	Spec	Actual
KOEO		
Low idle		
High idle - Initial		
High idle – After 2 min.		
Aerated oil	Yes ____ No ____	After 2 min. ____

- If BCP is above zero, when engine brake is inactive, diagnose BCP sensor, circuit, and engine brake components.
- If ICP is high or unstable, hold at high idle for 2 minutes. Return to idle, take oil sample, check for foam, and correct condition if oil is aerated.
- If oil is not aerated, disconnect ICP sensor and check for engine stability.
- If problem is corrected, see "Operational Voltage Checks" for ICP Sensor in Section 7 in EGES270.
- If still high or unstable, replace IPR and retest.

H31152

Figure 307

Purpose

To determine if the ICP system is providing enough hydraulic pressure to operate the injectors

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- ICP System Test Adapter
- Oil sample line with inline shut-off valve
- Socket or wrench (EOT sensor)

Monitoring ICP and BCP using EST

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

NOTE: If an EST is not available, use alternate test procedures following this test.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) for specifications and record on Diagnostic Form.

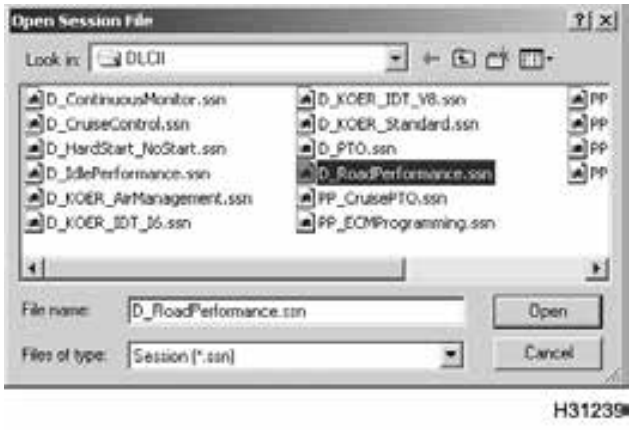


Figure 308 Road Performance.ssn

2. Open D_RoadPerformance.ssn to monitor engine operation.
3. Turn the ignition switch to ON. Do not start engine. Monitor KOEO Inject Ctrl Press (ICP). Record results on Diagnostic Form.
   - If injection control pressure is higher than specification, the ICP sensor or circuitry may be the cause.

     This will cause a lower than normal injection control pressure command. See "ICP Sensor" in Section 7.
   - If injection control pressure is in KOEO specification, continue to step 4.
4. Run engine at low idle, monitor ICP, and record reading on Diagnostic Form.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NOTE: BCP value should be 0 psi. However, BCP values may fluctuate as much as 345 kPa (50 psi). Electromagnetic Interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem.

5. Run engine at high idle, monitor ICP, and record initial results on Diagnostic Form. Continue to run the engine at high idle for 2 minutes, monitor ICP, and record the 2 minute results on Diagnostic Form. Compare the two ICP readings. ICP that rises above the specification at any point during the two minutes, indicates oil aeration.
   - If ICP is high or unstable for low or high idle, do step 6.
   - If BCP is above zero when engine brake is inactive, diagnose BCP sensor, circuit, and engine brake components.
   - If ICP is to specification, continue with Test 11 Injector Disable.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following when taking oil sample:

- **When routing oil line, do not run the line too close to moving parts.**
- **Do not let the line touch hot engine surfaces.**
- **Oil is hot. Use protective gloves when taking oil sample. Use caution handling oil sample to avoid spilling.**

WARNING: To avoid serious personal injury or possible death, do not allow engine fluids to stay on your skin. Clean your skin and nails with soap and water, or a good hand cleaner. Wash or properly throw away clothing or rags containing engine fluids. Engine fluids contain certain elements that may be unhealthy for skin and could even cause cancer.

NOTE: Engine fluids, oil, fuel, and coolant, can be a threat to the environment. Never dispose of engine fluids by putting them in the trash, pouring them on the ground, in the sewers, in streams or bodies of water. Collect and dispose of engine fluids according to local regulations.

6. Turn off engine.
7. Use the ICP system test adapter and inline shut-off valve to make a test line assembly to take oil sample.

   NOTE: The mechanic is expected to keep the test line for future diagnostics. Expense the test line as an essential tool and keep it with other diagnostic tools. Warranty will not cover the cost of the test line.

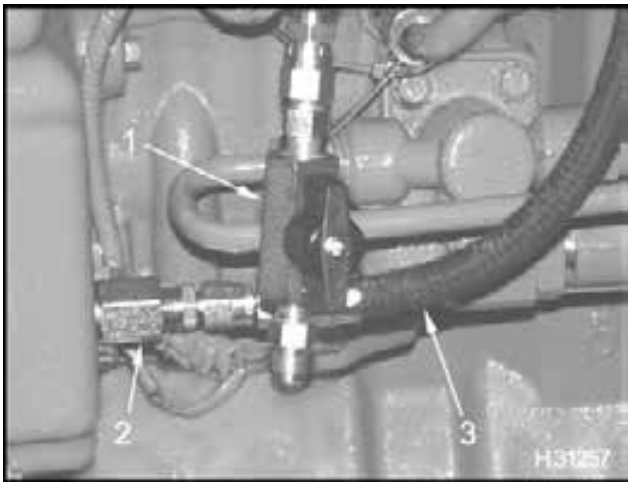


Figure 309 Test line assembly installed

1. Inline shut-off valve
2. ICP system test adapter
3. Oil sample line

8. Remove EOT sensor from EOT port. **Oil will spill out. Quickly install test line assembly**.
9. Run engine at high idle for 2 minutes.
10. Return engine to low idle, take oil sample, and check for aerated oil.
11. Record results on Diagnostic Form.
    - If oil is aerated, a large quantity of air bubbles mixed throughout the oil, or foam build up on top of the oil will be seen. Correct condition.
    - If oil is not aerated, disconnect ICP sensor and check engine stability. If problem is corrected, see “ICP Operational Voltage Checks” in Section 7.

©August 2008 Navistar, Inc.

- If ICP is still high or unstable, replace IPR following procedures in *Engine Service Manual* and retest.

Possible Causes

- **Low injection control pressure**
  - Injection control pressure system leakage
  - Failed IPR wiring (power and control)
  - Failed IPR valve
  - Failed injector
  - Cracked or porous high-pressure rail
  - Injector oil inlet adapter O-rings
  - Injector oil inlet adapter
  - O-ring for high-pressure oil rail
  - End plugs in high-pressure oil rail
  - Low oil pressure
  - Inoperative high-pressure oil pump
  - Failed ICP sensor circuit
  - Failed ICP sensor
  - Inoperative brake shut-off valve of Diamond Logic® engine brake
  - Brake pressure relief valve (optional)

    If relief valve is leaking, the brake shut-off valve is suspect.
  - If ECM detect low boost pressure, an incorrect feedback signal from APS or the ICP sensor, the ECM commands the IPR valve to reduce injection control pressure.
- **High injection control pressure**
  - Aerated lube oil
  - Bias high ICP sensor – low duty cycle
- **Erratic injection control pressure**
  - ICP sensor
  - IPR wiring
  - IPR valve
  - Middle seal IPR valve
- **Brake control pressure**
  - Failed BCP sensor circuit
  - Failed BCP sensor
  - Inoperative brake shut-off valve of Diamond Logic® engine brake
  - Brake control pressure system leakage

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Monitoring ICP using VC Gasket Breakout Harness

NOTE: Do this procedure, if an EST is not available. This is an alternate method.

Tools

- VC Gasket Breakout Harness
- DMM
- ICP System Test Adapter
- Oil sample line with inline shut-off valve
- Clear container (for oil sample)
- Socket or wrench (EOT sensor)

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

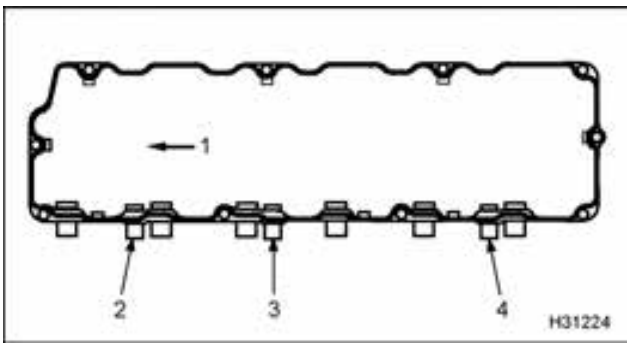


Figure 310 Valve cover gasket

1. Front of engine
2. Pass-through connector for BCP sensor
3. Pass-through connector for brake shut-off valve
4. Pass-through connector for ICP sensor

1. See “DT 466 Performance Specifications” – Appendix A (page 595), “DT 570 and HT 570 Performance Specifications” – Appendix B (page 619) or Section 7 “Operational Voltages Checks” – for specifications and record on Diagnostic Form.
2. Disconnect engine harness connector from valve cover gasket for ICP sensor and do steps 3 to 10.

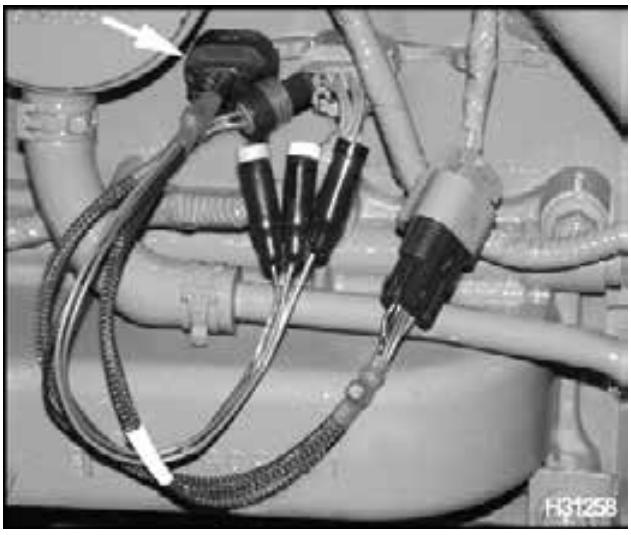


Figure 311 VC Gasket Breakout Harness to pass-through connector for ICP sensor

3. Connect VC Gasket Breakout Harness to the pass-through connector for ICP sensor and engine harness.
4. Use DMM to measure ICP.
   - Connect POS to green (signal circuit) and NEG to black (ground circuit).

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When routing DMM leads, do not crimp the leads, run the leads too close to moving parts, or let the leads touch hot engine surfaces. Secure the DMM and leads in the cab so as not to obstruct the operator.

5. Turn the ignition switch to ON. (Do not start engine.) Measure KOEO ICP signal voltage and record on Diagnostic Form.
   - If ICP voltage is higher than specification, the ICP sensor or circuitry may be at cause. This will cause a lower than normal injection control pressure command. See “ICP Sensor” in Section 7.
   - If ICP voltage is in KOEO specification, continue to step 6.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

6. Run engine at low idle, measure ICP signal voltage, and record on Diagnostic Form.
   - If ICP is high or unstable for low or high idle, do step 8.
   - If ICP is in specification, continue with Test 11 Injector Disable.
7. Run engine at high idle, monitor ICP, and record initial results on Diagnostic Form. Continue to run the engine at high idle for 2 minutes, monitor ICP, and record the 2 minute results on Diagnostic Form. Compare the two ICP readings. ICP that rises above the specification at any point during the two minutes, indicates oil aeration.
   - If ICP is high or unstable for low or high idle, do step 8.
   - If ICP is in specification, continue with Test 11 Injector Disable.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following when taking oil sample:

- **When routing oil line, do not run the line too close to moving parts.**
- **Do not let the line touch hot engine surfaces.**
- **Oil is hot. Use protective gloves when taking oil sample. Use caution handling oil sample to avoid spilling.**

WARNING: To avoid serious personal injury or possible death, do not allow engine fluids to stay on your skin. Clean your skin and nails with soap and water, or a good hand cleaner. Wash or properly throw away clothing or rags containing engine fluids. Engine fluids contain certain elements that may be unhealthy for skin and could even cause cancer.

NOTE: Engine fluids, oil, fuel, and coolant, can be a threat to the environment. Never dispose of engine fluids by putting them in the trash, pouring them on the ground, in the sewers, in streams or bodies of water. Collect and dispose of engine fluids according to local regulations.

8. Turn off engine.
9. Use the ICP system test adapter and inline shut-off valve to make a test line assembly to take oil sample.

   NOTE: The mechanic is expected to keep the test line for future diagnostics. Expense the test line as an essential tool and keep it with other diagnostic tools. Warranty will not cover the cost of the test line.

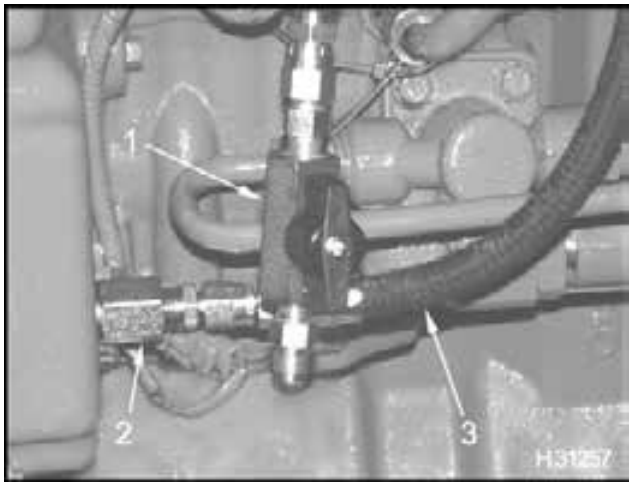


Figure 312 Test hose assembly

1. Inline shut-off valve
2. ICP system test adapter
3. Oil sample line

10. Remove EOT sensor from EOT port. **Oil will spill out. Quickly install test hose assembly and capture oil sample in clear container**.
11. Run engine at high idle for 2 minutes.
12. Return engine to low idle, take oil sample, and check for aerated oil.
13. Record results on Diagnostic Form.
    - If oil is aerated, a large quantity of air bubbles mixed throughout the oil, or foam build up on top of the oil will be seen. Correct condition.
    - If oil is not aerated, disconnect ICP sensor and check engine stability. If problem is corrected, see “ICP Operational Voltage Checks” – Section 7 (page 457).
    - If ICP is still high or unstable, and engine has optional engine brake, continue to “Monitoring BCP using VC Gasket Breakout Harness.”

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- If ICP is still high or unstable, and engine does not have optional engine brake, replace the IPR following procedures in *Engine Service Manual* and test again.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Monitoring BCP using VC Gasket Breakout Harness

NOTE: Only do this procedure if directed here from "Monitoring ICP using Gasket Breakout Harness." This is an alternate method when an EST is not available.

Tools

- VC Gasket Breakout Harness
- DMM

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

NOTE: BCP should be zero, when engine brake is inactive. However, BCP values may fluctuate as much as 345 kPa (50 psi). Electromagnetic interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem. This should be equal to KOEO BCP signal voltage.

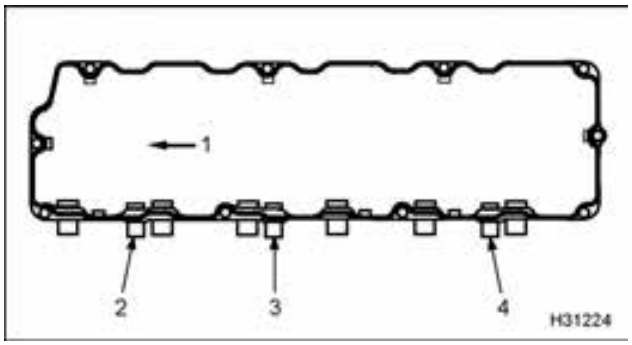


Figure 313 Valve cover gasket

1. Front of engine
2. Pass-through connector for BCP sensor
3. Pass-through connector for brake shut-off valve
4. Pass-through connector for ICP sensor

1. Disconnect engine harness connector from the pass-through connector for the BCP sensor and do steps 2 to 6.

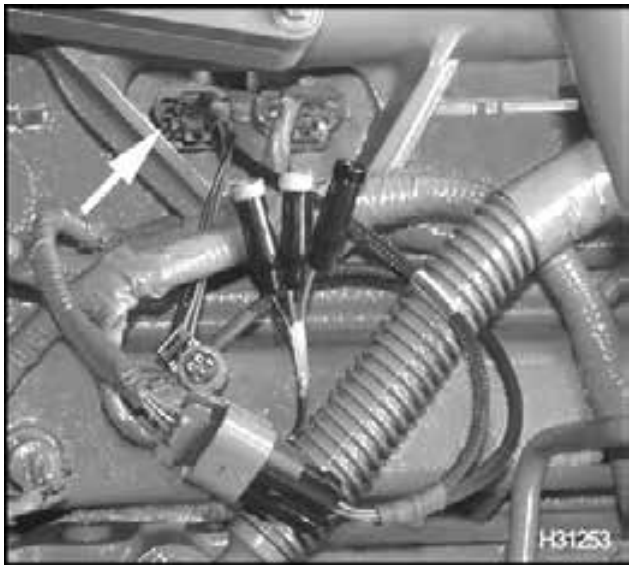


Figure 314 VC Gasket Breakout Harness to pass-through connector for BCP sensor

2. Connect VC Gasket Breakout Harness to the pass-through connector for the BCP sensor and engine harness.
3. Use DMM to measure BCP.
   - Connect POS to green (signal circuit) and NEG to black (ground circuit).

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

When routing DMM leads, do not crimp the leads, run the leads too close to moving parts, or let the leads touch hot engine surfaces.

4. Turn the ignition switch to ON. (Do not start engine.) Measure KOEO BCP signal voltage and record on Diagnostic Form.
   - If BCP signal voltage is above KOEO specification, see "BCP Sensor Operational Diagnostics" in Section 7.
   - If BCP signal voltage is in KOEO specification, continue to step 5.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

5. Run engine at low idle and compare KOEO BCP signal voltage to low idle signal voltage.
   - If BCP low idle signal voltage is more than KOEO BCP signal voltage, when engine brake is inactive, diagnose BCP sensor, circuit, and engine brake components. The BCP voltage reading should be zero psi; however, BCP values may fluctuate as much as 345 kPa (50 psi). Electromagnetic interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem.
   - If BCP low idle signal voltage is equal to KOEO BCP signal voltage, continue with step 6.
6. Run engine at high idle and compare KOEO BCP signal voltage to high idle signal voltage.
   - If BCP high idle signal voltage is more than KOEO BCP signal voltage, when engine brake is inactive, diagnose BCP sensor, circuit, and engine brake components. The BCP voltage reading should be zero psi; however, BCP values may fluctuate as much as 345 kPa (50 psi). Electromagnetic interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem.
   - If BCP high idle signal voltage is equal to KOEO BCP signal voltage, there is no problem with the BCP sensor signal or the engine brake.

©August 2008 Navistar, Inc.

11. Injector Disable Test

☐ Use EST to run injector disable diagnostics to identify suspect cylinders.

Selected cylinder	EOT	Average fuel rate	Deviation	Average engine load	Deviation
Base Line					
1					
2					
3					
4					
5					
6					
Base Line					
Cut-off values:		Fuel rate		Engine load	

- If any cylinder is suspect, do **Test 12**.

H31150

Figure 315

Purpose

To determine the cause of rough engine idle

The Injector Disable Tests can only be done with the EST; MasterDiagnostics® software is required.

The Injector Disable Tests allows the technician to shut-off injectors to determine if a specific cylinder is contributing to engine performance. Injectors can be shut off one at a time, alternative cylinders at a time or alternative cylinders plus one.

Alternate cylinders are every other cylinder in firing order.

Firing order: 1–5–3–6–2–4

When all cylinders are active, the contribution of each cylinder is 17% of its overall effect to maintain governed speed. When three cylinders are shut off, contribution of each remaining cylinder is 33% of its overall effect to maintain governed speed. The technician should monitor fuel rate and engine load.

NOTE: The Relative Compression Test 12 should be done after doing the Injector Disable Test 11 to distinguish between an injector or mechanical problem.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

NOTE: Before doing the Automatic Test or Manual Test for injector disable, make sure Tests 1 through 10 were completed and the following conditions are maintained:

- Make sure accessories are turned off. (Example – engine fan and air conditioning) Items cycled during this test could corrupt the test results.
- Maintain engine idle.
- Keep EOT within a 2 °C (5 °F) range from the beginning to the end of the test. EOT affects injection timing; too much of a change in EOT temperature could corrupt the test results.

Automatic Test – Auto Run

The Automatic Test is best done when comparing cylinder to cylinder test data.

NOTE: If MasterDiagnostics® software does not have the Automatic Test (auto run feature), Injector Disable – Manual Test in Section 3 for procedure to compare cylinder to cylinder.

NOTE: Do KOER Standard test before doing this test.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

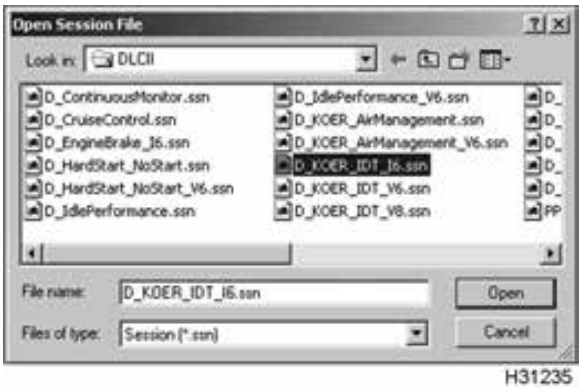


Figure 316 KOER IDT I6 .ssn

1. While engine is running, open D_KOER_ IDT_ I6.ssn to monitor engine operation.

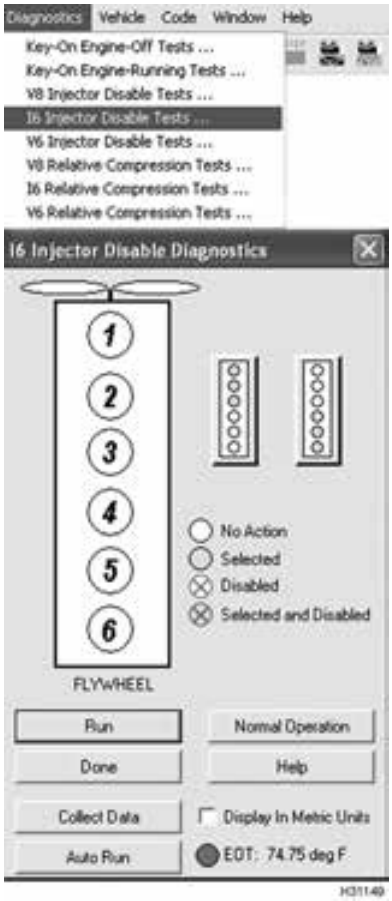


Figure 317 Injector Disable Tests

2. Select Diagnostics from menu bar.
3. Select I6 Injector Disable Test from drop down menu.

   NOTE: The EOT indicator will change from red to green when engine temperature reaches 70 °C (158 °F) or higher.

   - If the EOT indicator is red, erroneous comparisons are likely from cylinder to cylinder.

     However, when diagnosing a cold misfire, a technician can listen to tone changes from cylinder-to-cylinder.

   - When the EOT indicator is green and the engine temperature is 70 °C (158 °F) or higher, fuel rate and timing are more stable, making comparisons from cylinder to cylinder more accurate. Overall engine operation is more stable.

4. Select Auto Run.

   NOTE: While running the engine, listen for sound variations from cylinder to cylinder.

   NOTE: If any injectors are removed and reinstalled or replaced, test drive vehicle for 20 miles before checking for misfire or rough idle.

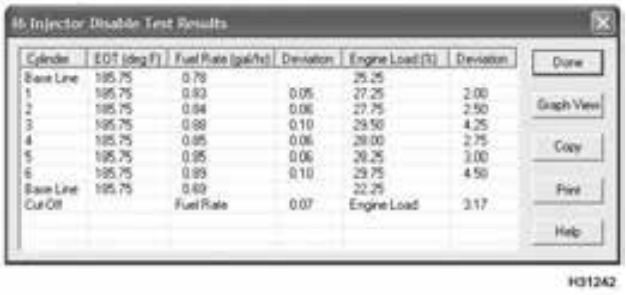


Figure 318 I6 Injector Disable Test Results (Auto Run – Text View)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

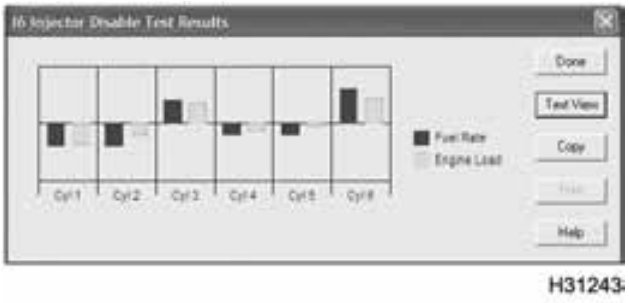


Figure 319 I6 Injector Disable Test Results (Auto Run – Graph View)

During Auto Run, injectors are shut off one at a time (1 through 6 in numerical sequence). Baseline data and results for each cylinder is displayed in the window (Text View) for I6 Injector Disable Test Results. Test data for each injector can also be viewed by selecting the (Graph View).

5. Record data from window (Text View) on Diagnostic Form.
   - If deviation values for average fuel rate and average engine load are less than the cut off values for fuel rate and engine load, the injector is suspect for weak cylinder contribution.
   - If only one deviation value is less than a cut off value, do not suspect that cylinder.
   - If a suspect cylinder(s) is identified, do Test 12 Relative Compression to distinguish between an injector or mechanical problem.
   - If Test 12 shows that cylinders are mechanically sound, but the Injector Disable Test shows that one or more cylinders are bad, continue with step 6.
6. Remove valve cover following procedure in *Engine Service Manual*.
7. Replace faulty injector(s) following procedures in the *Engine Service Manual.*
8. Test drive vehicle for 20 miles to purge air from ICP system and fuel supply system. Check for rough idle.
9. If rough idle continues, do the Injector Disable Test again.

Possible Causes

- Failed connection from wiring harness to injector solenoid
- Open or shorted wiring harness to injector solenoid
- Failed solenoid on fuel injector
- Scuffed or damaged injector
- Failed IDM
- Failed ECM

Manual Test

The Manual Test is best done when diagnosing each cylinder for cold misfire, considering EOT changes.

The EOT indicator will change from red to green when engine temperature reaches 70 °C (158 °F) or higher.

- If the EOT indicator is red, erroneous comparisons are likely from cylinder to cylinder.

  However, when diagnosing a cold misfire, a technician can listen to tone changes from cylinder-to-cylinder.
- When the EOT indicator is green and the engine temperature is 70 °C (158 °F) or higher, fuel rate and timing are more stable, making comparisons from cylinder to cylinder more accurate. Overall engine operation is more stable.

Shut off one injector at a time and listen for changes in exhaust tone.

NOTE: If any injectors are removed and reinstalled or replaced, test drive vehicle for 20 miles before checking for misfire or rough idle.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

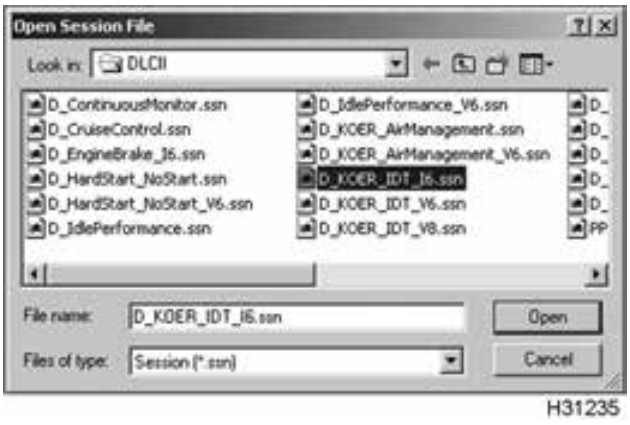


Figure 320 KOER IDT I6 .ssn

1. While engine is running, open D_ KOER_IDT_I6.ssn. to monitor engine operation.

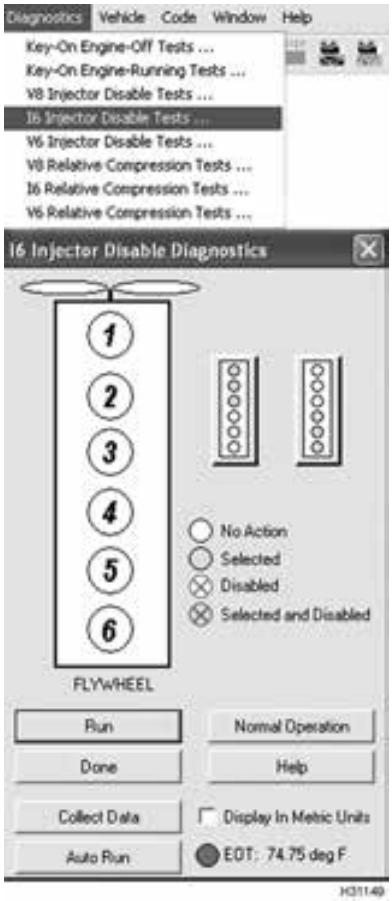


Figure 321 Injector Disable Test

2. Select Diagnostics from menu bar.
3. Select I6 Injector Disable Test from drop down menu.

   NOTE: The EOT indicator will change from red to green when engine temperature reaches 70 °C (158 °F) or higher.

   - If the EOT indicator is red, erroneous comparisons are likely from cylinder to cylinder.
   - When the EOT indicator is green and the engine temperature is 70 °C (158 °F) or higher, fuel rate and timing are more stable, making comparisons from cylinder to cylinder more accurate. Overall engine operation is more stable.
4. Select cylinder number and select Run. (Injector selected will be disabled and engine noise should change.)
5. Select Normal Operation. Injector will be enabled and engine noise should return to previous state of operation.
6. Repeat steps 4 and 5 for the remaining cylinders.

   NOTE: Listen for tone changes from cylinder to cylinder.

   NOTE: If any injectors are removed and reinstalled or replaced, test drive vehicle for 20 miles before checking for misfire or rough idle.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

12. Relative Compression

☐ Turn ignition key to ON.
☐ Use EST to run Relative Compression Test.
☐ Crank engine following EST instructions on screen.

Cylinder Compression Test	Value
Cylinder 1 Relative Compression	
Cylinder 2 Relative Compression	
Cylinder 3 Relative Compression	
Cylinder 4 Relative Compression	
Cylinder 5 Relative Compression	
Cylinder 6 Relative Compression	

- If a Relative Compression Test and Injector Disable Test identify a suspect cylinder, check for a mechanical problem.
- If a Relative Compression Test does not identify a suspect cylinder, but the Injector Disable Test does, replace suspect injector(s).

H31151

Figure 322

Purpose

To determine if compression is too low in any cylinder

NOTE: During this test the IDM shuts off the injectors so no fueling occurs.

NOTE: This test can only be done with the EST; MasterDiagnostics® software is required.

NOTE: This test is used in conjunction with the Injector Disable Test to distinguish between an injector problem or a mechanical problem.

The Relative Compression Test provides the difference between the fastest and slowest crankshaft speed during the power stroke of each cylinder.

As the engine is cranked, the IDM uses the cam and crank sensor signals to measure crankshaft speed, as piston reaches two points: Top Dead Center (TDC) compression and about 30 degrees after TDC compression.

When the piston approaches TDC, crankshaft speed should be slower because of compression resistance. As the piston passes TDC, compression resistance dissipates and crankshaft speed increases.

At TDC compression, the cylinder reaches its highest compression and resistance to crankshaft rotation — Crankshaft speed is the slowest. A cylinder with low compression will have less resistance to crankshaft rotation. Crankshaft speed will be faster than normal.

About 30 degrees after TDC, crankshaft speed should be fastest because compression has dissipated. On a cylinder that has low compression, crankshaft speed will be close to, or less than crankshaft speed at TDC.

At TDC of each power cylinder, and about 30 degrees past TDC, the IDM collects data for crankshaft speed.

NOTE: If not cranked long enough to collect data, the EST will display 255. 255 represents an erroneous rpm value

The TDC value is subtracted from the value about 30 degrees after TDC and recorded for each cylinder.

Example: 200 rpm (30 degrees after TDC) - 180 rpm (TDC) = 20 rpm

The EST will display a value on the screen for each cylinder, as typified by the following example.

Relative Compression Test	Value
Cylinder 1 Relative Compression	18
Cylinder 2 Relative Compression	22
Cylinder 3 Relative Compression	24
Cylinder 4 Relative Compression	20
Cylinder 5 Relative Compression	21
Cylinder 6 Relative Compression	22

H31310

Figure 323

Compare the compression values of each cylinder with the other cylinder values. A cylinder with compression lower than the other cylinders indicates a suspect cylinder. Test value of 18 for cylinder one indicates a suspect cylinder.

If a cylinder value is zero or a much lower than other cylinders and this cylinder is a non-contributor (identified in the Injector Disable Test), check for a mechanical problem.

Example

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Relative Compression Test	Value
Cylinder 1 Relative Compression	5
Cylinder 2 Relative Compression	22
Cylinder 3 Relative Compression	24
Cylinder 4 Relative Compression	20
Cylinder 5 Relative Compression	21
Cylinder 6 Relative Compression	0

H31311

If TDC rpm is greater than rpm 30 degrees after TDC, the EST will display 0.

If the test value for a power cylinder is 0, the cylinder is suspect.

If the test value for a power cylinder is significantly below 15 rpm, the cylinder is suspect.

Test value 5 for cylinder 1 indicates a suspect cylinder. Test value 0 for cylinder 6 indicates a suspect cylinder.

When the Relative Compression test is done, the EST indicates, stop cranking the engine, and will display test values.

Test data displayed in this test should be compared with data collected from the Injector Disable test.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: Batteries must be fully charged before doing this test. If multiple tests are necessary, use a battery charger during this test; battery drain can be extensive.



H31236

Figure 325 Relative Compression Test

NOTE: Read and be familiar with all steps and time limits in this procedure before starting.

1. Select Diagnostics from the menu bar.
2. Select Relative Compression Tests from the drop down menu.
3. Follow the messages at the bottom of the window.
   - Turn the ignition switch to ON.
   - Select Run.

   WARNING: To avoid serious injury, possible death, or damage to the vehicle – comply with the following: After clicking Run, turn the ignition switch – within 5 seconds – to crank the engine; if not done in 5 seconds, the EST will cancel the test and the engine will start.

   - Crank engine for 15 seconds. (Another message may read Stop Cranking.) **Do not turn ignition switch to OFF**. **If the switch is turned to OFF, test results will be lost**.

   NOTE: If test results are identical to previous test results, the current test failed and the previous results were displayed.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4. Interpret results.
    - If a Relative Compression Test and Injector Disable Test identify a suspect cylinder, check for a mechanical problem.
    - If a Relative Compression Test does not identify a suspect cylinder, but the Injector Disable Test does, replace suspect injector(s).

Possible Causes

- Broken compression rings
- Leaking or bent valves
- Bent push rods
- Bent connecting rods
- Loose fuel injectors
- Scored cylinder sleeve
- Piston damage
- Incorrect valve lash adjustment

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

13. Air Management

☐ Use EST to monitor data while running Air Management Test.

DTCs found

- Correct problem causing active DTCs before continuing.

H31155

Figure 326

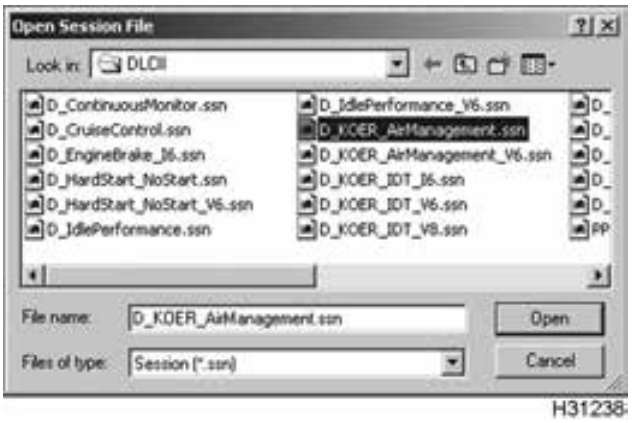


Figure 327 KOER Air Management.ssn

Purpose

To determine if intake, exhaust, VGT, and EGR systems are working correctly

NOTE: Before doing this test, make sure tests 1 through 12 were completed. Problems with other systems (injectors, fuel supply, etc.) can affect air management test results.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

NOTE: The KOEO Injector Test can only be done with the EST using MasterDiagnostics® software.

1. Open D_KOER_AirManagement.ssn to monitor engine operation.



Figure 328 Air Management Test

2. Select Diagnostics from menu bar.
3. Select Key-On Engine-Running Tests from the drop down menu.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard Test is always selected and run first. If the ignition switch is not cycled, the Standard Test does not have to be run again.

4. From the KOER Diagnostics menu, select Air Management test and select Run to start the test.

   The ECM will start the Air Management Test and command the engine to accelerate to a predetermined rpm. The ECM will monitor the effects of the VGT and EGR control valve movement using feedback signals from the EBP sensor.

   - If a problem is detected the ECM will cancel the test, set a DTC, and restore normal engine operation.

5. Record DTCs on Diagnostic Form. See “Diagnostic Trouble Codes” – Appendix C (page 643) for DTCs.
6. Correct problems causing active DTCs. To help do Test 14 VGT Test.
7. Clear DTCs.

Possible Causes

- Exhaust leaks
- Intake leaks
- Intake and exhaust restrictions
- Plugged EBP tube assembly
- Biased MAP or EBP sensor
- Failed VGT actuator
- Failed turbocharger
- Failed EGR control valve

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

14. VGT Test

☐ Use EST to toggle turbocharger operation and monitor EBP and MAP.

Duty Cycle	Yes	No
Low to medium		
Medium to high		
High to low		
Low to high		

- Did EBP and MAP change for each transition?
- If turbocharger is suspected cause of low power, see "Low Power (Turbocharger Assembly and Actuator" in Section 4 of EGES-270.

H31167

Figure 329

Purpose

To determine if EBP and MAP change, as VGT control changes

This is a manual test that allows the technician to set VGT duty to low, medium or high.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

Procedure

⚠ WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: The KOER VGT Test can only be done with the EST using MasterDiagnostics® software.

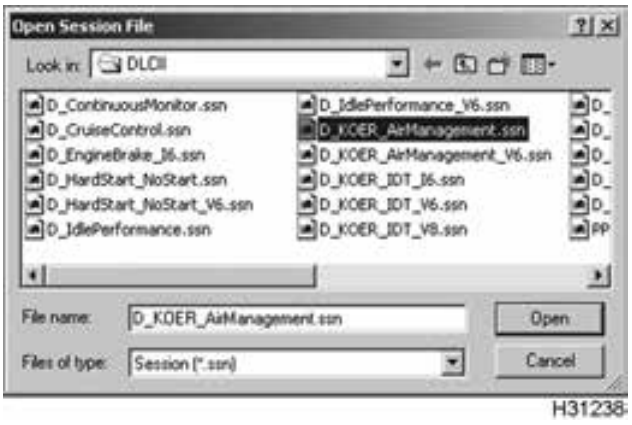


Figure 330 VGT session

1. With the engine running, select D_KOER_AirManagement.ssn from the open session file window and select OPEN to open the session. Monitor EBP and MAP at low, medium, and high duty cycle.



Figure 331

2. Select Diagnostics from the menu bar.
3. Select Key-On Engine-Running Tests from the drop down menu.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NOTE: When using the EST to do KOEO or KOER diagnostic tests, Standard Test is always selected and run first. If the ignition switch is not cycled, the Standard Test does not have to be run again.

4. From the KOER Diagnostics menu, select Low Duty cycle from VGT Tests, and select Run to start test:

   Use the suggested toggle sequence below, to check turbocharger operation from one duty cycle to the other.

   - Low to medium
   - Medium to high
   - High to low
   - Low to high

   To toggle between duty cycles, select one of the two remaining duty cycles and select Run to start.

   As the VGT duty cycle increases when toggled through the low, medium, and high duty cycles, the EBP and MAP values should increase in relationship to the VGT duty cycle. Conversely, when duty cycle is reduced, there should be a reduction to the EBP and MAP values.

   If the ECM does not receive a request from the EST, after about 40 seconds, the test will automatically end and the engine will return to normal operation.

5. Record results on Diagnostics Form.
   - Did EBP and MAP change for each transition?
     — If yes, continue to the next diagnostic test.
     — If no, turbocharger is suspect for low power condition. See “Low Power (Turbocharger Assembly and Actuator)” in Section 4.

Possible Causes

- Intake or exhaust leaks
- Intake or exhaust restrictions
- Plugged EBP tube assembly
- Biased MAP or EBP sensor
- Failed VGT actuator
- Failed turbocharger
- Failed EGR control valve

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

15. Torque Converter Stall (Automatic only)

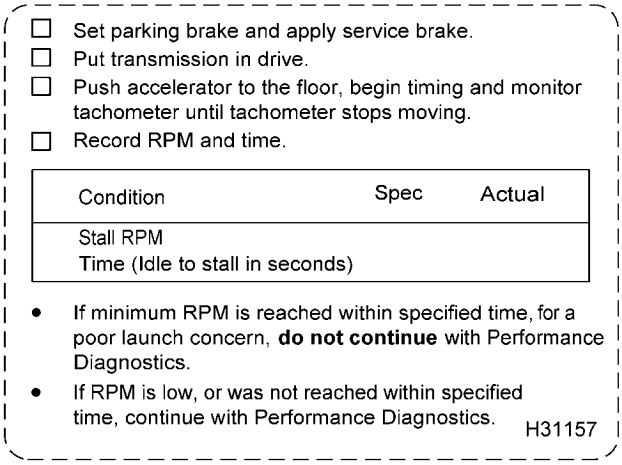


Figure 332

Purpose

To determine if the engine develops specified stall rpm within idle to stall time, when diagnosing a poor launch concern

Tools

- None

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, make sure brakes are correctly adjusted and in good condition. This procedure should be done in an open lot.

CAUTION: Avoid damage to the drive train. Do not do this test for more than 10 seconds at a time or more than twice back to back. (If doing twice – wait 2 minutes between tests.)

1. See "DT 466 Performance Specifications" – Appendix A (page 595) and "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) for specifications and record on Diagnostic Form.
2. Set parking brake and apply service brake.
3. Put transmission in drive.
4. Press accelerator pedal fully to the floor, begin timing and monitor TACH until TACH stops moving.
5. Record stall RPM and idle to stall time on Diagnostic Form.
   - If minimum RPM is reached in the specified time, with Performance Diagnostics, for a poor launch concern **do not continue** with Performance Diagnostics.
   - If RPM is low or not reached in the specified time, continue Performance Diagnostics.

Possible Causes

- Intake leaks (hoses, clamps)
- Boost leaks
- Restricted intake or exhaust
- Exhaust leaks
- Low fuel pressure
- Low ICP
- Control system faults
- Failed EGR control valve
- Inoperative fuel injectors
- Failed turbocharger
- Diamond Logic® engine brake malfunction
- Biased BAP, EBP, ICP or MAP sensors
- Power cylinder condition

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

16. Crankcase Pressure

Note: Engine coolant temperature must be above 70 °C (158 °F).

☐ Measure at road draft tube with crankcase pressure test adapter.

☐ Measure at high idle, no load.

Instrument	Spec	Actual
Magnehelic gauge or Manometer		

H31153

Figure 333

Purpose

To measure the condition of the power cylinders

Tools

- Magnehelic gauge on gauge bar or water manometer
- Crankcase pressure test adapter

Procedure

⚠ WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) for specifications and record on Diagnostic Form.
2. Park vehicle on level ground.
3. Make sure the engine oil level is not above operating range and the oil level gauge is secured.
4. Make sure breather tube is clean, secure in valve cover, and the valve cover is tight.
5. Make sure all hoses are secure and not leaking.

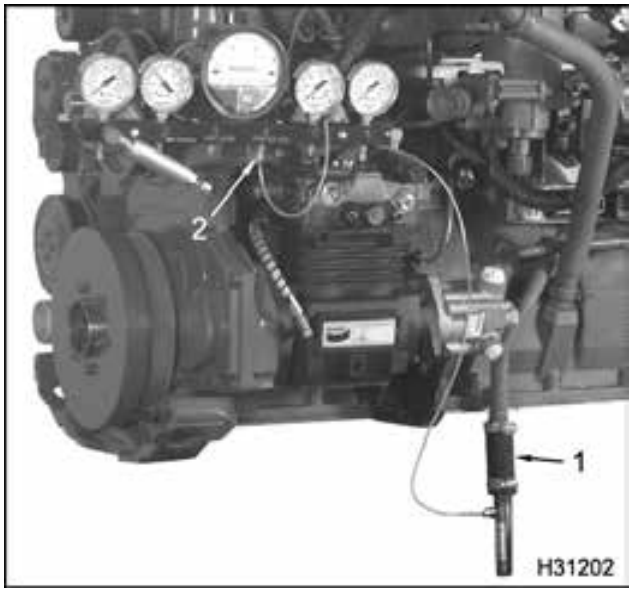


Figure 334 Test line connection to magnehelic gauge

1. Crankcase pressure test adapter
2. Test line with pressure fitting

6. Install crankcase pressure test adapter to road draft tube.

   NOTE: If the engine has a breather extension tube, the extension tube must be removed before testing.

⚠ WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

- **When routing test line , do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces.**
- **Test line must be free of fluid. Magnehelic gauge can be damaged.**

7. Connect test line from the crankcase pressure test adapter to the magnehelic gauge on the gauge bar or to a water manometer.

©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

8. Run engine to reach normal engine operating 70 °C (158 °F) or higher, before measuring crankcase pressure.
9. Run engine at high idle (no load) rpm. Allow the gauge reading to stabilize before taking pressure reading.
10. Record crankcase pressure on Diagnostic Form.
    - If pressure is below specification, continue Performance Diagnostics.
    - If pressure is above specification, continue with step 10.

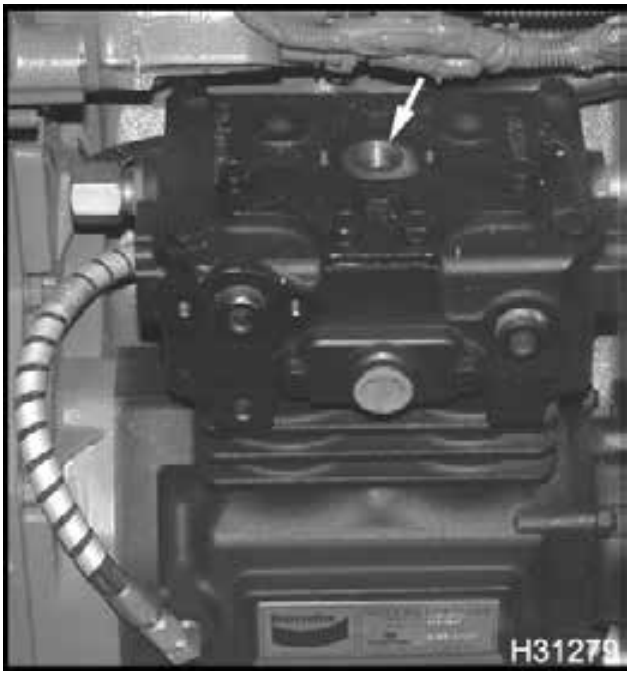


Figure 335 Discharge port

11. If engine has an air compressor, remove discharge air line and retest.
    - If pressure is below specification, repair or replace air compressor.
    - If pressure is above specification, continue with step 11.
12. Disconnect VGT control module and retest.
    - If pressure is below specification, reconnect the VGT control module, and retest doing Test 13 (Air Management) to see if crankcase pressure increases as turbocharger demand increases.

      If pressure fluctuates above and below specification, as the VGT is cycling, replace the turbocharger.
    - If disconnecting or cycling the turbocharger does not bring pressure below specification, continue with step 12.
13. Do Test 12 Relative Compression Test to pin point suspect cylinders.
14. Do Test 11 Injector Disable to further pin point suspect cylinders.
15. Inspect air induction for dirt ingestion.

Possible Causes

High oil consumption and excessive crankcase pressure may indicate the following:

- Dirt in air induction system
- Badly worn or broken rings
- Cylinder sleeves badly worn or scored
- Leaking valve seals or worn valve guides
- A restricted orifice in crankcase pressure test adapter
- Failed turbocharger
- Failed air compressor

Low oil consumption and excessive crankcase pressure may indicate the following:

- Air compressor affecting crankcase pressure.
- A restricted orifice in crankcase pressure test adapter

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

17. Test Drive (Full load, rated speed)

Monitor the following parameters during one test drive:

- Boost Pressure using EST
- Fuel Pressure using EST (optional, or mechanical gauge)
- ICP and BCP using EST

Monitoring Engine Parameters using EST and Fuel Pressure Gauge

☐ Use EST to monitor **boost pressure** and engine speed.

Condition	Spec	Spec	Actual
	Engine rpm	Boost	EST boost reading
Peak HP Peak Torque			

- If boost pressure is not to spec continue performance diagnostics. **If to spec, do not continue**.

H31156

Figure 336

☐ Measure **Fuel Pressure** at fuel rail (full load, rated speed)

☐ If equipped with optional EFP, use EST to monitor fuel pressure

Instrument/EST	Spec	Actual
0-100 psi gauge		

- If fuel pressure is low, replace fuel filter, clean strainer, and retest.
- If fuel pressure is still low, measure fuel inlet restriction at full load, rated speed.

H31158

Figure 337

☐ Use EST to monitor **ICP** and engine speed.
BCP should be zero, when engine brake is inactive.

Instrument	Spec	Actual
EST Aerated oil Yes____ No____ After 2 min. ____		

- If BCP is above zero, when engine brake is inactive, diagnose BCP sensor, circuit, and engine brake components.
- Disconnect ICP and test drive vehicle.
- If problem is corrected, see Operational Voltage checks for ICP Sensor in Section 7 in EGES270.
- If still high or unstable, replace IPR and retest.

H31267

Figure 338

Purpose

To verify engine performance at full load and rated speeds by means of maximum boost, minimum fuel pressure, and minimum injection control pressure

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Fuel Pressure Gauge
- Fuel Pressure Test Adapter
- Fuel/Oil Pressure Test Adapter

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

NOTE: If an EST is not available, use the Fuel Pressure Gauge setup in this procedure with the alternative procedure for testing boost pressure (MAP), injection control pressure (ICP), and brake control pressure (BCP) if equipped.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) for specifications and record on Diagnostic Form.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

2. Does the engine have an optional Engine Fuel Pressure (EFP) sensor?
   - If yes, the EST can record fuel pressure during the road test. Continue to step 5.
   - If no, the fuel pressure must be measured with a mechanical gauge. Continue to step 3.

CAUTION: Be sure to place a rag or suitable container under the fuel pressure test valve when bleeding the fuel rail. Dispose of fuel in a correct container clearly marked DIESEL FUEL according to local regulations.

NOTE: Engine fuel can be a threat to the environment. Never dispose of engine fuel by putting it in the trash, pouring on the ground, in the sewers, in streams, or bodies of water.



Figure 339 Shrader valve assembly

1. Valve
2. Center stem

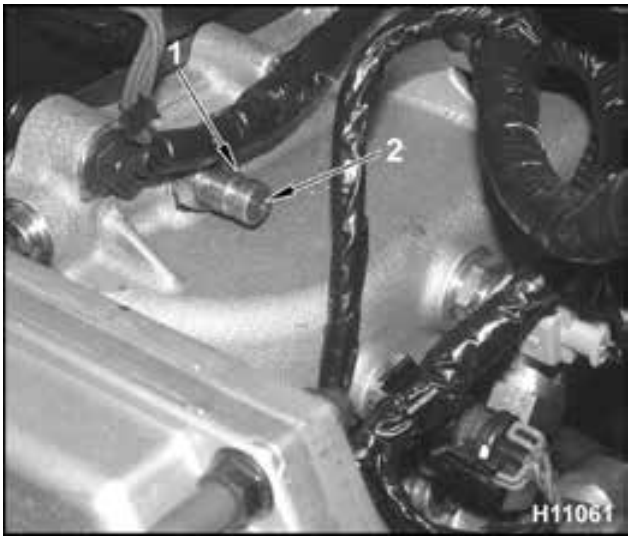


Figure 340 Diagnostic coupling

1. Valve
2. Center section

NOTE: Engines are equipped with a fuel pressure test valve in the form of either a Shrader valve or a diagnostic coupling.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

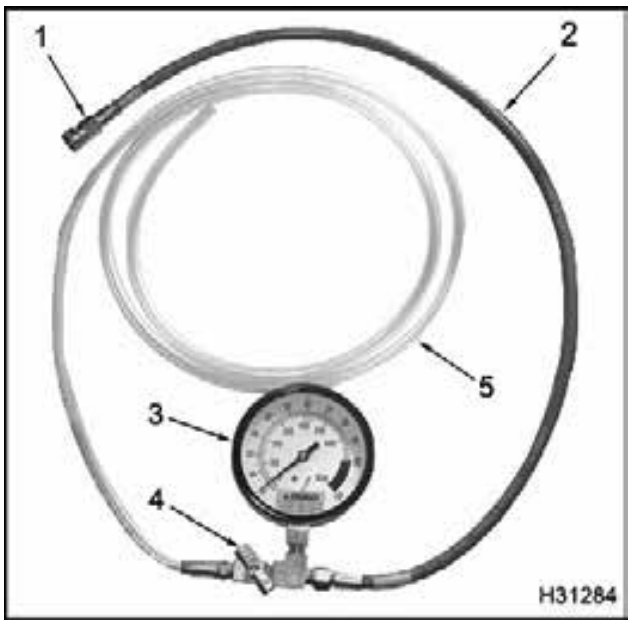


Figure 341 Fuel Pressure Gauge

1. Quick disconnect check valve
2. Fuel test line
3. Fuel Pressure Gauge
4. Inline shut-off valve
5. Clear test line



Figure 342 Fuel Pressure Test Adapter

NOTE: If the engine is equipped with a Shrader valve, use the Fuel Pressure Test Adapter.



Figure 343 Fuel/Oil Pressure Test Coupler

NOTE: If the engine is equipped with a diagnostic coupling, adapt the Fuel/Oil Pressure Test Coupler to the Fuel Pressure Gauge.

3. Connect the Fuel Pressure Gauge and shut-off valve to the intake manifold fuel pressure test port.

   NOTE: Breaking any fuel system joint will induce air into the fuel system. The air should pass in a short period of time.

4. Mount the Fuel Pressure Gauge where it can be seen from the drivers seat.

   WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

   When routing test line, do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces. Secure the gauge and test line in the cab so as not to obstruct the operator.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

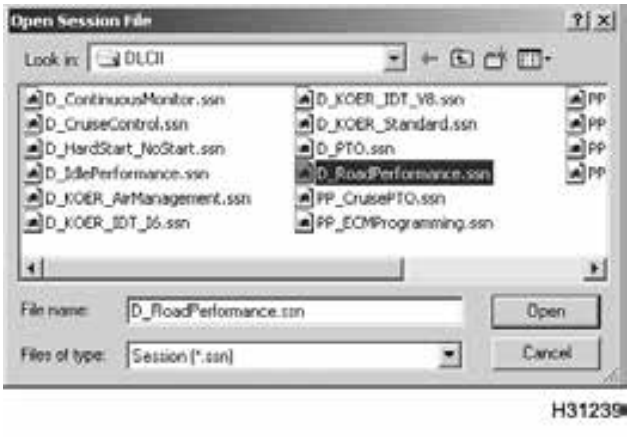


Figure 344 Road Performance. ssn

5. Open D_RoadPerformance.ssn to monitor engine operation.
6. Verify that the following are listed in the session and snapshot setup:
   - Engine Speed (rpm)
   - Engine Load (EL %)
   - Boost Pres (MAP)
   - Inject Ctrl Pres (ICP)
   - Brake Ctrl Pres (BCP) – if equipped
   - Fuel Delivery Pres (EFP) – if equipped
7. Drive vehicle and make sure engine operating temperature reaches 70 °C (158 °F) or higher.
8. Find a long, open stretch of road. When driving conditions are safe, select a suitable gear, press accelerator pedal fully to the floor, and accelerate to rated speed at 100% load. Start the snapshot and, if a gauge is being used, monitor fuel pressure.
9. After the test is complete, park the vehicle. Replay the snapshot by selecting the following:
   - Engine Speed (rpm)
   - Engine Load (EL %)
   - Boost Pres (MAP)
   - Inject Ctrl Pres (ICP)
   - Brake Ctrl Pres (BCP) – if equipped
   - Fuel Delivery Pres (EFP) – if equipped
10. Record results on Diagnostic Form.
11. Review the results of boost pressure.
    - If boost pressure is in specification, vehicle does not have a Performance Diagnostics problem at this time. The issue and symptoms should be discussed with customer.
    - If boost pressure is not to specification, continue to step 12.
12. Review the results of fuel pressure.
    - If fuel pressure is in specification, continue with step 13.
    - If fuel pressure is below specification, replace the filter, clean the strainer, and test again.
    - If fuel pressure is still low after replacing fuel filter and cleaning the strainer, continue to “Fuel Inlet Restriction.”
13. Review the results of Inject Ctrl Pres (ICP).
    - If the injection control pressure is in specification, do not continue with ICP system diagnostics.
    - If the injection control pressure is not in specification, and **is** equipped with optional engine brake, continue to step 14.
    - If the injection control pressure is not in specification, and **is not** equipped with optional engine brake, continue to step 15.
14. Review the results of Brake Ctrl Pres (BCP).

    NOTE: BCP should be reading 0 kPa (0 psi). Values can fluctuate as high as 345 kPa (50 psi). Electromagnetic Interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem.

    - If BCP is in specification, continue to step 15.
    - If BCP is not zero when engine brake is inactive, diagnose the BCP sensor, circuit, and engine brake components.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following when taking oil sample:

- **When routing oil line, do not run the line too close to moving parts.**
- **Do not let the line touch hot engine surfaces.**
- **Oil is hot. Use protective gloves when taking oil sample. Use caution handling oil sample to avoid spilling.**

WARNING: To avoid serious personal injury or possible death, do not allow engine fluids to stay on your skin. Clean your skin and nails with soap and water, or a good hand cleaner. Wash or properly throw away clothing or rags containing engine fluids. Engine fluids contain certain elements that may be unhealthy for skin and could even cause cancer.

NOTE: Engine fluids, oil, fuel, and coolant, can be a threat to the environment. Never dispose of engine fluids by putting them in the trash, pouring them on the ground, in the sewers, in streams or bodies of water. Collect and dispose of engine fluids according to local regulations.

15. Turn off engine.

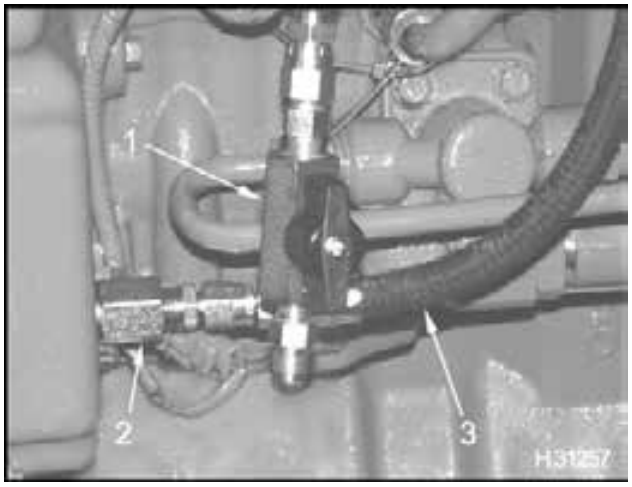


Figure 345 Test hose assembly

1. Inline shut-off valve
2. ICP system test adapter
3. Oil sample line

16. Use the ICP system test adapter and inline shut-off valve to make a test line assembly to take oil sample.

    NOTE: The mechanic is expected to keep the test line for future diagnostics. Expense the test line as an essential tool and keep it with other diagnostic tools. Warranty will not cover the cost of the test line.

17. Remove EOT sensor from EOT port. **Oil will spill out. Quickly install test hose assembly**.
18. Run engine at high idle for 2 minutes.
19. Return engine to low idle, take oil sample, and check for aerated oil.
    - If oil is aerated, a large quantity of air bubbles mixed throughout the oil, or foam build up on top of the oil will be seen. Check for cracked oil pickup tube or a missing or faulty pickup tube gasket.
    - If oil is not aerated, disconnect ICP sensor and check engine stability. If problem is corrected, see “ICP Operational Voltage Checks” in Section 7.
    - If ICP is still high or unstable, replace IPR following procedures in *Engine Service Manual* and retest.

©August 2008 Navistar, Inc.

Boost Possible Causes

• Intake leaks (hoses, clamps)	• Failed EGR control valve
• Boost leaks	• Failed EGR control valve
• Restricted intake or exhaust	• Inoperative fuel injectors
• Exhaust leaks	• Failed turbocharger
• Low fuel pressure	• Diamond Logic® engine brake malfunction
• Low ICP	• Biased BAP, EBP, ICP or MAP sensors
• Control system faults	• Power cylinder condition

Injection Control Pressure Possible Causes

Low injection control pressure	
• Injection control pressure system leakage	• Inoperative high-pressure oil pump
• Failed IPR wiring (power and control)	• Failed ICP sensor circuit
• Failed IPR valve	• Failed ICP sensor
• Failed injector	• Inoperative brake shut-off valve of Diamond Logic® engine brake
• Cracked or porous high-pressure rail	• Brake pressure relief valve (optional) If relief valve is leaking, the brake shut-off valve is suspect.
• Injector oil inlet adapter O-rings	• If ECM detect low boost pressure, an incorrect feedback signal from APS or the ICP sensor, the ECM commands the IPR valve to reduce injection control pressure.
• Injector oil inlet adapter	
• O-ring for high-pressure oil rail	
• End plugs in high-pressure oil rail	
• Low oil pressure	
High injection control pressure	
• Aerated lube oil	• Bias high ICP sensor – low duty cycle
Erratic injection control pressure	
• ICP sensor	• IPR valve
• IPR wiring	• Middle seal IPR valve
Brake control pressure	
• Failed BCP sensor circuit	• Inoperative brake shut-off valve of Diamond Logic® engine brake
• Failed BCP sensor	• Brake control pressure system leakage

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel Possible Causes

No fuel

- Low fuel level in fuel tank
- Debris in tank can cause high-restriction and low fuel pressure.
- Inline fuel valve (if equipped) could be shut-off
- Failed seals or fuel lines between fuel tanks
- Ice in fuel lines
- Inoperative fuel tank transfer pump
- Fuel tank pickup tube cracked

Low fuel pressure

- Dirty filter element
- Debris or rust in fuel strainer
- Restriction from the fuel tank to the fuel filter housing inlet can cause high-restriction and low fuel pressure.
- Plugged supplemental filters or water separators can cause high-restriction and low fuel pressure.
- Debris in tank can cause high-restriction and low fuel pressure.
- A kinked or bent fuel supply line or a blocked pickup tube can cause high-restriction and low fuel pressure.
- Waxed or jelled fuel in the fuel filter will cause high-restriction and low fuel pressure. (Usually Grade 2-D)
- Ice in fuel lines.
- A restriction between the fuel inlet fitting, strainer, and fuel pump can cause high-restriction and low fuel pressure.
- Debris in the fuel regulator valve
- Failed fuel pressure regulator valve.
- Failed fuel pump
- Failed high-pressure oil pump (can not operate fuel pump)

Aerated fuel

- Failed seal for inlet fitting in fuel filter housing
- Supply filter or water separator leaking
- A loose fuel line on the suction side of the fuel system can ingest air into the system and cause low fuel pressure (most noticeable under load).
- Strainer drain valve loose or damaged
- Strainer bowl warped or damaged
- Missing O-ring from strainer bowl
- Damaged seals on steel inlet tube to fuel pump
- Primer pump seals damaged

Fuel restriction

- Dirty filter element
- Debris or rust in fuel strainer
- Restriction from the fuel filter housing inlet to the fuel tank can cause high-restriction and low fuel pressure.
- Plugged supplemental filters or water separators can cause high-restriction and low fuel pressure.
- Debris in tank can cause high-restriction and low fuel pressure.
- A kinked or bent fuel supply line or a blocked pickup tube can cause high-restriction and low fuel pressure.
- Waxed or jelled fuel in the fuel filter will cause high-restriction and low fuel pressure. (Usually Grade 2-D)
- Ice in fuel lines.
- A restriction between the fuel inlet fitting, strainer, and fuel pump can cause high-restriction and low fuel pressure.

©August 2008 Navistar, Inc.

Fuel Possible Causes (cont.)

High fuel pressure (pulsating fuel pressure)

- Debris in the fuel regulator valve
- Inoperative fuel pressure regulator valve.
- Combustion gases leaking into fuel system

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel Inlet Restriction

NOTE: This test should only be done if fuel pressure was low during test drive.

Tools

- Gauge bar (0–30 in Hg vacuum gauge)
- Fuel/Oil Pressure Test Coupler
- Test fitting

Procedure

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) or "DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) for restriction specifications and record on Diagnostic Form.
2. Remove cap from test fitting.

   NOTE: If an O-ring plug is installed instead of a test fitting, remove O-ring plug and install Fuel Test Fitting.



Figure 346 Fuel Test Fitting

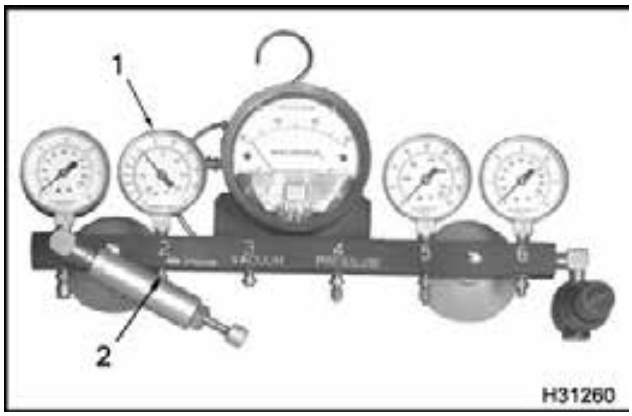


Figure 347 Test line connection to 0–30 in Hg vacuum gauge

1. 0–30 in Hg vacuum gauge
2. Test line connection

3. Connect test line to the Fuel/Oil Pressure Test Coupler and the 0–30 in Hg vacuum gauge.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When routing test line, do not crimp the line, run the line too close to moving parts, or let the line touch hot engine surfaces. Secure the gauge bar and test line in the cab so as not to obstruct the operator.

4. Route test line from cab to engine.

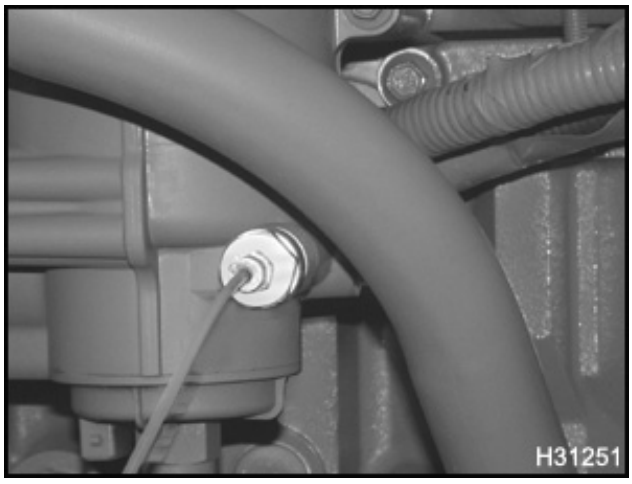


Figure 348 Fuel/oil test coupler with test line

©August 2008 Navistar, Inc.

5. Connect Fuel/Oil Test Coupler to test fitting.
6. Drive vehicle and make sure engine operating temperature reaches 70 °C (158 °F) or higher.
7. Find a long, open stretch of road.
8. When driving conditions are safe, select a suitable gear, press accelerator pedal fully to the floor, and accelerate to rated speed at 100% load.
9. Memorize gauge reading for fuel inlet restriction. After parking vehicle, record reading on Diagnostic Form; **do not record reading while driving**.
    - If inlet restriction exceeds specification, find the restriction on the suction side of the fuel system and correct.
    - If inlet restriction is to specification, but fuel pressure is below specification, test Operation of Fuel Pump in Test 6 of this section.
    - If fuel pump is operating correctly, replace fuel regulator valve.
    - If inlet restriction and fuel pressure are to specification, continue with performance diagnostics.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Monitoring Boost Pressure using Pressure Sensor Breakout Harness

NOTE: Do this test only if an EST is not available. This is an alternate method.

Tools

- Pressure Sensor Breakout Harness
- DMM

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

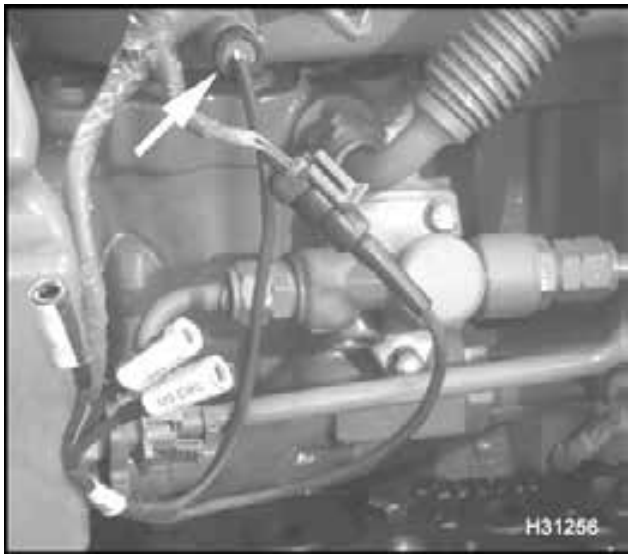


Figure 349 Pressure Sensor Breakout Harness to MAP sensor

1. See "DT 466 Performance Specifications" – Appendix A (page 595) ,"DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) or Section 7 "Operational Voltages Checks" – for specifications and record on Diagnostic Form.
2. Connect Pressure Sensor Breakout Harness to MAP sensor and engine harness.
3. Use DMM to measure MAP at rated speed and full load.
   - Connect POS to green (signal circuit) and NEG to black (ground circuit).
4. Route DMM and leads into cab.

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When routing DMM leads, do not crimp the leads, run the leads too close to moving parts, or let the leads touch hot engine surfaces. Secure the DMM and leads in the cab so as not to obstruct the operator.

5. Monitor DMM voltage signal for MAP.
6. Drive vehicle and make sure engine operating temperature reaches 70 °C (158 °F) or higher.
7. Find a long, open stretch of road.
8. When driving conditions are safe, select a suitable gear, press accelerator pedal fully to the floor, and accelerate to rated speed at 100% load.
9. Memorize DMM voltage reading for boost pressure. After parking vehicle, record reading for boost pressure on Diagnostic Form; **do not record reading while driving**.
   - If boost pressure is to specification, **do not continue** with Performance Diagnostics.
   - If boost pressure is not to specification, continue Performance Diagnostics.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Monitoring ICP using VC Gasket Breakout Harness

NOTE: Do this test only if an EST is not available. This is an alternate method.

Tools

- VC Gasket Breakout Harness
- DMM
- ICP System Test Adapter
- Oil sample line with inline shut-off valve
- Clear container (for oil sample)
- Socket or wrench (EOT sensor)

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) ,"DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) or Section 7 "Operational Voltages Checks" – for specifications and record on Diagnostic Form.

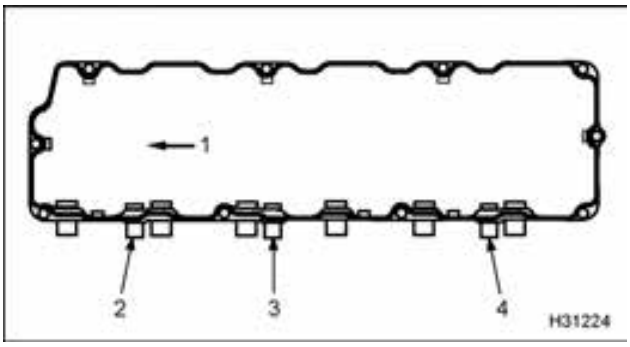


Figure 350 Valve cover gasket

1. Front of engine
2. Pass-through connector for BCP sensor
3. Pass-through connector for brake shut-off valve
4. Pass-through connector for ICP sensor

2. Disconnect engine harness connector from pass-through connector for the ICP sensor and complete steps 3 through 9.

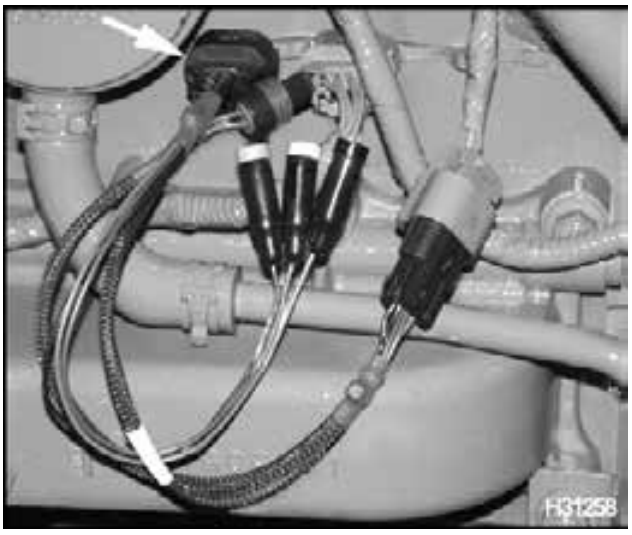


Figure 351 VC Gasket Breakout Harness to pass-through connector for ICP sensor

3. Connect VC Gasket Breakout Harness to the pass-through connector for the ICP sensor and engine harness.
4. Use DMM to measure ICP.
   - Connect POS to green (signal circuit) and NEG to black (ground circuit).

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When routing DMM leads, do not crimp the leads, run the leads too close to moving parts, or let the leads touch hot engine surfaces. Secure the DMM and leads in the cab so as not to obstruct the operator.

5. Run DMM leads into cab.
6. Drive vehicle and make sure engine operating temperature reaches 70 °C (158 °F).
7. Find a long, open stretch of road.
8. When driving conditions are safe, select a suitable gear, press accelerator pedal fully to the floor, and accelerate to rated speed at 100% load.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

9. Memorize DMM voltage for ICP. After parking vehicle, record reading on Diagnostic Form; **do not record reading while driving**.
   - If ICP is to specification, **do not continue** with ICP system diagnostics.
   - If ICP is not to specification, continue with step 10.
   - If ICP is still unstable, replace IPR valve following procedures in the *Engine Service Manual* and retest

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following when taking oil sample:

- **When routing oil line, do not run the line too close to moving parts.**
- **Do not let the line touch hot engine surfaces.**
- **Oil is hot. Use protective gloves when taking oil sample. Use caution handling oil sample to avoid spilling.**

WARNING: To avoid serious personal injury or possible death, do not allow engine fluids to stay on your skin. Clean your skin and nails with soap and water, or a good hand cleaner. Wash or properly throw away clothing or rags containing engine fluids. Engine fluids contain certain elements that may be unhealthy for skin and could even cause cancer.

NOTE: Engine fluids, oil, fuel, and coolant, can be a threat to the environment. Never dispose of engine fluids by putting them in the trash, pouring them on the ground, in the sewers, in streams or bodies of water. Collect and dispose of engine fluids according to local regulations.

10. Turn off engine.

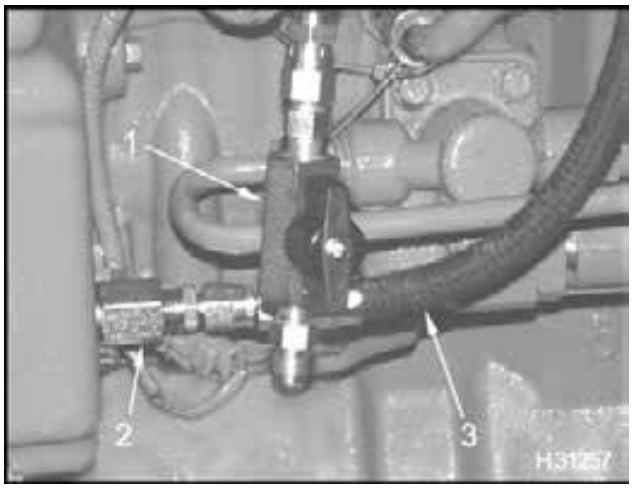


Figure 352 Test hose assembly

1. Inline shut-off valve
2. ICP system test adapter
3. Oil sample line

11. Use the ICP system test adapter and inline shut-off valve to make a test line assembly to take oil sample.

    NOTE: The mechanic is expected to keep the test line for future diagnostics. Expense the test line as an essential tool and keep it with other diagnostic tools. Warranty will not cover the cost of the test line.

12. Remove EOT sensor from EOT port. **Oil will spill out. Quickly install test hose assembly**.
13. Run engine at high idle for 2 minutes. Record ICP initially as high idle is set, then again after 2 minutes. Compare the two ICP readings. ICP that rises above the spec, at any point during the two minutes, indicates aeration.
14. Return engine to low idle, take oil sample, and check for aerated oil.
    - If oil is aerated, a large quantity of air bubbles mixed throughout the oil, or foam build up on top of the oil will be seen. Correct condition.
    - If oil is not aerated, disconnect ICP sensor and check engine stability. If problem is corrected, see “ICP Operational Voltage Checks” in Section 7.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- If ICP is still high or unstable, replace IPR following procedures in *Engine Service Manual* and retest.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Monitoring BCP using VC Gasket Breakout Harness

NOTE: Do this procedure, if an EST is not available. This is an alternate method.

Tools

- VC Gasket Breakout Harness
- DMM

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

1. See "DT 466 Performance Specifications" – Appendix A (page 595) ,"DT 570 and HT 570 Performance Specifications" – Appendix B (page 619) or Section 7 "Operational Voltages Checks" – for specifications and record on Diagnostic Form.

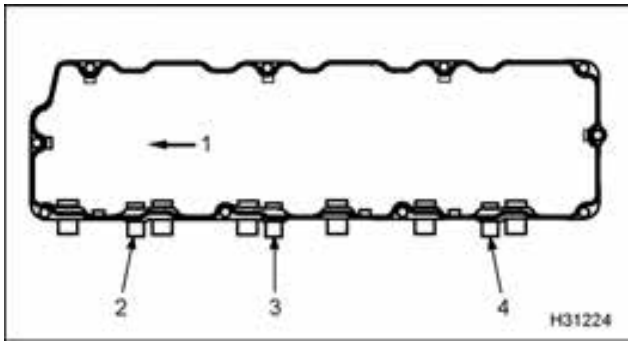


Figure 353 Valve cover gasket

1. Front of engine
2. Pass-through connector for BCP sensor
3. Pass-through connector for brake shut-off valve
4. Pass-through connector for ICP sensor

2. Disconnect engine harness connector from the pass-through connector for the BCP sensor and complete steps 3 through 9.



Figure 354 VC Gasket Breakout Harness to pass-through connector for BCP sensor

3. Connect VC Gasket Breakout Harness to the pass-through connector for the BCP sensor and engine harness.
4. Use DMM to measure BCP.
   - Connect POS to green (signal circuit) and NEG to black (ground circuit).

WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle – comply with the following:

When routing DMM leads, do not crimp the leads, run the leads too close to moving parts, or let the leads touch hot engine surfaces. Secure the DMM and leads in the cab so as not to obstruct the operator.

5. Run DMM leads into cab.
6. Drive vehicle and make sure engine operating temperature reaches 70 °C (158 °F).
7. Find a long, open stretch of road.
8. When driving conditions are safe, select a suitable gear, press accelerator pedal fully to the floor, and accelerate to rated speed at 100% load.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

9. Memorize DMM voltage for BCP. After parking vehicle, record reading on Diagnostic Form; **do not record reading while driving**.

   - If BCP signal voltage is more than KOEO BCP signal voltage, when engine brake is inactive, diagnose BCP sensor, circuit, and engine brake components. The BCP voltage reading should be zero psi; however, BCP values may fluctuate as much as 345 kPa (50 psi). Electromagnetic Interference (EMI) or ground shift can cause an insignificant voltage shift that does not indicate a problem.
   - If BCP signal voltage is equal to KOEO BCP signal voltage, there is no problem with the BCP sensor signal or the engine brake.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

18. Valve Lash and Brake Lash



Figure 355

NOTE: If Tests 1-17 meet specifications, engine operation is good: Test 18 is not necessary.

☐ Valve lash and engine brake actuator lash:
Engine OFF - Cold.

Instrument	Spec	Actual
Feeler gauge	0.019 in	

H31154

Figure 356

Purpose

- To check or adjust valve lash for intake and exhaust valves
- To check or adjust actuator lash for Diamond Logic® engine brake

Tools

- Feeler gauge
- Straight-blade screwdriver
- Open end wrench (two sizes)
- Torque wrench
- Crows foot (two sizes)

⚠ WARNING: To avoid serious personal injury, possible death or damage to the engine or vehicle, read all safety instructions in the "Safety Information" section of this manual.

Valve Lash for Intake and Exhaust Valves

During the procedure to adjust valve lash, the crankshaft is rotated two times:

- Six valve adjustments are made when piston 1 is at Top Dead Center (TDC) compression.
- Six valve adjustments are made when piston 6 is at Top Dead Center (TDC) compression.

If the engine is equipped with the Diamond Logic® engine brake, corresponding brake actuator lash can be adjusted before rotating the crankshaft the second time.

Adjusting Valve Lash

1. Remove valve cover following procedure in *Engine Service Manual*.
2. Turn crankshaft in the direction of engine rotation to remove gear lash from gear train and align the timing mark on the damper pulley with the TDC mark on the front cover.
3. Confirm that piston 1 is at TDC compression by turning both push rods by hand to verify that valves are closed.
   - If push rods are loose and turn easily, piston 1 is at TDC compression and valves are closed. If piston 1 is at TDC compression, see and do steps 4, 5, and 6.
   - If push rods will not turn easily for cylinder 1, piston 6 is at TDC compression. Confirm that valves are closed by making sure that push rods for cylinder 6 are loose and turn easily. If piston 6 is at TDC compression, see and do steps 4, 5, and 6.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Valve and brake lash adjustments (Inches) with piston 1 at TDC compression											
Cylinder 1		Cylinder 2		Cylinder 3		Cylinder 4		Cylinder 5		Cylinder 6	
Intake 1	Exhaust 2	Intake 3	Exhaust 4	Intake 5	Exhaust 6	Intake 7	Exhaust 8	Intake 9	Exhaust 10	Intake 11	Exhaust 12
0.019	0.019	0.019			0.019	0.019			0.019		
Brake	0.019			Brake	0.019			Brake	0.019		

H08044

Figure 357 Valve lash adjustments with piston 1 at TDC compression

Valve and brake lash adjustments (Inches) with piston 6 at TDC compression											
Cylinder 1		Cylinder 2		Cylinder 3		Cylinder 4		Cylinder 5		Cylinder 6	
Intake 1	Exhaust 2	Intake 3	Exhaust 4	Intake 5	Exhaust 6	Intake 7	Exhaust 8	Intake 9	Exhaust 10	Intake 11	Exhaust 12
			0.019	0.019			0.019	0.019		0.019	0.019
		Brake	0.019			Brake	0.019			Brake	0.019

H08045

Figure 358 Valve lash adjustments with piston 6 at TDC compression

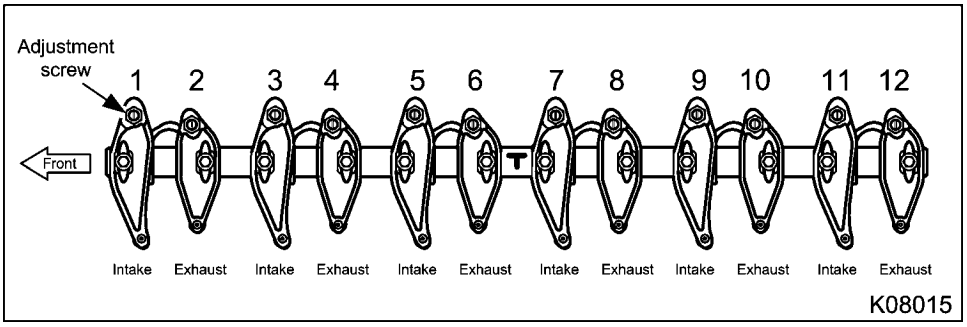


Figure 359 Valve lash adjustment

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

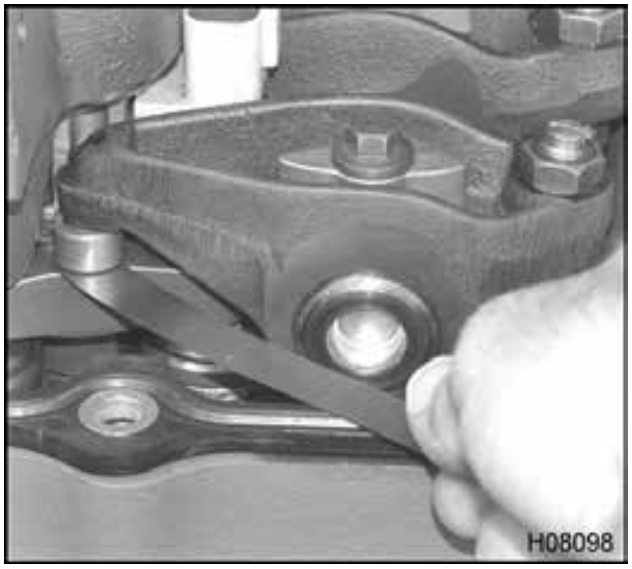


Figure 360 Feeler gauge between the pivot foot and valve bridge

4. Check cold valve lash with a (0.019 in) feeler gauge between the pivot foot and valve bridge. If adjustment is required, loosen the locknut and turn the valve adjustment screw until a light drag is felt.
5. Once valve adjustment is set, tighten the locknut to 27 N·m (20 lbf·ft) and remove the feeler gauge. Recheck for light drag on feeler gauge. If drag is too tight or loose, repeat steps 4 and 5.

   If engine is equipped with the Diamond Logic® engine brake, corresponding brake actuator lash can be adjusted before rotating the crankshaft. See “Brake Actuator Lash” in this section.
6. Turn crankshaft 360° in the direction of engine rotation to remove gear lash from gear train and realign the timing mark on the damper pulley with the TDC mark on the front cover.
   - If first adjustments were with piston 1 at TDC compression, cylinder 6 should be at TDC compression. Confirm that valves are closed by making sure that push rods for cylinder 6 are loose and turn easily. If piston 6 is at TDC compression, see and do steps 4 and 5.
   - If first adjustments were with piston 6 at TDC compression, cylinder 1 should be at TDC compression. Confirm that valves are closed by making sure that push rods for cylinder 1 are loose and turn easily. If piston 1 is at TDC compression, see and do steps 4 and 5.

   Before doing step 7, If engine is equipped with the Diamond Logic® engine brake corresponding brake actuator lash can be adjusted. See “Brake Actuator Lash” in this section.
7. Install valve cover following procedure in *Engine Service Manual*.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Brake Lash

- Three actuators are adjusted when piston 1 is at Top Dead Center (TDC) compression.
- Three actuators are adjusted when piston 6 is at Top Dead Center (TDC) compression.

Corresponding intake and exhaust valve lash should be adjusted before rotating the crankshaft.

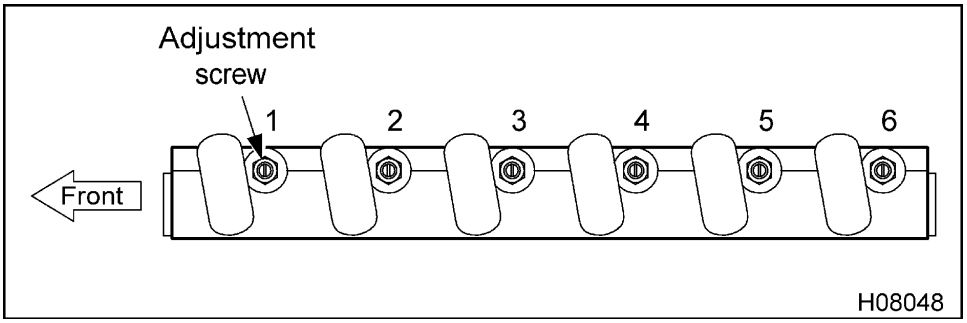


Figure 361 Brake lash adjustment

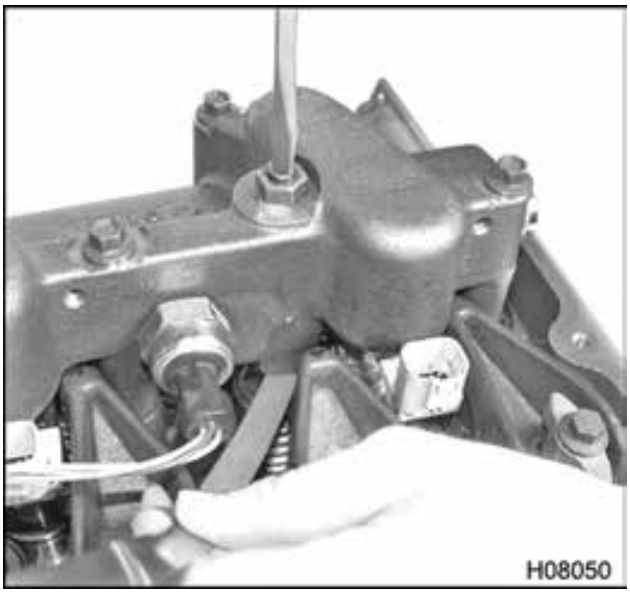


Figure 362 Feeler gauge between the valve bridge and brake actuator

1. Check cold brake lash with a (0.019 in) feeler gauge between the actuator and valve bridge. If adjustment is required, loosen the locknut and turn the actuator adjustment screw until a light drag is felt.
2. Once brake lash is set, tighten the locknut to 27 N·m (20 lbf·ft) and remove the feeler gauge. Recheck for light drag on feeler gauge. If drag is too tight or loose, repeat steps 1 and 2.

Possible Causes

- Worn valve train
- Worn valve seat or valve face
- Worn actuator in Diamond Logic® engine brake

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Table of Contents

Description....283
Section Information....283

Electronic Control System Diagnostics Form....284
EGED-285 Diagnostic Form Example....284

Sensor and Actuator Locations....285
Engine Mounted Components....285
Vehicle Mounted Components....288

Diagnostic Procedures for Sensors and Actuators....288
Pin Grip Inspection....288
Operational Diagnostics....289
V_{REF} Tests using MasterDiagnostics®....289
Temperature Sensor Tests using MasterDiagnostics®....289
Pin-Point Diagnostics....290
Connector Voltage Checks to Ground....290
Connector Resistance Checks to ECM Chassis Ground....290
Connector Resistance Checks to Chassis Ground....291
Harness Resistance Checks....292
Operational Voltage Checks....292

Circuit Diagnostics....293
AMS (Air Management System)....293
AMS Operation....294
APS/IVS (Accelerator Position Sensor and Idle Validation Switch)....300
APS/IVS Circuit Operation....301
APS/IVS Operational Diagnostics....304
APS/IVS Pin-Point Diagnostics....306
ATA Datalink (American Trucking Association)....309
ATA Circuit Operation....310
ATA Pin-Point Diagnostics....312
BAP Sensor (Barometric Absolute Pressure)....314
BAP Circuit Operation....315
BAP Pin-Point Diagnostics....316
BCP Sensor (Brake Control Pressure)....318
BCP Circuit Operation....320
BCP Operational Diagnostics....322
BCP Pin-Point Diagnostics (ECM to Valve Cover Gasket Connector)....328
BCP Pin-Point Diagnostics (ECM to BCP Sensor– valve cover removed)....333
Brake Shut-off Valve....334
Brake Shut-off Valve Circuit Operation....336
Brake Shut-off Valve Pin-Point Diagnostics (ECM to valve cover gasket connector)...338
Brake Shut-off Valve Pin-Point Diagnostics (ECM to brake valve – valve cover removed)....344
Brake Switch Circuit....347

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Brake Switch Operation.....347
CAN Communications (Controller Area Network).....348
CAN Pin-Point Diagnostics.....349
CKP Sensor (Crankshaft Position).....351
CKP Circuit Operation.....352
CKP Pin-Point Diagnostics.....353
CMP Sensor (Camshaft Position).....355
CMP Circuit Operation.....356
CMP Pin-Point Diagnostics.....357
EBP Sensor (Exhaust Back Pressure).....359
EBP Circuit Operation..... 360
EBP Operational Diagnostics.....361
EBP Pin-Point Diagnostics.....364
ECI System (Engine Crank Inhibit).....366
ECI Circuit Diagnostics.....368
ECL Sensor (Engine Coolant Level).....370
ECL Circuit Operation.....371
ECL Pin-Point Diagnostics.....372
ECM / IDM Communications (Electronic Control Module / Injector Driver Module).....373
ECM / IDM Circuit Operation.....374
ECM / IDM Pin-Point Diagnostics.....376
ECM PWR (Electronic Control Module Power).....381
ECM PWR Circuit Operation.....382
ECM PWR Pin-Point Diagnostics.....384
ECM Self Diagnostics (Electronic Control Module).....388
ECM Self Diagnostic Trouble Codes (DTCs).....389
ECT Sensor (Engine Coolant Temperature).....391
ECT Circuit Operation.....393
ECT Operational Diagnostics.....394
ECT Pin-Point Diagnostics.....396
EFAN Control (Engine Fan Control).....398
Fan Clutch Circuit Operation.....399
Fan Clutch Pin-Point Diagnostics.....400
Fan Air Solenoid Circuit Operation.....403
Fan Air Solenoid Pin-Point Diagnostics.....404
EFP Sensor (Engine Fuel Pressure – optional).....406
EFP Circuit Operation.....407
EFP Operational Diagnostics.....408
EFP Pin-Point Diagnostics.....410
EGR Actuator (Exhaust Gas Recirculation).....413
EGR Circuit Operation.....414
EGR Pin-Point Diagnostics.....417
EOP Sensor (Engine Oil Pressure).....426
EOP Circuit Operation.....427
EOP Operational Diagnostics.....428
EOP Pin-Point Diagnostics.....431
EOT Sensor (Engine Oil Temperature).....433
EOT Circuit Operation..... 434
EOT Operational Diagnostics.....436
EOT Pin-Point Diagnostics.....438
EWPS (Engine Warning and Protection System).....440

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EWPS Operational Diagnostics....441
IAH System (Inlet Air Heater)....444
IAH Circuit Operation....445
IAH Pin-Point Diagnostics....447
IAT Sensor (Intake Air Temperature)....451
IAT Circuit Operation....452
IAT Operational Diagnostics....453
IAT Pin-Point Diagnostics....455
ICP Sensor (Injection Control Pressure)....457
ICP Circuit Operation....458
ICP Operational Diagnostics....460
ICP Pin-Point Diagnostics (ECM to valve cover gasket connector)....465
ICP Pin-Point Diagnostics (ECM to ICP Sensor– valve cover removed)....469
ICP System (Injection Control Pressure)....472
ICP System Operation....472
IDM PWR (Injection Driver Module Power)....479
IDM PWR Circuit Operation....480
IDM PWR Pin-Point Diagnostics....482
INJ Circuits (Injector Drive)....489
INJ Circuit Operation....489
INJ Pin-Point Diagnostics....490
IPR (Injection Pressure Regulator)....494
IPR Circuit Operation....495
IPR Pin-Point Diagnostics....496
IST System (Idle Shutdown Timer)....497
IST Operation....497
MAP Sensor (Manifold Absolute Pressure)....500
MAP Circuit Operation....501
MAP Operational Diagnostics....503
MAP Pin-Point Diagnostics....505
MAT Sensor (Manifold Air Temperature)....508
MAT Circuit Operation....509
MAT Operational Diagnostics....510
MAT Pin-Point Diagnostics....512
RSE (Radiator Shutter Enable)....514
RSE Circuit Operation....515
RSE Pin-Point Diagnostics....516
SCCS (Speed Control Command Switches)....519
SCCS Circuit Operation....519
Tachometer Output Circuit....522
Tachometer Pin-Point Diagnostics....523
VGT Actuator (Variable Geometry Turbocharger)....524
VGT Circuit Operation....526
VGT Pin-Point Diagnostics....528
V_{REF} (Reference Voltage)....539
V_{REF} Circuit Operation....540
V_{REF} Pin-Point Diagnostics....542
VSS (Vehicle Speed Sensor)....544
VSS Circuit Operation (Manual and Allison Transmissions)....545
VSS Pin-Point Diagnostics (Manual Transmissions)....547
VSS Pin-Point Diagnostics (Allison Transmissions)....549

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WIF Sensor (Water in Fuel)....550
WIF Circuit Operation....551
WIF Pin-Point Diagnostics....552

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Description

Section Information

The following diagnostic information is included in this section:

- Sensor and actuator locations
- Sensor and actuator tests
- Diagnostic procedures for sensors and actuators
- Pin-point diagnostics
- Circuit diagnostics – Circuit diagnostics pertain to a specific ECM circuit and has the following structure:
  - Function diagram and text
  - Circuit diagram and diagnostic tests to diagnose Diagnostic Trouble Codes (DTCs) and verify circuit functions

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Electronic Control System Diagnostics Form

EGED-285 Diagnostic Form Example

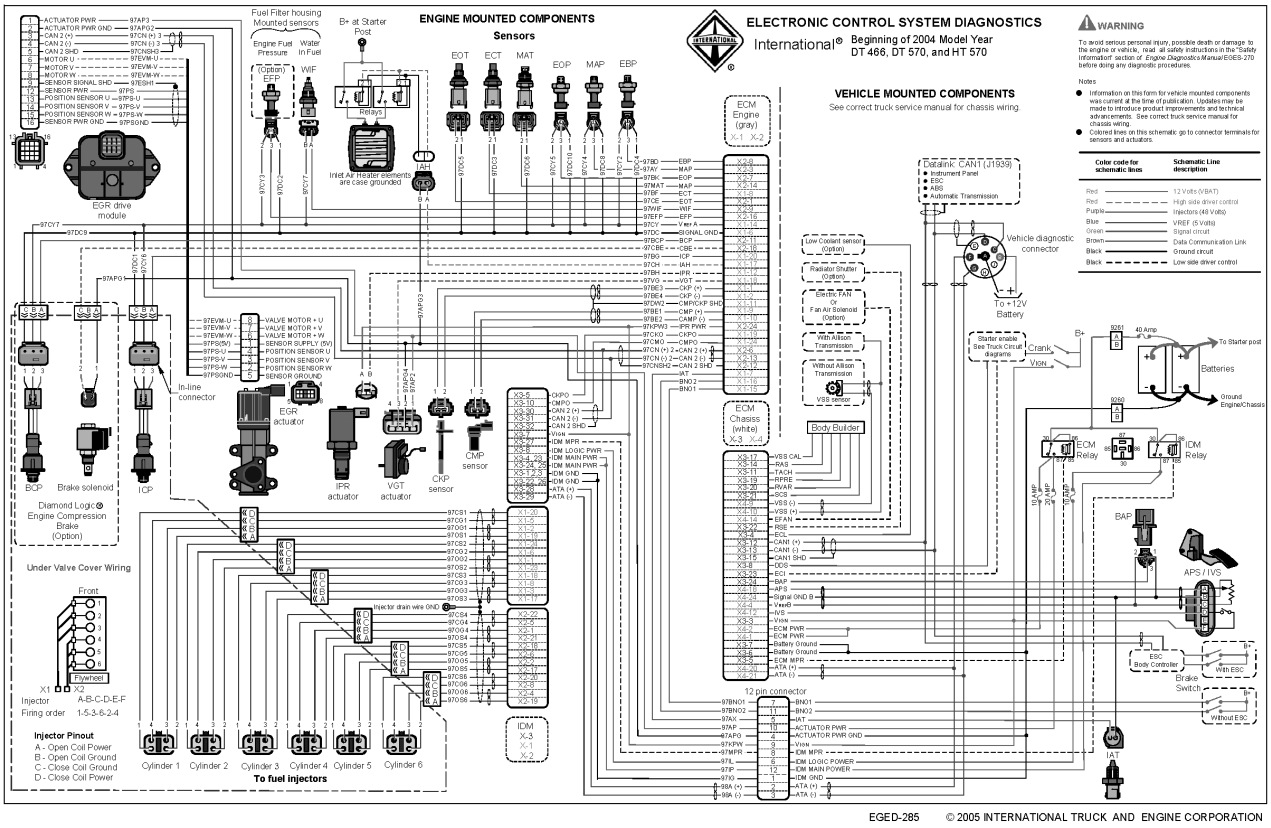


Figure 363 EGED-285 (Front Side)

Engine diagnostic forms assist technicians in troubleshooting International® diesel engines. Diagnostic schematics and signal values help technicians find problems systematically and quickly to avoid unnecessary repairs.

The front side of the Electronic Control System Diagnostics form consists of a circuit diagram for electrical components mounted on the engine side and vehicle side. For detailed description of vehicle circuits, circuit numbers, or connector and fuse locations, see truck *Chassis Electrical Circuit Diagram Manual* and *Electrical System Troubleshooting Guide*. The back side of the form consists of signal values.

NOTE: All recorded signal values are with the breakout box installed on the ECM and harness.

Diagnostic Form EGED-285 is available in 50 sheet pads. To order technical service literature, contact your International dealer.

©August 2008 Navistar, Inc.

Sensor and Actuator Locations

Engine Mounted Components

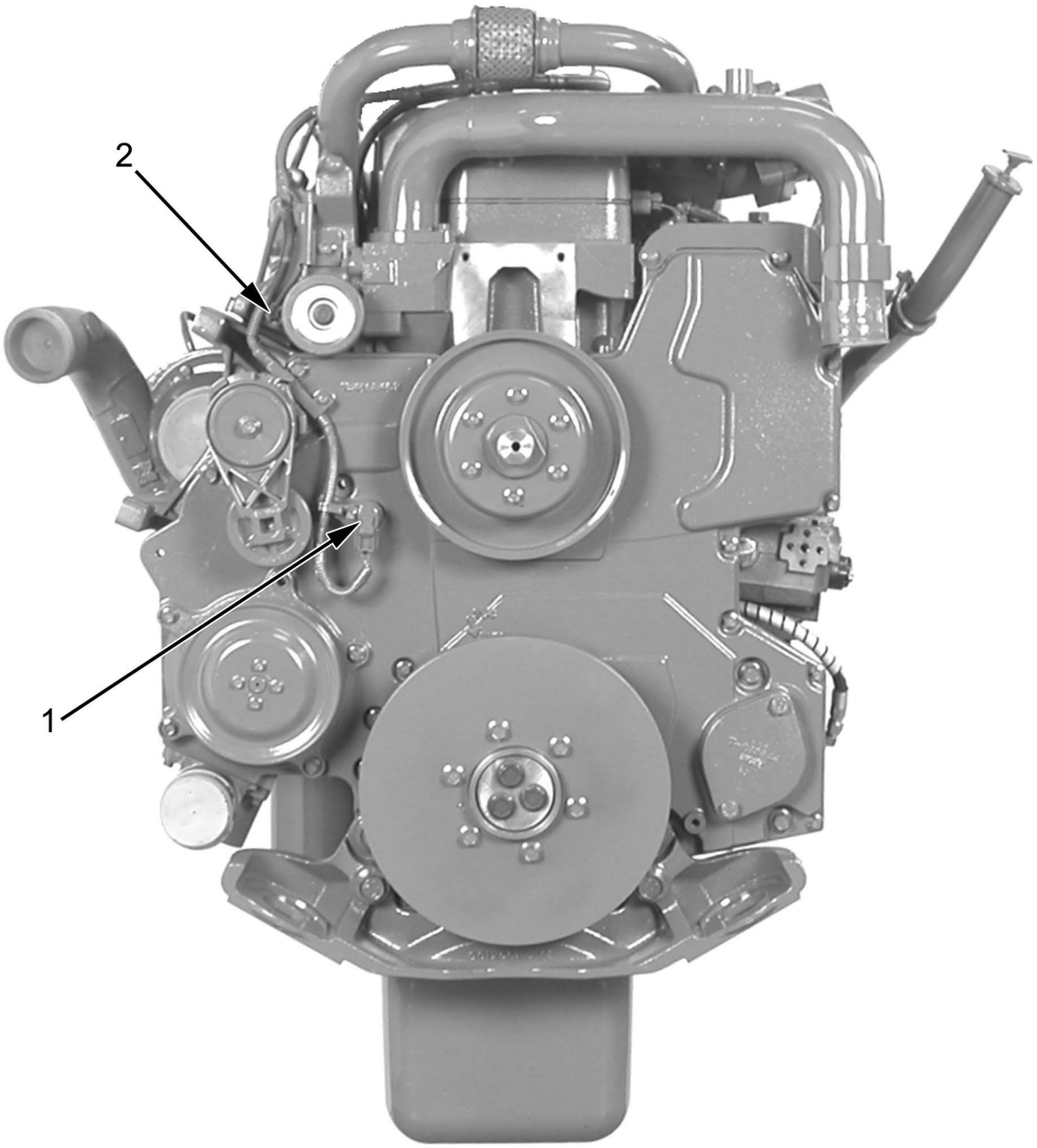


Figure 364 Sensor location – Front View

1. Camshaft Position (CMP) sensor
2. Engine Coolant Temperature (ECT) sensor

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

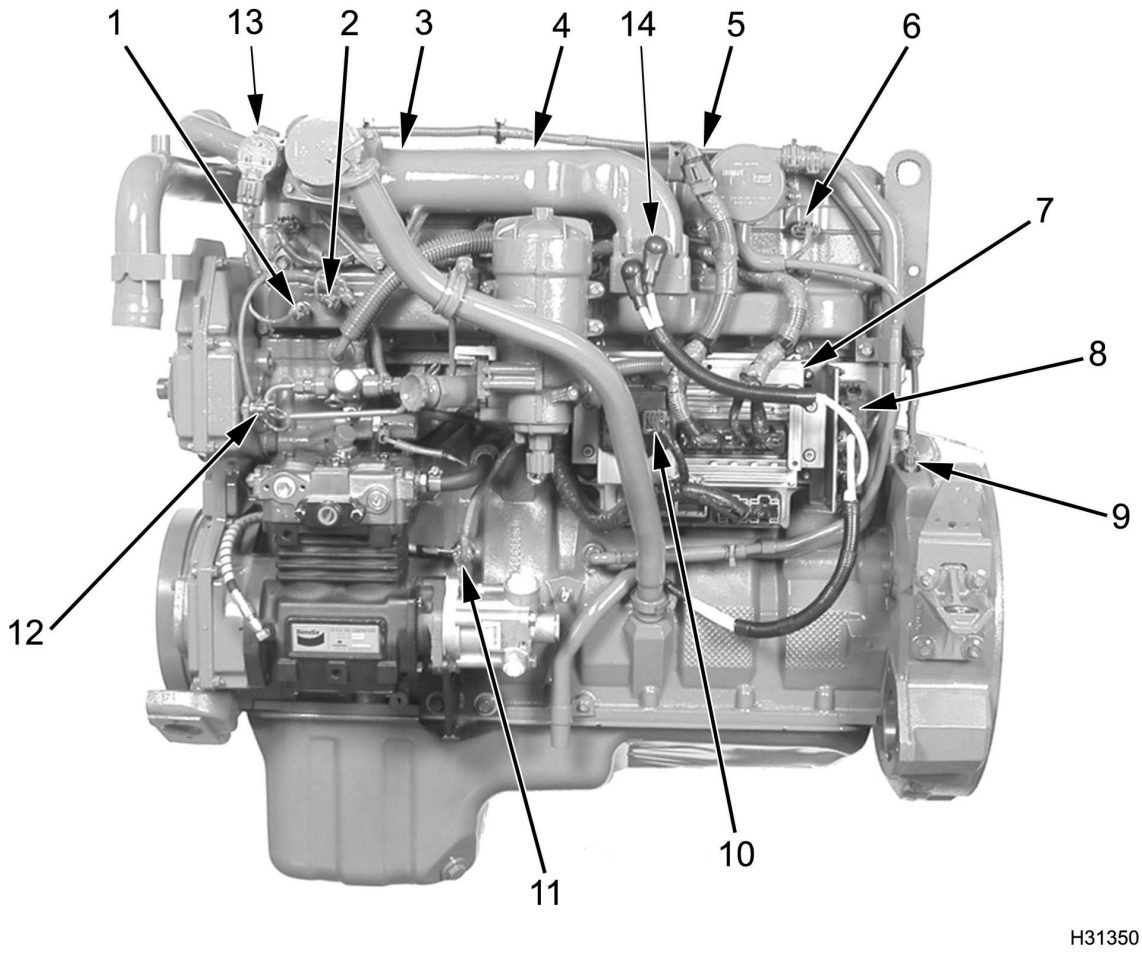


Figure 365 Sensor location – Left View

1. Manifold Absolute Pressure (MAP) sensor
2. Manifold Air Temperature (MAT) sensor
3. Optional Brake Control Pressure (BCP) sensor (under valve cover)
4. Optional Brake Shut-off Valve (under valve cover)
5. Injection Control Pressure (ICP) sensor (under valve cover)
6. Valve cover gasket pass-through connector
   a. (6) four-wire connectors for fuel injectors
   b. (1) three-wire connector for ICP sensor
   c. Engine brake application – (1) three-wire connector for the BCP sensor and (1) three-wire connector for the brake shut-off valve.
7. Electronic Control Module (ECM) and Injector Drive Module (IDM) assembly
8. Inlet Air Heater (IAH) relays
9. Crankshaft Position (CKP) sensor
10. Exhaust Gas Recirculation (EGR) drive module
11. Engine Oil Pressure (EOP) sensor
12. Engine Oil Temperature (EOT) sensor
13. Exhaust Gas Recirculation (EGR) valve
14. Inlet Air Heater (IAH) elements

NOTE: For Water in Fuel (WIF) sensor and optional Engine Fuel Pressure (EFP) sensor location, see “Fuel Flow” in Section 1 (page 35).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

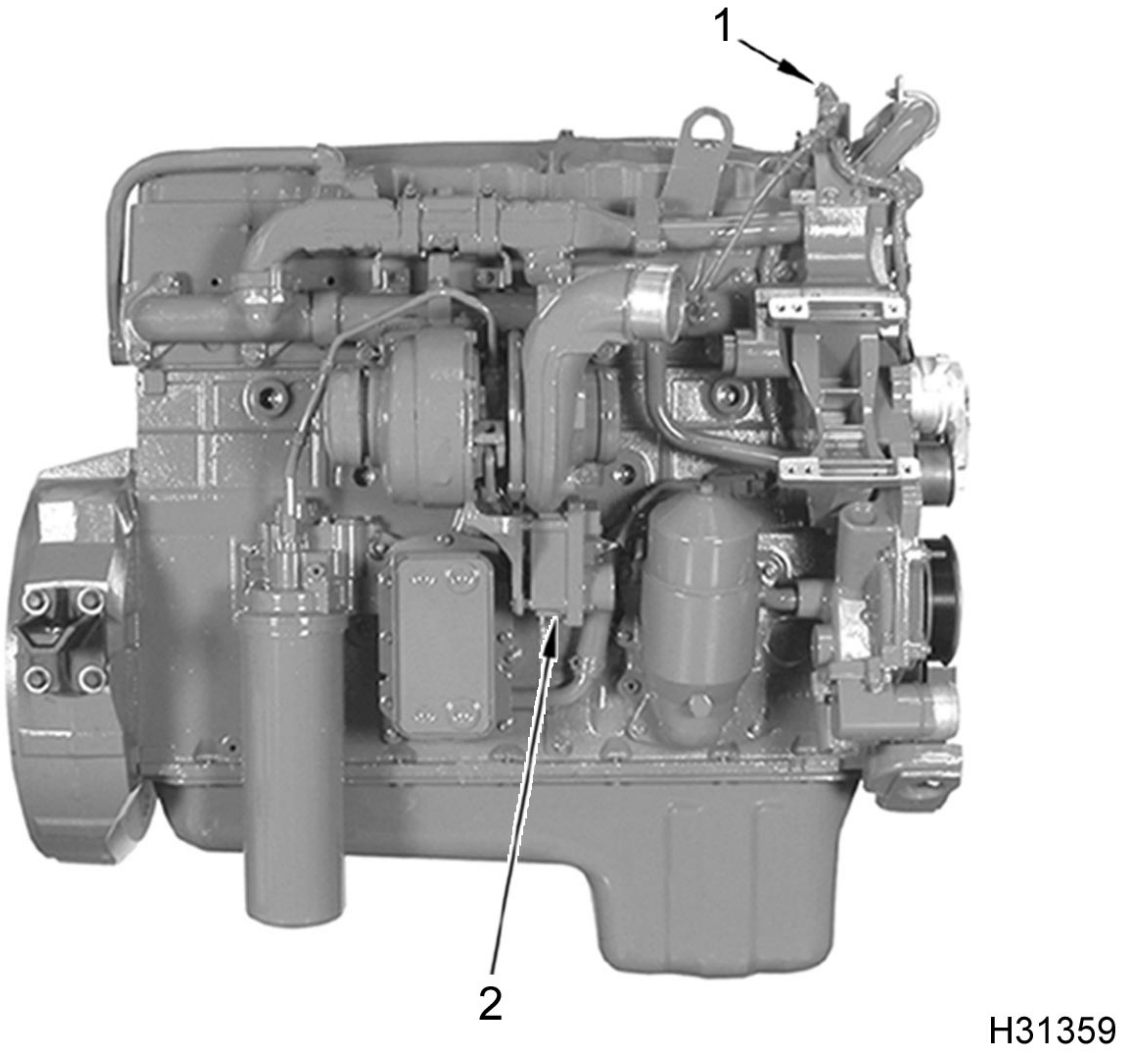


Figure 366 Sensor location – Right View

1. Exhaust Back Pressure (EBP) sensor
2. Turbocharger control module

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Vehicle Mounted Components

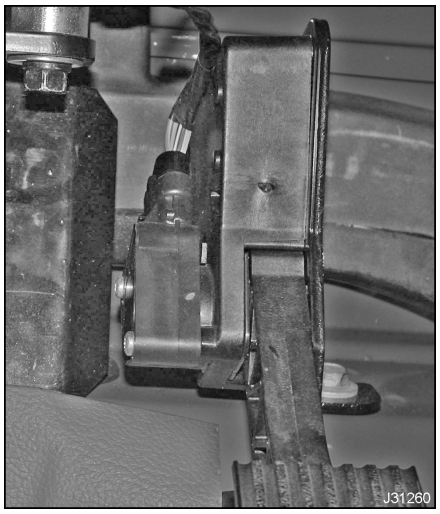


Figure 367 APS/IVS sensor

The APS/IVS sensor is located above the accelerator pedal.

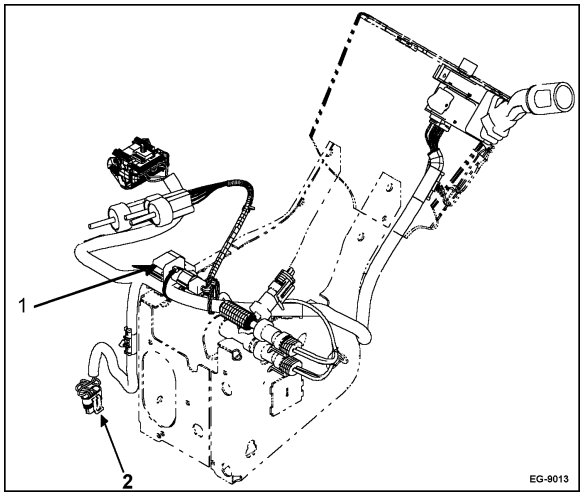


Figure 368 Under the dashboard sensors

1. Barometric Absolute Pressure (BAP) sensor
2. Accelerator Pedal Position and Idle Validation Connector (APS/IVS)

The BAP sensor is located in the cab of the vehicle.

Diagnostic Procedures for Sensors and Actuators

Pin Grip Inspection

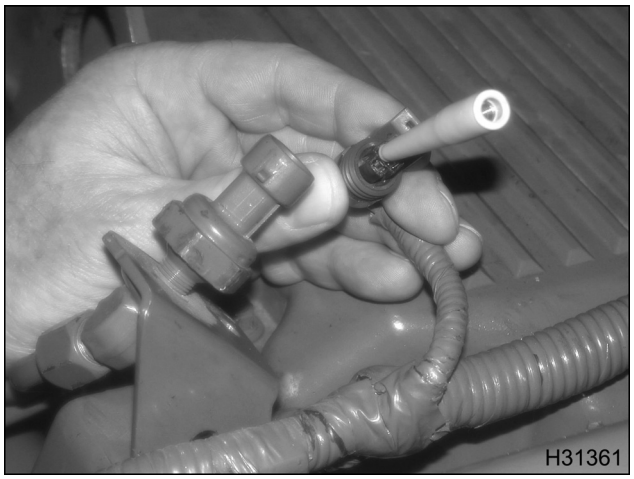


Figure 369 Pin grip check

1. Disconnect the harness connector from the sensor or actuator.
2. Inspect for corrosion, bent pins, spread pins, or conditions that could cause a loose or intermittent connection.
3. Check the pin grip in the female pin by inserting the correct tool from Terminal Test Adapter Kit.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Operational Diagnostics

Operational Diagnostic tests use the MasterDiagnostics® Continuous Monitor Test. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Continuous Monitor Test.

V_{REF} Tests using MasterDiagnostics®

1. Plug the Electronic Service Tool (EST) tool into the American Trucking Association (ATA) datalink connector and start MasterDiagnostics®.
2. Disconnect sensor to be tested.
3. Connect breakout harness to harness only.
4. Turn the ignition switch to ON.
5. Monitor signal voltage with the EST using continuous monitor session and initiating KOEO Continuous Monitor Test.

   Voltage should be near 0, unless the signal circuit is shorted or incorrectly wired to V_{REF}, B+, or other voltage sources. See Circuit Diagnostics in this section for sensor specifications.
6. Use a Digital Multimeter (DMM) to verify V_{REF} at BLUE pin (V_{REF}) in breakout harness (voltage should be 5 V ± 0.5 V). Connect positive to BLUE and negative to chassis ground.

   If voltage is greater than 5.5 V, check V_{REF} for short to B+.

   If voltage is less than 4.5 V, check V_{REF} for open or short to ground.
7. Install 500 ohm harness between GREEN (signal circuit), and BLUE (V_{REF}) pin of breakout harness. Monitor signal voltage with EST.

   If voltage is less than 4.5 V, check signal circuit for open or short to ground.
8. Use a DMM to check resistance from BLACK pin (signal ground) of breakout harness to chassis ground.

   If resistance is greater 5 ohm, check for open or high resistance between ECM and sensor connector.
9. Connect engine or chassis harness to sensor.
10. Use the EST to clear DTCs.

    If an active DTC remains after checking test conditions, replace sensor.

Temperature Sensor Tests using MasterDiagnostics®

1. Plug the Electronic Service Tool (EST) tool into the ATA connector and start MasterDiagnostics®.
2. Disconnect sensor to be tested.
3. Connect breakout harness to harness only.
4. Turn the ignition switch to ON.
5. Monitor signal voltage with the EST using continuous monitor session and initiating KOEO Continuous Monitor Test (voltage should be greater than 4.6 V). See Circuit Diagnostics in this section for sensor specifications.

   If voltage is less than 4.6 V, check signal circuit for short to ground.

   If voltage is greater than 5.5 V, check signal circuit for short to B+.
6. Install 3–Banana plug harness between GREEN (signal circuit), and BLACK (signal ground) pin of breakout harness.

   If voltage is more than 0.127 V, check ground circuit for open or high resistance. See Circuit Diagnostics in this section for sensor specifications.
7. Remove 3–Banana plug harness.
8. Connect engine or chassis harness to sensor.
9. Use the EST to clear DTCs.

   If an active DTC remains after checking test conditions, replace sensor.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Pin-Point Diagnostics

Some Pin-Point Diagnostic tests use the MasterDiagnostics® Output State Tests. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests.

Connector Voltage Checks to Ground



Figure 370 V_{REF} check

Procedure

1. Turn the ignition switch to ON.
2. Connect breakout harness to the harness only.
3. Measure voltage at each pin with a DMM.
4. Compare sensor or actuator voltage readings with the expected voltages. See Circuit Diagnostics in this section for circuit specifications.

   If a breakout harness is not available, use the correct tool from Terminal Test Adapter Kit. Do not directly probe the connector pins with the DMM leads. For a circuit with an expected voltage, this test will verify circuit integrity.
5. Turn the ignition to OFF.

For circuits without an expected voltage, this test will determine if that circuit is shorted or incorrectly wired to ground, V_{REF}, B+ or other voltage sources.

Connector Resistance Checks to ECM Chassis Ground



Figure 371 Resistance check to ECM chassis ground

Procedure

NOTE: The truck *Chassis Electrical Circuit Diagram Manual* should always be used for chassis ground circuit information.

1. Disconnect chassis connector 9260.

   NOTE: Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck *Chassis Electrical Circuit Diagram Manual* for complete chassis side ECM and IDM ground circuit information.
2. Connect breakout harness to harness only.
3. Use breakout harness to measure resistance from the lead of the breakout harness to the connector 9260 Pin A.

   See Circuit Diagnostics in this section for circuit specifications.

   Sensor signal ground circuits should measure less than 5 ohms.

   V_{REF} and signal circuits should measure more than 1 k ohm.

   The control side of an actuator will measure more than 1 k ohms, but the expected voltage for the other side of the actuator circuit will measure the

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

voltage that the control side was switching, either power or ground.

If the ECM is switching the ground circuit, the other side of the actuator circuit should measure more than 1 k ohms from the connector pin to connector 9260 Pin A.

If the ECM is switching the power circuit, the other side of the actuator circuit should measure less than 5 ohms from the connector pin to connector 9260 Pin A.

Connector Resistance Checks to Chassis Ground

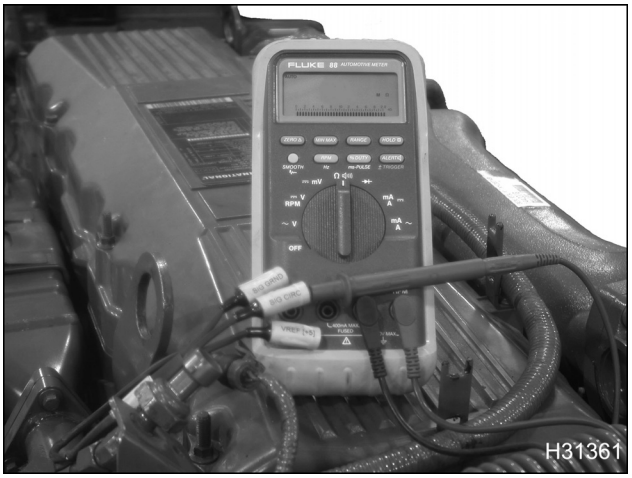


Figure 372 Resistance check to chassis ground

Procedure

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

NOTE: The truck *Chassis Electrical Circuit Diagram Manual* should always be used for chassis ground circuit information.

1. Disconnect chassis connector 9260.

   NOTE: Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck *Chassis Electrical Circuit Diagram Manual* for complete chassis side ECM and IDM ground circuit information.

2. Connect breakout harness to harness only.
3. Disconnect negative battery cable.
4. Use breakout harness to measure resistance from the lead of the breakout harness to the negative battery cable.

   See Circuit Diagnostics in this section for circuit specifications.

   Sensor signal ground circuits should measure greater than 500 ohms.

   V_{REF} and signal circuits should measure more than 1 k ohm.

   The control side of an actuator will measure more than 1 k ohms, but the expected voltage for the other side of the actuator circuit will measure the voltage that the control side was switching, either power or ground.

   If the ECM is switching the ground circuit, the other side of the actuator circuit should measure more than 1 k ohms from the connector pin to battery ground.

   If the ECM is switching the power circuit, the other side of the actuator circuit should measure greater than 500 ohms from the connector pin to battery ground.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Harness Resistance Checks

Procedure

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting the connector or relay for the ECM and IDM. Failure to turn the switch to OFF will cause a voltage spike and damage to electrical components.

1. Check harness resistance if high resistance or an open circuit is suspected.
2. Connect breakout harness to harness only.
3. Connect breakout box to the ECM end of the harness only.
4. Measure resistance from breakout box pin to the breakout harness pin. Circuit wires should have a resistance of less than 5 ohms.

   See Circuit Diagnostics in this section for circuit specifications.

Operational Voltage Checks

Operational voltages checks determine In-range faults or intermittent connections.

To determine in-range faults and intermittent connections, monitor a suspected circuit and recreate conditions likely to cause the problem.

Monitor signal voltage with the EST using continuous monitor session and initiating KOEO Continuous Monitor Test. See Circuit Diagnostics in this section for circuit specifications.

Use a DMM and breakout harness or a DMM and breakout box. See Circuit Diagnostics in this section for circuit specifications.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Circuit Diagnostics

AMS (Air Management System)

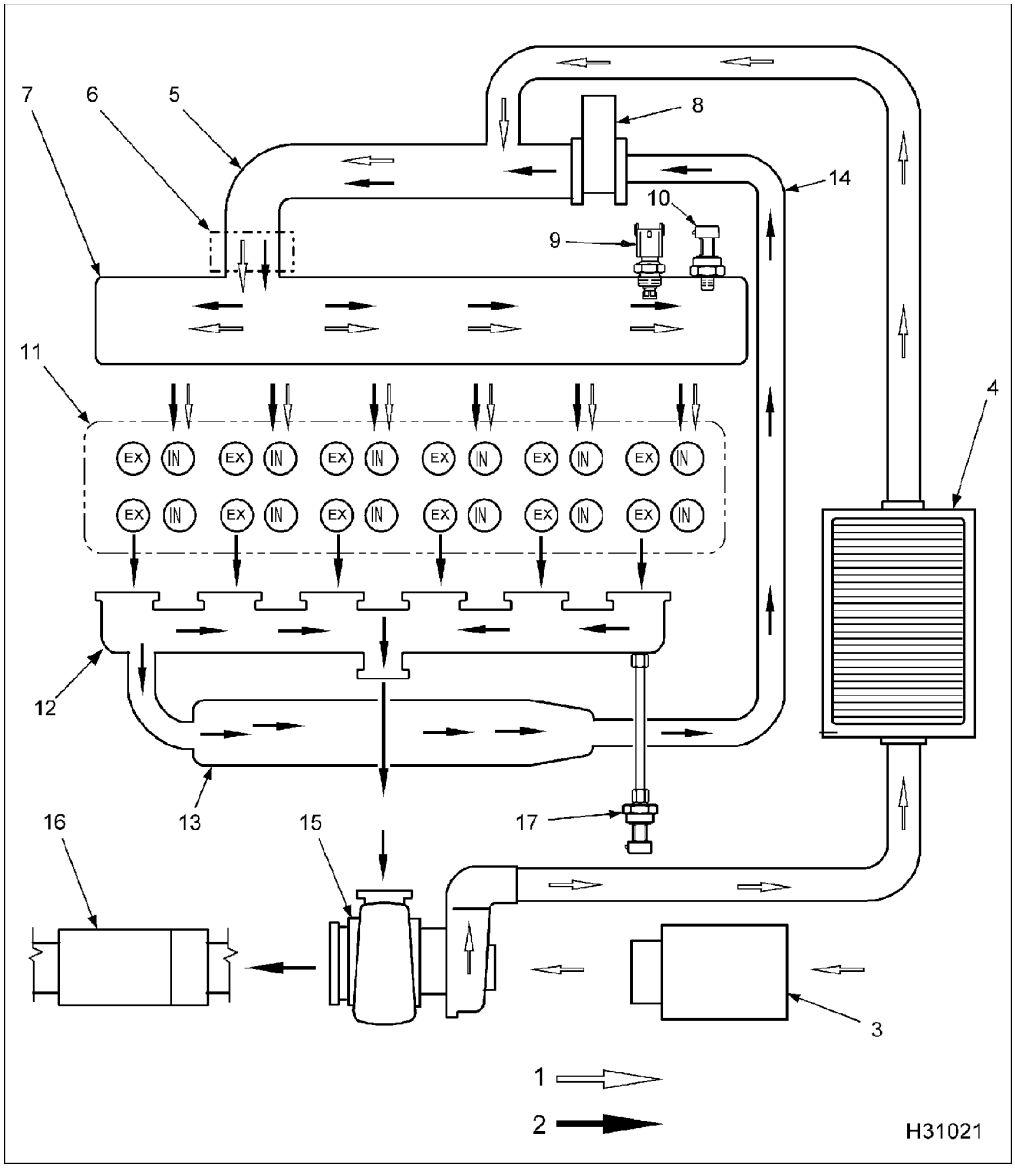


Figure 373 Air Management System (AMS)

1. Intake air
2. Exhaust gas
3. Air filter assembly
4. Charge Air Cooler (CAC)
5. Inlet and EGR mixer duct
6. Inlet Air Heater (IAH) assembly
7. Intake manifold
8. EGR valve
9. Manifold Air Temperature (MAT) sensor
10. Manifold Absolute Pressure (MAP) sensor
11. Cylinder head
12. Exhaust manifold
13. EGR cooler
14. Exhaust gas crossover
15. Variable Geometry Turbocharger (VGT)
16. Muffler
17. Exhaust Back Pressure (EBP) sensor

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

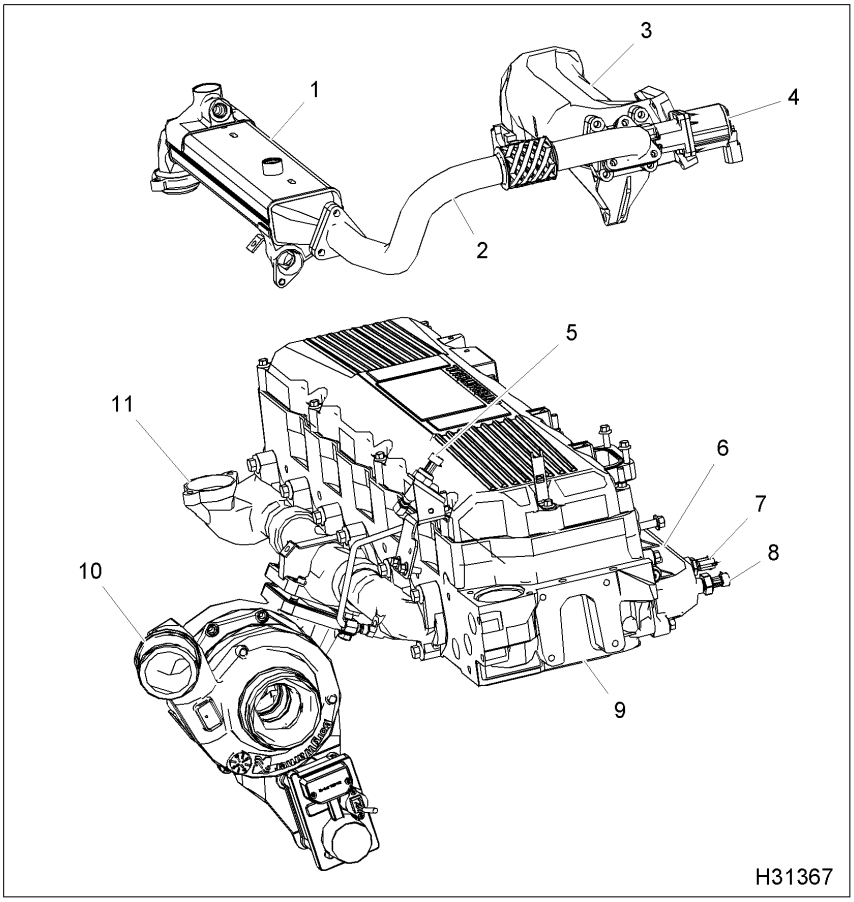


Figure 374 AMS components

1. EGR cooler
2. EGR tube assembly crossover
3. Intake and EGR mixer duct (heater optional)
4. EGR valve assembly
5. EBP sensor
6. Intake manifold
7. MAT sensor
8. MAP sensor
9. Cylinder head
10. Turbocharger (VGT)
11. Exhaust manifold

AMS Operation

Function

The **Variable Geometry Turbocharger (VGT)** has actuated vanes in the turbine housing. The vanes modify flow characteristics of exhaust gases through the turbine housing. The benefit is the ability to control boost pressure for various engine speeds and load conditions.

The VGT is a closed loop system that uses the Exhaust Back Pressure (EBP) sensor to provide feedback to the Electronic Control Module (ECM). The ECM uses the EBP sensor to continuously monitor EBP and adjust the duty cycle to the VGT to match engine requirements.

The VGT actuator is a control module that contains a microchip and a DC motor. The VGT actuator is located below the turbocharger. The microchip operates a DC motor which rotates a crank lever controlling the vane position in the turbine housing. The position of the vanes is based off the pulse width modulated signal sent from the ECM.

Actuated vanes are mounted around the inside circumference of the turbine housing. A unison ring links all the vanes. When the unison ring moves, all vanes move to the same position. Unison ring

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

movement occurs when the crank lever in the control module moves.

Exhaust gas flow can be regulated depending on required exhaust back pressure for engine speed and load. As demand for EBP increases, the ECM increases the pulse-width modulation to the VGT control module. When EBP demand decreases, the ECM decreases the duty cycle to the control module.

Actuator control for the vane position is achieved by setting a pulse width modulated signal from the ECM in response to the following:

- Engine speed
- Desired fuel quantity
- Boost
- Exhaust back pressure and altitude

The **Exhaust Gas Recirculation (EGR) system** controls the amount of exhaust gas being introduced to the engine mixer duct by modulating the EGR valve. The EGR actuator is located at the front of the engine on the mixer duct.

The EGR drive module controls the EGR actuator and is located on the left side of the engine on the ECM and Injector Driver Module (IDM).

The ECM calculates the appropriate desired EGR valve position in response to the changing engine speed, fuel desired, operator demand, engine operating temperatures, exhaust back pressure, boost pressure and altitude. The ECM uses sensor input from the following:

- Variable Geometry Turbocharger (VGT) actuator
- Accelerator Position Sensor (APS)
- EGR actuator with position sensors
- EGR drive module
- Exhaust Back Pressure (EBP) sensor
- Manifold Absolute Temperature (MAT) sensor
- Barometric Absolute Pressure (BAP) sensor
- Engine Coolant Temperature (ECT) sensor
- Engine Oil Temperature (EOT) sensor
- Manifold Absolute Pressure (MAP) sensor

The EGR drive module provides feedback to the ECM on the valve position. The EGR drive module interprets the ECM command and sends the command using three pulse width modulated signals to the valve actuator.

The system is closed loop control using the EGR position signals. The EGR drive module provides a 9 V supply and ground to the Integrated Circuit (IC) in the motor of the valve. When the EGR drive module directs the valve to move, the IC with three Hall effect sensors provides the EGR drive module with the valve position signals. The EGR drive module interprets the three signals to determine valve position and sends the information back to the ECM.

Fault Detection / Management

The ECM continuously monitors the Air Management System (AMS). When the ECM detects a fault in the any of the interdependent systems, the ECM will set a DTC and illuminate the amber ENGINE lamp.

The Variable Geometry Turbocharger (VGT) is continuously monitored by the ECM using the exhaust back pressure and the VGT pulse-width modulated signal's duty cycle. A DTC is logged when the ECM determines that the duty cycle required to reach the desired boost or exhaust back pressure is greater or less than the ECM's pre-programmed expected values.

The Exhaust Gas Recirculation (EGR) actuator is continuously monitored by the EGR drive module. When an EGR control error is detected, the EGR drive module sends a message to the ECM, a DTC is set, and the amber ENGINE lamp is illuminated. For additional function and operational information, see "EGR Actuator" (page 413).

AMS Diagnostic Trouble Codes (DTCs)

DTCs are read using the Electronic Service Tool (EST) or by counting the flashes from the amber and red ENGINE lamp.

NOTE: Before proceeding make sure all sensor, injector and actuator electrical DTCs have been repaired. Follow the procedures outlined in Section 6 or Performance Diagnostics form.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 343 – Excessive EBP (gauge)

DTC 343 is set by the ECM when the exhaust back pressure is greater than 260 kPa (37.7 psi) for more than 2.5 seconds.

Possible Causes	Comment
EBP sensor bias high	Check sensor signal voltage. See “EBP Sensor”(page 359) .
EBP signal ground open	Check sensor signal voltage. See “EBP Sensor” (page 359).
Exhaust restriction (muffler or catalytic converter)	Inspect exhaust. Do “Performance Diagnostics” (page 205).
VGT actuator or vanes stuck closed	Do “Performance Diagnostics” (page 205).
VGT control circuit short to B+	Do VGT Pin-Point Diagnostics. See “VGT Actuator” (page 524).

DTC 344 – EBP above spec when engine off

DTC 344 is set by the ECM when the EBP is greater than 300 kPa (43.5 psi) when engine is off or being cranked for more than 2.5 seconds.

Possible Cause	Comment
EBP sensor bias high	Check sensor signal voltage. See “EBP Sensor” (page 359).
EBP sensor or tube line plugged	Clean and retest. Replace if required.

DTC 345 – Faults detected during VGT portion of the AMS test

DTC 345 is set by the ECM during the AMS test when the ECM measures the EBP and does not see the expected response in pressures.

Possible Cause	Comment
High intake restriction	Do “Performance Diagnostics” (page 205).
Intake / CAC system leak (pipes, loose clamps, hoses)	Do “Performance Diagnostics” (page 205).
Exhaust system leak	Do “Performance Diagnostics” (page 205).
MAP sensor bias	Check sensor signal voltage. See “MAP Sensor” (page 500).
EBP sensor bias	Check sensor signal voltage. See “EBP Sensor” (page 359).
EGR valve stuck open	Do “Performance Diagnostics” (page 205).
VGT actuator or vanes sticking	Do “Performance Diagnostics” (page 205).
EBP sensor or tube plugged	Clean and retest (replace if needed)
Power cylinder integrity	Do “Performance Diagnostics” (page 205)
VGT control circuit open or short to ground	Do VGT Pin-Point Diagnostics. See “VGT Actuator” (page 524).
VGT power and ground circuits	Do VGT Pin-Point Diagnostics. See “VGT Actuator” (page 524).

©August 2008 Navistar, Inc.

DTC 346 – Faults detected during EGR portion of the AMS test

DTC 346 is set by the ECM during AMS test when the ECM measures EBP and does not see the expected response in pressures.

Possible Cause	Comment
EGR valve stuck or sticking	Do “Performance Diagnostics” (page 205).
EBP sensor bias	Check sensor signal voltage. See “EBP Sensor” (page 359).
EBP sensor or tube plugged	Clean and retest (replace if needed)
EGR control circuit	Do EGR Pin-Point Diagnostics. See “EGR Actuator” (page 413).

DTC 353 – VGT control over duty cycle

DTC 353 is set when the ECM overcompensates by increasing duty cycle to the VGT to achieve desired boost/back pressure.

Possible Cause	Comment
High intake restriction	Do “Performance Diagnostics” (page 205).
Intake / CAC system leak (pipes, loose clamps, hoses)	Do “Performance Diagnostics” (page 205).
Exhaust system leak	Do “Performance Diagnostics” (page 205)
BAP sensor bias low	Check sensor signal voltage. See “BAP Sensor” (page 314).
MAP sensor bias low	Check sensor signal voltage. See “MAP Sensor” (page 500).
EBP sensor bias low	Check sensor signal voltage. See “EBP Sensor” (page 359).
ICP sensor bias high	Check sensor signal voltage. See “ICP Sensor” (page 457).
Power cylinder integrity	Do “Performance Diagnostics” (page 205).
ICP system integrity	Do “Performance Diagnostics”
Injector operation / part number	Check previous repairs. Do “Performance Diagnostics” (page 205).
EGR valve stuck open	Do “Performance Diagnostics” (page 205).
VGT actuator or vanes sticking	Do “Performance Diagnostics” (page 205).
VGT control circuit open or short to ground	Do VGT Pin-Point Diagnostics. See “VGT Actuator” (page 524).
VGT power and ground circuits.	Do VGT Pin-Point Diagnostics. See “VGT Actuator” (page 524).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 354 – VGT control under duty cycle	
DTC 354 is set when the ECM overcompensates by decreasing duty cycle to the VGT to achieve the desired boost/back pressure.	
Possible Cause	**Comment**
BAP sensor bias high	Check sensor signal voltage. See “BAP Sensor” (page 314).
MAP sensor bias high	Check sensor signal voltage. See “MAP Sensor” (page 500).
EBP sensor bias high	Check sensor signal voltage. See “EBP Sensor” (page 359).
Open Exhaust (no muffler)	Inspect exhaust system.
ICP sensor bias low	Check sensor signal voltage. See “ICP Sensor” (page 457).
ICP system integrity	Do “Performance Diagnostics” (page 205).
Injector operation / part number	Check previous repairs. Do “Performance Diagnostics” (page 205).
Exhaust restriction (muffler or catalytic converter)	Inspect exhaust. Do“Performance Diagnostics” (page 205).
VGT control circuit short to B+.	Do VGT Pin-Point Diagnostics. See “VGT Actuator” (page 524).
VGT actuator or vanes stuck	Do “Performance Diagnostics” (page 205).

DTC 355 – VGT overspeed	
DTC 355 is set when the ECM detects turbo over speed several times in a specific period of time (dependent on ECM calibration). Turbo speed is estimated by engine speed, boost pressure, and barometric pressure.	
Possible Cause	**Comment**
High intake restriction	Do “Performance Diagnostics” (page 205).
Intake / CAC system leak (pipes, loose clamps, hoses)	Do “Performance Diagnostics” (page 205).
Restricted CAC system	Do “Performance Diagnostics” (page 205).
VGT actuator or vanes sticking	Do “Performance Diagnostics” (page 205).
Open exhaust (no muffler)	Inspect exhaust system
BAP sensor bias	Check sensor signal voltage. See “BAP Sensor” (page 314).
MAP sensor bias high	Check sensor signal voltage. See “MAP Sensor” (page 500).
EBP sensor bias low	Check sensor signal voltage. See “EBP Sensor” (page 359).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 361 – VGT control input (EBP) above or below desired level	
DTC 361 is set when the ECM detects an in range error in the EBP signal.	
Possible Cause	**Comment**
High intake restriction	Do “Performance Diagnostics” (page 205).
Intake / CAC system leak (pipes, loose clamps, hoses)	Do “Performance Diagnostics” (page 205).
BAP sensor bias	Check sensor signal voltage. See “BAP Sensor” (page 314).
MAP sensor bias	Check sensor signal voltage. See “MAP Sensor” (page 500).
EBP sensor bias	Check sensor signal voltage. See “EBP Sensor” (page 359).
ICP sensor bias	Check sensor signal voltage. See “ICP Sensor” (page 457).
Power cylinder integrity	Do “Performance Diagnostics” (page 205).
ICP system integrity	Do “Performance Diagnostics” (page 205).
Injector operation / part number	Check previous repairs. Do “Performance Diagnostics” (page 205).
EGR valve stuck open	Do “Performance Diagnostics” (page 205)
VGT actuator or vanes sticking	Do “Performance Diagnostics” (page 205)
VGT control circuit open, short to ground, or short to B+	Do VGT Pin-Point Diagnostics. See “VGT Actuator” (page 524).
Open Exhaust (no muffler)	Inspect exhaust system.
Exhaust restriction or leak (muffler or catalytic converter)	Inspect exhaust and do “Performance Diagnostics” (page 205).
VGT power or ground circuits	Do VGT Pin-Point Diagnostics. See “VGT Actuator” (page 524).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

APS/IVS (Accelerator Position Sensor and Idle Validation Switch)

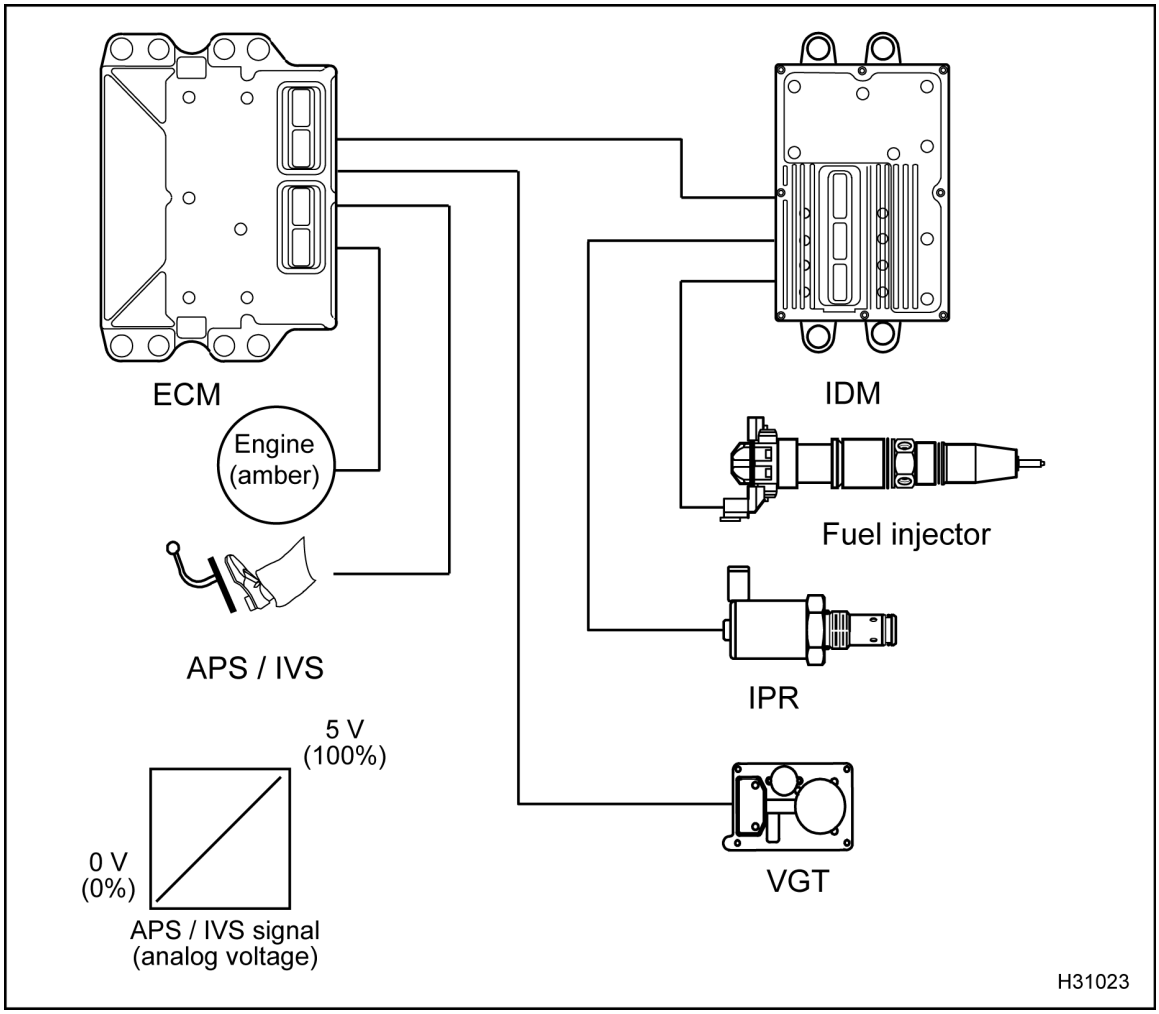


Figure 375 Function diagram for the APS/IVS

The function diagram for the APS/IVS includes the following:

- APS/IVS
- Injection Control Pressure Regulator (IPR)
- Electronic Control Module (ECM)
- Variable Geometry Turbocharger (VGT)
- Injection Driver Module (IDM)
- Fuel injector
- ENGINE lamp (amber)

Function

The APS/IVS sensor is a cab mounted potentiometer sensor. When the APS receives a 5 V reference signal and a ground from the ECM, a linear analog voltage signal from the sensor will indicate the operator's demand for power. The IVS provides 0 V or 12 V to the ECM as redundant signal to verify the pedal idle position.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

APS/IVS Circuit Operation

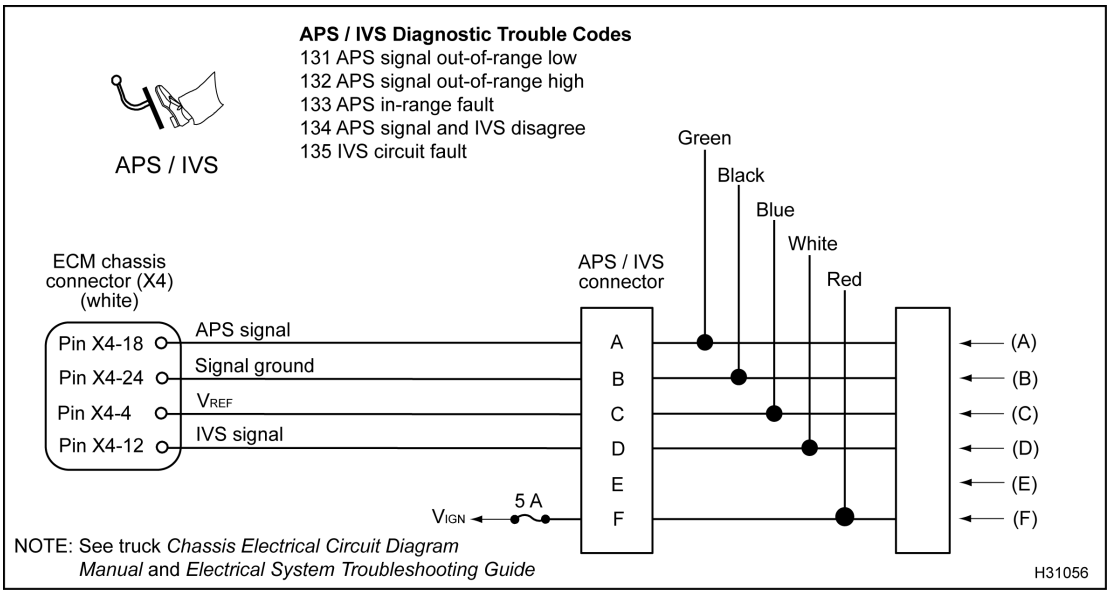


Figure 376 APS/IVS circuit diagram

The APS/IVS are integrated into one component and mounted on the pedal. The accelerator pedal assembly is serviceable to the extent that the APS/IVS switch can be replaced without replacing the complete assembly.

The ECM determines the accelerator pedal position by processing input signals from the APS and the IVS.

The accelerator pedal position is one of the controlling variables in the calculation of desired injection control pressure.

APS

The ECM supplies a regulated 5 V signal from ECM chassis connector Pin X4–4 to APS connector Pin C. The APS returns a variable voltage signal (depending on pedal position) from the APS connector Pin A to ECM Pin X4–18. The APS is grounded at Pin B from the ECM Pin X4–24.

APS Auto-Calibration

The ECM learns the lowest and highest pedal positions by reading and storing the minimum and maximum voltage levels from the APS. In this manner the ECM auto-calibrates the system to allow maximum pedal sensitivity. The ECM auto-calibrates as the ignition switch is on, but when the ignition switch is turned OFF, these values are lost. When the key is turned on again, this process starts over. When the pedal is disconnected (or a new one is installed), the pedal does not need to be calibrated. It simply auto-calibrates the new pedal assembly whenever the key is turned on again.

IVS

The ECM expects to receive one of two signals through the ECM chassis connector Pin X4–12 from APS/IVS connector Pin D:

- 0 V when the pedal is at the idle position.
- B+ when the pedal is depressed

The IVS receives a 12 V ignition voltage at Pin F from the ignition fuse in the power distribution box. When the pedal is not in the idle position (throttle applied), the IVS supplies a 12 V signal to the ECM.

The ECM compares APS/IVS inputs to verify when the pedal is in the idle position. If the APS signal at Pin X4–18 indicates throttle is being applied, the ECM expects to see 12 V at the IVS. If the APS signal indicates throttle is not applied, the ECM expects to see 0 V at the IVS. The timing process is critical between the APS and IVS sensors. For this reason, it is very difficult to determine if the APS/IVS assembly

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

is working correctly when using a Digital Multimeter (DMM).

Fault Detection / Management

When the key is on, the ECM continuously monitors the APS/IVS circuits for expected voltages. It also compares the APS and IVS signals for conflict. If the signals are not what the ECM expects to see, Diagnostic Trouble Codes (DTCs) will be set.

Any detected malfunction of the APS/IVS sensor circuit will illuminate the amber ENGINE lamp. If the ECM detects an APS signal Out of Range HIGH or LOW, the engine will ignore the APS signal and operate at low idle. If a disagreement in the state of IVS and APS is detected by the ECM and the ECM determines that it is an IVS fault, the ECM will only allow a maximum of 50% APS to be commanded. If the ECM cannot discern if it is an APS or IVS fault, the engine will be allowed to operate at low idle only.

APS/IVS Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

NOTE: If multiple APS/IVS DTCs are present, verify the APS/IVS part number is correct for the specific vehicle model.

NOTE: If elevated low idle rpm is experienced after replacing the pedal assembly or APS/IVS sensor, and there are no DTCs present, check pedal assembly or APS/IVS sensor part numbers for correctness.

DTC 131
APS signal out-of-range low

- DTC 131 is set if the ECM detects voltage less than 0.147 V. The ECM will then restrict engine speed to idle.
- DTC 131 can be set due to a short to ground or an open V_{REF} or signal circuits. If the condition causing DTC 131 is intermittent and the condition is no longer present, the code will become inactive and normal engine operation will resume.
- When DTC 131 is active the amber ENGINE lamp is illuminated.

DTC 132
APS signal out-of-range high

- DTC 132 is set if the ECM detects a voltage greater than 4.55 V. The ECM will then restrict engine speed to idle.
- DTC 132 can be set due to a short to V_{REF} or B+ in the APS signal circuit.
- When DTC 132 is active the amber ENGINE lamp is illuminated.

DTC 133, 134, and 135

- The ECM checks the voltage output of the APS by comparing the APS signal to the IVS signal. APS and IVS signals can disagree in the following situations:
  - The APS signal indicates the pedal is pressed down to accelerate, but the IVS signal indicates idle position.
  - The APS signal indicates the pedal has been released to allow the engine to return to idle, but the IVS signal indicates off-idle position of the pedal.

  If the ECM detects either of the above conditions, the ECM attempts to isolate the source of conflict and set a DTC.

DTC 133
APS in-range fault

- If the IVS signal is changing and the APS signal is constant, the ECM assumes the APS is the conflict source and sets DTC 133. The engine rpm is restricted to idle.
- When DTC 133 is active the amber ENGINE lamp is illuminated.

DTC 134
APS signal and IVS disagree

- If neither the APS or IVS is changing, or both are changing, or the ECM cannot determine the DTC in specified time, DTC 134 is set and engine rpm is restricted to idle.
- When DTC 134 is active the amber ENGINE lamp is illuminated.

©August 2008 Navistar, Inc.

DTC 135
IVS circuit fault

- If the APS is changing but IVS is constant, the ECM assumes the IVS is the conflict source and sets DTC 135. In this case the ECM limits the APS signal to a lower value that provides less than full rpm, but does not limit engine rpm to idle.
- When DTC 135 is active the amber ENGINE lamp is illuminated.

DTC 133, 134, and 135 are caused by intermittent conditions. These DTCs remain active until the vehicle has been shutdown and restarted. They do not recover without cycling the ignition switch. Later calibration versions may allow DTC recovery without cycling the ignition switch.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- Breakout Box
- APS/IVS Breakout Harness
- Terminal Test Adapter Kit

The APS/IVS circuit requires the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

APS/IVS Operational Diagnostics

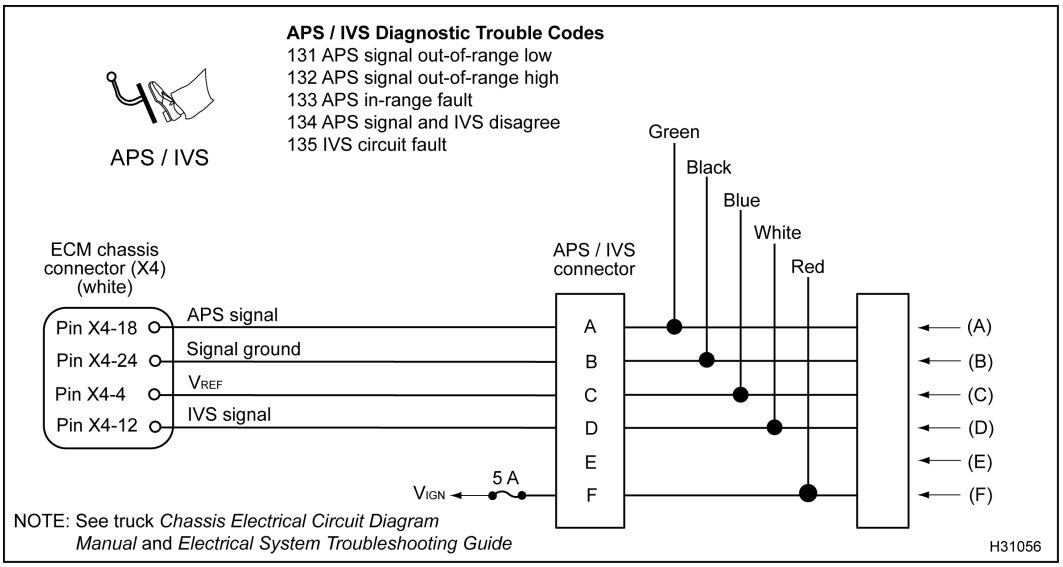


Figure 377 APS/IVS circuit diagram

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the continuous monitor session. To monitor signal voltage, run KOEO Continuous Monitor Test.

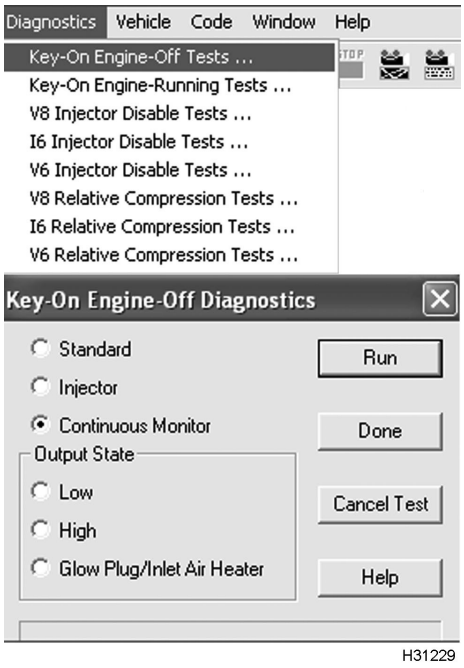


Figure 378 Continuous Monitor Test

2. To monitor signal voltage, run KOEO Continuous Monitor Test. For help, see “Continuous Monitor Test” in Section 3 (page 68).
3. Monitor APS signal voltage. Verify an active DTC for the APS/IVS circuit.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4. If code is active, do step 6 and 7 to check circuit for the APS sensor using the following table.
   - Circuit Checks for APS Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Disconnect chassis harness from APS sensor.

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

7. Connect APS Sensor Breakout Harness to chassis harness only.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Circuit Checks for APS Sensor (Use EST, DMM, breakout harness, and 500 Ohm Resistor Harness.)

Test Condition	Spec	Checks
Sensor disconnected using EST	0 V	If voltage > 0.147 V, check signal circuit for short to V_{REF} or B+.
Measure voltage from Pin C (Blue) to ground using DMM	5 V ±0.5 V	If voltage > 5.5 V, check V_{REF} for short to B+. If voltage is < 4.5 V, check V_{REF} for open or short to ground.
500 Ohm Resistor Harness connected between Pin A (Green) and Pin C (Blue) of breakout harness using.	5 V	If voltage < 4.55 V, check signal circuit for open or short to ground. — Disconnect connector 9260[1]. Measure resistance from Pin C to Pin A of connector 9260 (spec > 1 kΩ) to check for short to ground within wiring harness. — Disconnect negative battery cable. Measure resistance from Pin C to ground cable to check for short to ground. — Use a breakout box to measure from Pin A to Pin X4–18 (spec < 5 Ω) to check for open in the harness.
Resistance from Pin B (Black) of breakout harness to ECM chassis ground Pin A of connector 9260 using DMM.	< 5 Ω	If resistance is > 5 Ω, check for open or high resistance between ECM and sensor connector. Use a breakout box and measure resistance from between Pin B and Pin X4–24 (spec < 5 Ω).
Connect chassis harness to sensor and cycle key. Use the EST to clear DTCs. If an active code remains after checking test conditions, inspect pedal assembly for excessive wear. If pedal assembly is in tact, replace the APS/IVS sensor.		

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

APS/IVS Pin-Point Diagnostics

Connector Voltage Checks (Disconnect harness from sensor. Inspect for bent pins or corrosion. Connect breakout harness to chassis harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
A to gnd	0 to 0.25 V	Voltage > 0.25 V, signal is shorted to V_{REF} or B+
B to gnd	0 V	Ground circuit, no voltage expected
C to gnd	5 V ±0.05 V	Voltage > spec, wire shorted to B+; Voltage < spec, wire open or shorted to ground
D to gnd	0 V to 0.25 V	Voltage > 0.25 V, IVS signal wire shorted to V_{REF} or B+
F to gnd	B+	Voltage < 10.5 V check circuit for open or high resistance – blown fuse
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Connect breakout harness to chassis harness only. Disconnect chassis connector 9260[1].)		
A to Pin A (9260)	> 1 k Ω	If < 1 kΩ, check for short to ground within wiring harness.
B to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open signal ground.
C to Pin A (9260)	> 500 Ω	If < 500 Ω, check for short to ground within wiring harness.
D to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.
F to Pin A (9260)	> 1 kΩ	If < 1 kΩ with fuse removed, check for short to ground within wiring harness.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)

A to gnd cable	> 1 k Ω	If < 1 kΩ, check for short to ground.
B to gnd cable	> 500 Ω	If < 500 Ω, check for open signal ground.
C to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
D to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
F to gnd cable	> 1 kΩ	If < 1 kΩ with fuse removed, check for short to ground.

Harness Resistance Checks (Connect breakout box [X4 only] to chassis harness only. Connect breakout harness to chassis harness only.)

X4–18 to A	< 5 Ω	If > 5 Ω, check for APS signal wire open.
X4–24 to B	< 5 Ω	If > 5 Ω, check for open signal ground.
X4–4 to C	< 5 Ω	If > 5 Ω, check for open V_{REF} wire.
X4–12 to D	< 5 Ω	If > 5 Ω, check for open IVS signal wire.
Fuse to F	< 5 Ω	If > 5 Ω, check for open IVS power wire.

NOTE: See truck *Chassis Electrical Circuit Diagram Manual* for fuse location.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

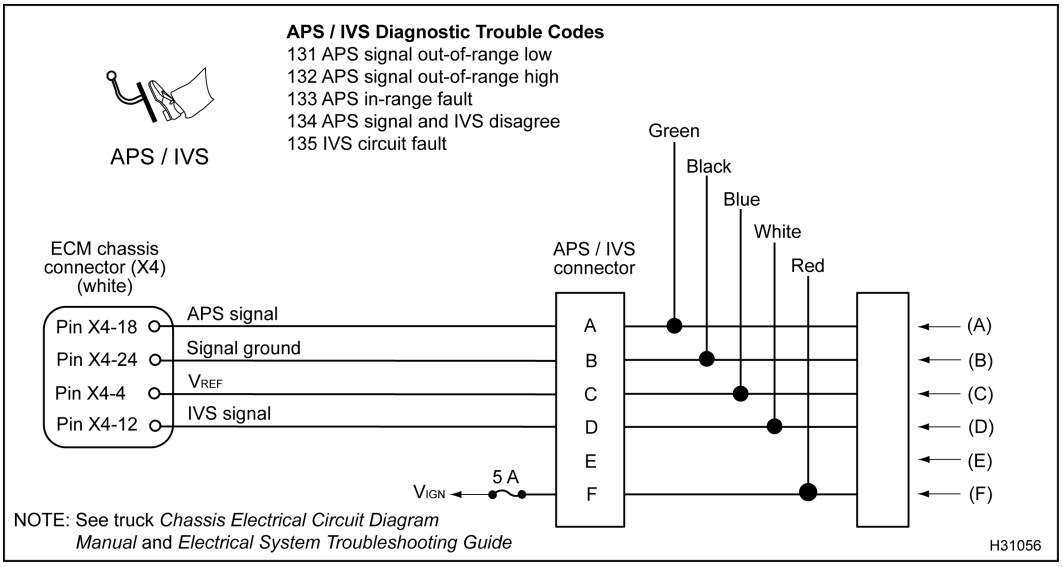


Figure 379 APS/IVS circuit diagram

Operational Voltage Checks for APS/IVS Sensor with Breakout Harness (Check with breakout harness connected to sensor and chassis harness with key-on engine-off.)

- **APS test points:** (+) A (Green) to (-) B (Black)
- **IVS test points:** (+) D (White) to (-) B (Black)

Position	Voltage	% APS	IVS Voltage	Comment
Low idle	0.64 V to 0.66 V	0%	0 V	IVS toggles only off idle
High idle	3.84 V to 3.86 V	98% to 102%	B+	

Operational Voltage Checks for APS/IVS Sensor with Breakout Box (Check with breakout box connected [X-4 only] to ECM and chassis harness with key-on engine-off.)

- **APS test points:** (+) X4–18 to (-) X4–24
- **IVS test points:** (+) X4–12 to (-) X4–24

Position	Voltage	% APS	IVS Voltage	Comment
Low idle	0.64 V to 0.66 V	0%	0 V	IVS toggles only off idle
High idle	3.84 V to 3.86 V	98% to 102%	B+	

APS / IVS Diagnostic Trouble Codes

DTC 131= APS signal voltage was < 0.147 V for more than 0.35 seconds

DTC 132= APS signal voltage was > 4.55 V for more than 0.35 seconds

DTC 133= APS signal in-range fault

DTC 134= APS and IVS disagree

DTC 135= Idle validation switch circuit fault – 50% APS only

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ATA Datalink (American Trucking Association)

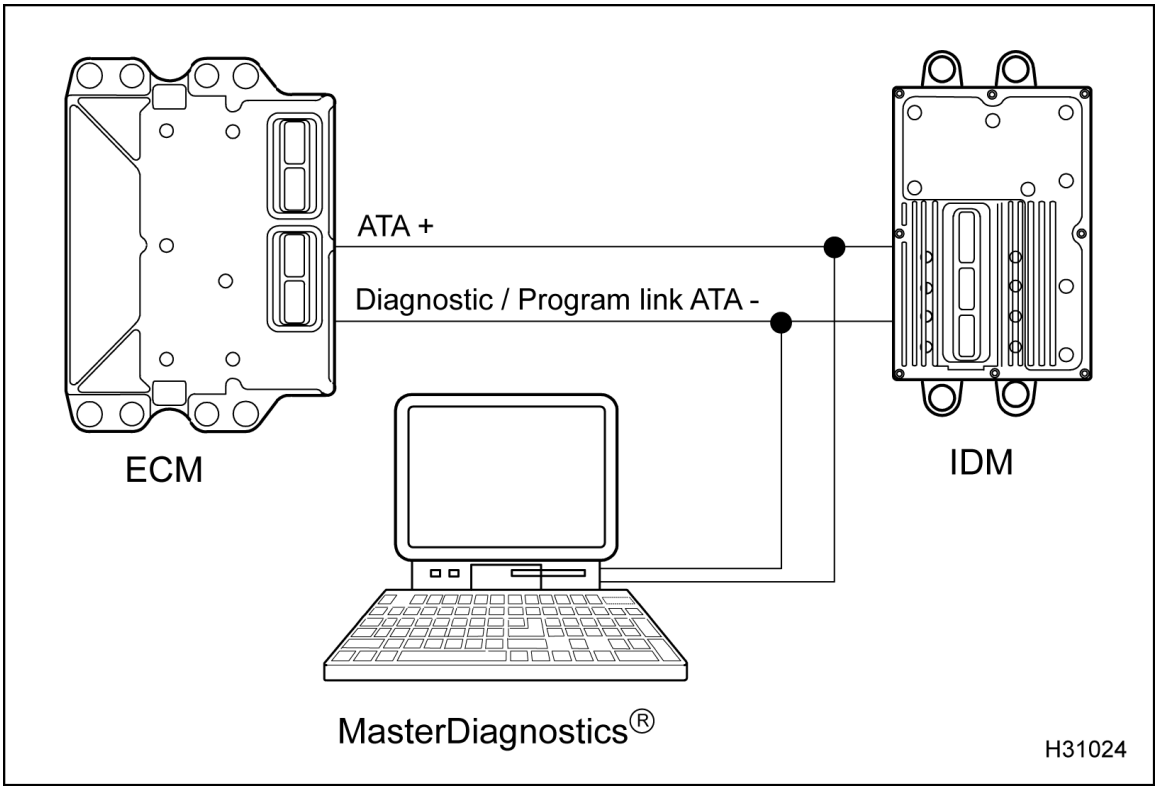


Figure 380 Function diagram for the ATA datalink

The function diagram for the ATA datalink includes the following:

- EST with MasterDiagnostics® software
- Electronic Control Module (ECM)
- Injection Driver Module (IDM)

Function

The Data Communication Link signal is a 0 V to 5 V variable width square wave form signal that enables communication between the MasterDiagnostics® software and the ECM. The data communication link also allows for programming the ECM and IDM.

©August 2008 Navistar, Inc.

ATA Circuit Operation

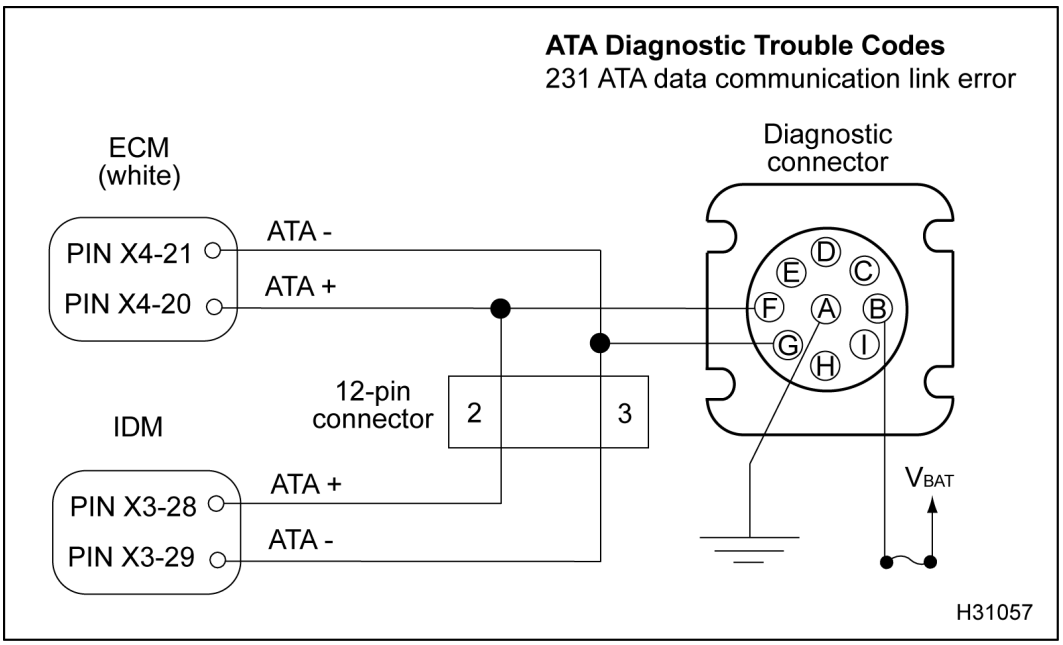


Figure 381 ATA circuit diagram

The ECM communicates with the EST and MasterDiagnostics® software through the diagnostic connector. The EST communicates with the ECM using the ATA datalink.

The IDM uses ATA only for programming.

The ATA circuit uses a twisted wire pair. All repairs must maintain one complete twist per inch along the entire length of the circuit. This circuit is polarized (one positive and one negative) and reversing the polarity of this circuit will disrupt communications.

ATA Datalink Connector

Vehicles are equipped with the ATA datalink connector for communication between the Electronic Control Module (ECM) and the EST.

The ATA datalink supports the following functions:

- Transmission of engine parameter data
- Transmission and clearing of DTCs
- Diagnostics and trouble shooting
- Programming performance parameter values
- Programming engine and vehicle features
- Programming calibrations and strategies in the ECM and IDM

Fault Detection / Management

The ECM continuously monitors the ATA datalink for an open, short or intermittent connection. If an active DTC occurs on the ATA datalink, the MasterDiagnostics® software will not display correct data.

The IDM uses ATA for programming only. DTCs are not transmitted from the IDM through the ATA datalink.

ATA Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 231
ATA data communication link error

- DTC 231 is set when the ECM can not access the ATA datalink. When this occurs, ATA data can not be retrieved using the EST. DTCs can only be retrieved using the cruise control feature.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- DTC 231 can be set when any of the following conditions occur:
  - Inoperative ATA device (transmission controller or anti-lock brake controller) is connected to ATA bus and pulls signal to ground.
  - Number of ATA devices exceeds limit
  - Inoperative ECM
- When DTC 231 is active the amber ENGINE lamp is not illuminated.

NOTE: Vehicles equipped with the Allison WTEC transmission may display DTC 231 when attempting to program the ECM. The WTEC controller must be disconnected when programming the engine ECM.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box
- Breakout Harness

The ATA circuit requires the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ATA Pin-Point Diagnostics

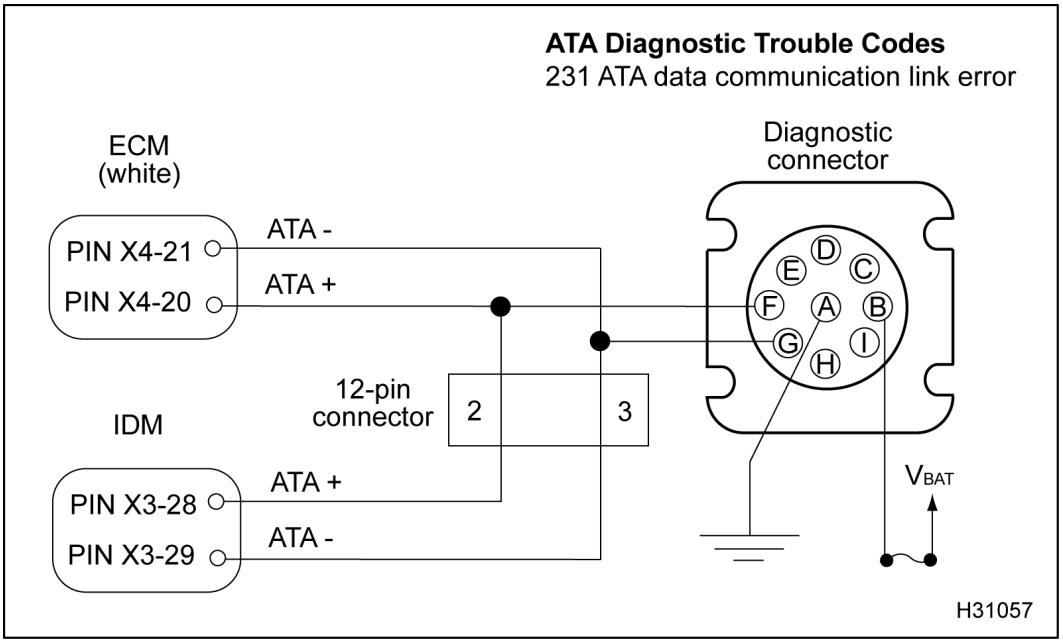


Figure 382 ATA circuit diagram

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Diagnostic Connector Voltage Checks (Key-on engine-off.)

Test Point	Spec	Signal	Comment
B to A	B+	Voltage	Should be voltage at B at all times. If no voltage is present, check ground and power circuits.
Diagnostic Connector to Chassis Ground (Turn the ignition switch to OFF and disconnect negative battery cable.)			
F to gnd	> 1 kΩ	ATA +	If < 1 kΩ, check for short to ground through harness or internal within the ECM and IDM. Disconnect ECM and IDM and measure ground again. If short is still present, disconnect other devices connected to data communication link and retest. If short is still present, repair harness.
G to gnd	> 1 kΩ	ATA –	
B to gnd	> 1 kΩ	Power	With fuse removed, if< 1 kΩ, check for short to ground.
A to gnd	< 5 Ω	gnd	If > 5 Ω, check for an open circuit. The EST tool will not communicate.

©August 2008 Navistar, Inc.

Harness Resistance Checks – Diagnostic Connector to ECM (Turn the ignition switch to OFF. Connect breakout box [X4 only] to engine harness only.)			
F to ECM X4–20	< 5 Ω	ATA +	Resistance from ECM chassis connector to EST connector.
G to ECM X4–21	< 5 Ω	ATA –	Resistance from ECM chassis connector to EST connector.
B to fuse	< 5 Ω	Power	Resistance from EST connector to power fuse. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
A to gnd	< 5 Ω	gnd	If > 5 Ω, check for an open circuit. Open circuit will prevent EST power up.
Harness Resistance Checks – Diagnostic Connector to IDM (Turn the ignition switch to OFF.)			
F to IDM X3–28	< 5 Ω	ATA +	Resistance from IDM connector to EST connector.
G to IDM X3–29	< 5 Ω	ATA –	Resistance from IDM connector to EST connector.
ATA Diagnostic Trouble Codes			
231 ATA data communication link error – ATA wiring or connector			

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

BAP Sensor (Barometric Absolute Pressure)

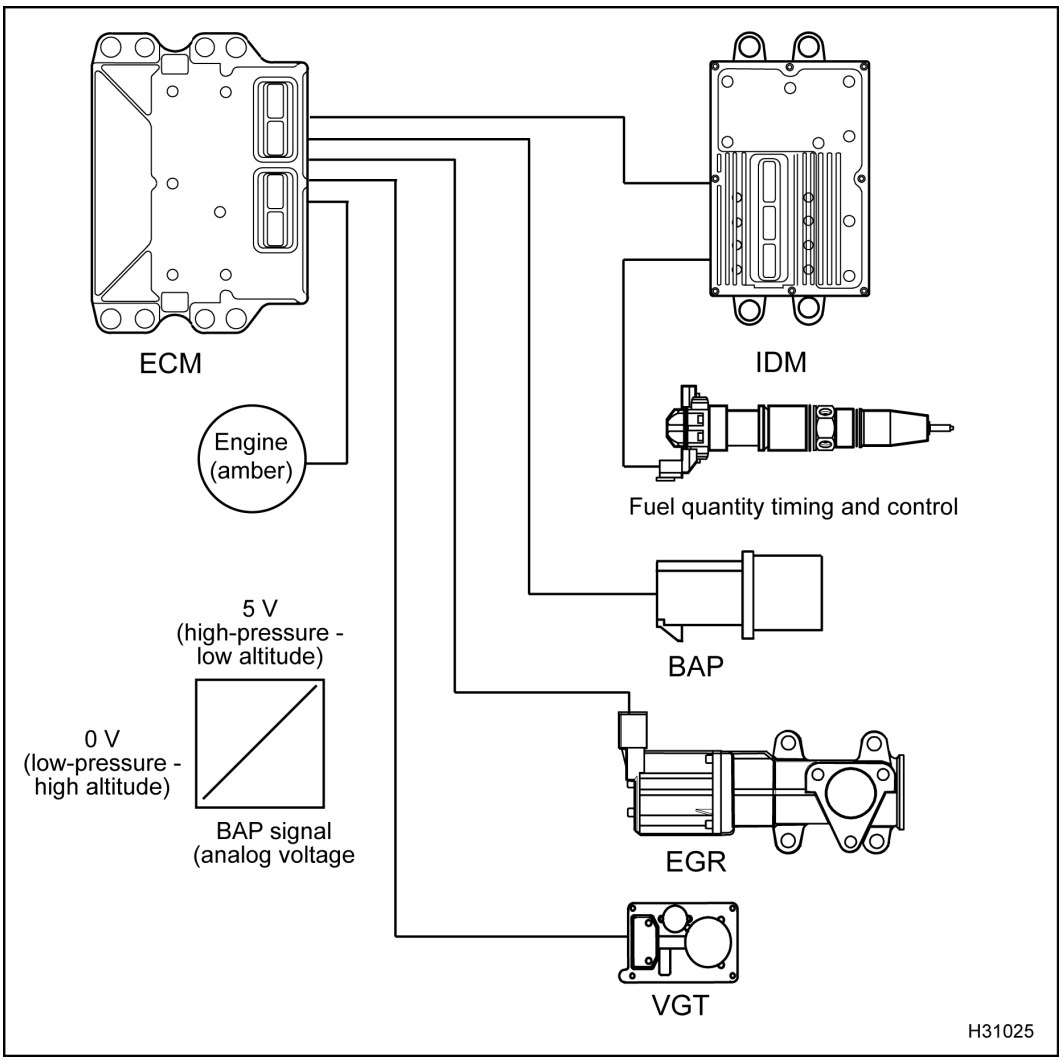


Figure 383 Function diagram for the BAP sensor

The function diagram for the BAP sensor includes the following:

- BAP sensor
- Electronic Control Module (ECM)
- Injection Driver Module (IDM)
- Fuel injector
- Exhaust Gas Recirculation (EGR)
- Variable Geometry Turbocharger (VGT)
- ENGINE lamp (amber)

Function

The BAP sensor is a variable capacitance sensor and is located in the cab. The ECM supplies a 5 V reference signal which the BAP sensor uses to produce a linear analog voltage signal that indicates pressure.

The primary function of the BAP sensor is to provide a feedback signal to the ECM to adjust timing and fuel quantity. The ECM monitors the BAP signal to determine altitude, adjust timing, fuel quantity, and inlet air heater operation.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

BAP Circuit Operation

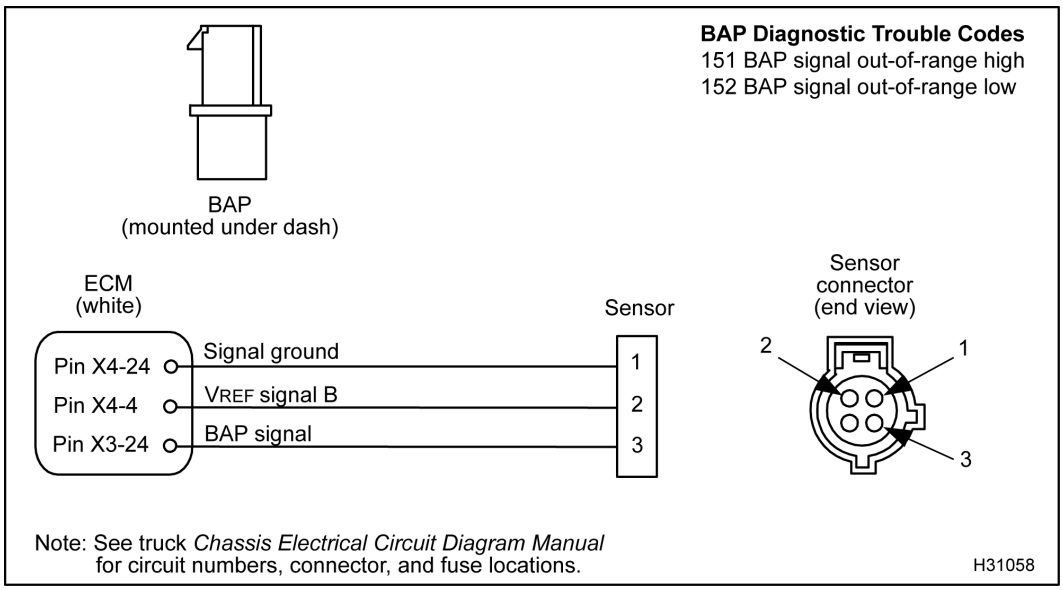


Figure 384 BAP circuit diagram

The BAP sensor is supplied with a 5 V reference voltage at Pin 2 from ECM Pin X4–4 . The BAP sensor is grounded at Pin 1 from ECM Pin X4–24. The BAP sensor returns a variable voltage signal from Pin 3 to ECM at Pin X3–24.

Fault Detection / Management

When the ECM detects the BAP voltage signal out of range high or low, the ECM will ignore the BAP signal and use the Manifold Absolute Pressure (MAP) signal generated at low idle as an indication of barometric pressure. When a MAP fault is detected, the BAP signal will default to barometric pressure at sea level, 101 kPa (29.8 in Hg).

BAP Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 151
BAP signal out-of-range high

- DTC 151 is set when the BAP signal is greater than 4.95 V for more than 0.5 second.
- DTC 151 can be set when the signal circuit is shorted to V_{REF} or B+ or a failed BAP sensor.
- When DTC 151 is active the amber ENGINE lamp is illuminated.

DTC 152
BAP signal out-of-range low

- DTC 152 is set when the BAP signal is less than 1.0 V for more than 0.5 second.
- DTC 152 can be set when the signal circuit is shorted to ground or open, V_{REF} is shorted to ground, or a failed BAP sensor.
- When DTC 152 is active the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

BAP Pin-Point Diagnostics

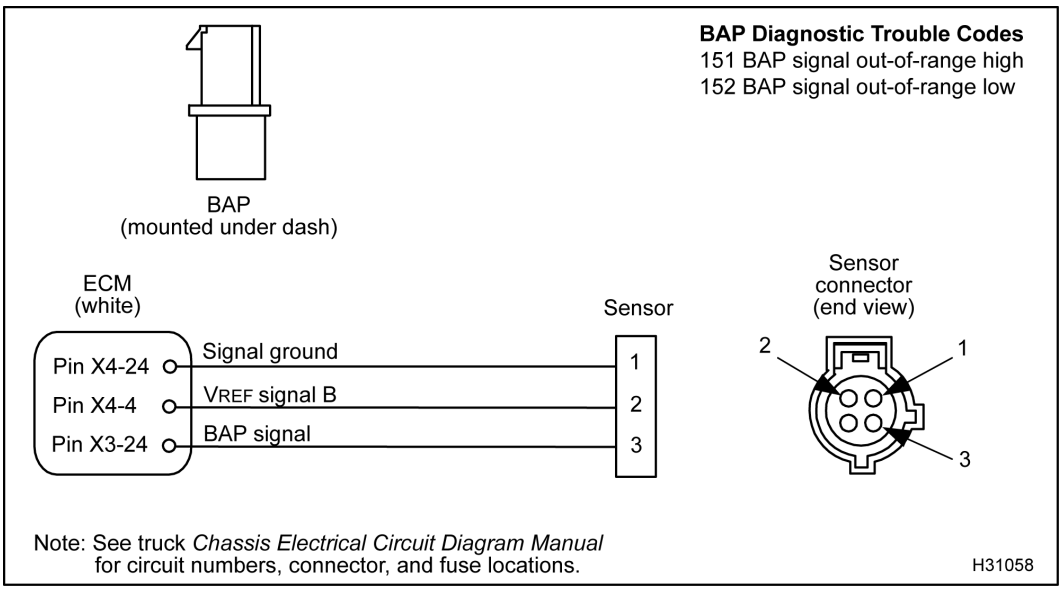


Figure 385 BAP circuit diagram

NOTE: See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Connector Voltage Checks to Ground (Disconnect harness from sensor. Inspect for bent pins or corrosion. Turn the ignition switch to ON.)

Test Point	Spec	Comment
1 to gnd	0 V to 0.25 V	If > 0.25 V, check ground circuit for open or high resistance. Check signal ground for short to V_{REF} or B+.
2 to gnd	5 V ± 0.5 V	If voltage is not to spec, V_{REF} circuit is shorted to ground, shorted to B+, or open.
3 to gnd	0 V to 0.25 V	If voltage > 0.25 V, signal circuit is shorted to V_{REF} or B+.

Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1].)

1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open signal ground.
2 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for V_{REF} short to ground.
3 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for signal short to ground.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)

1 to gnd cable	> 500 Ω	If < 500 Ω , check for short to ground.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

2 to gnd cable	> 1 kΩ	If < 1 kΩ, check for V_{REF} short to ground.
3 to gnd cable	> 1 kΩ	If < 1 kΩ, check for signal short to ground.
Harness Resistance Checks (Connect breakout box to chassis harness [X3 and X4 only].)		
X4-24 to 1	< 5 Ω	If > 5 Ω, check for open signal ground.
X4–4 to 2	< 5 Ω	If > 5 Ω, check for open V_{REF}.
X3–24 to 3	< 5 Ω	If > 5 Ω, check for open signal circuit.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Operational Voltage Checks for BAP Sensor (Check with breakout box connected [X3 and X4 only] to ECM and chassis harness.)

Test Point	Voltage	Pressure	Comment
X3–24 to X4–24	4.89 V	105 kPa (31 in Hg)	High atmospheric pressure.
X3–24 to X4–24	4.60 V	100 kPa (29.5 in Hg)	Normal atmospheric pressure at sea level.
X3–24 to X4–24	2.60 V	60 kPa (17.7 in Hg)	Normal atmospheric pressure at 10,000 feet.

BAP Diagnostic Trouble Codes

DTC 151 = Signal voltage was > 4.95 V for more than 0.5 second

DTC 152 = Signal voltage was < 1.0 V for more than 0.5 second

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

BCP Sensor (Brake Control Pressure)

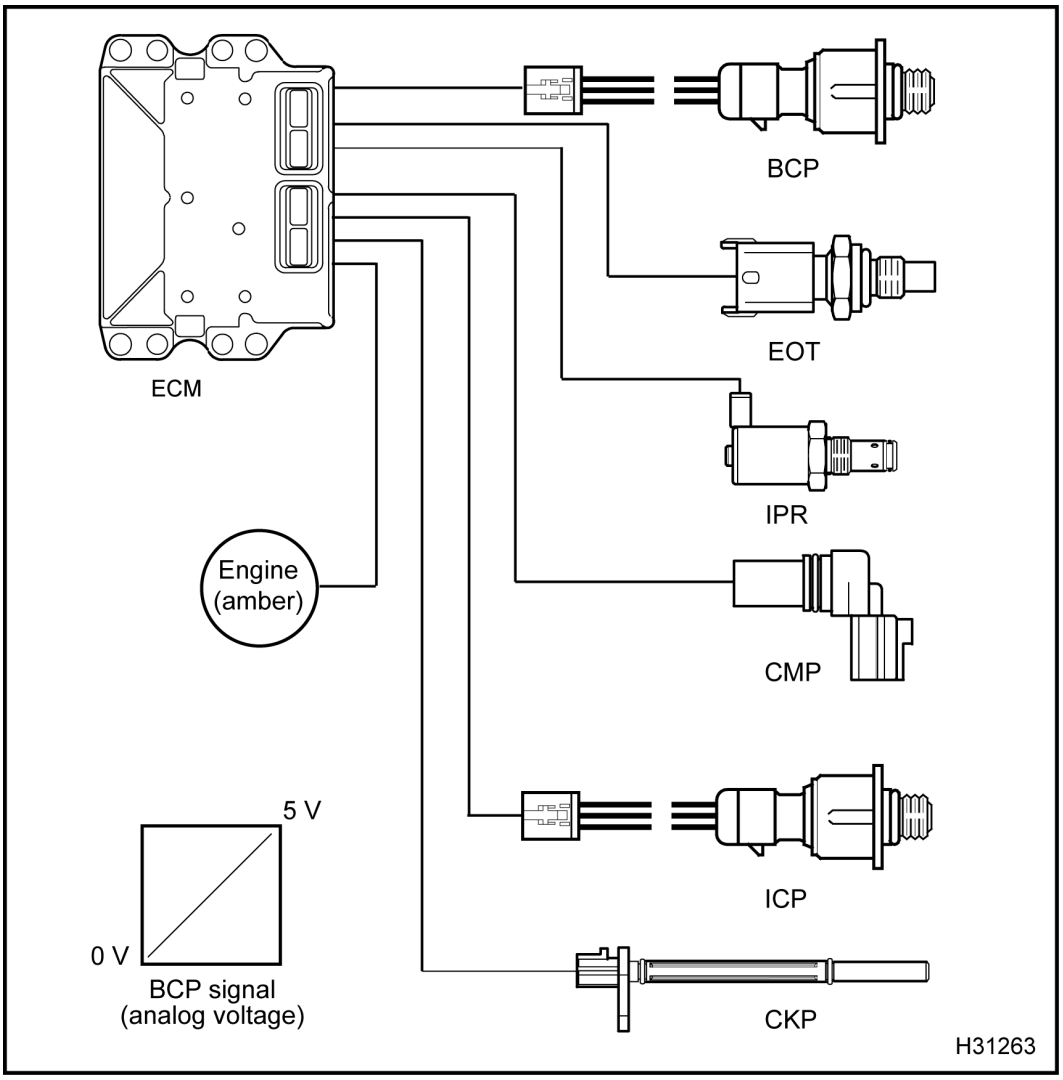


Figure 386 Function diagram for the BCP sensor

The function diagram for the BCP sensor includes the following:

- BCP sensor
- Injection Control Pressure (ICP) sensor
- Camshaft Position (CMP) sensor
- Crankshaft Position (CKP) sensor
- Injection Pressure Regulator (IPR)
- Electronic Control Module (ECM)
- Engine Oil Temperature (EOT) sensor
- ENGINE lamp (amber)

Function

The BCP sensor is a Micro Strain Gauge (MSG) sensor. The BCP sensor is under the valve cover, forward of the No. 2 fuel injector in the high-pressure oil rail. The engine harness connection on the valve cover gasket for the BCP sensor is left of the No. 2 injector connector. The ECM supplies a 5 V reference signal which the BCP sensor uses to produce a linear analog voltage that indicates pressure.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The ECM monitors the BCP signal to determine the oil pressure in the brake gallery of the high-pressure oil rail. During engine brake operation, if the ECM recognizes that the BCP signal is greater than desired brake control pressure or less than the ICP signal, the ECM will set a DTC and illuminate the amber ENGINE lamp.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

BCP Circuit Operation

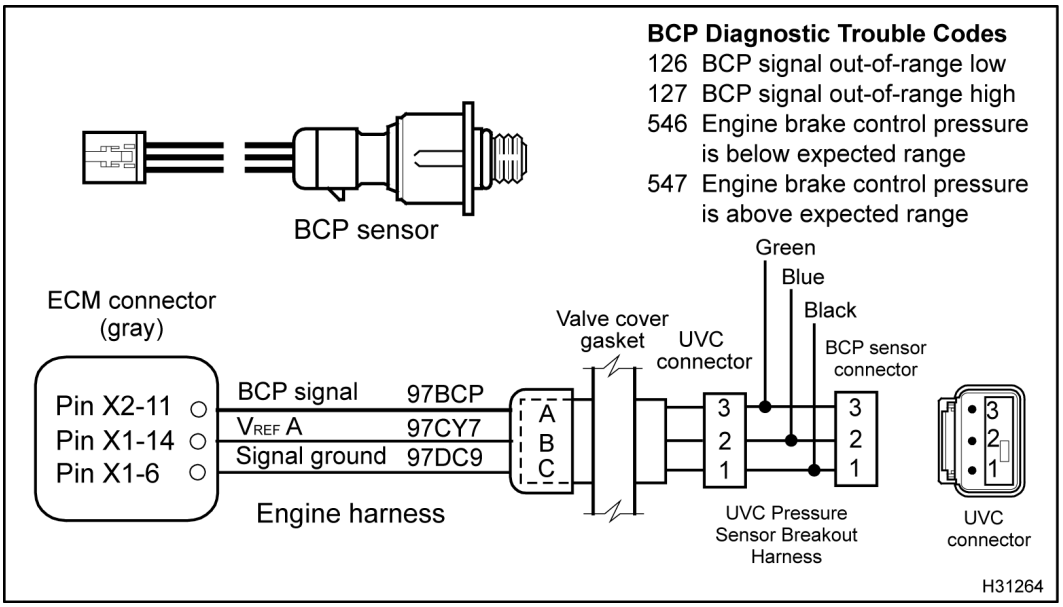


Figure 387 BCP circuit diagram

The BCP sensor is supplied with a 5 V reference signal at Pin 2 through the valve cover gasket Pin B from ECM Pin X1–14. The BCP sensor is supplied a signal ground at Pin 1 through the valve cover gasket Pin C from ECM Pin X1–6. The BCP sensor sends a signal from sensor Pin 3 through valve cover gasket Pin A to ECM Pin X2–11.

Fault Detection / Management

The ECM continuously monitors the signal of the BCP sensor to determine if the signal is within an expected range. If the ECM detects a voltage greater or less than expected, the ECM will set a DTC and illuminate the amber ENGINE lamp.

BCP Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamps.

DTC 126
BCP signal out-of-range low

- DTC 126 is set by the ECM if signal voltage is less than 0.039 V for more than 0.35 second.
- DTC 126 can be set due to an open or short to ground on the signal circuit, a failed BCP sensor, an open V_{REF} circuit or V_{REF} short to ground.
- When DTC 126 is active the amber ENGINE lamp is illuminated.

DTC 127
BCP signal out-of-range high

- DTC 127 is set by the ECM if the signal voltage is greater than 4.9 V for more than 0.35 second.
- DTC 127 can be set due to a signal circuit shorted to V_{REF} or B+, or a failed BCP sensor.
- When DTC 127 is active the amber ENGINE lamp is illuminated.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 546
Engine brake control pressure below expected range

- DTC 546 is set by the ECM when the brake control pressure is less than injection control pressure by 4 MPa (580 psi) for more than 3.0 seconds.
- DTC 546 can be set due to a bias low BCP sensor or a failed BCP sensor.
- DTC 546 can be set due to an open control circuit (power or ground), a failed brake shut-off valve, or a failed brake shut-off valve solenoid. See “Brake Shut-off Valve – Section 7.
- When DTC 546 is active the amber ENGINE lamp is illuminated.

DTC 547
Engine brake control pressure above expected range

- DTC 547 is set by the ECM when the brake control pressure is greater than desired brake control pressure of 4.5 MPa (653 psi) for more than three seconds.
- DTC 547 can be set due to an open signal ground, V_{REF} shorted to a voltage source higher than 5.5 V, or a faulty BCP sensor.
- DTC 547 can be set due to a control circuit short to B+ or a brake shut-off valve stuck open. See “Brake Shut-off Valve – Section 7.
- When DTC 547 is active the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- VC Gasket Breakout Harness
- UVC Pressure Breakout Harness
- Breakout Box
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

BCP Operational Diagnostics

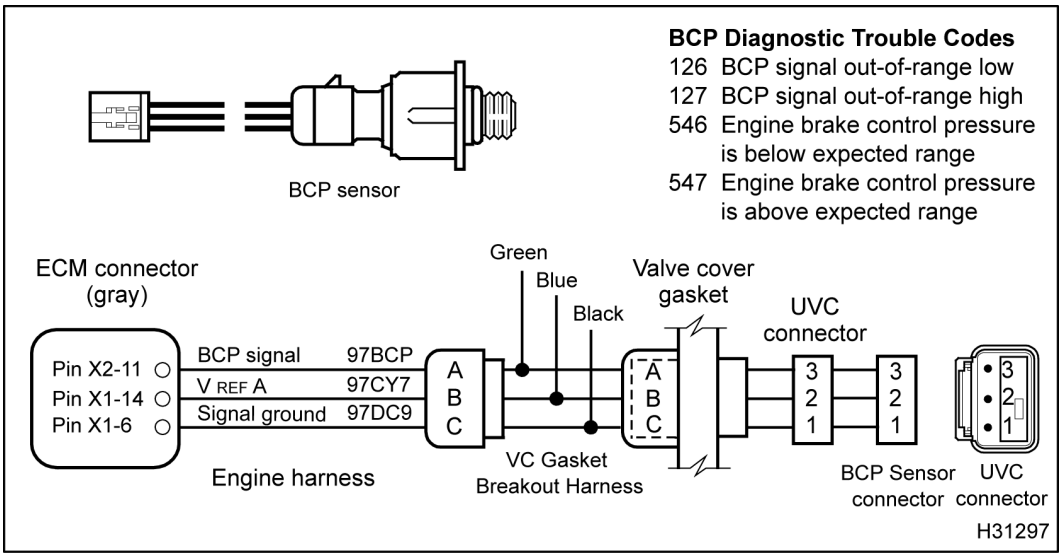


Figure 388 BCP circuit diagram

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the D_ContinuousMonitor.ssn.

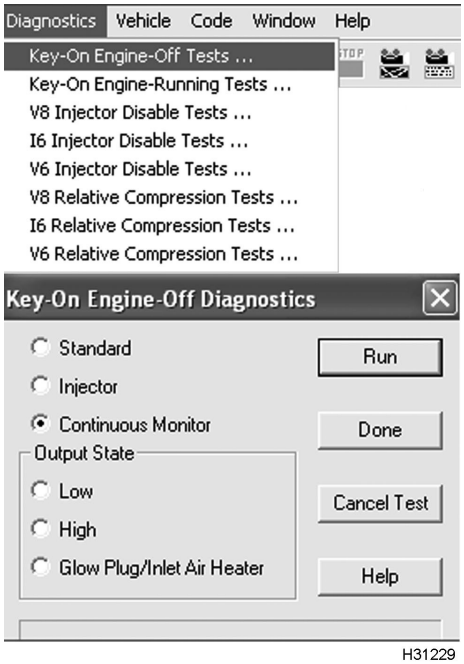


Figure 389 Continuous Monitor Test

2. To monitor signal voltage, run KOEO Continuous Monitor Test.
3. Monitor BCP signal voltage. Verify an active DTC for the BCP circuit.

©August 2008 Navistar, Inc.

4. If code is active, do step 6 and 7 to check circuit for the BCP sensor using the following tables:
   - Circuit Checks for BCP Sensor – ECM to Valve Cover Gasket Connector
   - Circuit Checks for BCP Sensor – ECM to BCP Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Disconnect engine harness from valve cover gasket connector.

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

7. Connect VC Gasket Breakout Harness to engine harness only.

©August 2008 Navistar, Inc.

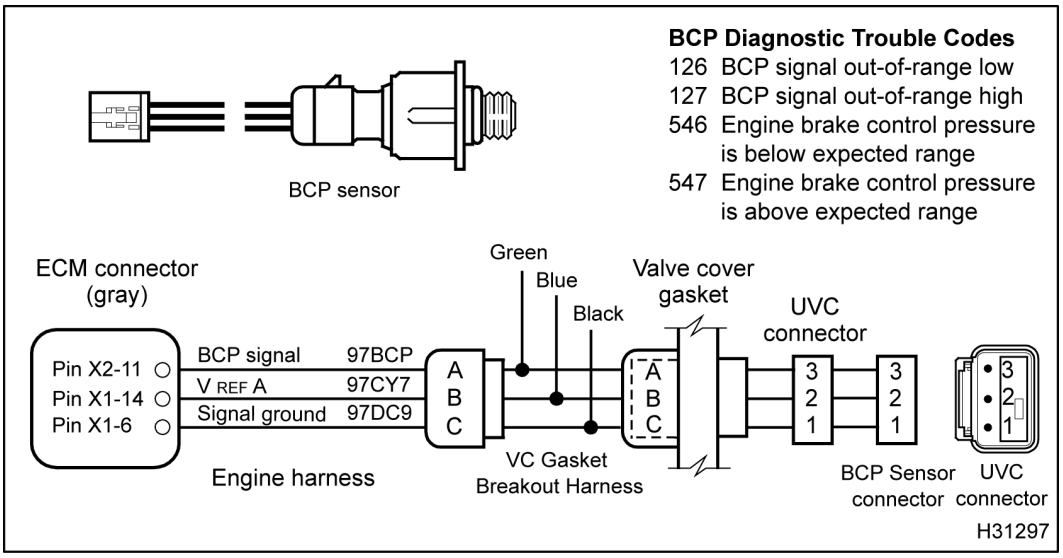


Figure 390 BCP circuit diagram with breakout harness

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Circuit Checks for BCP Sensor – ECM to Valve Cover Gasket Connector (Use EST, DMM, 500 Ohm Resistor Harness, and VC Gasket Breakout Harness to engine harness only.)

Test Condition	Spec	Checks
Harness disconnected from valve cover gasket connector using EST	0 V	If voltage > 0.039 V, check BCP signal for short to V_{REF} or B+.
Voltage from Pin B (Blue) of VC Gasket Breakout Harness to ground using DMM	5 V ±0.5 V	If voltage > 5.5 V, check V_{REF} for short to B+. If voltage is < 4.5 V, check V_{REF} for open or short to ground.
500 Ohm Resistor Harness connected between Pin A (Green) and Pin B (Blue) of VC Gasket Breakout Harness using EST.	5 V	If voltage < 4.9 V, check BCP signal for open or short to ground. — Disconnect connector 9260[1]. Measure resistance from Pin A to Pin A of connector 9260 (spec > 1 kΩ) to check for short to ground within wiring harness. — Disconnect negative battery cable. Measure resistance from Pin A to ground cable to check for short to ground. — Use a breakout box to measure from Pin A to Pin X2-11 (spec < 5 Ω) to check for open in the harness.
Resistance from Pin C (Black) of VC Gasket Breakout Harness to	< 5 Ω	If resistance is > 5 Ω, check for open or high resistance between ECM and UVC. Use a breakout box to measure

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM chassis ground (Pin A of connector 9260) using DMM.	resistance from X1-6 to Pin C (spec < 5 Ω).
Connect engine harness to UVC connector. Use the EST to clear DTCs. If test results are to spec for all test conditions, but an active code remains, remove valve cover and check between UVC gasket connection and BCP sensor. (See Circuit Checks for BCP – ECM to BCP Sensor.)	

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

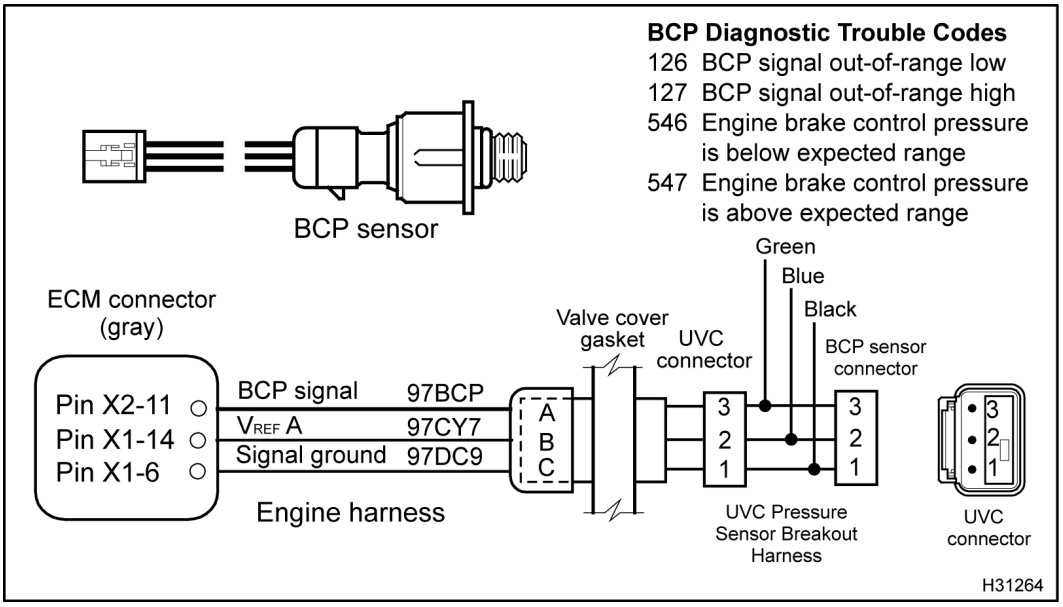


Figure 391 BCP circuit diagram with UVC Pressure Sensor Breakout Harness

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Circuit Checks for BCP Sensor – ECM to BCP Sensor (If Circuit Checks for BCP Sensor – ECM to Valve Cover Gasket Connector are complete and test results are to specification for all test conditions, but an active code remains, remove valve cover following procedure in the *Engine Service Manual*. Use EST, DMM, 500 Ohm Resistor Harness, and UVC Pressure Sensor Breakout Harness connected to UVC connector only.)

Test Condition	Spec	Checks
BCP sensor connector removed from UVC connector using EST	0 V	If voltage > 0.039 V, check BCP signal for short to V_{REF} or B+.
Voltage from Pin 2 (Blue) of UVC Pressure Sensor Breakout Harness to ground using DMM.	5 V ±0.5 V	If voltage > 5.5 V, check V_{REF} for short to B+. If voltage is < 4.5 V, check V_{REF} for open or short to ground.
500 Ohm Resistor Harness connected between Pin 3 (Green) and Pin 2 (Blue) of VC Gasket Breakout Harness using EST	5 V	If voltage < 4.9 V, check BCP signal for open or short to ground. — Disconnect connector 9260[1]. Measure resistance from Pin 3 to Pin A of connector 9260 (spec > 1 kΩ) to check for short to ground within wiring harness. — Disconnect negative battery cable. Measure resistance from Pin 3 to ground cable to check for short to ground. — Use a breakout box to measure from Pin 3 to Pin X2-11 (spec < 5 Ω) to check for open in the harness.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Resistance from Pin 1 (Black) of UVC Pressure Sensor Breakout Harness to ECM chassis ground (Pin A of connector 9260) using DMM.	< 5 Ω	If resistance is > 5 Ω, check for open or high resistance between ECM and UVC connector. Use a breakout box to measure resistance from X1-6 to Pin 1 (spec < 5 Ω).

Connect BCP sensor to UVC connection. Use the EST to clear DTCs. If test results are to spec for all test conditions, but an active code remains, replace sensor.

NOTE: If all tests are to specification, but DTCs return when the valve cover is torqued down, replace the valve cover gasket.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

BCP Pin-Point Diagnostics (ECM to Valve Cover Gasket Connector)

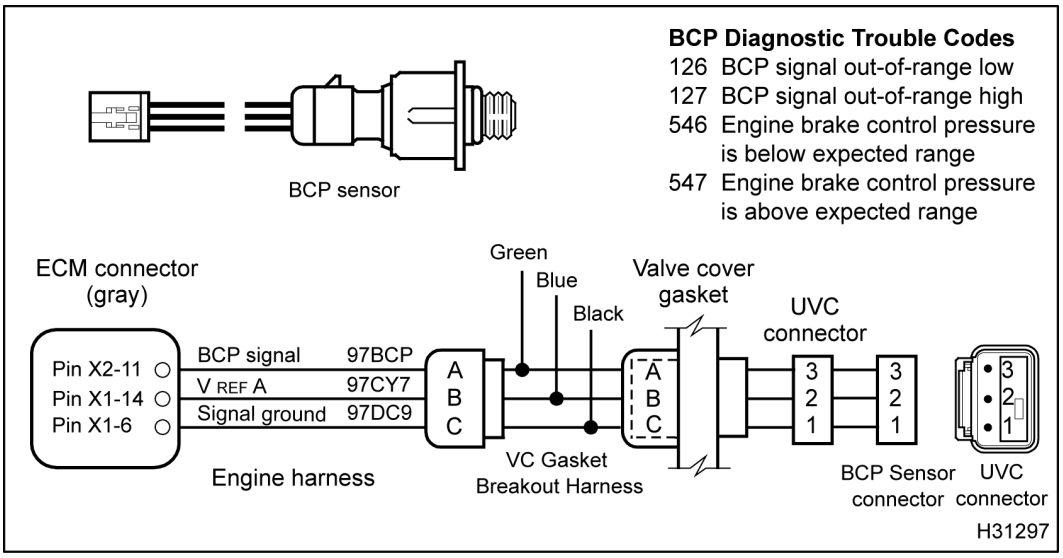


Figure 392 BCP circuit diagram with VC Gasket Breakout Harness

Connector Voltage Checks (Disconnect engine harness from valve cover gasket connector and connect VC Gasket Breakout Harness to engine harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
A to gnd	0 V to 0.25 V	If > 0.25 V, signal circuit is shorted to V_{REF} or B+.
B to gnd	5 V ± 0.5 V	If voltage is not to spec, V_{REF} shorted to ground, shorted to B+, or open.
C to gnd	0 V to 0. 25 V	Signal ground (no voltage expected). If > 0.25 V, check ground circuit for open or high resistance and check signal ground for short to V_{REF} or B+.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect harness from valve cover gasket connector. Connect VC Gasket Breakout Harness to engine harness only.[1])		
A to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.
B to Pin A (9260)	> 500 Ω	If < 500 Ω, check for short to ground within wiring harness.
C to Pin A (9260)	< 5 kΩ	If > 5 kΩ, check for open circuit .

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)		
A to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
B to gnd cable	> 500 Ω	If< 500 Ω , check for short to ground.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

C to gnd cable	> 500 Ω	If< 500 Ω , check for short to ground.

Harness Resistance Checks (Connect breakout box [X1] to engine harness only. Connect VC Gasket Breakout Harness to engine harness only.)

X1–20 to A	< 5 Ω	If > 5 Ω, check for open BCP signal.
X1–14 to B	< 5 Ω	If > 5 Ω, check for open V_{REF}.
X2–11 to C	< 5 Ω	If > 5 Ω, check for open ground.

[1] Connector 9260 is a 2-wire connector usually in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

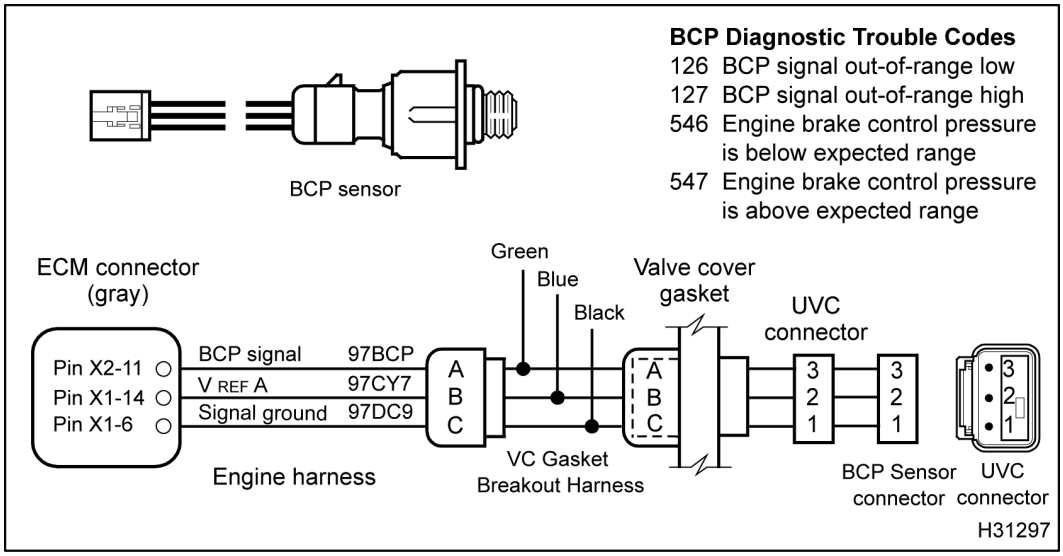


Figure 393 BCP circuit diagram with VC Gasket Breakout Harness

Operational Voltage Checks for BCP Sensor with VC Gasket Breakout Harness (These checks are done if an EST is not available and the valve cover is not removed. Check with VC Gasket Breakout Harness connected to valve cover gasket connector and engine harness.)

Test Point	EST voltage readings: Signal to ground	Spec	Checks
A to C	0.15 V to 0.3 V	0 psi (0 kPa)	Atmospheric pressure with key-on engine-off
A to C	0.15 V to 0.3 V	0 psi (0 kPa)	Maximum at engine cranking speed

Operational Voltage Checks for BCP Sensor with breakout box (Check with breakout box connected to ECM and engine harness.)

X2–11 to X1–6	0.15 V to 0.3 V	0 psi (0 kPa)	Atmospheric pressure with key-on engine-off
X2–11 to X1–6	0.15 V to 0.3 V	0 psi (0 kPa)	Maximum at engine cranking speed

BCP Diagnostic Trouble Codes

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 126 = Signal voltage was < 0.039 V for more than 0.1 second

DTC 127 = Signal voltage was > 4.9 V for more than 0.1 second

DTC 546 = Brake control pressure was < 4 MPa (580 psi) for more than 3.0 seconds

DTC 547 = Brake control pressure was > 4.5 MPa (653 psi) for more than 3.0 seconds

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

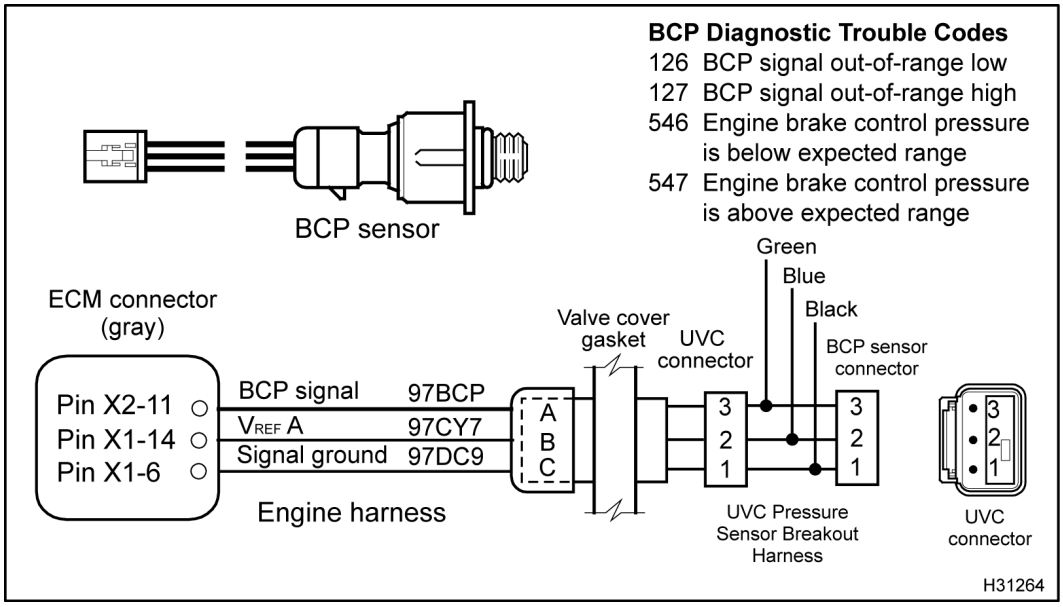


Figure 394 BCP circuit diagram with UVC Pressure sensor Breakout Harness

Connector Voltage Checks to Ground with Valve Cover Removed (Disconnect sensor from UVC connector and connect UVC Pressure Sensor Breakout Harness to UVC connector only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
1 to gnd	0 V to 0.25 V	Signal ground (no voltage expected). If > 0.25 V, check ground circuit for open or high resistance and check for short to V_{REF} or B+.
2 to gnd	5 V ± 0.5 V	If voltage is not to spec, V_{REF} is shorted to ground, shorted to B+, or open.
3 to gnd	0 V to 0.25 V	If voltage > 0.25 V, signal circuit is shorted to V_{REF} or B+.
Connector Resistance Checks to ECM Chassis Ground with Valve Cover Removed (Turn the ignition switch to OFF. Disconnect sensor from UVC connector. Disconnect chassis connector 9260[1]. Connect UVC Pressure Sensor Breakout Harness to UVC connector only.)		
1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit.
2 to Pin A (9260)	> 500 Ω	If < 500 Ω, check for short to ground within wiring harness.
3 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground with Valve Cover Removed (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

1 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
2 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
3 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
Harness Resistance Checks with valve cover removed (Connect breakout box [X1 and X2] to engine harness only. Connect UVC Pressure Sensor Breakout Harness to UVC connector only.)		
X1–6 to 1	< 5 Ω	If > 5 Ω, check for open ground.
X1–14 to 2	< 5 Ω	If > 5 Ω, check for open V_{REF}.
X2–11 to 3	< 5 Ω	If > 5 Ω, check for open BCP signal.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

BCP Pin-Point Diagnostics (ECM to BCP Sensor– valve cover removed)

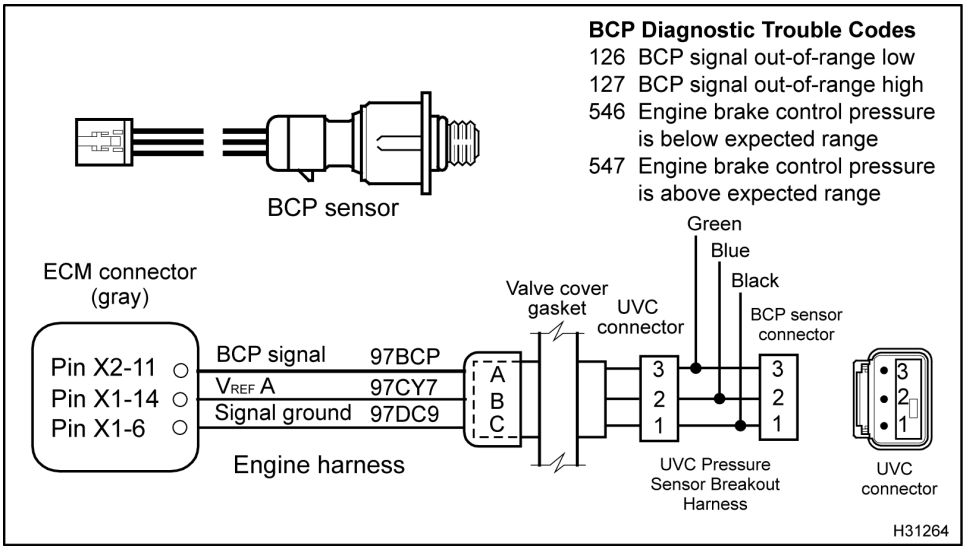


Figure 395 BCP circuit diagram with UVC Pressure Sensor Breakout Harness

Operational Voltage Checks for BCP Sensor with UVC Pressure Sensor Breakout Harness (Check with UVC Pressure Sensor Breakout Harness connected to UVC connector and sensor.)

NOTE: These checks are done only if an EST is not available. Do not use this method to measure BCP when engine is running.

Test Point	EST voltage readings: Signal to ground	Spec	Checks
3 to 1	0.15 V to 0.3 V	0 kPa (0 psi)	Atmospheric pressure with key-on engine-off
3 to 1	0.15 V to 0.3 V	0 kPa (0 psi)	Maximum at engine cranking speed

BCP Diagnostic Trouble Codes

DTC 126 = Signal voltage was < 0.039 V for more than 0.1 second

DTC 127 = Signal voltage was > 4.9 V for more than 0.1 second

DTC 546 = Brake control pressure was < 4 MPa (580 psi) for more than 3.0 seconds

DTC 547 = Brake control pressure was > 4.5 MPa (653 psi) for more than 3.0 seconds

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Brake Shut-off Valve

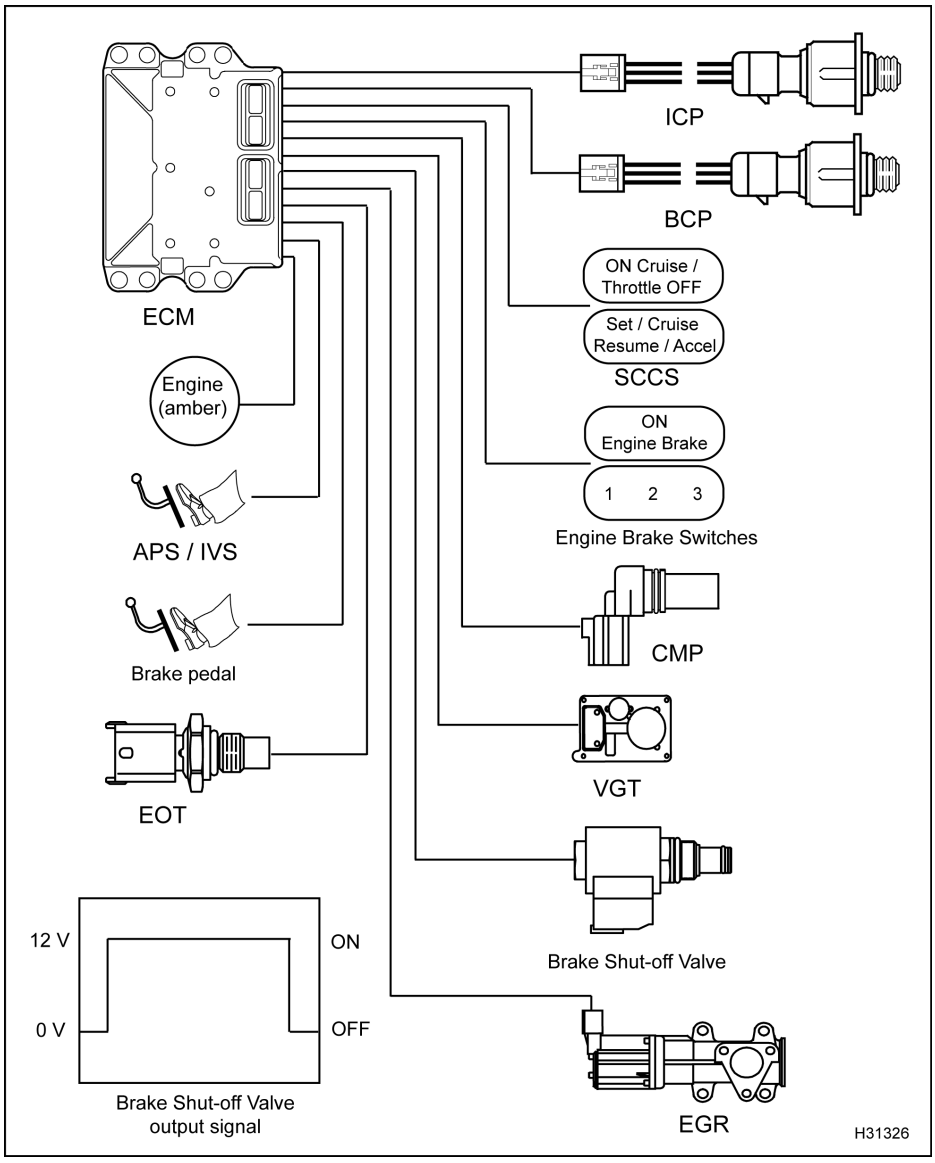


Figure 396 Function diagram for the Brake Shut-off Valve

The function diagram for the brake shut-off valve includes the following:

- Engine Oil Temperature (EOT) sensor
- Speed Control Command Switches (SCCS)
- Injection Control Pressure (ICP) sensor
- Brake Control Pressure (BCP) sensor
- Engine brake switches
- Camshaft Position (CMP) sensor
- Accelerator Position / Idle Validation (APS/IVS) sensors
- Electronic Control Module (ECM)
- Brake pedal
- Brake shut-off valve
- Variable Geometry Turbocharger (VGT) actuator

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- Exhaust Gas Recirculation (EGR) actuator
- ENGINE lamp (amber)

Function

The brake shut-off valve controls pressure in the oil gallery of the high-pressure oil rail. When the engine brake is activated, the ECM provides power to activate the brake shut-off valve to allow oil from the injector oil gallery to flow to the brake oil gallery. High oil pressure activates the brake actuator pistons to open the exhaust valves.

The ECM removes the power from the brake shut-off valve to deactivate the engine brake. Residual brake gallery pressure initially bleeds from the actuator bore. When brake gallery pressure reaches 1000 psi, the brake pressure relief valve opens, and oil drains back to sump.

The brake shut-off valve consists of a solenoid and valve assembly and is located in the center of the high-pressure oil rail.

The ECM monitors the following criteria to make sure certain conditions are met.

- ABS (inactive)
- RPM (greater than 1200)
- APS (less than 5%)
- EOT (greater than 60 °C [140 °F])
- Idle validation
- Operator input switches (On/Off) (power selection – Low, Medium, High)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Brake Shut-off Valve Circuit Operation

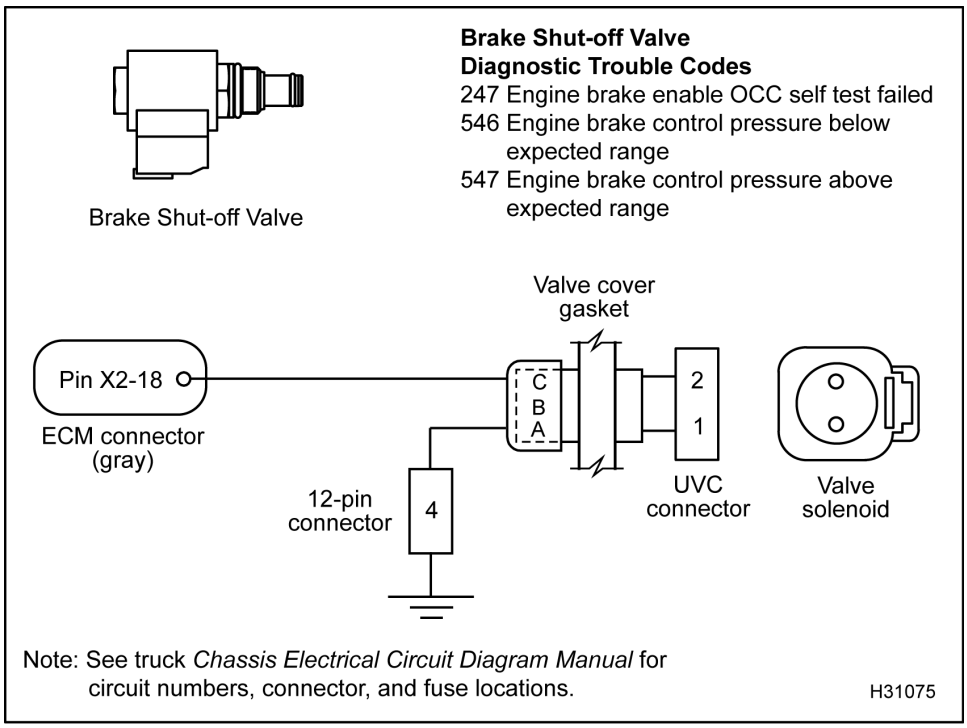


Figure 397 Brake Shut-off Valve circuit diagram

The brake shut-off valve is supplied ground to Pin 1 from the battery through Pin 4 of the 12-pin connector and then through Pin A of the valve cover gasket. The ECM controls the engine brake by supplying 12 volts through Pin C of the valve cover gasket to Pin 2 of the brake shut-off valve.

Fault Detection / Management

An open or short to ground in the brake shut-off valve control circuit can be detected by an on demand Output Circuit Check (OCC) during KOEO Standard Test. If there is a circuit fault detected a DTC will be set.

When the engine is running, the ECM compares engine brake control pressure to injection control pressure and BCP desired. When the brake is activated, brake control pressure will equal injection control pressure.

If the brake control pressure does not match injection control pressure, the ECM will disable the engine brake, a DTC will be set, and the amber ENGINE lamp will be illuminated.

When the engine brake is not active and the ECM detects an undesired value, the ECM will set a DTC and the amber ENGINE lamp will be illuminated.

A bias BCP sensor can also cause the fault. The brake shut-off valve and the BCP sensor circuit should both be diagnosed.

Brake Shut-off Valve Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 247
Engine brake enable OCC self-test failed

- DTC 247 is set by the ECM when the OCC test has failed after the KOEO Standard Test has been run.
- DTC 247 can be set when a poor connection, an open or short to ground in the brake shut-off valve control circuit, or a failed brake shut-off valve solenoid exists.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- When DTC 247 is active the amber ENGINE lamp will be illuminated.

DTC 546
Engine brake control pressure below expected range

- DTC 546 is set by the ECM when the brake control pressure is less than injection control pressure 4 MPa (580 psi) for more than 3 seconds.
- DTC 546 can be set due to a bias low BCP sensor or a failed BCP sensor. See “Brake Control Pressure (BCP) Sensor – Section 7.
- DTC 546 can be set due to an open control circuit (power or ground), a failed brake shut-off valve, or a failed brake shut-off valve solenoid.
- When DTC 546 is active the amber ENGINE lamp is illuminated.

DTC 547
Engine brake control pressure above expected range

- DTC 547 is set by the ECM when the brake control pressure is greater than desired brake control pressure by 4.5 MPa (653 psi) for more than 3 seconds.
- DTC 547 can be set due to an open signal ground, V_{REF} shorted to a voltage source higher than 5.5 V, or a failed BCP sensor. See “Brake Control Pressure (BCP) Sensor – Section 7.
- DTC 547 can be set due to a control circuit short to B+ or a brake shut-off valve stuck open.
- When DTC 547 is active the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- VC Gasket Breakout Harness
- 12-Pin Breakout Harness
- 500 Ohm Resistor Harness
- Breakout Box
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Brake Shut-off Valve Pin-Point Diagnostics (ECM to valve cover gasket connector)

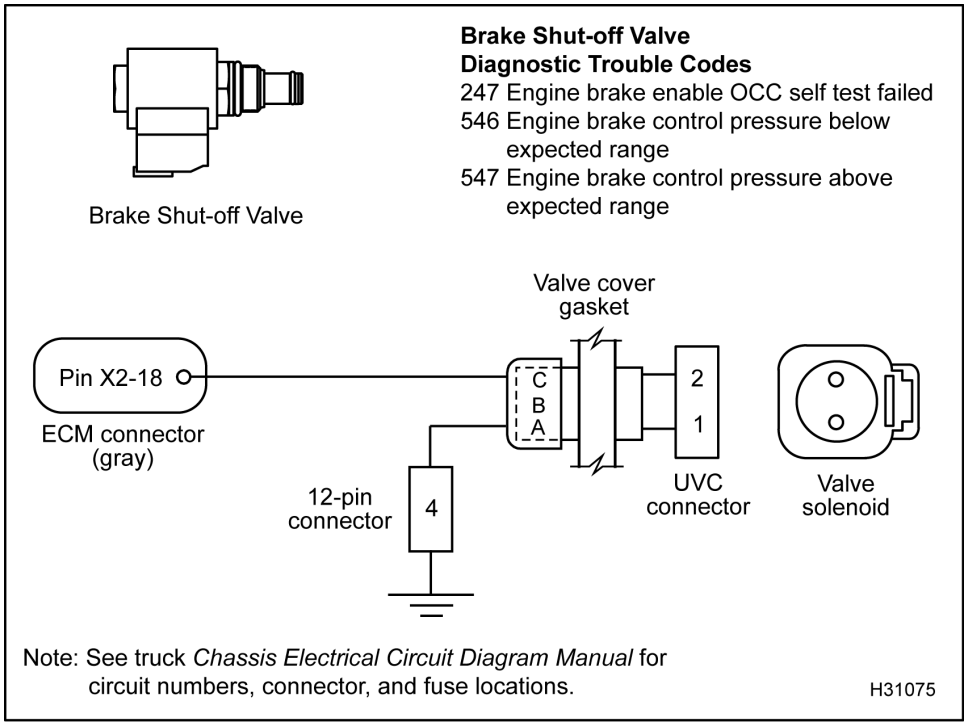


Figure 398 Brake Shut-off Valve circuit diagram

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NOTE: Complete all pin-point diagnostics (ECM to valve cover gasket connector) before removing valve cover for under-valve-cover diagnostics.

- Turn the ignition switch to OFF before disconnecting engine wiring harness connectors from components.
- See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Actuator Control Voltage Check at Valve Cover Gasket Connector (Disconnect engine harness from valve cover gasket. Inspect for bent pins or corrosion. Connect VC Gasket Breakout Harness to engine harness and valve cover gasket. Turn the ignition switch to ON.)

Test Point	Spec	Comment
C to A	0 V to 0.25 V	If > 0.25 V, continue with next test point, C to ground.
C to gnd	0 V to 0.25 V	If > 0.25 V, control wire is shorted to V_{REF} or B+, or an open ground, open control circuit, or open solenoid exists.
A to gnd	0 V to 0.25 V	If > 0.25 V, ground wire is shorted to V_{REF} or B+.

Output State Test - Signal Check at Valve Cover Gasket Connector (Disconnect engine harness from valve cover gasket. Connect VC Gasket Breakout Harness to engine harness and valve cover gasket. Run the Output State Tests. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests.)

Test State/Point	Setting/Spec	Comment
KOEO	DMM set to V - DC	
C to A	0 V to 0.25 V	If > 0.25 V, disconnect VC Gasket Breakout Harness from gasket. Connect 500 Ohm Resistor Harness between C and A and retest. • If > 0.25 V, run the Low and High Output State Test. • If < 0.25 V, the concern is the valve cover gasket, UVC wiring, or brake shut-off valve.
Output State Test - Low	DMM set to V - DC	Toggling between the Low and High Output State Tests can be done during this procedure.
C to A	0 V to 0.25 V	If > 0.25 V, disconnect VC Gasket Breakout Harness from gasket. Connect 500 Ohm Resistor Harness between C and A and retest Output State Test - Low. • If > 0.25 V the concern is the engine harness or ECM, check for a short to B+ or V_{REF}. • If < 0.25 V, the concern is the valve cover gasket, UVC wiring, or Brake Shut-off Valve.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Output State Test - High	DMM set to V - DC	Toggling between the Low and High Output State Tests can be done during this procedure.
C to A	B+ ± 0.5 V	If < B+, disconnect VC Gasket Breakout Harness from gasket. Connect 500 Ohm Resistor Harness between C and A and retest and retest Output State Test - High. • If equal to B+ the concern is the valve cover gasket, UVC wiring, or Brake Shut-off Valve. Check for short to ground or open on control circuit, or open ground circuit. • If < B+ the concern is the engine harness or ECM. Check the ECM programming and check for a short to ground or open control circuit. Do the Actuator Control Voltage Check at ECM (page 341) and Harness Resistance Checks (page 342).

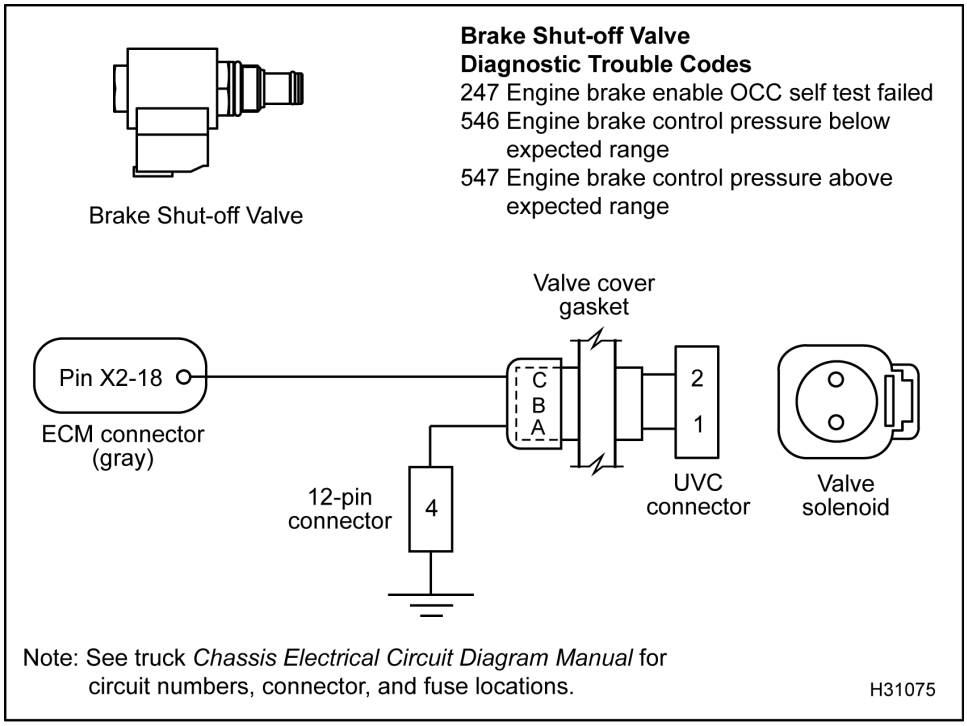


Figure 399 Brake Shut-off Valve circuit diagram

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NOTE: Complete all pin-point diagnostics (ECM to valve cover gasket connector) before removing valve cover for under-valve-cover diagnostics.

- Turn the ignition switch to OFF before disconnecting engine wiring harness connectors from components.
- See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Actuator Control Voltage Check at ECM (Connect breakout box [X2 only] to ECM and engine harness. Engine harness is not connected to valve cover gasket. Connect 500 Ohm Resistor Harness to X2–18 and ground. Turn the ignition switch to ON. Run Low and High Output State Test. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests. Measure across X2–18 and ground.)

Test State/Point	Setting/Spec	Comment
KOEO	DMM set to V - DC	
X2 - 18 to gnd	0 V to 0.25 V	If > 0.25 V, disconnect engine harness from breakout box harness and retest. • If > 0.25 V, run the Low and High Output State Tests. • If < 0.25 V, diagnose engine wiring harness. Check for short to V_{REF} or B+.
Output State Test - Low	DMM set to V - DC	Toggling between the Low and High Output State Tests can be done during this procedure.
X2 - 18 to gnd	0 V to 0.25 V	If > 0.25 V, disconnect engine harness from breakout box harness and retest. • If < 0.25 V, diagnose engine wiring harness. Check for short to V_{REF} or B+. • If > 0.25 V with breakout box connected only to ECM, replace ECM.
Output State Test - High	DMM set to V - DC	Toggling between the Low and High Output State Tests can be done during this procedure.
X2 - 18 to gnd	B+ ± 0.5 V	If < B+, disconnect engine harness from breakout box harness and retest. • If equal to B+, diagnose engine wiring harness. Do Harness Resistance Checks (page 342). Check for short to ground or open circuit. • If < B+ with breakout box connected only to ECM, replace the ECM.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

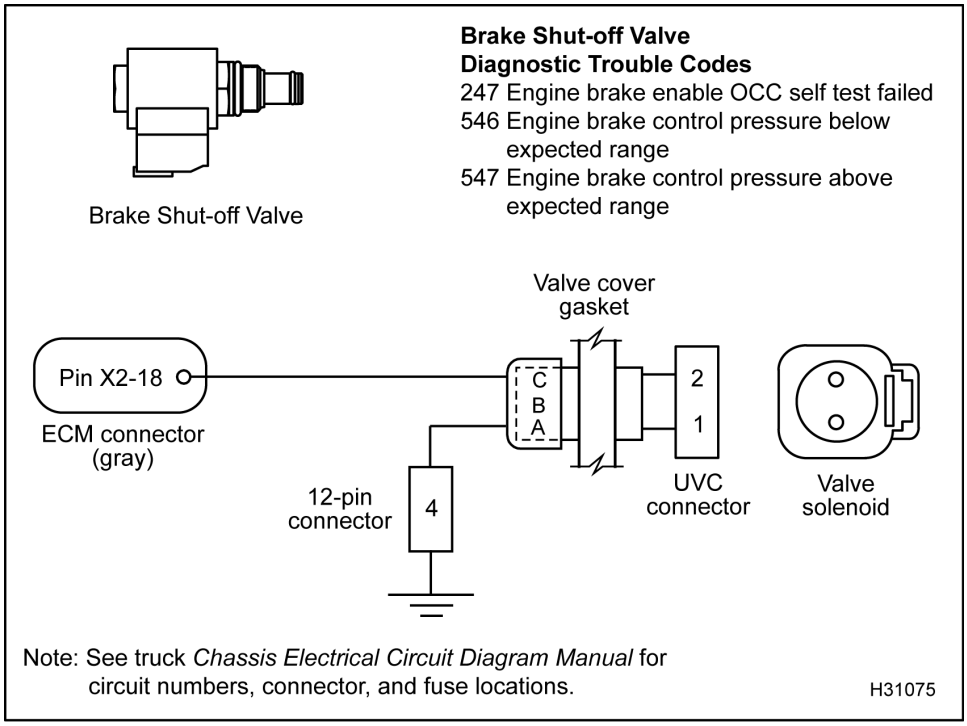


Figure 400 Brake Shut-off Valve circuit diagram

NOTE: Complete all pin-point diagnostics (ECM to valve cover gasket connector) before removing valve cover for under-valve-cover diagnostics.

- Turn the ignition switch to OFF before disconnecting engine wiring harness connectors from components.
- See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Harness Resistance Check – Valve Cover Gasket Connector to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Connect VC Gasket Breakout Harness to engine wiring harness only.)

Test Point	Spec	Comment
A to Pin A (9260)	< 5 Ω	If > 5 Ω, check for an open circuit.
C to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Harness Resistance Check – Valve Cover Gasket Connector to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from valve cover gasket. Use disconnected negative battery cable for ground test point.)

A to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
C to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Harness Resistance Check – 12-Pin Connector to ECM Chassis Ground (Turn the ignition switch to OFF. Connect 12-pin Breakout Harness to chassis wiring harness only. Disconnect chassis connector 9260[1].)		
4 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open in chassis wiring harness ground circuit.
Harness Resistance Check – 12-Pin Connector to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect 12–pin connector and use chassis side for test point. Use disconnected negative battery cable for ground test point.)		
4 to gnd cable	< 500 Ω	If > 500 Ω, check for short to ground.
Harness Resistance Check – Valve Cover Gasket Connector to 12-Pin Connector (Connect VC Gasket Breakout Harness to engine wiring harness only. Connect 12-Pin Breakout Harness to engine wiring harness only.)		
A to 4[1]	< 5 Ω	If > 5 Ω, check for open in actuator ground.
Harness Resistance Check – Valve Cover Gasket Connector to ECM (Connect VC Gasket Breakout Harness to engine wiring harness only. Connect breakout box X2 to engine wiring harness only.)		
C to X2-18	< 5 Ω	If > 5 Ω, check for open in control wire.
Resistance Check – Valve Cover Gasket, UVC Wiring, and Brake Shut-off Valve/Solenoid (Connect VC Gasket Breakout Harness to valve cover gasket only.)		
A to C	10 Ω ± 2 Ω	• If > 12 Ω, the concern is the valve cover gasket, UVC wiring, or brake shut-off valve/solenoid. Do Harness Resistance Check – Valve Cover Gasket Connector to UVC Connector (page 346) and Solenoid Resistance Check – Brake Shut-off Valve (page 346). • If < 8 Ω, a short to ground exists. The concern is the valve cover gasket, UVC wiring, or brake shut-off valve/solenoid.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Brake Shut-off Valve Pin-Point Diagnostics (ECM to brake valve – valve cover removed)

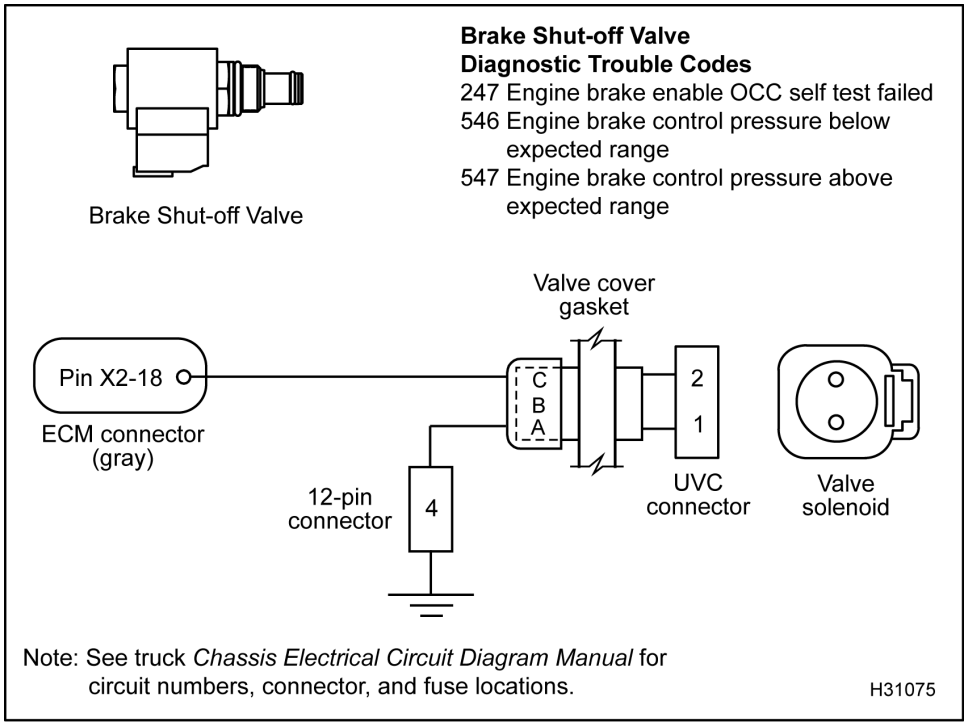


Figure 401 Brake Shut-off Valve circuit diagram

NOTE: Complete all pin-point diagnostics (ECM to valve cover gasket connector) before removing valve cover for under-valve-cover diagnostics.

- Turn the ignition switch to OFF before disconnecting engine wiring harness connectors from components.
- See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Actuator Control Voltage Check at UVC Connector (Remove valve cover following procedure in the *Engine Service Manual*. Disconnect UVC connector from valve. Use the Terminal Test Adapter Kit to connect the 500 Ohm Resistor harness to the UVC connector Pin 2 and ground. Turn the ignition switch to ON.)

Test Point	Spec	Comment
2 to 1	0 V to 0.25 V	If > 0.25 V, continue with next test point, 2 to chassis ground.
2 to chassis gnd	0 V to 0.25 V	If > 0.25 V, control wire is shorted to V_{REF} or B+.
1 to chassis gnd	0 V to 0.25 V	If > 0.25 V, ground wire is shorted to V_{REF} or B+.

Output State Test - Signal Check at UVC Connector (Disconnect UVC connector from valve. Use the Terminal Test Adapter Kit to connect the 500 Ohm Resistor harness to the UVC connector Pin 2 and ground. Run the Output State Tests. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests. Measure across adapter and ground.)

Test State/Point	Setting/Spec	Comment

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Output State Test - Low	DMM set to V - DC	Toggling between the Low and High Output State Tests can be done during this procedure.
2 to gnd	0 V to 0.25 V	If > 0.25 V, and all pin-point diagnostic tests (ECM to valve cover gasket) were in spec, the valve cover gasket or UVC wiring are suspect. Check for short to V_{REF} or B+.
Output State Test - High	DMM set to V - DC	Toggling between the Low and High Output State Tests can be done during this procedure.
2 to gnd	B+ ± 0.5 V	If < B+, and all pin-point diagnostic tests (ECM to valve cover gasket) were in spec, the valve cover gasket or UVC wiring are suspect. Check for short to ground, open control wire, or open ground wire. Do Harness Resistance Checks (page 346). If equal to B+, and all pin-point diagnostic tests (ECM to valve cover gasket) were in spec, do Solenoid Resistance Check – Brake Shut-off Valve (page 346).

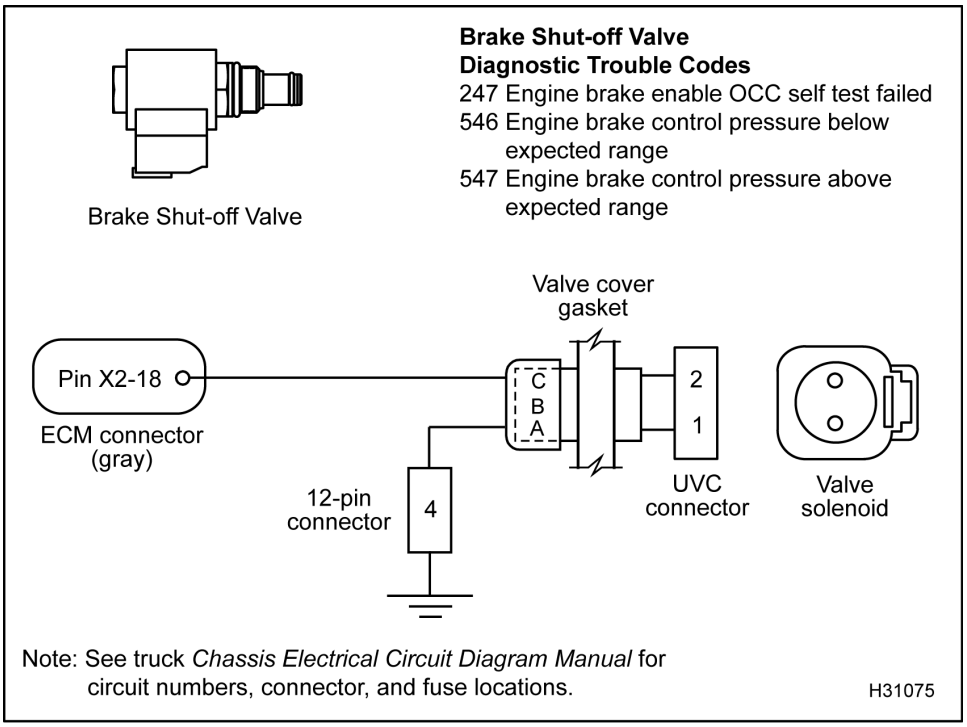


Figure 402 Brake Shut-off Valve circuit diagram

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NOTE: Complete all pin-point diagnostics (ECM to valve cover gasket connector) before removing valve cover for under-valve-cover diagnostics.

- Turn the ignition switch to OFF before disconnecting engine wiring harness connectors from components.
- See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Harness Resistance Check – UVC Connector to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1].)

Test Point	Spec	Comment
1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for an open circuit.
2 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

Harness Resistance Check – UVC Connector to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from valve. Use disconnected negative battery cable for ground test point.)

1 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
2 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.

Harness Resistance Check – Valve Cover Gasket Connector to UVC Connector (Connect VC Gasket Breakout Harness to valve cover gasket only.)

A to 1	< 5 Ω	If > 5 Ω, check for open in actuator ground.
C to 2	< 5 Ω	If > 5 Ω, check for open in control wire.

Solenoid Resistance Check – Brake Shut-off Valve (Measure across terminals of solenoid.)

2 to 1	10 Ω ± 2 Ω	If not to specification, replace brake shut-off valve.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Brake Switch Circuit

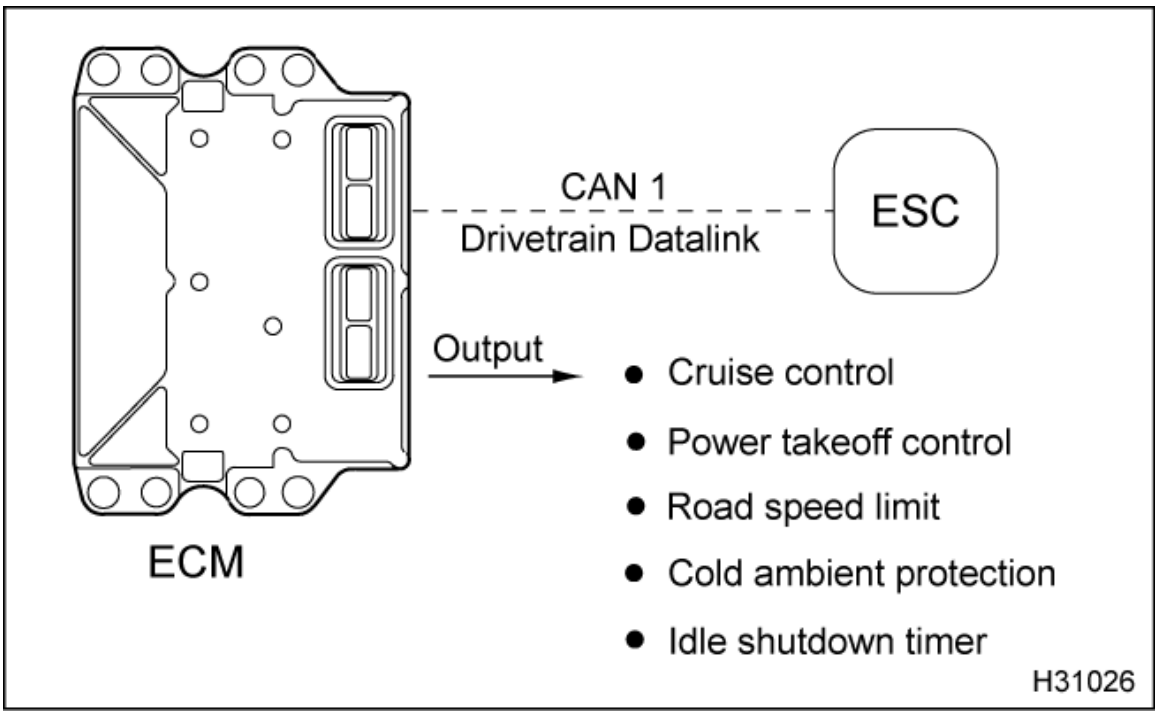


Figure 403 Function diagram for the Brake Switch

Brake Switch Operation

The service brake circuit signals the ECM when the brakes are applied. The information is used to disengage the Cruise control and Power Takeoff (PTO) function. The brake signal will interrupt the Cold Ambient Protection (CAP) feature and will reset the time interval for the Idle Shutdown Timer (IST) feature.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

CAN Communications (Controller Area Network)

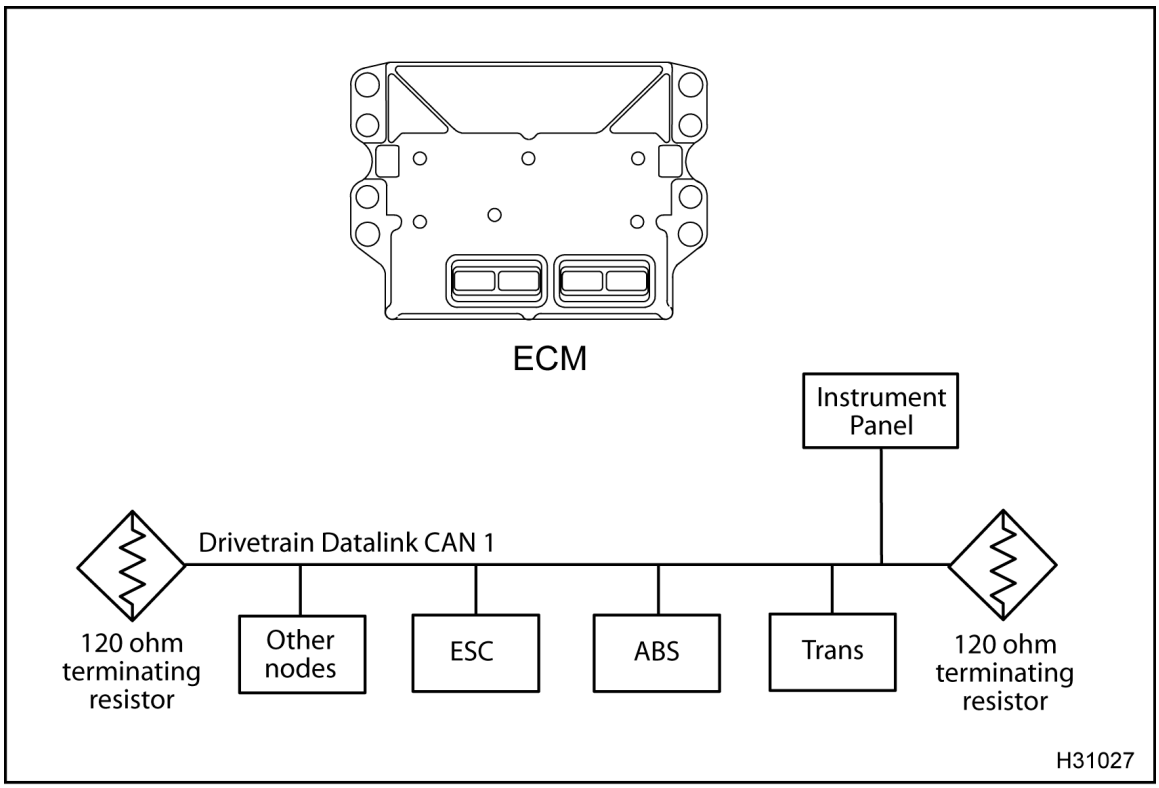


Figure 404 Function diagram for the CAN

The function diagram for the CAN includes the following:

- Electronic Control Module (ECM)
- Drivetrain Datalink (CAN 1)
- Terminating resistors – 120 ohm
- Instrument panel (lamps)

Function

The Drivetrain Datalink is a Society of Automotive Engineers (SAE) term referring to one of the datalinks common to all trucks. The Drivetrain Datalink is the communication link for the engine Electronic Control Module (ECM), cab and chassis Electronic System Controller (ESC), and the instrument panel. The Drivetrain Datalink is also used for power train communication and control.

The ECM transmits component information across the Drivetrain Datalink to the instrument panel. The following instrument panel components are in constant communication with the Drivetrain Datalink:

- Oil pressure gauge
- Engine oil temperature gauge
- Tachometer
- Speedometer
- Odometer / hourmeter
- Coolant temperature gauge
- Coolant level lamp
- ENGINE lamp (red)
- ENGINE lamp (amber)
- Fuel filter lamp
- Change oil message
- Cruise / PTO control
- WAIT TO START lamp

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The ECM and ESC use the Drivetrain Datalink to provide the instrument panel with status information on the following features.

- Cruise control ON/OFF
- Cruise control Set / Cruise
- Cruise control resume / accelerate
- Driveline Disengagement Switch (DDS)
- Brake pedal
- AC demand
- Self-test input
- Remote Accelerator Pedal (RPS)
- In-Cab PTO / Throttle switch

Fault Detection / Management

There are no engine DTCs for CAN 1 communications. See truck *Electrical System Troubleshooting Guide*.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)

CAN Pin-Point Diagnostics

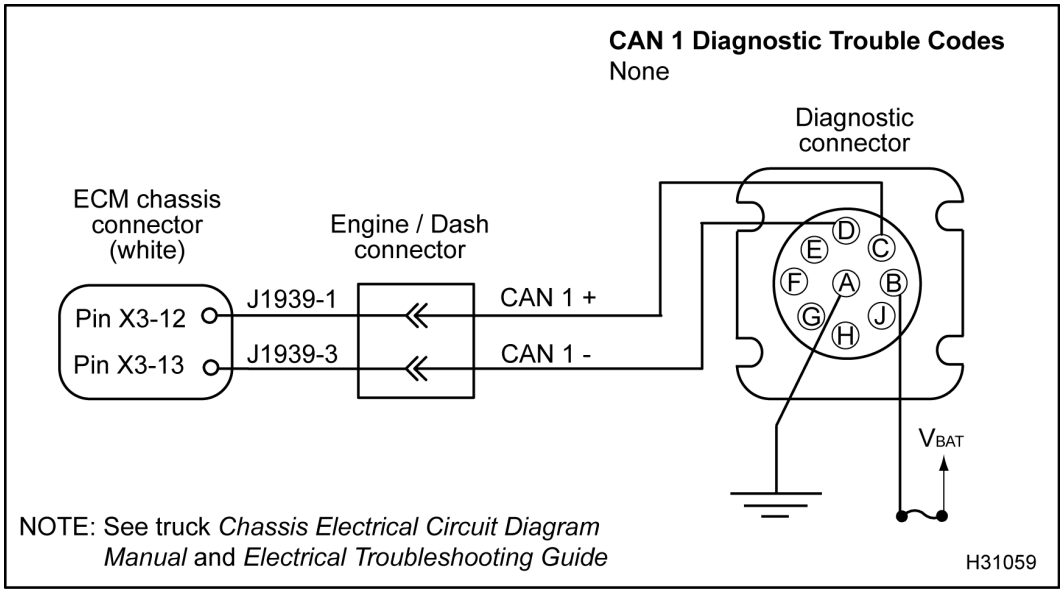


Figure 405 CAN communication circuit diagram

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Voltage Check at Diagnostic Connector (Check at diagnostic connector with key-on engine-off.)

Test Point	Spec	Signal	Comment
B to A	B+	Power	Should be B+ power at B all times. If no power, check ground and power circuits. See truck *Chassis Electrical Circuit Diagram Manual*.
C to A	1 V to 4 V	Digital signal	The sum of C to A and D to A equals 4 V to 5 V.
D to A	1 V to 4 V	Digital signal	The sum of C to A and D to A equals 4 V to 5 V.
Resistance Check at Diagnostic Connector (Turn the ignition switch to OFF. Check at diagnostic connector with negative battery cable disconnected.)			
C to A	> 1 MΩ	CAN+	If < 1 MΩ, a short between CAN+ and ground exists. Disconnect ECM X3 and check again. If short is no longer present, replace ECM. If short exists, harness or other node component is inoperative.
D to A	> 1 MΩ	CAN –	If < 1 MΩ, a short between CAN – and ground exists. Disconnect ECM X3 and check again. If short is no longer present, replace ECM. If short still exists, harness or other node component inoperative.
C to D	60 Ω	CAN	The datalink has two terminating resistors in parallel of 120 Ω each. If > 70 Ω, check for missing terminating resister or open in the CAN+ or CAN – wires. If < 50 Ω, check for extra terminating resistor. If < 5 Ω, check for short between CAN+ and CAN –.

©August 2008 Navistar, Inc.

CKP Sensor (Crankshaft Position)

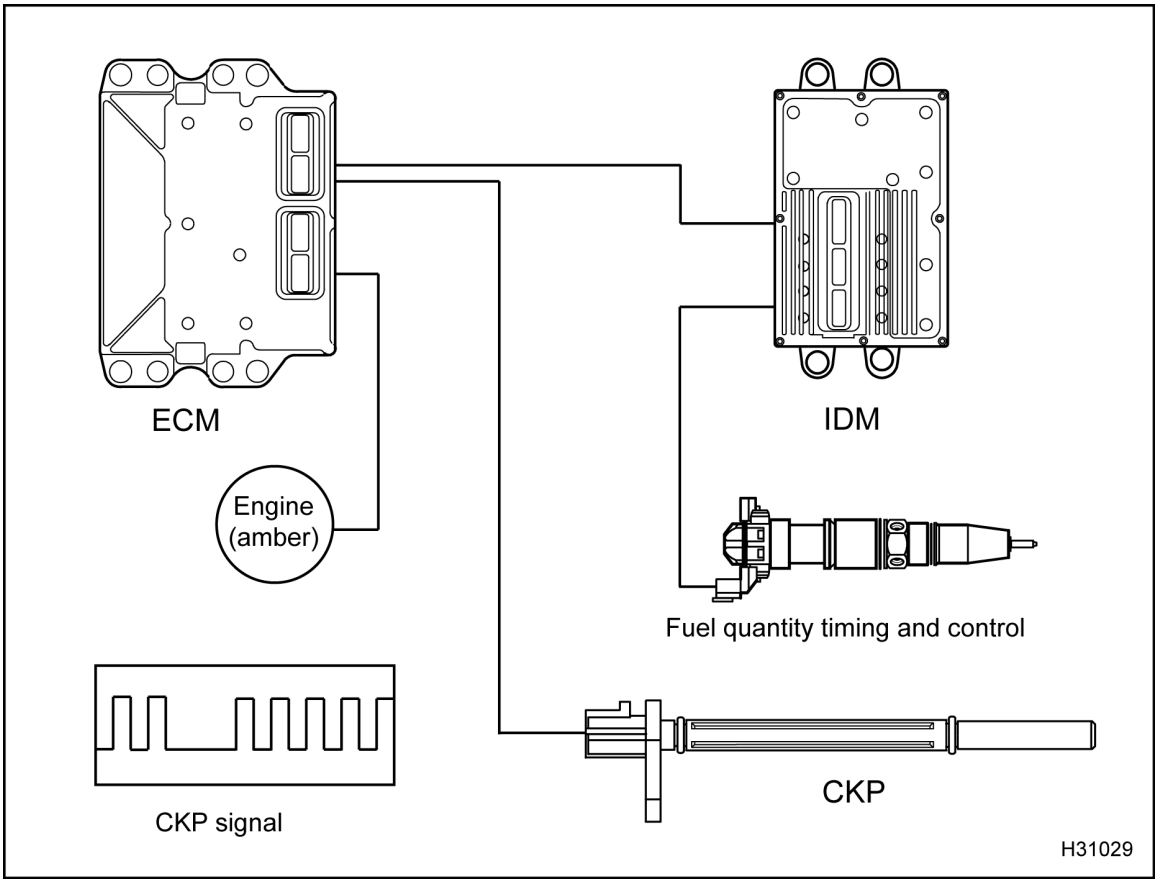


Figure 406 Function diagram for the CKP sensor

The function diagram for the CKP sensor includes the following:

- CKP sensor
- Electronic Control Module (ECM)
- Injector Driver Module (IDM)
- Fuel injector
- ENGINE lamp (amber)

Function

The CKP sensor provides the ECM with a signal that indicates crankshaft speed and position. As the crankshaft turns the CKP sensor detects a 60 tooth timing disk on the crankshaft. 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 is installed in the top left side of the flywheel housing.

The sensor produces pulses for each tooth edge that passes it. Crankshaft speed is derived from the frequency of the CKP sensor signal. The crankshaft position is determined by synchronizing the SYNC tooth with the SYNC gap signals from the target disk. From the CKP signal frequency, the ECM can calculate engine rpm and timing requirements. Diagnostic information on the CKP input signal is obtained by performing accuracy checks on frequency, and duty cycle with software strategies.

NOTE: The long CKP sensor, used with International® DT 466, DT 570, and HT 570 diesel engines, is the Camshaft Position (CMP) sensor used with other International® diesel engines.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

CKP Circuit Operation

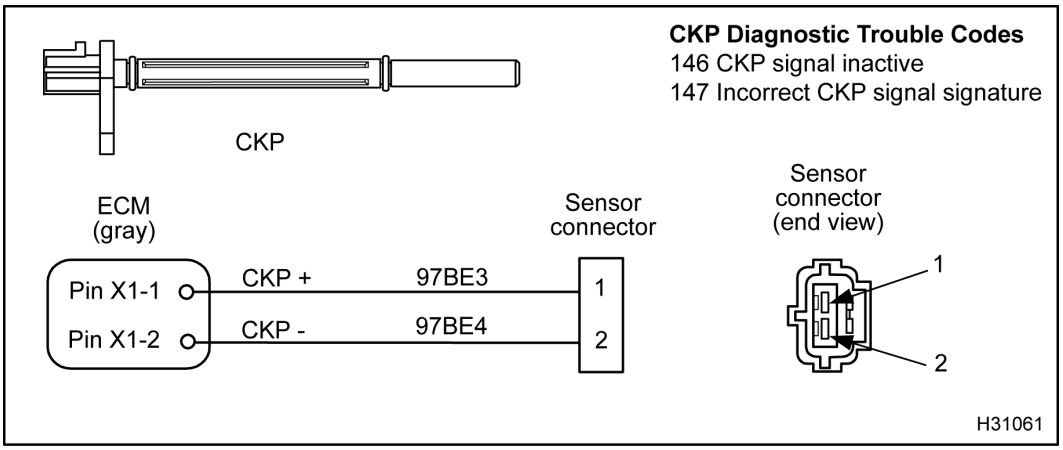


Figure 407 CKP circuit diagram

The ECM uses the CKP and CMP signal to calculate engine speed and position. The CKP sensor provides the ECM with a signal that indicates crankshaft speed and position. The CKP contains a permanent magnet that creates a magnetic field. The signal is created when the timing disk rotates and breaks the magnetic field created by the sensor. The ECM pins for the CKP sensor are CKP negative X1-2 and CKP positive X1-1.

NOTE: Engine will not operate without CKP signal.

Fault / Detection Management

An inactive CKP signal during cranking is detectable by the ECM. During engine cranking the ECM monitors the CMP signal and Injection Control Pressure (ICP) to verify the engine is rotating. If the CKP signal is inactive during this time a DTC will be set. Electrical noise can also be detected by the ECM, if the level is sufficient to effect engine operation a corresponding DTC will be set. An inactive CKP signal will cause a no start condition.

CKP Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 146
CKP signal inactive

- DTC 146 is set by the ECM when CKP signal is not detected while the CMP signal is active or ICP has increased.
- DTC 146 can be set due to an open short to ground or voltage source in the CKP circuit. A failed CKP sensor can also set DTC 146.

DTC 147
Incorrect CKP signal signature

- DTC 147 is set by the ECM when the CKP signal has too few or many transitions per engine rotation.
- DTC 147 can be set due to an electrical noise in the CKP circuit or a failed CKP sensor.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

CKP Pin-Point Diagnostics

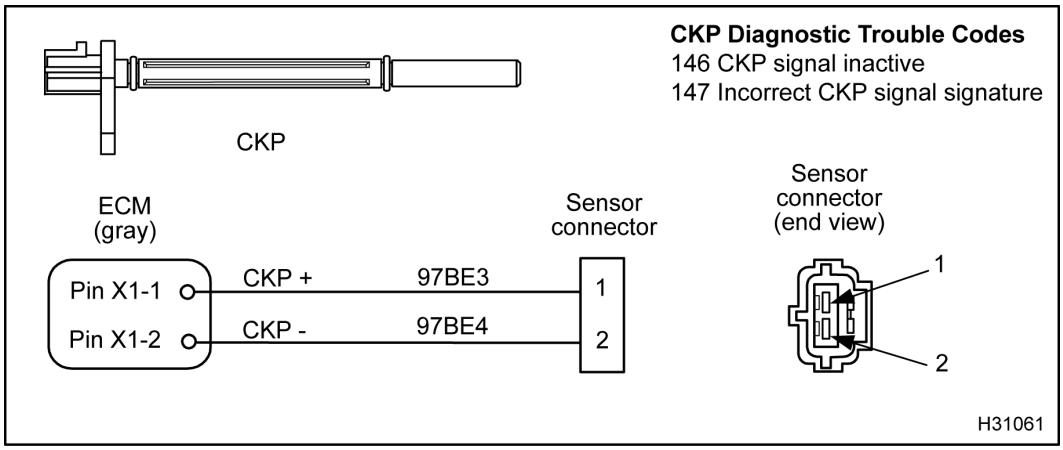


Figure 408 CKP circuit diagram

Sensor and Circuit Resistance Check (Check with breakout box connected [X1 only] to engine harness only and CKP sensor connected. Disconnect chassis connector 9260[1]. Inspect for bent pins or corrosion. **Note:** Set DMM to 4 kΩ range.)		
Test Point	**Spec**	**Comment**
X1–1 to X1–2	800 Ω to 1 kΩ	Resistance through sensor and complete circuit. If not within spec, do Sensor Resistance Check. If in spec, check for short to ground or open within wiring.
X1–1 to Pin A (9260)	800 Ω to 1 kΩ	Resistance through sensor and complete circuit. If not within spec, do Sensor Resistance Check. If in spec, check for short to ground or open within wiring.
Sensor Resistance Check (Disconnect harness from sensor. **Note:** Test point to sensor only.)		
1 to 2	800 Ω to 1 kΩ	If within spec, check for short to ground or open within wiring. If not within spec, replace sensor.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect harness from sensor. Disconnect chassis connector 9260[1].)		
X1–1 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.
X1–2 to Pin A (9260)	< 5 kΩ	If > 5 kΩ, check for open circuit within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)		
X1–1 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
X1–2 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Harness Resistance Check (Check with breakout box connected to engine harness only. Check from ECM to sensor harness connector.)

X1–1 to 2	< 5 Ω	If > 5 Ω, check for open circuit.
X1–2 to 1	< 5 Ω	If > 5 Ω, check for open circuit.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. Refer to truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Operational Checks for CKP Sensor (Check with breakout box connected to ECM and engine harness.)

Test Point	Engine Cranking	Low Idle	High Idle	Comment
X1–1 to X1–6	130 Hz - 225 Hz @ 130–225 rpm	650–700 Hz @ 700 rpm	2.80 kHZ - 3.00 kHz @ 2950 rpm	Set DMM to DCmV-Hz

NOTE: If the tachometer or MasterDiagnostics® display no rpm signal, but both indicate CMP and CKP sensor activity, check the engine static timing.

CKP Diagnostic Trouble Codes

DTC 146 = CKP signal inactive (CMP signal active and ICP increased)

DTC 147 = Incorrect CKP signal signature

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

CMP Sensor (Camshaft Position)

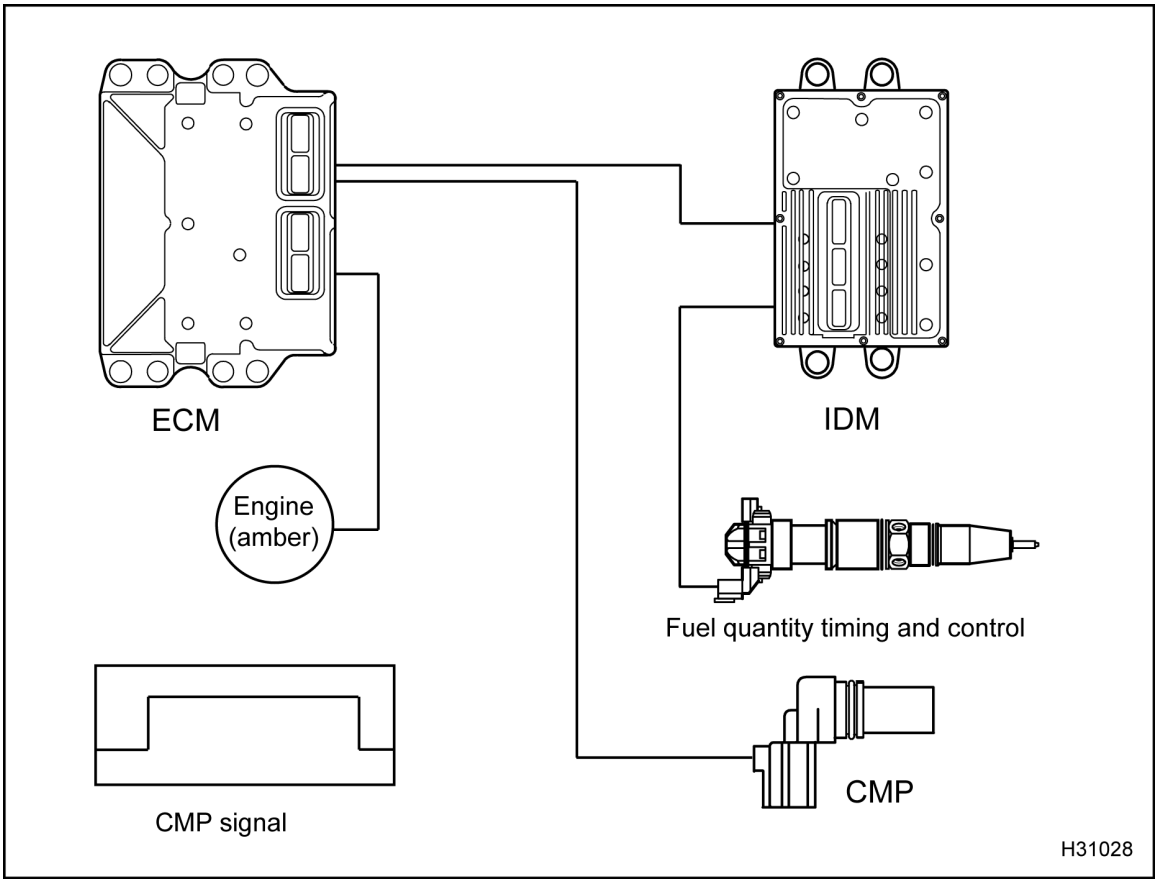


Figure 409 Function diagram for the CMP sensor

The function diagram for the CMP sensor includes the following:

- CMP sensor
- Electronic Control Module (ECM)
- Injector Drive Module (IDM)
- Fuel Injector
- ENGINE lamp (amber)

The CMP sensor provides the ECM with a signal that indicates camshaft position. As the cam rotates, the sensor identifies the position of the cam by locating a peg on the cam. The CMP is installed in the front cover, above and to the right of the water pump pulley.

Camshaft speed is calculated from the frequency of the CMP sensor signal. Diagnostic information on the CMP input signal is obtained by performing accuracy checks on signal levels, frequency, and duty cycle with software strategies.

NOTE: The short CMP sensor, used with International® DT 466, DT 570, and HT 570 diesel engines, is the Crankshaft Position (CKP) sensor used with other International® diesel engines.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

CMP Circuit Operation

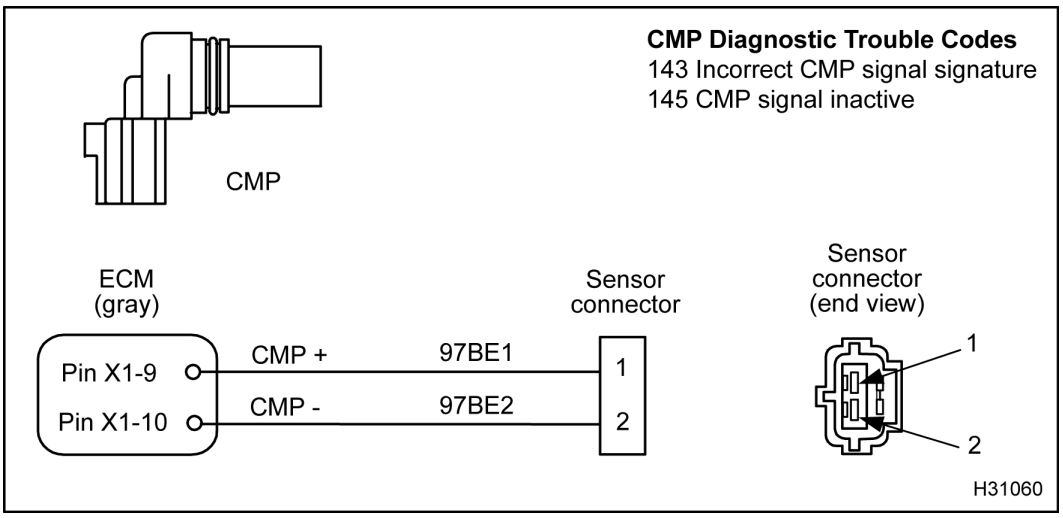


Figure 410 CMP circuit diagram

The ECM uses the CKP and CMP signal to calculate engine speed and position. The CMP sensor provides the ECM with a signal that indicates camshaft position. The CMP contains a permanent magnet which creates a magnetic field. The signal is created when the camshaft peg rotates past the sensor breaking the magnetic field. The ECM pins for the CMP sensor are CMP positive X1-9 and CMP negative X1-10.

NOTE: Engine will not operate without CMP signal.

Fault Detection / Management

An inactive CMP signal during cranking is detectable by the ECM. During engine cranking the ECM monitors the CKP signal and Injection Control Pressure (ICP) to verify the engine is rotating. If the CMP signal is inactive during this time a DTC will be set. Electrical noise can also be detected by the ECM. When the level is sufficient to effect engine operation a corresponding DTC will be set. An inactive CMP signal will cause a no start condition.

CMP Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 143
Incorrect CMP signal signature

- DTC 143 is set by the ECM when the CMP transition occurs at the wrong CKP location.
- DTC 143 can be set due to a mistimed camshaft to crankshaft, electrical noise in the CMP circuit, or a failed CMP sensor.

DTC 145
CMP signal inactive

- DTC 145 is set by the ECM when CMP signal is not detected while CKP signal is active or ICP has increased.
- DTC 145 can be set due to an open, short to ground or open voltage source in the CMP circuit. A failed CMP sensor can cause DTC 145 to be set.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

CMP Pin-Point Diagnostics

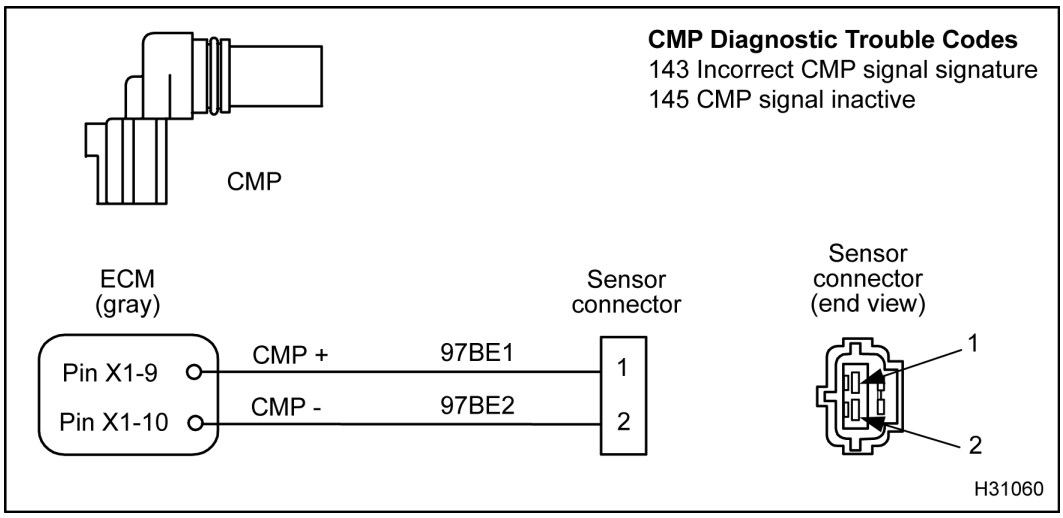


Figure 411 CMP circuit diagram

Sensor and Circuit Resistance Check (Check with breakout box connected [X1 only] to engine harness only and CMP sensor connected. Disconnect chassis connector 9260[1]. Inspect for bent pins or corrosion.)		
Test Point	**Spec**	**Comment**
X1–9 to X1–10	300 Ω to 400 Ω	Resistance through sensor and complete circuit. If not within spec, do Sensor Resistance Check. If in spec, check for short to ground or open within wiring.
X1–9 to Pin A (9260)	300 Ω to 400 Ω	Resistance through sensor and complete circuit. If not within spec, do Sensor Resistance Check. If in spec, check for short to ground or open within wiring.
Sensor Resistance Check (Disconnect harness from sensor. **Note:** Test point to sensor only.)		
1 to 2	300 Ω to 400 Ω	If within spec, check for short to ground or open within wiring. If not within spec, replace sensor.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect harness from sensor. Disconnect chassis connector 9260[1].)		
X1–9 to Pin A (9260)	> 500 Ω	If < 500 Ω, check for short to ground within wiring harness.
X1–10 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)		
X1–9 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

X1–10 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.

Harness Resistance Check (Check with breakout box connected to engine harness only. Check from ECM to sensor harness connector.)

X1–9 to 1	< 5 Ω	If > 5 Ω, check for open circuit.
X1–10 to 2	< 5 Ω	If > 5 Ω, check for open circuit.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. Refer to truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Operational Checks for CMP Sensor (Check with breakout box connected to ECM and engine harness.)

Test Point	Engine Cranking	Low Idle	High Idle	Comment
X1–9 to X1–6	130 rpm to 225 rpm[2] @ 130 rpm to 225 rpm	700 rpm[2] @ 700 rpm	2950 rpm[2] @ 2950 rpm	Set DMM to DCmV-rpm[2]

NOTE: If the tachometer or MasterDiagnostics® display no rpm signal, but both indicate CMP and CKP sensor activity, check the engine static timing.

CMP Diagnostic Trouble Codes

DTC 143 = Incorrect CMP signal signature

DTC 145 = CMP signal inactive

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EBP Sensor (Exhaust Back Pressure)

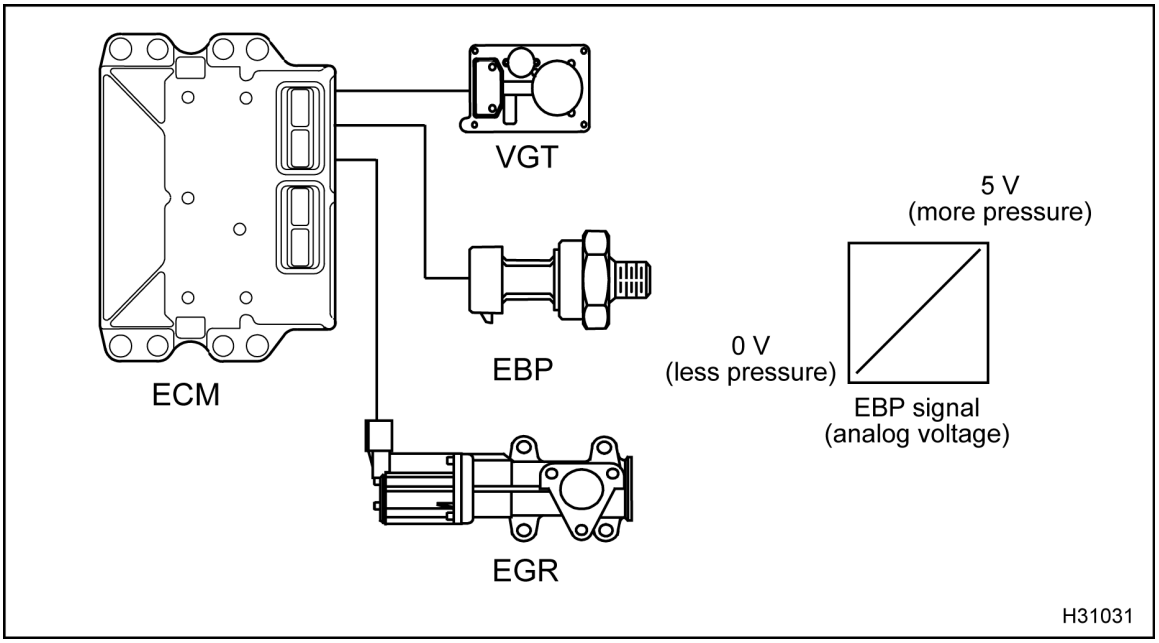


Figure 412 Function diagram for the EBP sensor

The function diagram for the EBP sensor includes the following:

- EBP sensor
- Electronic Control Module (ECM)
- Variable Geometry Turbocharger (VGT)
- Exhaust Gas Recirculation (EGR)

Function

The EBP sensor is a variable capacitance sensor installed in a bracket mounted on the water supply housing (Freon® compressor bracket). The ECM supplies a 5 V reference signal that the EBP sensor uses to produce a linear analog voltage that indicates pressure. The EBP sensor measures exhaust back pressure so that the ECM can control the VGT and EGR systems.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EBP Circuit Operation

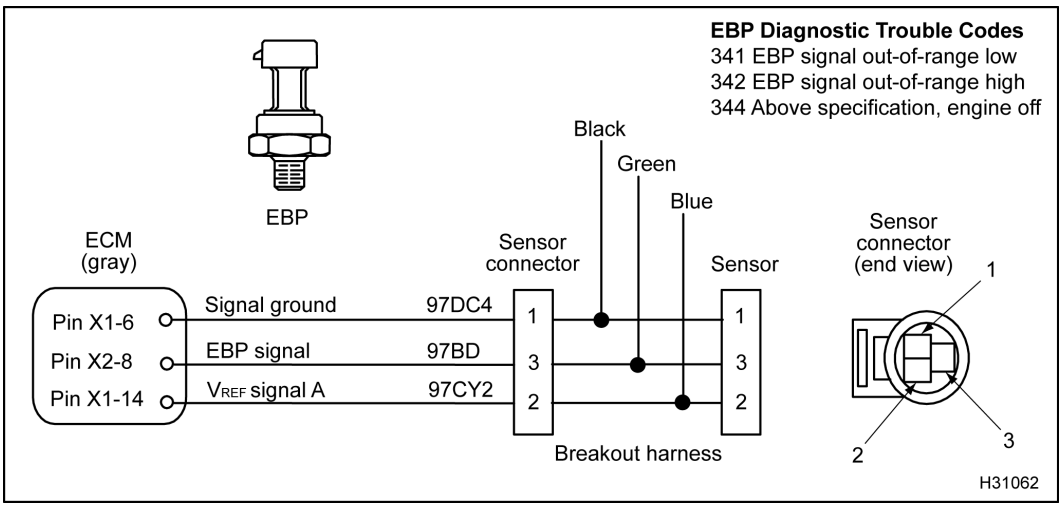


Figure 413 EBP circuit diagram

The EBP sensor is supplied with a 5 V reference voltage at Pin 2 from ECM Pin X1–14. The EBP sensor is grounded at Pin 1 from ECM Pin X1–6. The EBP sensor returns a variable voltage signal from Pin 3 to ECM Pin X2–8.

Fault Detection / Management

When the EBP signal voltage is detected out of range high or low, the ECM will cause the engine to ignore the EBP signal. The EGR valve will close and the ECM will rely on the VGT pre-programmed values.

EBP Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 341
EBP signal out-of-range low

- DTC 341 is set by the ECM when the EBP signal is less than 0.039 V for more than 0.5 second.
- DTC 341 can be set due to an open or short to ground on the signal circuit, a failed EBP sensor or an open V_{REF} circuit or V_{REF} short to ground.
- When DTC 341 is active the amber ENGINE lamp is illuminated.

DTC 342
EBP signal out-of-range high

- DTC 342 is set by the ECM when the EBP signal is more than 4.9 V for more than 0.5 second.
- DTC 342 can be set due to a signal circuit shorted to V_{REF} or B+, or a failed EBP sensor.
- When DTC 342 is active the amber ENGINE lamp is illuminated.

DTC 344
Above specification, engine off

- DTC 344 is set by the ECM when the exhaust back pressure is greater than expected with the key-on engine-off.
- DTC 344 can be set due to a plugged EBP sensor, a restriction in the tube leading to the sensor, an open signal ground, or a failed EBP sensor. To check for possible restriction, remove the sensor and tube and inspect for carbon deposits.
- When DTC 344 is active the amber ENGINE lamp is illuminated.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- Breakout Box
- Breakout Harness
- Terminal Test Adapter Kit

EBP Operational Diagnostics

⚠ WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the D_ContinuousMonitor.ssn.

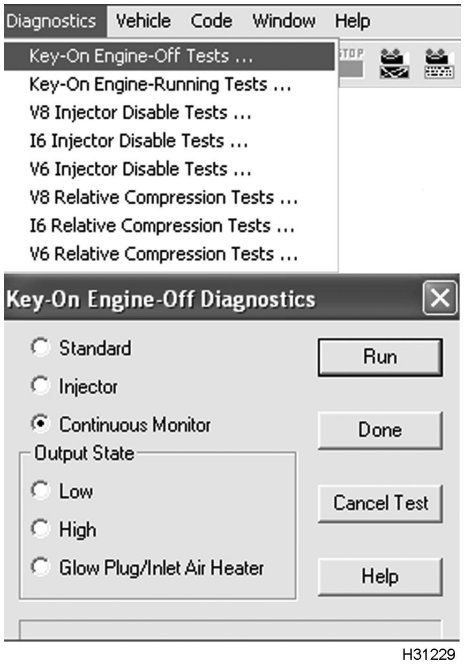


Figure 414 Continuous Monitor Test

2. To monitor signal voltage, run KOEO Continuous Monitor Test. For help, see “Continuous Monitor Test” in Section 3 (page 68).
3. Monitor EBP signal voltage. Verify an active DTC for the EBP circuit.
4. If code is active, do step 6 and 7 to check circuit for the EBP sensor using the following table.
   - Circuit Checks for EBP Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Disconnect engine harness from pressure sensor.

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

7. Connect Pressure Sensor Breakout Harness to engine harness only.

©August 2008 Navistar, Inc.

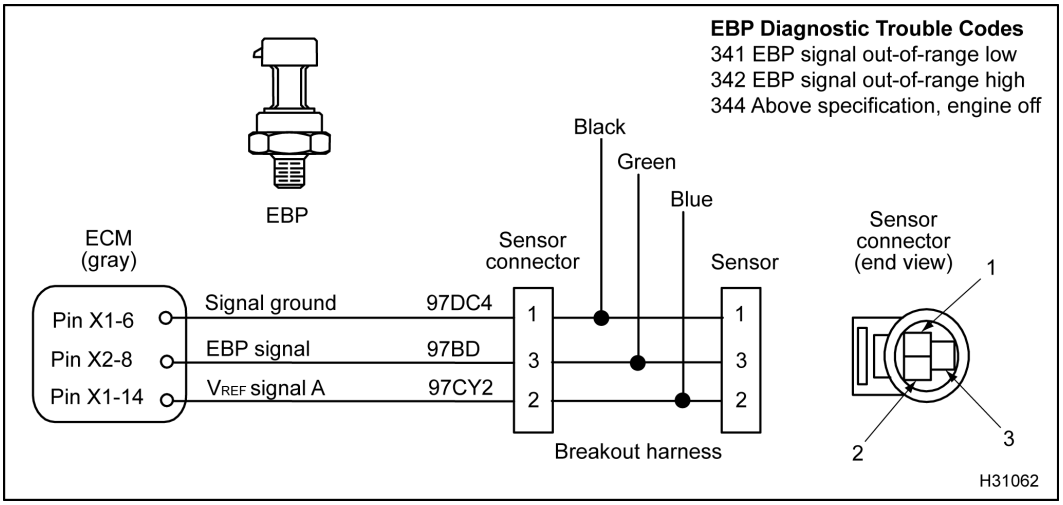


Figure 415 EBP circuit diagram

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Circuit Checks for EBP Sensor (Use EST, DMM, breakout harness, and 500 Ohm Resistor Harness.)

Test Condition	Spec	Checks
Sensor disconnected using EST	0 V to 0.25 V	If > 0.25 V, check ground circuit for open or high resistance, check signal ground for short to V_{REF} or B+.
Voltage from Pin 2 (Blue) to ground using DMM	5 V ±0.5 V	If voltage > 5.5 V, check V_{REF} for short to B+. If voltage is < 4.5 V, check V_{REF} circuit for open or short to ground.
500 Ohm Resistor Harness connected between Pin 3 (Green) and Pin 2 (Blue) of breakout harness.	5 V	If voltage < 4.9 V, check signal circuit for open or short to ground. — Disconnect connector 9260[1]. Measure resistance from Pin 3 to Pin A of connector 9260 (spec > 1 kΩ) to check for short to ground within wiring harness. — Disconnect negative battery cable. Measure resistance from Pin 3 to ground cable to check for open in harness. — Use a breakout box from Pin 3 to Pin X2–8 (spec < 5 Ω) to check for open in the harness.
Resistance from Pin 1 (Black) of breakout harness to ECM chassis ground Pin A of connector 9260 using DMM.	< 5 Ω	If resistance is > 5 Ω, check for open or high resistance between ECM and sensor connector. Use a breakout box and measure resistance from between Pin 1 and Pin X1–6 (spec < 5 Ω).
Connect engine harness to sensor. Use the EST to clear DTCs. If an active code remains after checking test conditions, replace the EBP sensor.		

©August 2008 Navistar, Inc.

1 Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EBP Pin-Point Diagnostics

Connector Voltage Checks to Ground (Disconnect harness from sensor. Inspect for bent pins or corrosion. Connect breakout harness to engine harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
1 to gnd	0 V to 0.25 V	Signal ground (no voltage expected). If > 0.25 V, check ground circuit for open or high resistance and check signal ground for short to V_{REF} or B+.
2 to gnd	5 V ±0.5 V	If voltage is not to spec, V_{REF} is open or shorted to ground.
3 to gnd	0 V to 0.25 V	If > 0.25 V, signal circuit is shorted to V_{REF} or B+.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Connect breakout harness to engine harness only. Disconnect chassis connector 9260[1].)		
1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit.
2 to Pin A (9260)	> 500 Ω	If < 500 Ω, check for short to ground within wiring harness.
3 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)		
1 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
2 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
3 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
Harness Resistance Checks (Connect breakout box [X1 and X2] to engine harness only. Connect breakout harness to engine harness only.)		
X1–6 to 1	< 5 Ω	If > 5 Ω, check for open ground wire.
X1–14 to 2	< 5 Ω	If > 5 Ω, check for open V_{REF} wire.
X2–8 to 3	< 5 Ω	If > 5 Ω, check for open signal wire.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Operational Voltage Checks for EBP with Breakout Harness (Check with breakout harness connected to sensor and engine harness.)		
Test Point	**Voltage**	**Pressure**
3 (Green) to 1 (Black)	0.63 V	0 kPa (0 psi)
3 (Green) to 1 (Black)	1.20 V	55 kPa (8 psi)
3 (Green) to 1 (Black)	1.92 V	124 kPa (18 psi)
Operational Voltage Checks for EBP with Breakout Box (Check with breakout box connected [X1 and X2 only] to the ECM and engine harness.)		
X2–8 to X1–6	0.63 V	0 kPa (0 psi)
X2–8 to X1–6	1.20 V	55 kPa (8 psi)
X2–8 to X1–6	1.92 V	124 kPa (18 psi)
EBP Diagnostic Trouble Codes		
DTC 341 = Signal voltage was < 0.039 V for more than 0.5 second		
DTC 342 = Signal voltage was > 4.9 V for more than 0.5 second		
DTC 344 = Exhaust back pressure was > expected with key-on engine-off		

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECI System (Engine Crank Inhibit)

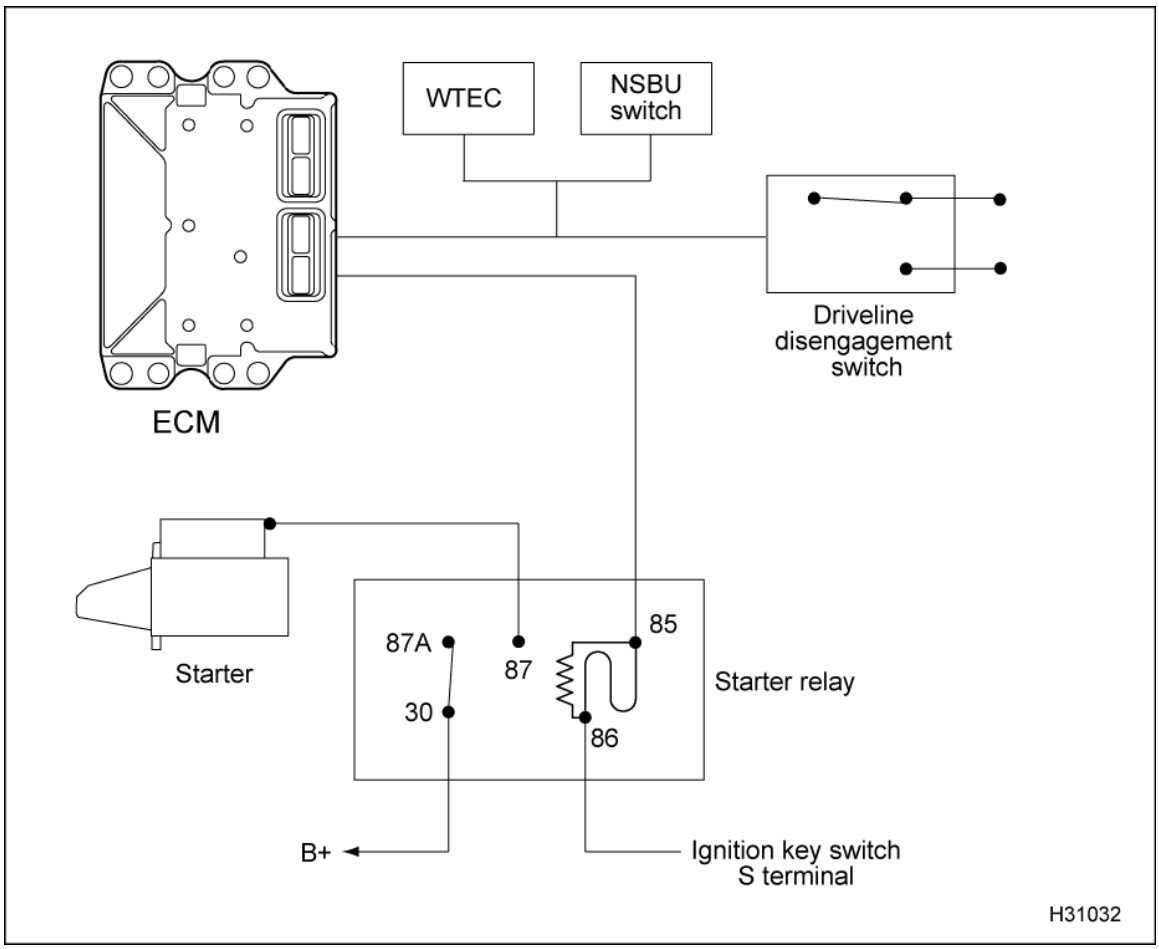


Figure 416 Function diagram for ECI system

The function diagram for the ECI system consists of the following.

- Electronic Control Module (ECM)
- Starter
- Starter relay
- World Transmission Electronically Controlled (WTEC)
- Neutral Start Backup Switch (NSBU)
- Driveline Disengagement Switch (DDS)

Function

The Engine Crank Inhibit (ECI) is a function of the ECM to control the operation of the starter. The ECM prevents engagement of the starter when the engine is running. This prevents damage to the starter pinion and ring gear. The transmission neutral safety switch or clutch switch prevents engagement of the starter when the transmission is in gear or when the clutch pedal is not depressed.

The engine starter relay controls battery voltage to the starter solenoid. The starter relay can also be controlled by an optional over crank thermocouple.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Operation

The ECM controls the starting system. The clutch switch or transmission neutral switch provide input to the ECM. Both switches prevent the starter from being engaged unless the transmission is in neutral or the clutch is depressed.

Start Relay

The engine starter relay controls voltage to the starter motor. Turning the ignition switch to start position supplies current to energize the relay at Pin 86. If the engine is not running and the driveline is not engaged, the ECM Pin X3–23 will enable the relay by suppling a ground circuit to Pin 85 of the relay. When the relay is closed, current passes through the relay to the pins on the starter solenoid.

Before troubleshooting, inspect circuit connectors for loose or damaged pins or wires. Wires and connections must be free of damage or corrosion. When connectors corrode, a white residue will be present and must be removed. Make sure the batteries are fully charged. To ensure accurate readings, check battery cables and grounds for clean and tight connections.

Clutch Switch

Manual transmissions use the clutch switch to supply a signal to the ECM indicating that the driveline is disengaged. A 12 V signal on the Driveline Disengagement Switch (DDS) circuit indicates that the clutch is disengaged. A 0 V signal indicates that the clutch is engaged.

Neutral Switch

Allison LCT transmissions use the neutral position switch to supply power to the starter relay and a signal to the ECM that the driveline is disengaged. Vehicles programmed for Allison AT/MT transmissions receive a 12 V signal on the DDS circuit indicating that the transmission is out of gear. A 0 V signal indicates that the transmission is in gear. When the transmission is in gear no power is available to the ECI relay.

WTEC MD with Auto Neutral

Allison MD World Transmission Electronically Controlled (WTEC) transmissions (with optional Auto Neutral) have a crank inhibit system with an additional relay. The relay inhibits cranking when the transmission is in auto neutral. Pin 6 of the transmission ECU controls 12 V to Pin 86 of the starter relay. Pin X3–8 of the ECM receives 12 V from the WTEC Auto Neutral relay when the transmission is shifted to neutral or auto neutral. Without the additional relay, the DDS input (Pin X3–8) allows cranking in auto neutral.

Electronic Control Module (ECM)

When the ECM recognizes that the engine is not running and the driveline is not engaged, the ECM will ground Pin X3–23. This provides a current path for the ECI relay to close when the Start switch is engaged or the starter button is depressed.

When the ECM recognizes that the engine is running or the driveline is engaged, the ECM will open Pin X3–23. This prevents the ECI relay from closing and the starter motor from engaging.

Fault Detection / Management

When the on demand Engine ON standard test is run, an open or short to ground can be detected on the coil side of the ECI relay.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- Relay breakout harness

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECI Circuit Diagnostics

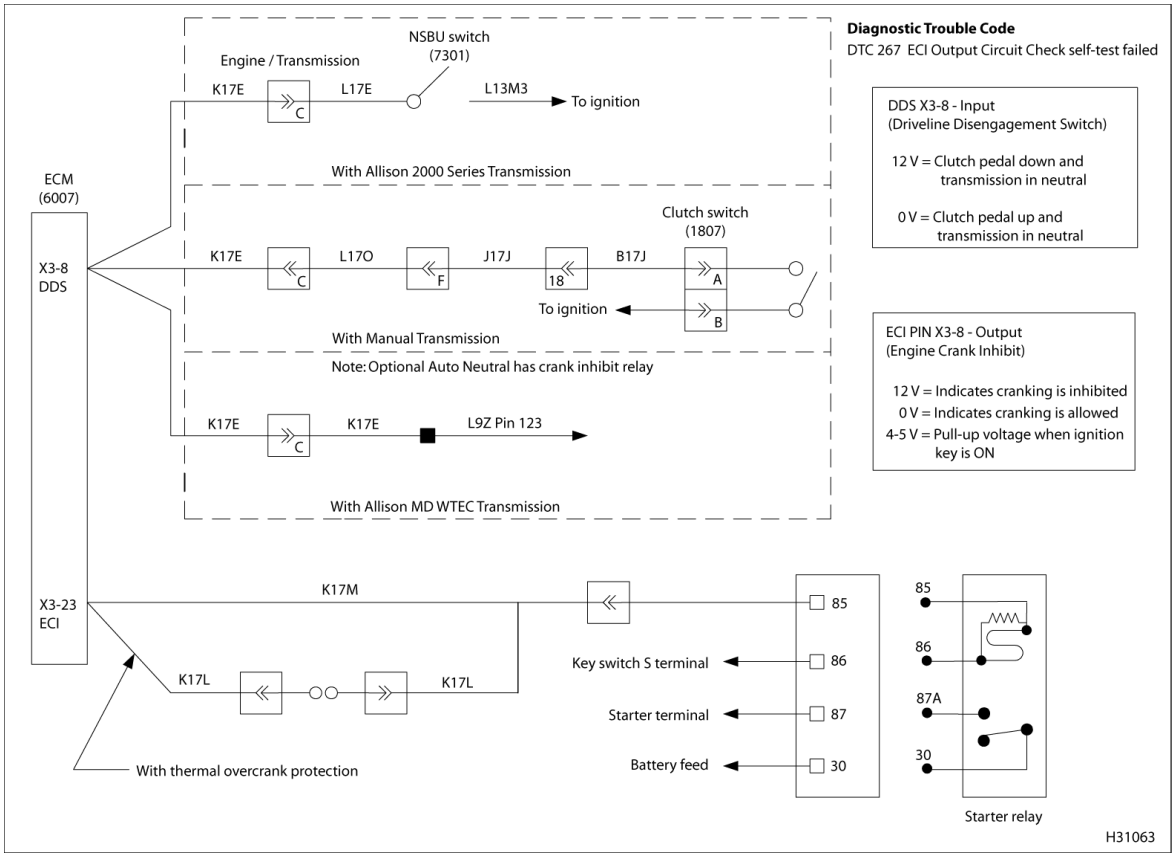


Figure 417 ECI circuit diagram

The ECI circuit requires the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

ECI Relay Voltage Checks (Turn the ignition switch to ON. Check with ECI relay removed.)		
Test Point	**Spec**	**Comment**
86 to gnd	12 V ±1.5 V	Check with relay disconnected and starter switch (key or button) engaged. If no voltage present, troubleshoot ignition crank circuit.
30 to gnd	12 V ± 1.5 V	If no voltage is present, troubleshoot battery wiring.
85 to gnd	4 V to 5 V	ECM will pull circuit up to 4 V to 5 V with switch ON and go to 0 V when the clutch is depressed or transmission is in neutral.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.

ECI Circuit Test – With the transmission out of gear and the clutch depressed with wheels safely blocked, insert a harness between socket Pin 86 and 87 of the starter relay. If the engine cranks when the start switch is engaged, check for failed ECI relay or problems with the ECM or ECM wiring harness.

ECI Chassis Circuit Checks (Check with key-on engine-off, ECI relay installed, and breakout box connected.)

Test Point	Spec	Comment
X3–8 to X3–7	0 V or 12 V	Manual Trans – 12 V with clutch pedal down, 0 V clutch pedal up.
		Auto Trans – 12 V with trans in neutral, 0 V trans in gear.
X3–23 to X3–7	12 V ± 1.5 V	If no voltage is present with ignition switch in start position or start button pressed, troubleshoot battery wiring.
	0 V to 0.6 V	At crank with clutch down or auto trans in neutral, if ECM Pin X3–8 is at 12 V and Pin X3–23 is not at 0 V to 0.6 V, check ECM programming. Cranking allowed. See truck *Electrical System Troubleshooting Guide*
	4 V to 5 V	Pull up voltage from ECM with key-on engine-off or running: transmission in gear or clutch up.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECL Sensor (Engine Coolant Level)

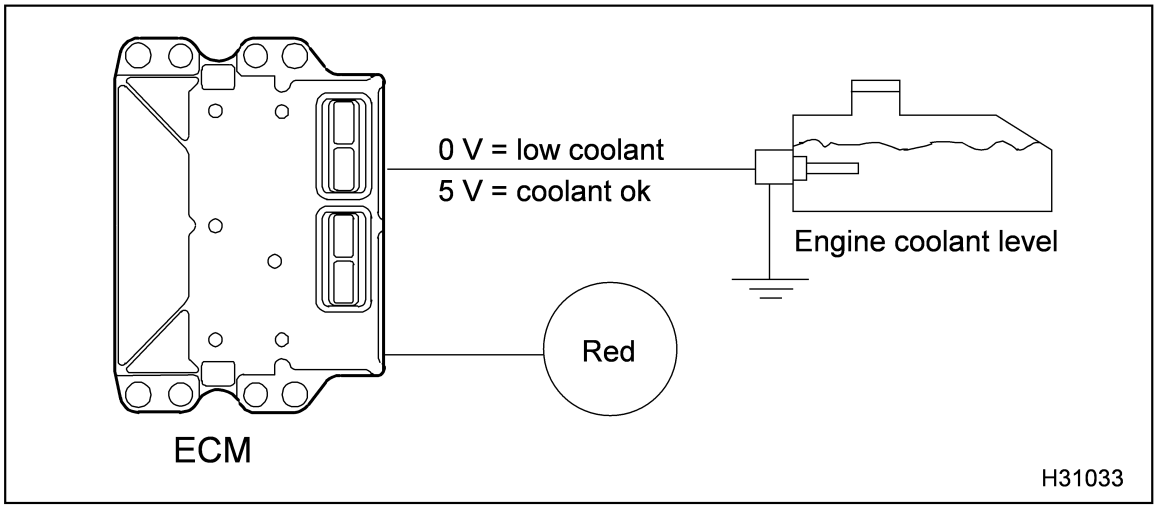


Figure 418 Function diagram for the ECL system

The ECM monitors engine coolant level and alerts the operator when coolant is low. The ECM can be programmed to shut the engine off when coolant is low.

The ECL system includes the Electronic Control Module (ECM) and the engine coolant tank with a coolant level sensor. The ECL switch is used in the plastic deaeration tank.

Coolant level monitoring is a customer programmable feature that can be programmed by the EST. The coolant level feature is operational if programmed for 3-way warning or 3-way protection. The feature can not be enabled if the ECM was not factory programmed for 3-way protection.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECL Circuit Operation

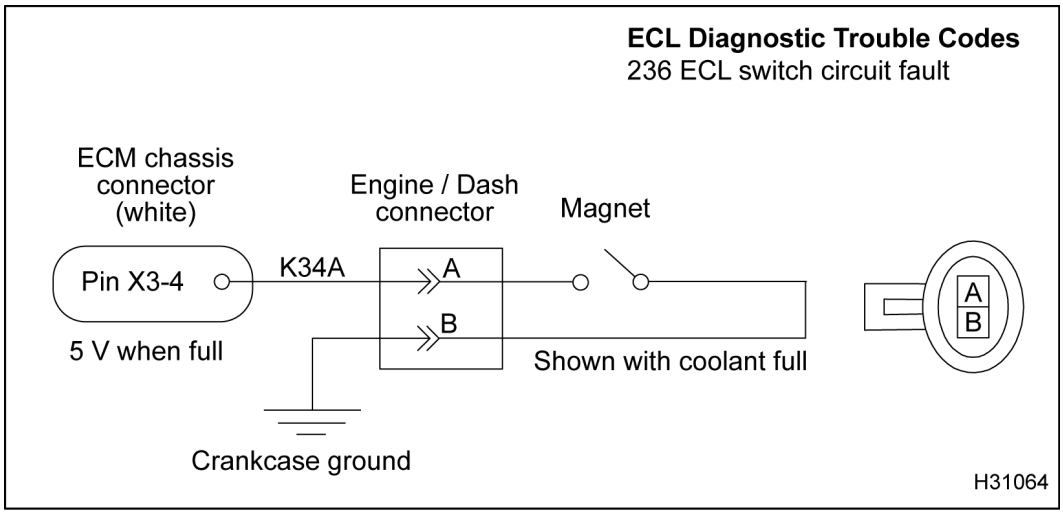


Figure 419 ECL circuit diagram

The coolant level sensor uses a floating ball with a magnetic switch. When the coolant level is full, the float will rise and the magnet will pull the level switch open. This allows a 5 V signal at ECM Pin X3–4. When the level is low, the switch will close and ECM Pin X3–4 will be 0 V.

Fault Detection / Management

The ECM continuously monitors the ECL circuit for in-range faults. The ECM does not detect open or short circuits in the ECL system. When the ECM detects an in-range fault, DTC 236 will be set.

ECL Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 236
ECL switch circuit fault

- DTC 236 is set when the ECM detects an in-range fault voltage and the voltage is between 3.4 V and 4.3 V at ECM Pin X3–4 for more than 2.0 seconds.
- DTC 236 is set when a high resistance connection or intermittent short to ground in the circuit exists.
- DTC 236 will not illuminate the red ENGINE lamp. If the condition is intermittent, the DTC will be logged as inactive.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECL Pin-Point Diagnostics

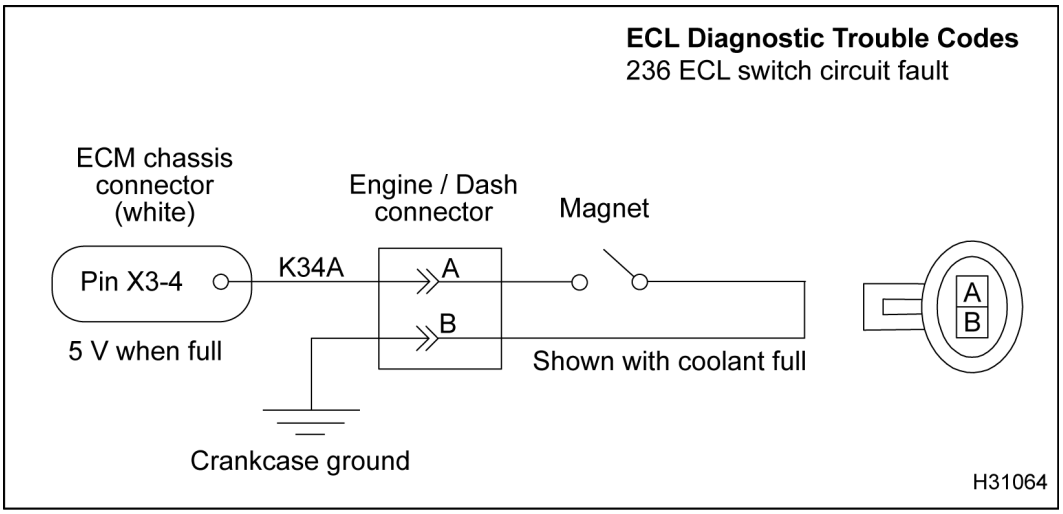


Figure 420 ECL system circuit diagram

The ECL circuit may require the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Coolant Level Sensor Connector (Disconnect sensor from harness and turn the ignition switch to ON. Test with coolant level full.) **Note:** After removing connector, inspect for damaged pins, corrosion, or loose pins. Repair as required.		
Test Point	**Spec**	**Comment**
A to gnd	5 V ±0.5 V	If voltage < 5 V, check for open signal circuit or failed ECM.
B to gnd	0 V	If voltage > 0 V, check for signal circuit shorted to another circuit
Sensor Resistance Checks (Disconnect sensor connector and measure across sensor)		
A to B	> 1 kΩ	If < 1 kΩ, check for low coolant, failed sensor, or shorted sensor harness.
Harness Resistance Checks (Turn the ignition switch to OFF. Connect breakout box to chassis harness only. Disconnect sensor.)		
B to gnd	< 5 Ω	If > 5 Ω, check for open ground wire
X3-4 to A	< 5 Ω	If > 5 Ω, check for open signal wire (breakout box connected)
Operational Voltage Checks for ECL (Check with breakout box connected and sensor connected. Turn the ignition switch to ON.)		
X3-4 to X3-7	5 V	Voltage > 4.3 V with tank full. Voltage < 3.4 V with tank empty (use breakout box)
ECL Diagnostic Trouble Codes		
DTC 236 = Signal voltage between 3.4 V and 4.3 V more than 2.0 seconds.		

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM / IDM Communications (Electronic Control Module / Injector Driver Module)

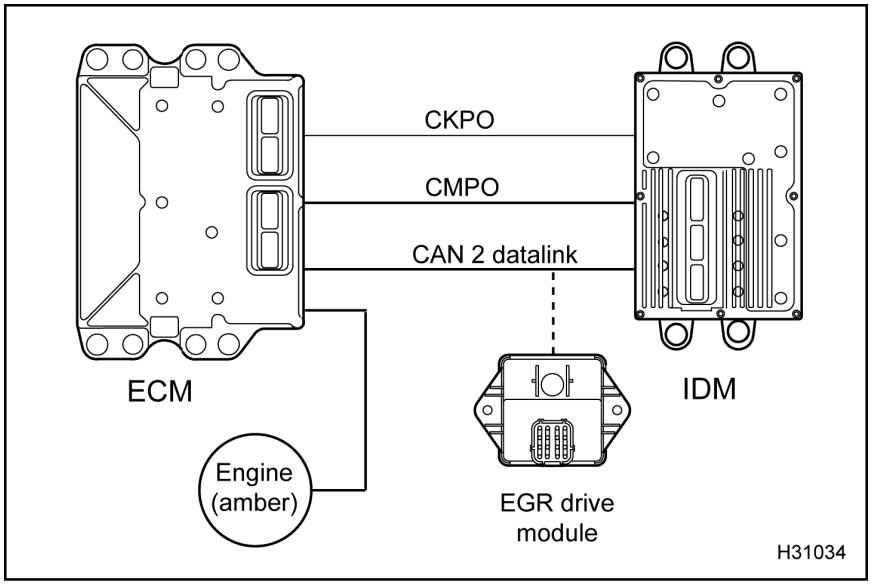


Figure 421 Function diagram for the ECM / IDM communication system

The function diagram for the ECM / IDM communication system includes the following:

- ECM
- IDM
- Exhaust Gas Recirculation (EGR) drive module
- Crankshaft Position Output (CKPO) signal
- Camshaft Position Output (CMPO) signal
- Controller Area Network (CAN 2) datalink
- ENGINE lamp (amber)

Function

The ECM provides two output channels to aid the IDM with engine speed and position signals. The CKPO and CMPO channels are in phase with the CKP and CMP signals received by the ECM.

The ECM and IDM are in continuous communication. The CKPO and CMPO signals are generated when the ECM switches these circuits to ground. The IDM uses these signals for engine speed and timing.

The CAN 2 datalink is a bidirectional communication line between the ECM, IDM, and EGR drive module. The ECM, IDM, and EGR drive module use the datalink to send operating strategies, sensor information, diagnostic demands, and Diagnostic Trouble Codes (DTCs).

NOTE: The engine will not operate without the CAN 2 datalink, CKPO, or CMPO signal.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM / IDM Circuit Operation

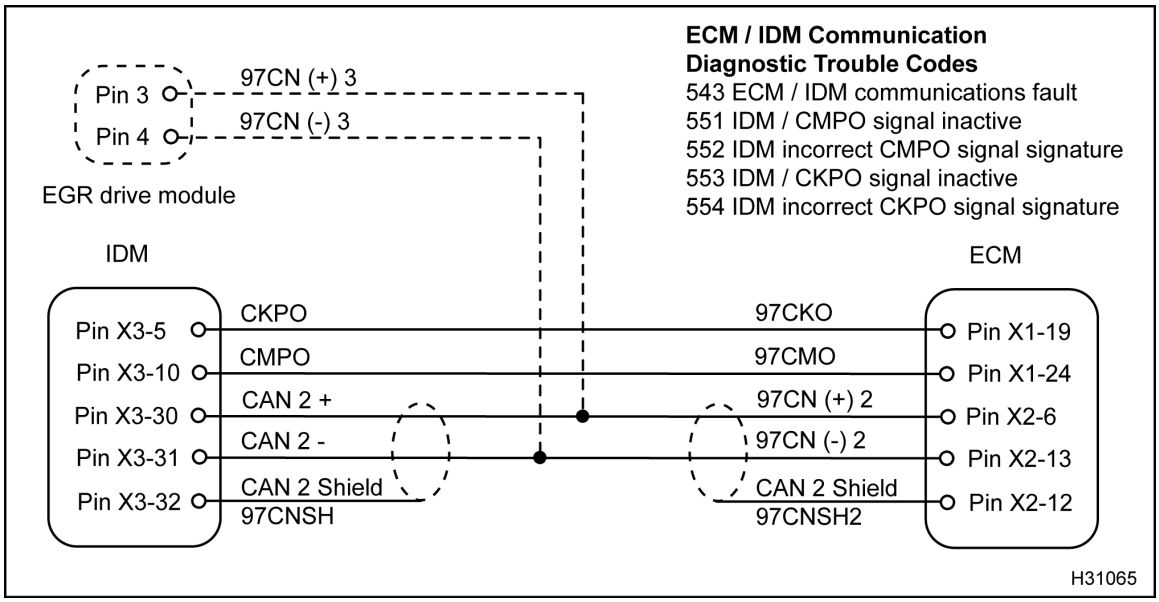


Figure 422 ECM / IDM circuit diagram

The ECM / IDM communication link consists of a series of interdependent signals that include the CKPO, CMPO, and the CAN 2 datalink.

The CKPO signal is a 0 V to 12 V signal that communicates (from ECM to IDM) the position of the crankshaft. The signal is used by the IDM to synchronize the injector firing sequence and is calculated from the signal generated from the CKP sensor. The ECM generates the CKPO signal by pulling down (switching to ground) a 12 V communication circuit in the IDM.

The CMPO signal is a 0 V to 12 V signal that communicates (from ECM to IDM) the position of the camshaft. The signal is used by the IDM to synchronize the injector firing sequence and is calculated from the signal generated from the CMP sensor. The ECM generates the CMPO signal by pulling down (switching to ground) a 12 V communication circuit in the IDM.

CAN 2 datalink is a J1939 high speed private communication datalink between the ECM, IDM, and EGR drive module. The ECM receives messages that include injector coil status, IDM calibration level, CMPO and CKPO DTCs, injector DTCs, IDM DTCs, and injector test results from the IDM. The IDM receives injector diagnostic commands, operation strategies, modes and conditions from the ECM.

NOTE: CAN 2 datalink is used only as communication between the ECM, IDM, and EGR drive module. There is no relation to the CAN 1 datalink that is used for communication with various processors on a vehicle.

Fault Detection / Management

The ECM continuously monitors the IDM. When the ECM fails to receive required continuous communication from the IDM, the ECM will set a DTC.

ECM / IDM Diagnostic Trouble Codes (DTCs)

DTCs are read using the Electronic Service Tool (EST) or by counting the flashes from the amber and red ENGINE lamp.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 543
ECM / IDM communications fault

- DTC 543 is set by the ECM when the ECM is not communicating with the IDM.
- DTC 543 can be set when CAN 2 datalink J1939 between ECM and IDM is shorted to ground, V_{REF}, or battery or the circuit is open. If IDM power is low, DTC 543 can be set.
- When DTC 543 is active the amber ENGINE lamp is illuminated.

NOTE: If a no start condition exists with DTC 543 and 368 active, check the CAN 2 datalink wiring (EGR to ECM and IDM to ECM). See “EGR Actuator” (page 413) in this section. One of the CAN 2 datalink wires (CAN 2 positive or negative) is open, short to ground, or a short to power exists.

DTC 551
IDM / CMPO signal inactive

- DTC 551 is set by the ECM when no CMPO signal is present while the CKPO is active. DTC 551 can also be set when no CMPO/CKPO is present while the ECM reports it is in the run mode.
- DTC 551 can be set when the CMPO is open, shorted to ground, or shorted to a voltage source. DTC 551 can also be set if logic power is low.

DTC 552
IDM incorrect CMPO signal signature

- DTC 552 is set when the CMPO transition occurs at the wrong CKPO tooth.
- DTC 552 can be set due to electrical noise creating a miscount on CMP location.

DTC 553
IDM / CKPO signal inactive

- DTC 553 is set by the ECM when no CKPO signal is present while the CMPO is active. DTC 552 can also be set when no CMPO/CKPO is present while the ECM reports it is in the run mode.
- DTC 553 can be set when CKPO is open, shorted to ground, or shorted to a voltage source. DTC 553 can also be set if logic power is low.

DTC 554
IDM incorrect CKPO signal signature

- DTC 554 is set by the ECM when CKPO signal has too few or too many transitions per engine rotation.
- DTC 554 can be set due to electrical noise creating a miscount on CKP location.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM / IDM Pin-Point Diagnostics

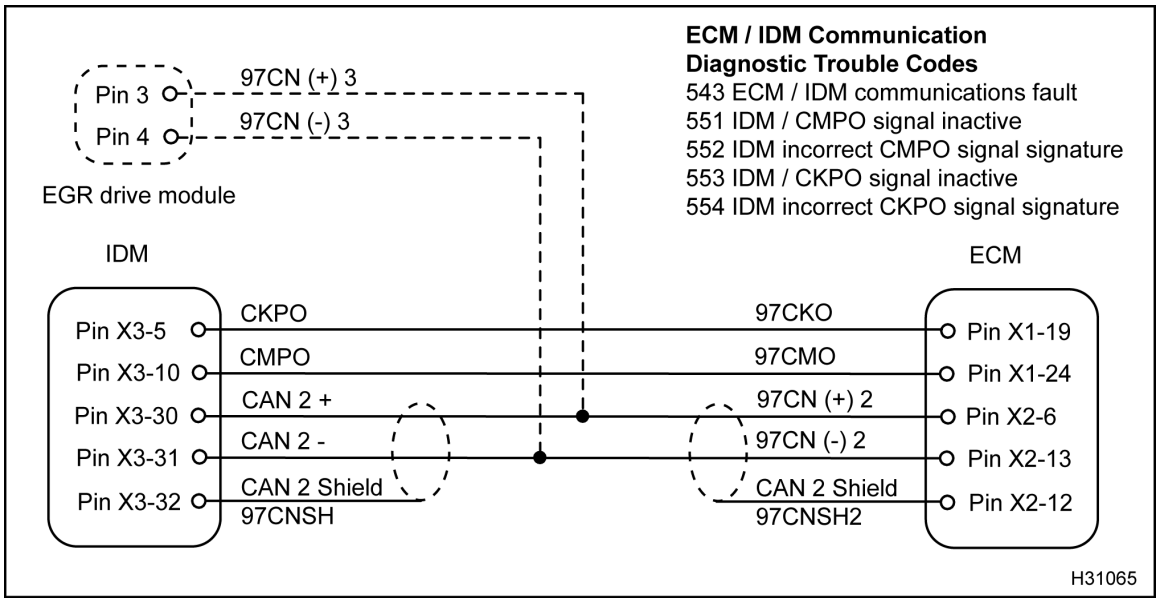


Figure 423 ECM / IDM circuit diagram

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting the connector or relay for the ECM and IDM. Failure to turn the switch to OFF will cause a voltage spike and damage to electrical components.

ECM Connector Voltage Checks to Chassis Ground (Check with breakout box connected [X1 and X2] to engine harness only. Inspect for bent pins or corrosion. Turn the ignition switch to ON. **Note:** ECM is not connected. IDM output is checked through the wiring harness.)

Test Point	Spec	Comment
X2–6 to gnd	1 V to 4 V	Digital signal. If no voltage check for open or short to ground and do resistance checks to chassis ground, harness resistance checks, and resistance checks - IDM CAN2 checks.
X2–13 to gnd	1 V to 4 V	Digital signal. If no voltage check for open or short to ground and do resistance checks to chassis ground, harness resistance checks, and resistance checks - IDM CAN2 checks.
X1–19 to gnd	11 V to 12 V	If < 11 V to 12 V, check for open or short to ground. Check IDM power relay.
X1–24 to gnd	11 V to 12 V	If < 11 V to 12 V, check for open or short to ground. Check IDM power relay.
X2–12 to gnd	0 V	Ground, no voltage expected

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Check with breakout box connected [X1 and X2] to engine harness only. Disconnect chassis connector 9260[1]. Inspect for bent pins or corrosion.)		
X1–19 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground or internal IDM problem. Test with IDM connector X3 disconnected. If problem remains, repair or replace harness. If disconnect of X3 corrected problem, replace IDM.
X1–24 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground or internal IDM problem. Test with IDM connector X3 disconnected. If problem remains, repair or replace harness. If disconnect of X3 corrected problem, replace IDM.
X2–6 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground or internal IDM problem. Test with IDM connector X3 disconnected. If problem remains, repair or replace harness. If disconnect of X3 corrected problem, replace IDM.
X2–13 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground or internal IDM problem. Test with IDM connector X3 disconnected. If problem remains, repair or replace harness. If disconnect of X3 corrected problem, replace IDM.
X2–12 to Pin A (9260)	< 10 Ω	If > 10 Ω, check for open in harness. CAN 2 shield is grounded through IDM. If X3 is not connected to IDM, spec will be > 500 Ω.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Check with breakout box connected [X1 and X2] to engine harness only. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Use disconnected negative battery cable for ground test point.)		
X1–19 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground or internal IDM problem. Test with IDM connector X3 disconnected. If problem remains, repair or replace harness. If disconnect of X3 corrected problem, replace IDM.
X1–24 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground or internal IDM problem. Test with IDM connector X3 disconnected. If problem remains, repair or replace harness. If disconnect of X3 corrected problem, replace IDM.
X2–6 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground or internal IDM problem. Test with IDM connector X3 disconnected. If problem remains, repair or replace harness. If disconnect of X3 corrected problem, replace IDM.
X2–13 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground or internal IDM problem. Test with IDM connector X3 disconnected. If problem remains, repair or replace harness. If disconnect of X3 corrected problem, replace IDM.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

X2–12 to gnd cable	< 10 Ω	If > 10 Ω, check for open in harness. CAN 2 shield is grounded through IDM. If X3 is not connected to IDM, spec will be > 500 Ω.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Harness Resistance Checks (Turn the ignition switch to OFF. Check with breakout box connected [X1 and X2] to engine harness only. IDM checked at harness connector X3 using terminal test pins. IDM pins are numbered on the mating end of the connector.)		
NOTE: Test points are from ECM to IDM.		
ECM X1–19 to IDM X3–5	< 5 Ω	If > 5 Ω, check for open in harness.
ECM X1–24 to IDM X3–10	< 5 Ω	If > 5 Ω, check for open in harness.
ECM X2–6 to IDM X3–30	< 5 Ω	If > 5 Ω, check for open in harness.
ECM X2–13 to IDM X3–31	< 5 Ω	If > 5 Ω, check for open in harness.
ECM X2–12 to IDM X3–32	< 5 Ω	If > 5 Ω, check for open in harness.
Resistance Checks – CAN 2 Datalink (Turn the ignition switch to OFF. Connect breakout box to ECM and chassis harness.)		
ECM X2–6 to gnd	3 MΩ ±0.1 MΩ	If > spec, check for short to ground or another circuit. Check ECM and IDM separately. If < spec, check for open circuit on CAN 2+. Check ECM and IDM separately.
ECM X2–13 to gnd	3 MΩ ±0.1 MΩ	If > spec, check for short to ground or another circuit. Check ECM and IDM separately. If < spec, check for open circuit on CAN 2+. Check ECM and IDM separately.
ECM X2–6 to X2–13	60 Ω	If > 60 Ω, check for open circuit on CAN 2+ and CAN 2-. Check ECM and IDM separately. Do Resistance Checks – ECM CAN 2 Circuit and Resistance Checks – IDM CAN 2.
ECM X2–12 to gnd	< 5 Ω	If > 5, check for open on CAN 2 shield (IDM Pin X3–32). Check ECM and IDM separately. Do Resistance Checks – ECM CAN 2 Circuit and Resistance Checks – IDM CAN 2.
Resistance Checks – ECM CAN 2 Circuit (Remove ECM following procedure in the *Engine Service Manual*. Measure directly to ECM pins only.)		
NOTE: Use ECM ground pins (X3–7 or X3–6) only for this test.		
ECM X2–6 to gnd	3.9 MΩ ±0.2 MΩ	If > spec, replace the ECM.
ECM X2–13 to gnd	3.9 MΩ ±0.2 MΩ	If > spec, replace the ECM.
ECM X2–6 to X2–13	120 Ω	If > spec, replace the ECM.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IDM CAN 2 Checks (Remove ECM following procedure in the *Engine Service Manual*. Measure directly to ECM pins only.)

NOTE: Use IDM ground pins (X3–1, X3–2, X3–3, X3–22, or X3–26) only for this test.

IDM X3–30 to gnd	1.85 MΩ ±0.20 MΩ	If > spec, replace the IDM.
IDM X3–31 to gnd	1.85 MΩ ±0.20 MΩ	If > spec, replace the IDM.
IDM X3–30 to X3–31	120 Ω	If > 120 Ω, replace the IDM.
IDM X3–32 to gnd	< 5 Ω	If > 5 Ω, replace the IDM.
IDM housing to gnd	< 5 Ω	If > 5 Ω, replace the IDM.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. Refer to truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Operational Checks for CMPO and CKPO (Check with breakout box connected to ECM and engine harness.)

Test Point	Engine Cranking	Low Idle	High Idle	Comment
X1–24 to X1–6	130–225 rpm[2] @ 130–225 rpm	700 rpm[2] @ 700 rpm	2750 rpm [2] @ 2750 rpm	Set DMM to DC-rpm[2]
X1–19 to X1–6	130–225 Hz @ 130–225 rpm	700 Hz @ 700 rpm	2.75 kHZ to 3.00 kHz	Set DMM to DC-Hz

Diagnostic Trouble Codes

DTC 543 = ECM / IDM communication fault

DTC 551 = IDM CMPO signal inactive

DTC 552 = IDM incorrect CMPO signal signature

DTC 553 = IDM CKPO signal inactive

DTC 554 = IDM incorrect CKPO signal signature

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM PWR (Electronic Control Module Power)

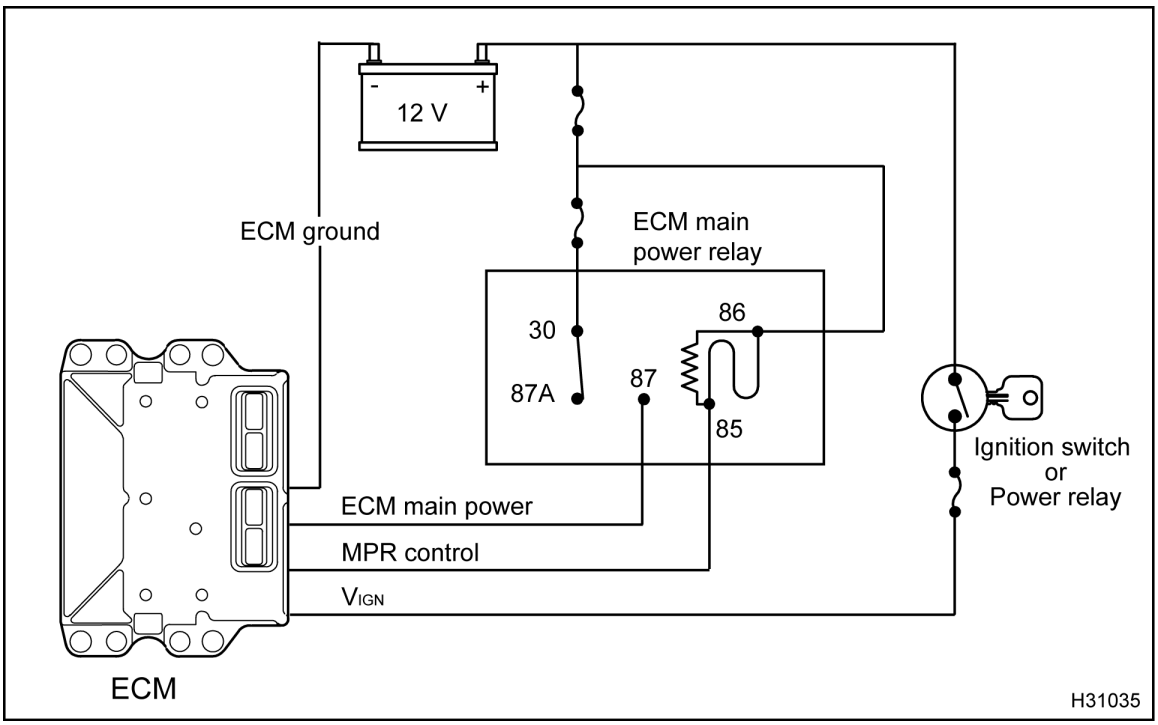


Figure 424 Function diagram for the ECM PWR

The function diagram for ECM PWR includes the following:

- ECM
- ECM main power relay
- Ignition switch or power relay
- Battery
- Fuses

Function

The Electronic Control Module (ECM) requires a 12 V power source to function correctly. The operating power is received from the vehicle batteries through the ECM main power relay contacts each time the ignition switch is turned ON.

When the ignition switch is turned ON, the ECM provides an internal ground to the coil side of the ECM main power relay. This closes the relay contacts and provides the ECM with necessary power.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM PWR Circuit Operation

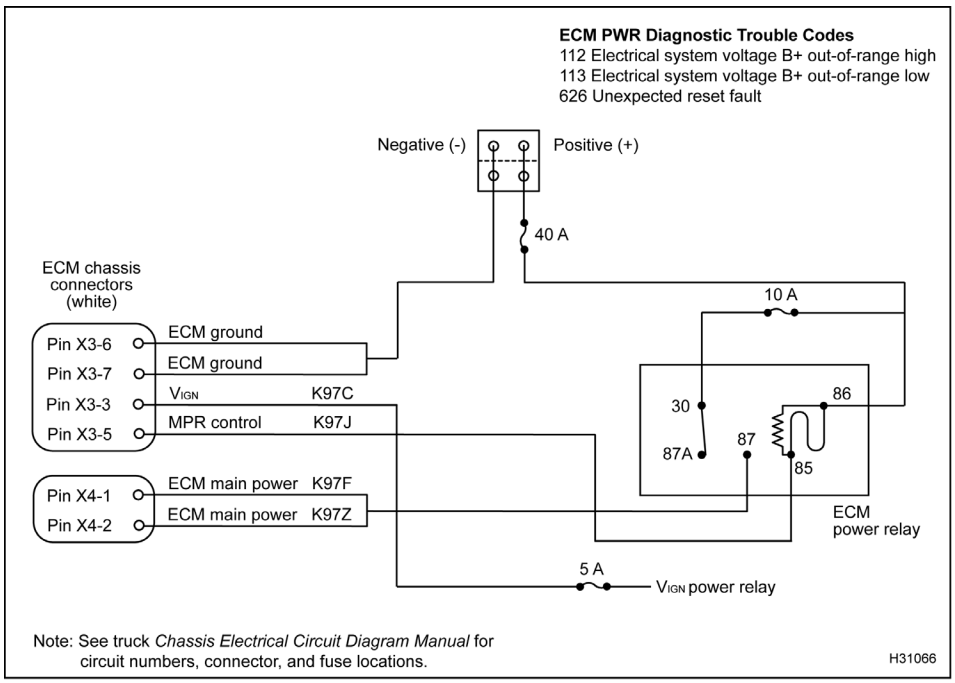


Figure 425 ECM PWR circuit diagram

The ECM is grounded to the battery negative terminal at ECM Pin X3-6 and X3-7.

The ECM receives V_{IGN} power at Pin X3-3. The power signals the ECM to provide a ground path from Pin X3-5 to 85 to switch the ECM main power relay. Switching the relay provides power from the battery positive terminal through 2 fuses and relay contacts 30 and 87 to Pins X4-1 and X4-2. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Fault Detection / Management

The ECM internally monitors battery voltage. When the ECM continuously receives less than 7 V or more than 23 V, a Diagnostic Trouble Code (DTC) will be set.

ECM PWR Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 112
Electrical system voltage B+ out of range high

- DTC 112 is set when the ECM detects an alternator output greater than 23 V at Pin X3–3 for more than 0.5 second.
- DTC 112 can be set when jump starting the engine and additional voltage is introduced. Incorrect external battery connections can cause the voltage increase.
- If the condition causing DTC 112 is intermittent, the code will change from active to inactive status. DTC 112 will not illuminate the amber ENGINE lamp.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 113
Electrical system voltage B+ out of range low

- DTC 113 is set when the ECM detects less than 7.0 V at Pin X3–3 for more than 0.5 second.
- DTC 113 can be set by a inoperative alternator or ECM power relay, discharged batteries, or increased resistance in the battery feed circuits.
- If the condition causing DTC 113 is intermittent, the code will change from active to inactive status. DTC 113 will not illuminate the amber ENGINE lamp.

DTC 626
Unexpected reset fault

- DTC 626 is set when power is interrupted to the ECM. Loose or dirty connections at fuses, relay connections, and battery or ground cables can cause the ECM to power down.
- After circuit becomes intact, the ECM will reboot. Erratic engine performance can occur. Turning engine ignition switch OFF and then ON will cause the code to change from active to inactive status.
- When DTC 626 is active, monitor the voltage at ECM Pin X4–1 and X4–2. Examine for intermittent connections in the power feed wiring. The EST can be used to indicate DTCs and display the V_{IGN} voltage measured by the ECM to Pin X3–3.
- DTC 626 will not illuminate the amber ENGINE lamp.

When DTC 112, 113, or 626 is active, see truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box
- Relay Breakout Harness
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM PWR Pin-Point Diagnostics

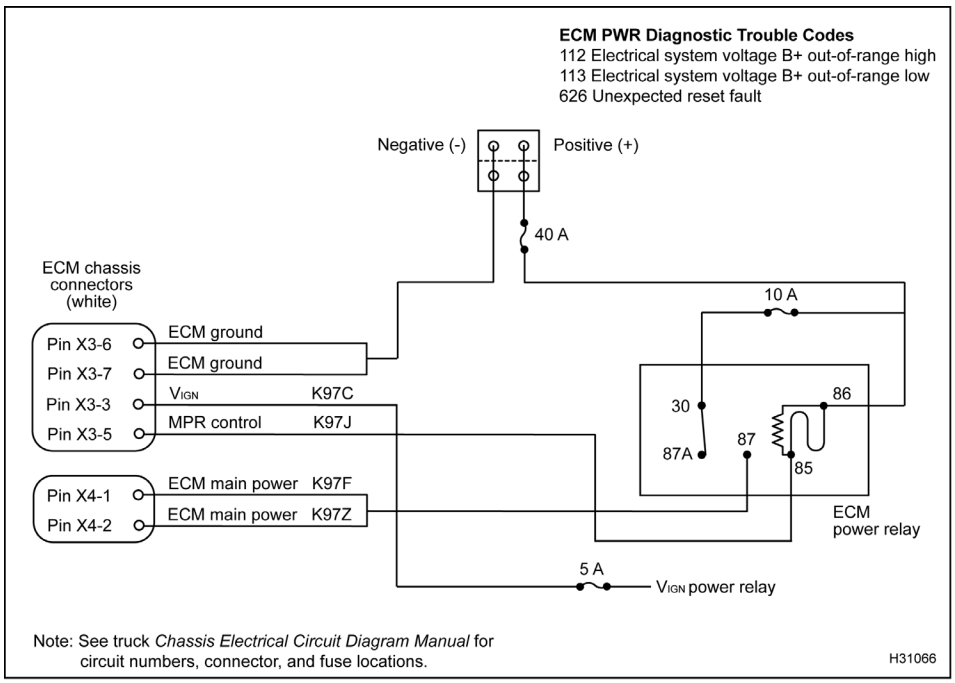


Figure 426 ECM PWR circuit diagram

The ECM PWR circuit requires the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before removing main power relay or any ECM connector supplying power to the ECM. Failure to turn the ignition switch to OFF will cause a voltage spike and damage to electrical components.

Voltage Checks at ECM Power Relay Socket – Key-On Engine-Off (Follow tests in order. Check with relay breakout harness connected to relay and power distribution center and turn the ignition switch on. Inspect for bent pins or corrosion.)

Test Point	Spec	Comment
86 to gnd	12 V ±1.5 V	Continuous voltage. If no voltage, check power circuits from batteries through fuse. If fuse is blown, check for short to ground. If fuse is good, check for open between Pin 30 and B+. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.
30 to gnd	12 V ± 1.5 V	Continuous voltage. If no voltage, check fuses. If fuse is blown, check for short to ground. If fuse is good, check for open between Pin 30 and B+. See truck *Chassis Electrical Circuit Diagram Manual* for fuse and relay locations.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

85 to gnd	0.06 V to 2 V	If > 2 V is present, check for open circuit between Pin X3–5 to Pin 85 on relay or V_{IGN} circuit. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.
87 to gnd	12 V ±1.5 V	Continuous voltage. If previous test points are in spec and no voltage is present, replace relay.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before removing main power relay or any ECM connector supplying power to the ECM. Failure to turn the ignition switch to OFF will cause a voltage spike and damage to electrical components.

Voltage Checks at ECM – Key-On Engine-Off (Follow tests in order. Check with breakout box connected between chassis harness and ECM. Inspect for bent pins and corrosion.)

Test Point	Spec	Comment
X3–3 to gnd	12 V ±1.5 V	Power from ignition switch to ECM. If no voltage, see truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.
X3–6 to gnd	0 V to 0.25 V	Ground – voltage reading indicates poor ground to battery. If voltage is present check for open or high resistance between battery (–) and ECM pins.
X3–7 to gnd	0 V to 0.25 V	Ground – voltage reading indicates poor ground to battery. If voltage is present check for open or high resistance between battery (–) and ECM pins.
X3–5 to gnd	0.06 V to 2 V	ECM grounds relay through internal transistor. If > 2 V is present, replace ECM.
X4–1 to gnd	12 V ±1.5 V	Power from relay to ECM. If no voltage, check for open between X4–1 and 87 on ECM relay. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.
X4–2 to gnd	12 V ±1.5 V	Power from relay to ECM. If no voltage, check for open between X4–2 and 87 on ECM relay. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before removing main power relay or any ECM connector supplying power to the ECM. Failure to turn the ignition switch to OFF will cause a voltage spike and damage to electrical components.

Harness Resistance Checks – ECM to Main Power Relay (Turn the ignition switch to OFF. Inspect for bent pins or corrosion. Connect relay breakout harness and breakout box to X3 and X4 chassis harness only.)

Test Point	Spec	Comment
X3–5 to 85 (ECM relay)	< 5 Ω	If > 5 Ω, check connections for open between ECM and relay. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.
X4–1 to 87 (ECM relay)	< 5 Ω	If > 5 Ω, check connections for open between ECM and relay. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.
X4–2 to 87 (ECM relay)	< 5 Ω	If > 5 Ω, check connections for open between ECM and relay. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.

©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Harness Resistance Checks – Main Power Relay to Battery (Turn the ignition switch to OFF. Disconnect negative battery cable. Disconnect harness from sensor. Inspect for bent pins or corrosion. Connect relay breakout harness.)

30 (ECM relay) to B+ cable	< 5 Ω	If > 5 Ω, check connections for open between relay and positive battery cable. Check fuses. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.
86 (ECM relay) to B+ cable	< 5 Ω	If > 5 Ω, check connections for open between relay and positive battery cable. Check fuse. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.

Harness Resistance Checks – ECM to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Inspect for bent pins or corrosion. Connect breakout box [X3 and X4] to chassis harness only.)

X3–6 to Pin A (9260)	< 5 Ω	If > 5 Ω, check connections to battery ground. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.
X3–7 to Pin A (9260)	< 5 Ω	If > 5 Ω, check connections to battery ground. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.
X3–3 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.
X3–5 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.
X4–1 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.
X4–2 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Harness Resistance Checks – ECM to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)

X3–6 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
X3–7 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
X3–3 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
X3–5 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
X4–1 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
X4–2 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.

Harness Resistance Checks – ECM to Ignition Power Relay (Turn the ignition switch to OFF. Inspect for bent pins or corrosion. Connect relay breakout harness and breakout box [X3 and X4] to chassis harness only.)

©August 2008 Navistar, Inc.

X3–3 to 87 (V_{IGN} - power relay)	< 5 Ω	If > 5 Ω, check connections or open between ECM and V_{IGN} power relay. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.

ECM PWR Diagnostic Trouble Codes

DTC 112 = Internal voltage power out of range high > 23 V

DTC 113 = Internal voltage power out of range low < 7 V

DTC 626 = Unexpected reset fault

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM Self Diagnostics (Electronic Control Module)

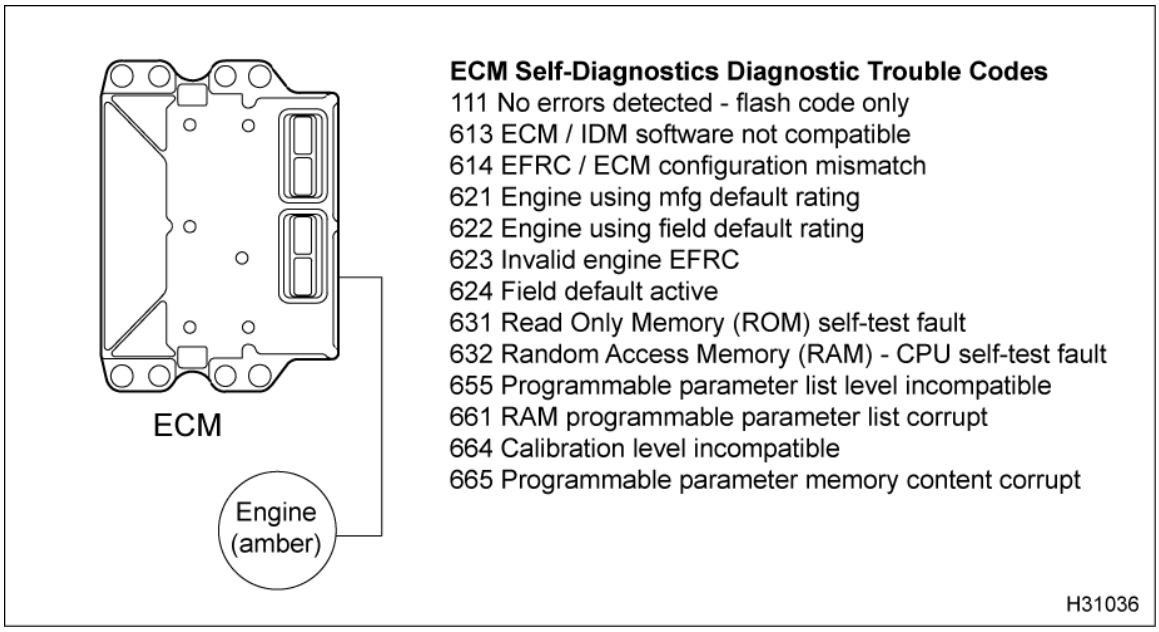


Figure 427 Function diagram for the ECM

The ECM does the following:

- Monitors and controls the engine operation and performance
- Enables Power Takeoff and cruise control
- Communicates engine and vehicle information to instrument cluster
- Enables electronically controlled transmission (for vehicles with feature)
- Enables diagnostic programming tools

Fault Detection / Management

The ECM automatically performs diagnostic self-checks. The ECM self-test includes memory, programming, and internal power supply checks. The ECM will detect internal Diagnostic Trouble Codes (DTCs) depending on the severity of the problem. Additionally, the ECM provides DTC management strategies to permit limited engine and vehicle operation.

When DTCs 613, 614, 621, 622, and 623 are set by the ECM, the amber ENGINE lamp will be illuminated.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM Self Diagnostic Trouble Codes (DTCs)

DTC 111 – No errors detected - flash code only	
Condition:	No DTC conditions detected
Note:	Can only determine if ECM has detected continuous DTCs detected during an Output Circuit Check. DTCs generated during an On-Demand Test such as KOER Standard Test can only be accessed by an EST.
DTC 613 – ECM / IDM software not compatible	
Condition:	ECM / Injector Drive Module (IDM) software is incompatible
Symptoms:	Possible no start – low power
Possible Causes:	Field replacement ECM or IDM mismatch
Actions:	Program ECM or IDM. May require ECM or IDM replacement.
DTC 614 – EFRC / ECM configuration mismatch	
Condition:	Engine Family Rating Code (EFRC) / ECM configuration mismatch
Symptoms:	Possible hard start and no start or low power condition
Possible Causes:	Wrong EFRC selected for the ECM strategy programmed in the module.
Actions:	Check EFRC and verify that it matches the ECM strategy level. Reprogram the ECM or change the EFRC as required.
DTC 621 – Engine using mfg default rating	
Condition:	Manufacturing defaults selected.
Symptoms:	Very low power (25 hp).
Possible Causes:	Programmable parameters for the ECM were never programmed in module. (Usually occurs in new vehicle or new module).
Actions:	Program ECM.
DTC 622 – Engine using field default rating	
Condition:	Engine using field default rating.
Symptoms:	Low power (lowest rating in engine class) and vehicle features not working.
Possible Causes:	Programmable parameters for the ECM incorrectly programmed in module.
Actions:	Program ECM.
DTC 623 – Invalid engine EFRC	
Condition:	Invalid EFRC
Symptoms:	Possible hard start and no start or low power condition.
Possible Causes:	Wrong EFRC selected for the ECM strategy programmed in the module.
Actions:	Check the EFRC and verify that it matches the ECM strategy level. Reprogram the ECM or change the EFRC as necessary.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 624 – Field default active	
Condition:	Field defaults active.
Symptoms:	Low power (lowest rating in engine class) and vehicle features not functioning.
Possible Causes:	Programmable parameters for the ECM incorrectly programmed in module.
Actions:	Program ECM
DTC 631 – Read Only Memory (ROM) self-test fault	
Condition:	ROM self-test fault
Symptoms:	No start.
Possible Causes:	Internal ECM problem.
Actions:	Replace the ECM.
DTC 632 – Random Access Memory (RAM) - CPU self-test fault	
Condition:	RAM Memory - CPU self-test fault.
Symptoms:	No start.
Possible Causes:	Internal ECM problem.
Actions:	Replace the ECM.
DTC 655 – Programmable parameter list level incompatible	
Condition:	Programmable parameter list level incompatible.
Symptoms:	No start or run in field defaults.
Possible Causes:	Programming problem or internal ECM problem.
Actions:	Program ECM. May require ECM replacement.
DTC 661 – RAM programmable parameter list corrupt	
Condition:	RAM programmable parameter list corrupt.
Symptoms:	No start or run in field defaults.
Possible Causes:	Internal ECM problem.
Actions:	Program ECM. May require ECM replacement.
DTC 664 – Calibration level incompatible	
Condition:	Calibration level incompatible.
Symptoms:	No start or run in field defaults.
Possible Causes:	Programmable problem or internal ECM problem.
Actions:	Program ECM
DTC 665 – Programmable parameter memory content corrupt	
Condition:	Programmable parameter memory content corrupt.
Symptoms:	No start or run in field defaults.
Possible Causes:	Internal ECM problem.
Actions:	Replace the ECM.

©August 2008 Navistar, Inc.

ECT Sensor (Engine Coolant Temperature)

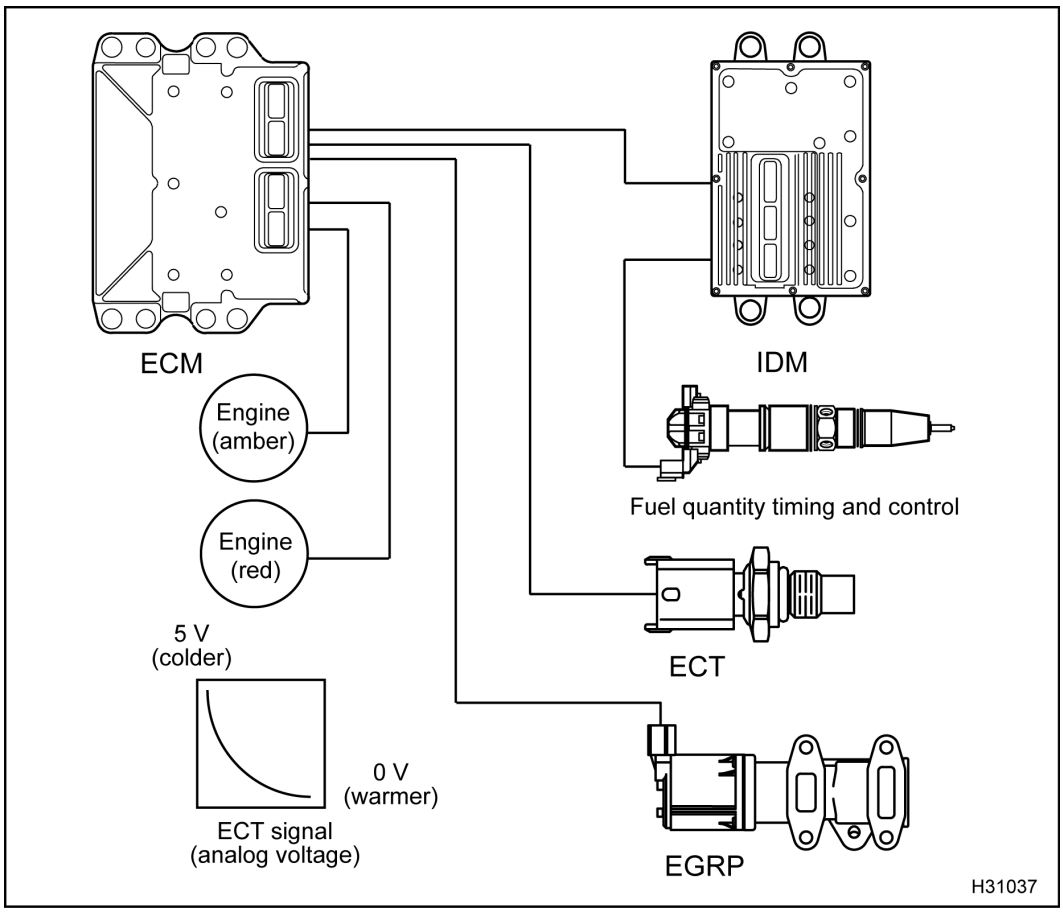


Figure 428 Function diagram for the ECT sensor

The function diagram for the ECT sensor includes the following:

- ECT sensor
- Electronic Control Module (ECM)
- Exhaust Gas Recirculation (EGR)
- Injector Drive Module (IDM)
- Fuel injector
- Variable Geometry Turbocharger (VGT)
- ENGINE lamp (amber and red)

Function

The ECT sensor is a thermistor sensor installed in the water supply housing (Freon® compressor bracket), right of the flat idler pulley assembly. The ECM supplies a 5 V reference signal which the ECT sensor uses to produce an analog voltage that indicates temperature.

The ECT sensor changes resistance when exposed to different temperatures. As the coolant temperature decreases, the resistance of the thermistor increases. This causes the signal voltage to increase. As the coolant temperature increases, the resistance of the thermistor decreases. This causes the signal voltage to decrease.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The ECT sensor provides a feedback signal to the ECM indicating engine coolant temperature. The ECM monitors the ECT signal to control the following features:

- Engine Warning and Protection System (EWPS)
- Cold Ambient Protection (CAP)
- Idle Shutdown Timer (IST)
- Cold idle advance
- Coolant compensation

During engine operation, if the ECM recognizes that the ECT signal is greater or less than the expected value it will set a Diagnostic Trouble Code (DTC).

Coolant Temperature Compensation

Coolant temperature compensation reduces fuel delivery if ECT is above cooling system specification.

The reduction in fuel delivery begins when ECT reaches approximately 107 °C (225 °F). A relatively rapid reduction of 15% will be achieved as the ECT reaches approximately 110 °C (230 °F).

Fuel reduction is calibrated to a maximum of 30% before standard engine warning or optional warning/protection is engaged. If warning or shutdown occurs, a DTC is stored in the ECM memory.

NOTE: Coolant temperature compensation may be disabled in emergency vehicles that require 100% power on demand.

Engine Warning and Protection (EWPS)

The EWPS is an optional feature that can be enabled or disabled. When enabled, the EWPS will warn the operator of an overheat condition and can be programmed to shut down the engine.

The red ENGINE lamp will come on when ECT reaches approximately 109 °C (228 °F). A warning buzzer will sound when ECT reaches approximately 112 °C (234 °F). The engine will shut down when the ECT reaches approximately 112 °C (234 °F), if 3-way protection is enabled.

©August 2008 Navistar, Inc.

ECT Circuit Operation

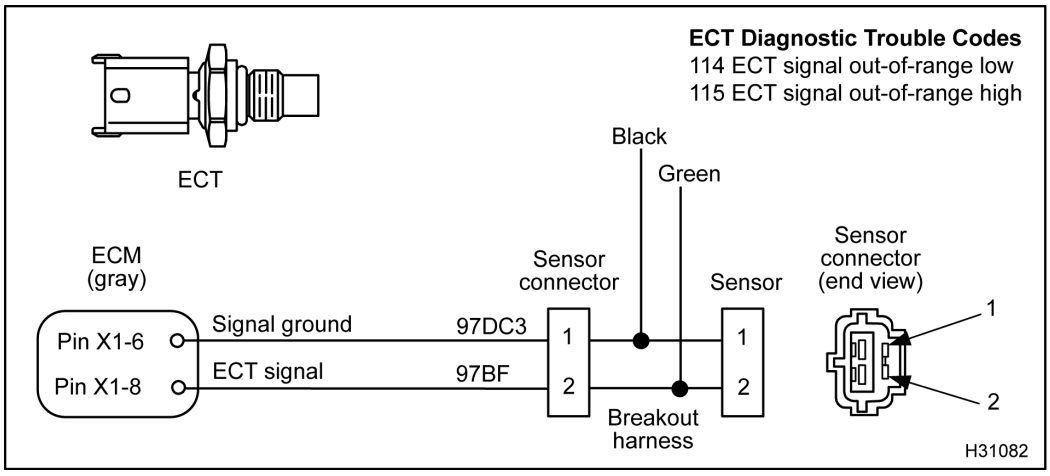


Figure 429 ECT circuit diagram

The ECT sensor is supplied with a 5 V reference voltage at Pin 2 from ECM Pin X1–8. The sensor is grounded at Pin 1 through the signal ground at the ECM Pin X1–6. As the coolant temperature increases or decreases, the sensor changes resistance and provides the coolant temperature signal voltage at the ECM. The signal voltage is monitored by the ECM to determine the temperature of the coolant.

Fault Detection / Management

The ECM continuously monitors the signal of the ECT sensor to determine if the signal is within an expected range. If the ECM detects an out of range high or low, the ECM will ignore the ECT signal and assume an engine coolant temperature of -20 °C (-4 °F) for starting and 82 °C (180 °F) for engine running conditions. When this occurs, the EWPS, CAP, IST, cold idle advance, and coolant temperature compensation features are disabled.

ECT Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 114
ECT signal out-of-range low

- DTC 114 set by the ECM when the ECT signal is less than 0.127 V for more than 0.35 second.
- DTC 114 can set due to a short to ground in the signal circuit or a failed ECT sensor.
- When DTC 114 is active the amber ENGINE lamp is illuminated.

DTC 115
ECT signal out-of-range high

- DTC 115 set by the ECM when the ECT signal is more than 4.6 V for more than 0.35 second.
- DTC 115 can set due to an open signal or ground circuit, a short to a voltage source, or a failed ECT sensor.
- When DTC 115 is active the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- Breakout Box
- Breakout Harness
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECT Operational Diagnostics

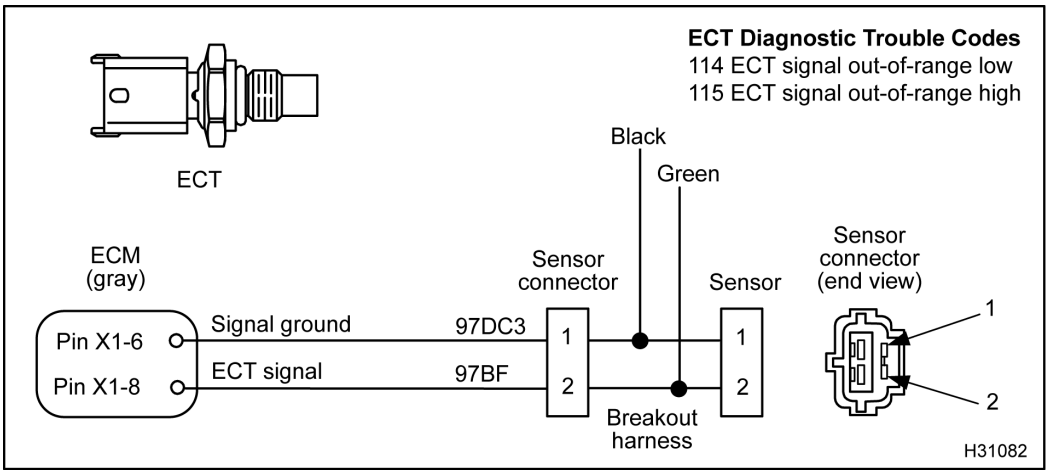


Figure 430 ECT circuit diagram

⚠ WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the D_ContinuousMonitor.ssn.

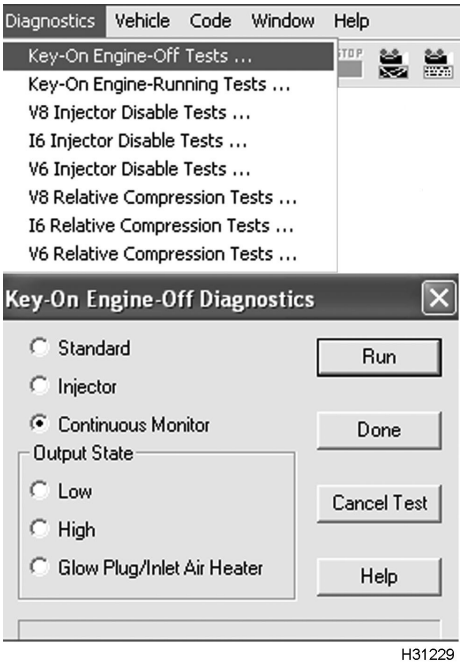


Figure 431 Continuous Monitor Test

2. To monitor signal voltage, run KOEO Continuous Monitor Test. For help, see “Continuous Monitor Test” in Section 3 (page 68).
3. Monitor ECT signal voltage. Verify an active DTC for the ECT circuit.
4. If code is active, do step 6 and 7 to check circuit for the ECT sensor using the following table.
   - Circuit Checks for ECT Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Disconnect engine harness from temperature sensor.

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

7. Connect Temperature Sensor Breakout Harness to engine harness only.

©August 2008 Navistar, Inc.

Circuit Checks for ECT Sensor (Use EST, breakout harness, 3-Banana Plug Harness, and 500 Ohm Resistor Harness.)

Test Condition	Spec	Checks
Sensor disconnected	> 4.6 V	If voltage < 4.6 V, check signal circuit for short to ground.
3-Banana Plug Harness connected between Pin 2 (Green) and Pin 1 (Black) of breakout harness	0 V	If voltage is > 0.127 V, check ground and signal circuit for open or high resistance. Use a breakout box and measure resistance from Pin 1 to Pin X1–6 and from Pin 2 to X1–8 (spec < 5 Ω).
500 Ohm Resistor Harness connected between Pin 2 (Green) and Pin 1 (Black) of breakout harness	< 1.0 V	If voltage > 1.0 V, check signal circuit for short to V_{REF}, B+, or another sensor's signal voltage.

Connect engine harness to sensor. Use the EST to clear DTCs. If an active code remains after checking test conditions, replace the ECT sensor.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECT Pin-Point Diagnostics

Connector Voltage Checks to Ground (Disconnect harness from sensor. Inspect for bent pins or corrosion. Connect breakout harness to engine harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
2 to gnd	4.6 V to 5.0 V	Pull up voltage, if no voltage or low, circuit is open, has high resistance, or short to ground
1 to gnd	0 V to 0.25 V	Voltage > 0.25 V, wire shorted to V_{REF} or B+.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect harness from sensor. Connect breakout harness to engine harness only. Disconnect chassis connector 9260[1].)		
1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open ground circuit.
2 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for shorted signal to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Connect breakout harness to engine harness only. Use disconnected negative battery cable for ground test point.)		
1 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
2 to gnd cable	> 1 kΩ	If < 1 kΩ, check for signal short to ground.
Harness Resistance Checks (Connect breakout box to engine harness only. Disconnect harness from sensor. Connect breakout harness to engine harness only.)		
X1–6 to 1	< 5 Ω	If > 5 Ω, check for open ground wire
X1–8 to 2	< 5 Ω	If > 5 Ω, check for open signal wire

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

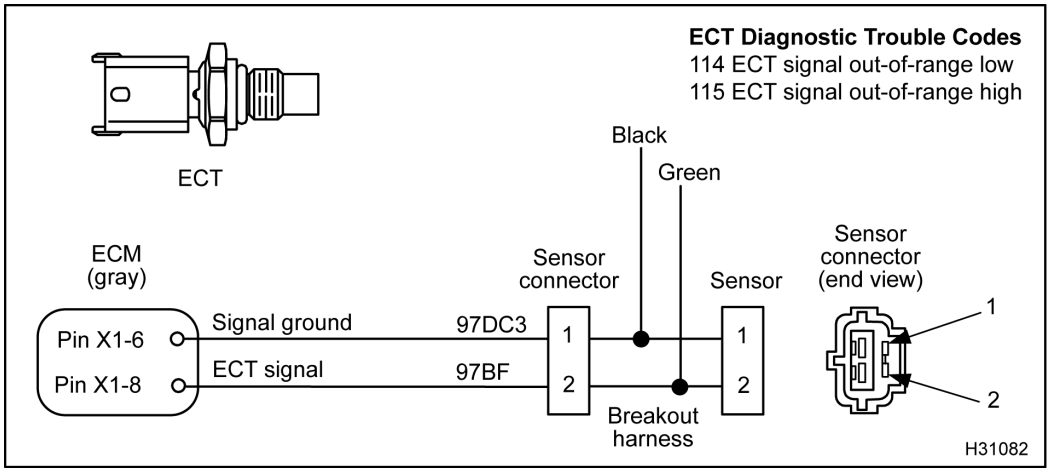


Figure 432 ECT circuit diagram

Operational Voltage Checks for ECT Sensor with Breakout Harness (Check with breakout harness connected to sensor and engine harness.)			
Test Point	**Coolant Temp**	**Resistance**	**Voltage**
2 (Green) to 1 (Black)	108 °C (228 °F)	1.605 kΩ	0.37 V
2 (Green) to 1 (Black)	87.7 °C (190 °F)	3 kΩ	0.65 V
2 (Green) to 1 (Black)	0 °C (32 °F)	91.1 kΩ	3.86 V
2 (Green) to 1 (Black)	–17.8 °C (0 °F)	208 kΩ	4.25 V
Operational Voltage Checks for ECT Sensor with Breakout Box (Check with breakout box connected [X-1 only] to ECM and engine harness.)			
X1–8 to X1–6	108 °C (228 °F)	1.605 kΩ	0.37 V
X1–8 to X1–6	87.7 °C (190 °F)	3 kΩ	0.65 V
X1–8 to X1–6	0 °C (32 °F)	91.1 kΩ	3.86 V
X1–8 to X1–6	–17.8 °C (0 °F)	208 kΩ	4.25 V

ECT Diagnostic Trouble Codes

DTC 114 = Signal voltage was < 0.127 V for more than 0.35 second.

DTC 115 = Signal voltage was > 4.6 V for more than 0.35 second.

DTC 316 = See “Engine Warning and Protection System” (page 440).

DTC 321 = See “Engine Warning and Protection System” (page 440).

DTC 322 = See “Engine Warning and Protection System” (page 440).

DTC 325 = See “Engine Warning and Protection System” (page 440).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EFAN Control (Engine Fan Control)

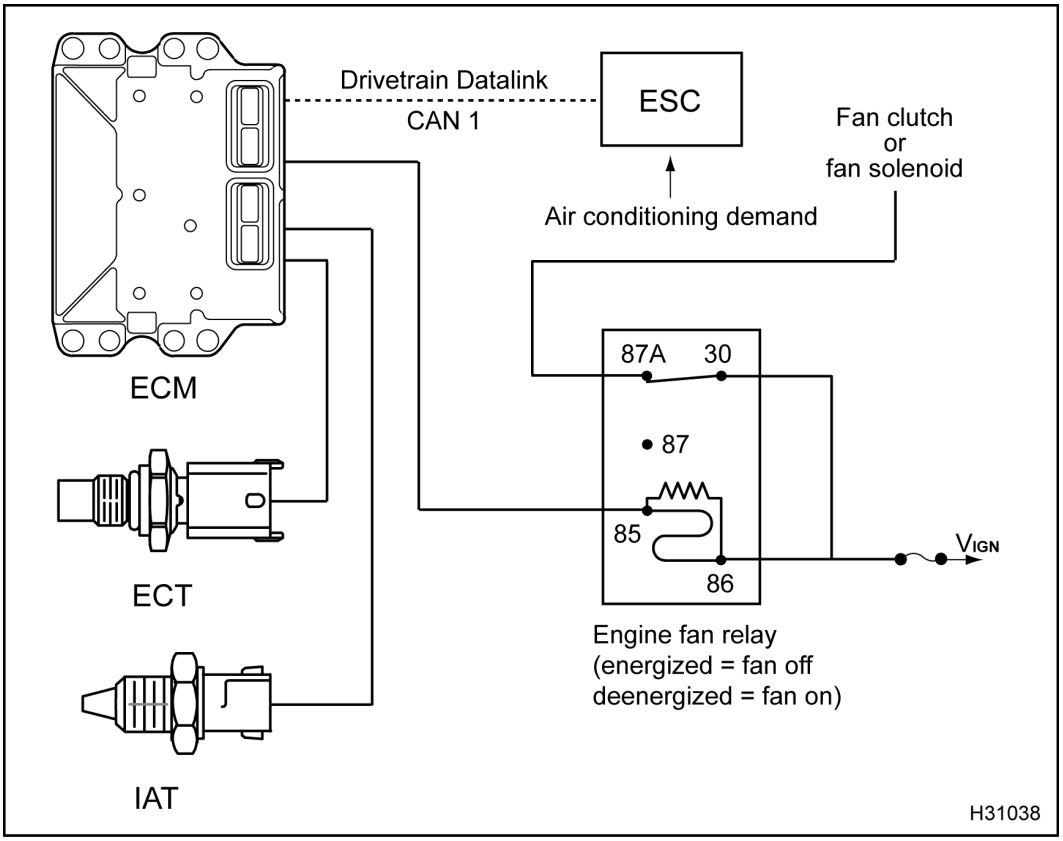


Figure 433 Function diagram for EFAN

The function diagram for EFAN includes the following:

- Electronic Control Module (ECM)
- Engine Coolant Temperature (ECT) sensor
- Intake Air Temperature (IAT) sensor
- Electronic System Controller (ESC)
- Engine fan relay

Function

The EFAN control provides ON/OFF control of the engine cooling system fan. The ECM can be programmed to set and monitor limits for engine coolant temperature, intake air temperature, engine mode selection (operating or diagnostic).

EFAN is accessible with the EST. Fan on and off temperature can be programmed by technician, but the mode of operation must be done by Tech Services.

The purpose of the engine fan control is to provide the correct logic to determine when the fan should be turned on or off by energizing/deenergizing the fan drive relay. The purpose of the engine fan is to allow a higher air flow for heat exchange between the radiator and the ambient air when needed.

Engine Fan Control – This parameter indicates to the on-board electronics whether or not the truck has the electronic engine fan control feature.
AC Fan Activation – This feature will allow fan activation through the ECM when requested from the ESC during AC operation.
Disable – Feature is turned off at all times.
Fan On Temperature – This parameter indicates the coolant temperature that the fan will be electronically activated.
Fan Off Temperature – This parameter indicates the coolant temperature that the fan will be electronically deactivated.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fan Clutch Circuit Operation

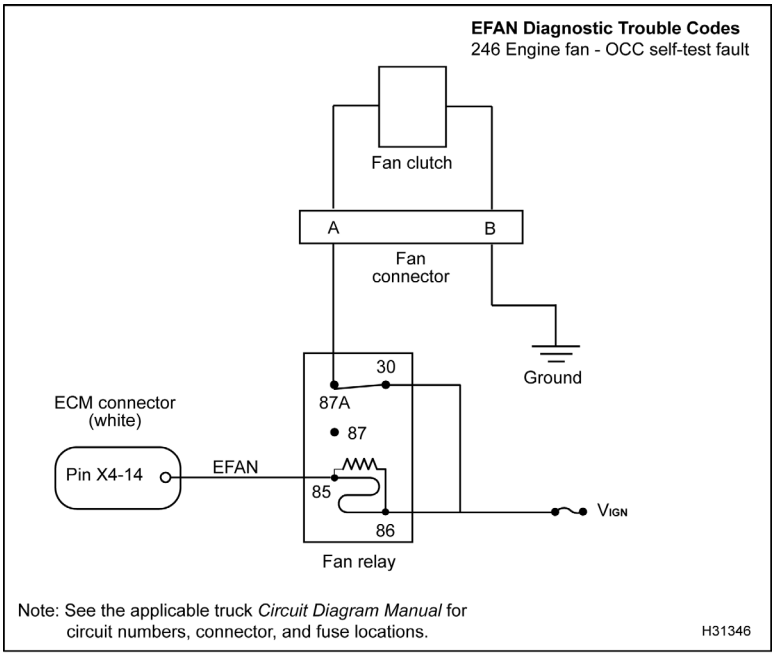


Figure 434 Fan clutch circuit diagram

The presence of electric current locks the fan clutch into place and allows fan activation and cooling.

When the fan needs to be activated, the ground is removed from ECM Pin X4–14. The coil side of the fan relay is deenergized causing the switch side to close, then sends 12 V from Pin 87A to the fan clutch. The fan clutch locks the fan in place when power is present at Pin 87A.

When fan needs to be deactivated, Pin X4–14 is grounded from the ECM. The coil side of the fan relay is energized, causing the switch side to open, and removes power from Pin 87A to the fan clutch. The fan clutch unlocks the fan when the power is removed from Pin 87A.

Fault Detection / Management

An open or short to ground in the EFAN can be detected by the ECM during an on-demand engine standard test. The IAT and ECT are monitored continuously. If a DTC is detected in the IAT or ECT, the EFAN control is disabled and the engine fan is on all the time.

NOTE: Before diagnosing, check that ECM is programmed correctly. Verify vehicle / application has an electronic fan.

EFAN Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 246
Engine Fan - OCC self-test fault

- DTC 246 is set by the ECM only during the KOEO Standard Test. During this test the ECM performs an output circuit test that momentarily enables the EFAN solenoid and measures the voltage drop across the relay

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Relay Breakout Harness

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fan Clutch Pin-Point Diagnostics

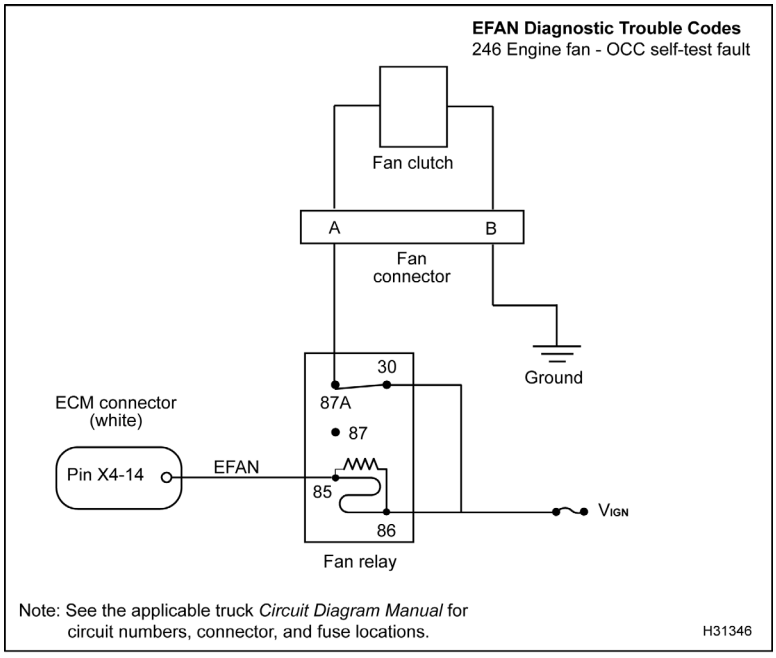


Figure 435 Fan clutch circuit diagram

Voltage Checks at Fan Connector (Disconnect fan connector. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
KOEO		
A to gnd	B+ ± 0.5 V	If < B+, check relay. Also check for an open circuit, short to ground, or short to voltage source. Do Output State Test - Voltage Check at Fan Connector.
B to gnd	0 V to 0.25 V	If > 0.25 V, check for an open ground circuit or a short to voltage source. Do Harness Resistance Checks.
Output State Test - Voltage Check at Fan Connector (Disconnect fan connector. Turn the ignition switch to ON. Run the Output State Tests. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests.)		
Test State/Point	**Spec**	**Comment**
Output State Test - Low		
A to gnd	0 V to 0.25 V	If > 0.25 V, check relay. Also check for short to voltage source.
Output State Test - High		
A to gnd	B+ ± 0.5 V	If < B+, check relay. Also check for an open circuit, short to ground, or a short to voltage source. Do Output State Test - Voltage Checks at Fan Relay.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Output State Test - Voltage Checks at Fan Relay (Check with relay breakout harness connected with relay. Turn the ignition switch to ON. Run the Output State Tests. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests.)

Test State/Point	Spec	Comment
Output State Test - Low		
30 to gnd	B+ ± 0.5 V	If < B+, do Harness Resistance Checks.
86 to gnd	B+ ± 0.5 V	If < B+, do Harness Resistance Checks.
85 to gnd	0 V to 0.25 V	If > 0.25 V, check for open circuit, short to voltage source, ECM programming, or failed ECM. Do Harness Resistance Checks.
87 to gnd	B+ ± 0.5 V	If < B+, and previous checks (30, 86, 85 to gnd) are within specification, replace relay.
87A to gnd	0 V to 0.25 V	If > 0.25 V, and previous checks (30, 86, 85 to gnd) are within specification, but 87 to gnd is not within specification, replace relay.
Output State Test - High		
30 to gnd	B+ ± 0.5 V	If < B+, do Harness Resistance Checks.
86 to gnd	B+ ± 0.5 V	If > B+, do Harness Resistance Checks.
85 to gnd	B+ ± 0.5 V	If < B+, check for open circuit, ECM programming, or failed ECM. Do Harness Resistance Checks.
87 to gnd	B+ ± 0.5 V	If > 0.25 V, and previous checks (30, 86, 85 to gnd) are within specification, replace relay.
87A to gnd	B+ ± 0.5 V	If < B+, and previous checks (30, 86, 85 to gnd) are within specification, but 87 to gnd is not within specification, replace relay.

Output State Test - Voltage Checks at ECM (Disconnect X3 and X4 from ECM. Connect breakout box X3 and X4 to ECM and wiring harness. Disconnect relay. Turn the ignition switch to ON. Run the Output State Tests. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests.)

Output State Test - Low		
X3–3 to X4–14	B+ ± 0.5 V	If < B+, **verify that ECM is programmed correctly.** If ECM is programmed correctly, replace ECM.
Output State Test - High		
X3–3 to X4–14	0 V to 0.25 V	If > 0.25 V, **verify that ECM is programmed correctly.** If ECM is programmed correctly, replace ECM.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Harness Resistance Checks (Turn the ignition switch to OFF. Disconnect fan. Remove relay and connect relay breakout harness. Connect breakout box X4 to chassis wiring harness only.)		
X4–14 to 85	< 5 Ω	If > 5 Ω, check for harness open between ECM and relay terminal.
87A to A (fan)	< 5 Ω	If > 5 Ω, check for harness open between relay terminal and A (fan).
30 to Fuse	< 5 Ω	If > 5 Ω, check for harness open between fuse and relay terminal. See truck *Chassis Electrical Circuit Diagram Manual* for fuse information.
86 to Fuse	< 5 Ω	If > 5 Ω, check for harness open between fuse and relay terminal. See truck *Chassis Electrical Circuit Diagram Manual* for fuse information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fan Air Solenoid Circuit Operation

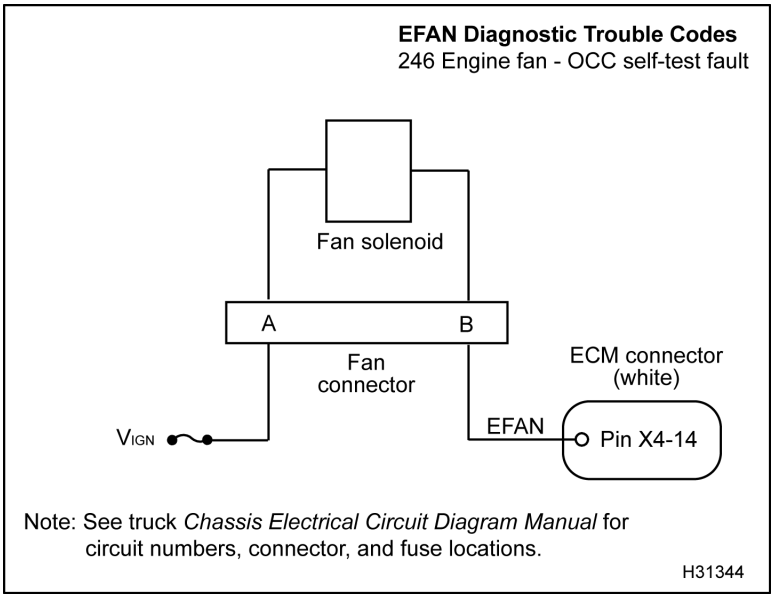


Figure 436 Fan air solenoid circuit diagram

The presence of air pressure locks the fan clutch into place and allows fan activation and cooling.

When the fan needs to be activated, the ground is removed from ECM Pin X4–14. The air fan solenoid is deenergized and stops the flow of compressed air to the fan clutch. The fan clutch locks the fan when compressed air is not present.

When the fan needs to be deactivated, Pin X4–14 is grounded from the ECM. The air fan solenoid is energized and allows compressed air to flow to the fan clutch. The fan clutch unlocks the fan when compressed air is present.

Fault Detection / Management

An open or short to ground in the EFAN can be detected by the ECM during an on-demand engine standard test. The IAT and ECT are monitored continuously. If a DTC is detected in the IAT or ECT, the EFAN control is disabled and the engine fan is on all the time.

NOTE: Before diagnosing, check that ECM is programmed correctly. Verify vehicle / application has an electronic fan.

EFAN Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 246
Engine Fan - OCC self-test fault

- DTC 246 is set by the ECM only during the KOEO Standard Test. During this test the ECM performs an output circuit test that momentarily enables the EFAN solenoid and measures the voltage drop across the relay

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fan Air Solenoid Pin-Point Diagnostics

Voltage Checks at Fan Solenoid Connector (Disconnect solenoid. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
KOEO		
A to gnd	B+ ± 0.5 V	If < B+, check for open circuit. Do Harness Resistance Checks.
B to gnd	0 V to 0.25 V	If > 0.25 V, check ECM programming or open circuit.
Output State Test - Voltage Check at Fan Solenoid Connector (Disconnect solenoid. Turn the ignition switch to ON. Run the Output State Tests. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests.)		
Test State/Point	**Spec**	**Comment**
Output State Test - Low		
B+ to Pin B	B+ ± 0.5 V	If < B+, check ECM programming and check for open circuit.
Output State Test - High		
B+ to Pin B	0 V to 0.25 V	If > 0.25 V, check ECM programming and check for short to voltage source.
Output State Test - Voltage Checks at ECM (Disconnect X3 and X4 from ECM. Connect breakout box X3 and X4 to ECM and wiring harness. Turn the ignition switch to ON. Run the Output State Tests. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests.)		
Output State Test - Low		
X3–3 to X4–14	B+ ± 0.5 V	If < B+, **verify that ECM is programmed correctly.** If ECM is programmed correctly, replace ECM.
Output State Test - High		
X3–3 to X4–14	0 V to 0.25 V	If > 0.25 V, **verify that ECM is programmed correctly.** If ECM is programmed correctly, replace ECM.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)

A to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
B to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
Harness Resistance Checks (Turn the ignition switch to OFF. Disconnect solenoid. Connect breakout box X4 to chassis wiring harness only.)		
X4–14 to B	< 5 Ω	If > 5 Ω, check for harness open between ECM and fan solenoid.
A to Fuse	< 5 Ω	If > 5 Ω, check for harness open between fuse and fan solenoid. See truck *Chassis Electrical Circuit Diagram Manual* for fuse information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EFP Sensor (Engine Fuel Pressure – optional)

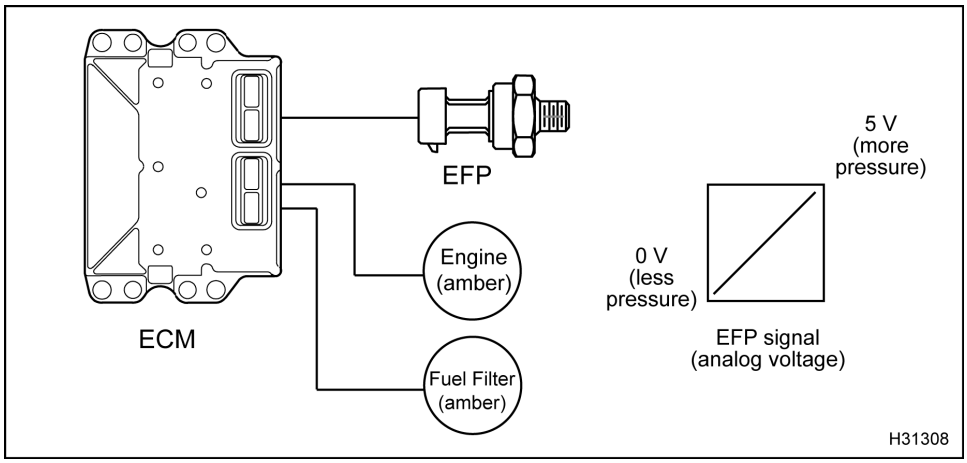


Figure 437 Function diagram for the EFP sensor

The function diagram for the EFP sensor includes the following:

- EFP sensor
- Electronic Control Module (ECM)
- ENGINE lamp (amber)
- FUEL FILTER lamp (amber)

Function

The EFP sensor is a variable capacitance sensor installed in the rear of the fuel filter assembly (crankcase side). The ECM supplies a 5 V reference signal which the EFP sensor uses to produce a linear analog voltage that indicates pressure. The ECM uses the EFP sensor signal to monitor engine fuel pressure and give an indication when the fuel filter needs to be changed.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EFP Circuit Operation

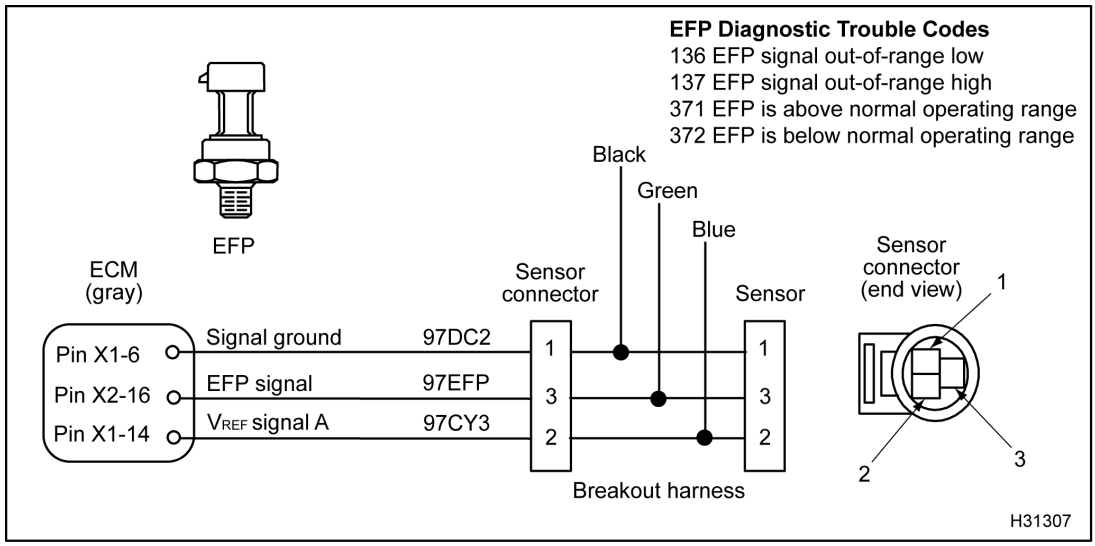


Figure 438 EFP circuit diagram

The EFP sensor is supplied with a 5 V reference voltage at Pin 2 from ECM Pin X1–14. The EFP sensor is grounded at Pin 1 from ECM Pin X1–6. The EFP sensor returns a variable voltage signal from Pin 3 to ECM Pin X2–16.

Fault Detection / Management

The ECM will ignore the EFP signal when the signal is detected to be out of range or an incorrect value is read.

EFP Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 136
EFP signal out-of-range low

- DTC 136 is set by ECM when the EFP signal is less than 0.039 V for more than 0.35 second.
- DTC 136 can be set due to an open or short to ground on the signal circuit, a failed EFP sensor or an open V_{REF} circuit or V_{REF} short to ground.
- When DTC 136 is active the amber ENGINE lamp is not illuminated.

DTC 137
EFP signal out-of-range high

- DTC 137 is set by the ECM when the EFP signal is greater than 4.9 V for more than 0.35 second.
- DTC 137 can be set due to a signal circuit short to V_{REF} or B+ or a failed EFP sensor.
- When DTC 137 is active the amber ENGINE lamp is not illuminated.

DTC 371
EFP is above normal operating range

- DTC 371 is set by ECM when measured fuel pressure is greater than expected pressure by 100 kPa (15 psi) for more than 60 seconds.
- DTC 371 can be set due to debris in fuel regulator valve, failed fuel regulator valve, open signal ground, V_{REF} shorted to a voltage source greater than 5.5 V, bias high circuit, or failed EFP sensor.
- When DTC 371 is active the amber FUEL FILTER lamp will not illuminate

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 372
EFP is below normal operating range

- DTC 372 is set by ECM when measured fuel pressure is less than expected pressure by 103 kPa (15 psi) for more than 30 seconds.
- DTC 372 can be set due to dirty fuel filter element, fuel inlet restriction, debris in fuel tank, debris in fuel regulator valve, failed fuel regulator valve, failed fuel pump, bias low circuit, or failed EFP sensor. See “Fuel Pressure and Aerated Fuel” – Section 6.
- When DTC 372 is active the amber FUEL FILTER lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- Breakout Box
- Breakout Harness
- Terminal Test Adapter Kit

EFP Operational Diagnostics

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the D_ContinuousMonitor.ssn.

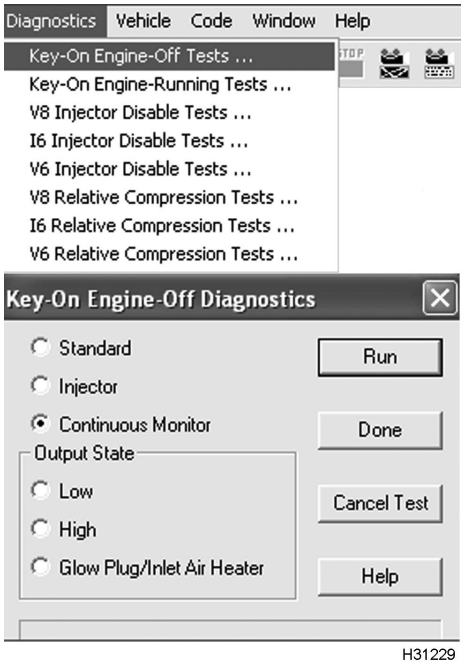


Figure 439 Continuous Monitor Test

2. To monitor signal voltage, run KOEO Continuous Monitor Test. For help, see “Continuous Monitor Test” in Section 3 (page 68).
3. Monitor EFP signal voltage. Verify an active DTC for the EFP circuit.
4. If code is active, do step 6 and 7 to check circuit for the EFP sensor using the following table.
   - Circuit Checks for EFP Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST display DTCs related to the condition.
6. Disconnect engine harness from pressure sensor.

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

7. Connect Pressure Sensor Breakout Harness to engine harness only.

©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Circuit Checks for EFP Sensor (Use EST, DMM, breakout harness, and 500 Ohm Resistor Harness.)

Test Condition	Spec	Checks
Sensor disconnected using EST	0 V	If voltage > 0.039 V, check signal circuit for short to V_{REF} or B+.
Voltage from Pin 2 (Blue) to ground using DMM	5 V ± 0.5 V	If voltage > 5.5 V, check V_{REF} for short to B+. If voltage is < 4.5 V, check V_{REF} for open or short to ground.
500 Ohm Resistor Harness connected between Pin 3 (Green) and Pin 2 (Blue) of breakout harness using EST	5 V	If voltage < 4.9 V, check signal circuit for open or short to ground. — Disconnect connector 9260[1]. Measure resistance from Pin 3 to Pin A of connector 9260 (spec > 1 kΩ) to check for short to ground within wiring harness. — Disconnect negative battery cable. Measure resistance from Pin 3 to ground cable to check for short to ground. — Use a breakout box from Pin 3 to Pin X2–16 (spec < 5 Ω) to check for open in the harness.
Resistance from Pin 1 (Black) of breakout harness to ECM chassis ground (Pin A of connector 9260) using DMM	< 5 Ω	If resistance is > 5 Ω, check for open or high resistance between ECM and sensor connector. Use a breakout box and measure resistance from between Pin 1 and Pin X1–6 (spec < 5 Ω).

Connect engine harness to sensor. Use the EST to clear DTCs. If an active code remains after checking test conditions, replace the EFP sensor.

1 Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EFP Pin-Point Diagnostics

Connector Voltage Checks (Disconnect harness from the sensor. Inspect for bent pins or corrosion. Connect breakout harness to engine harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
1 to gnd	0 V to 0.25 V	Signal ground (no voltage expected). If > 0.25 V, check ground circuit for open or high resistance and check signal ground for short to V_{REF} or B+.
2 to gnd	5 V ± 0.5 V	If voltage is not to spec, V_{REF} circuit is shorted to ground or B+.
3 to gnd	0 V to 0.25 V	If > 0.25 V, signal circuit is shorted to V_{REF} or B+.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Connect breakout harness to engine harness only. Disconnect chassis connector 9260[1].)		
1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit.
2 to Pin A (9260)	> 500 Ω	If < 500 Ω, check for short to ground within wiring harness.
3 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)		
1 to gnd cable	< 500 Ω	If > 500 Ω, check for short to ground.
2 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
3 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
Harness Resistance Checks (Connect breakout box [X1 and X2] to engine harness only. Connect breakout harness to engine harness only.)		
X1–6 to 1	< 5 Ω	If > 5 Ω, check for open ground wire
X1–14 to 2	< 5 Ω	If > 5 Ω, check for open V_{REF} wire
X2–16 to 3	< 5 Ω	If > 5 Ω, check for open signal wire

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

©August 2008 Navistar, Inc.

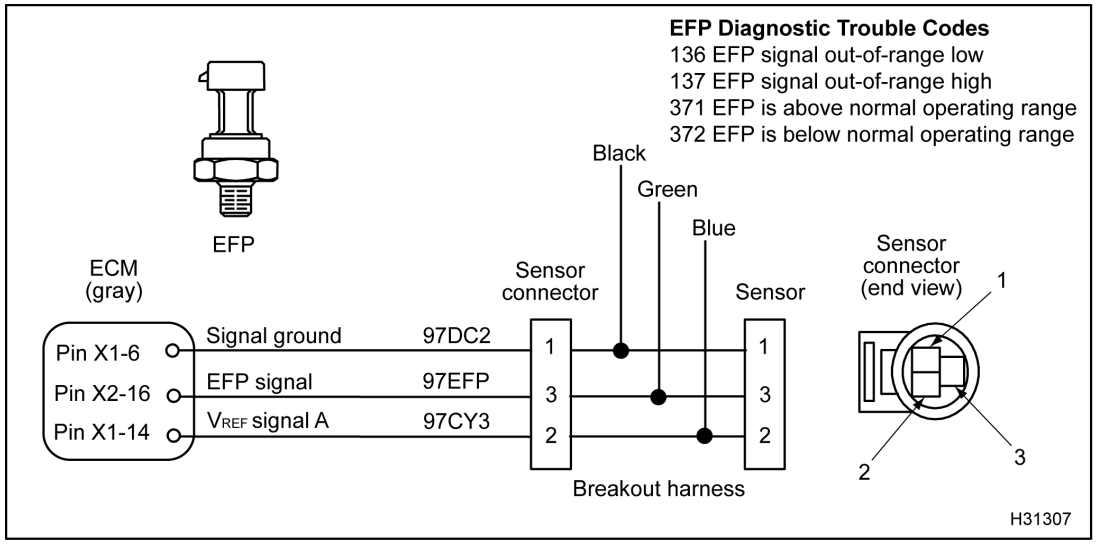


Figure 440 EFP circuit diagram

Operational Voltage Checks for EFP Sensor with Breakout Harness (Check with breakout harness connected to sensor and engine harness.)			
Test Point	**EST voltage readings: Signal to ground**	**Spec**	**Comment**
3 (Green) to 1 (Black)	0.66 V	5 kPa (0.75 psi)	Voltage with key-on engine-off.
3 (Green) to 1 (Black)	1.65 V	138 kPa (20 psi)	
3 (Green) to 1 (Black)	3.13 V	345 kPa (50 psi)	
3 (Green) to 1 (Black)	4.1 V	483 kPa (70 psi)	
Operational Voltage Checks for EFP Sensor with Breakout Box (Check with breakout box connected [X1 and X2 only] to the ECM and engine harness.)			
X2–3 to X1–6	0.66 V	5 kPa (0.75 psi)	Voltage with key-on engine-off.
X2–3 to X1–6	1.65 V	138 kPa (20 psi)	
X2–3 to X1–6	3.13 V	345 kPa (50 psi)	
X2–3 to X1–6	4.1 V	483 kPa (70 psi)	

EFP Diagnostic Trouble Codes
DTC 136 = Signal voltage was < 0.039 V for more than 0.35 second
DTC 137 = Signal voltage was > 4.9 V for more than 0.35 second
DTC 371 = Measured fuel pressure was greater than expected pressure by 100 kPa (15 psi) for more than 60 seconds.
DTC 372 = Measured fuel pressure was greater than expected pressure by 103 kPa (15 psi) for more than 30 seconds.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Operational Voltage Checks for EFP Sensor without Breakout Harness (Check with breakout box connected [X1 and X2 only] to the ECM and engine harness.)

Test Point	EST voltage readings: Signal to ground	Spec	Checks
X2–3 to X1–6	0.66 V	5 kPa (0.75 psi)	Voltage with key-on engine-off.
X2–3 to X1–6	1.65 V	138 kPa (20 psi)	Voltage with key-on engine-off.
X2–3 to X1–6	3.13 V	345 kPa (50 psi)	Voltage with key-on engine-off.
X2–3 to X1–6	4.1 V	483 kPa (70 psi)	Rated speed, full load

EFP Diagnostic Trouble Codes

DTC 136 = Signal voltage was < 0.039 V for more than 0.35 second

DTC 137 = Signal voltage was > 4.9 V for more than 0.35 second

DTC 371 = Engine fuel pressure is above normal operating range

DTC 372 = Engine fuel pressure is below normal operating range

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EGR Actuator (Exhaust Gas Recirculation)

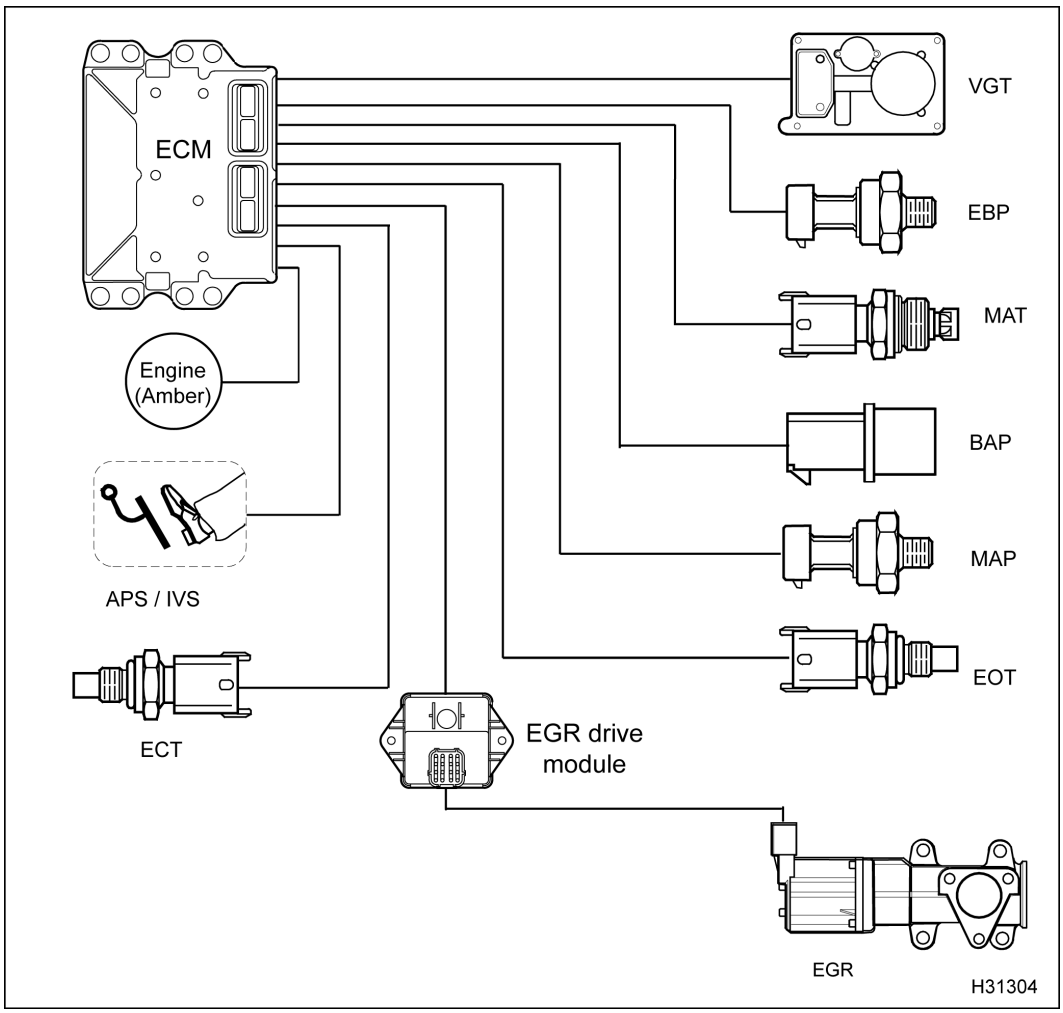


Figure 441 Function diagram for the EGR actuator

The function diagram for the EGR actuator includes the following:

- Electronic Control Module (ECM)
- Variable Geometry Turbocharger (VGT) actuator
- Accelerator Position Sensor (APS)
- EGR actuator with position sensors
- EGR drive module
- Exhaust Back Pressure (EBP) sensor
- Manifold Absolute Temperature (MAT) sensor
- Barometric Absolute Pressure (BAP) sensor
- Engine Coolant Temperature (ECT) sensor
- Engine Oil Temperature (EOT) sensor
- Manifold Absolute Pressure (MAP) sensor
- ENGINE lamp (amber)

Function

The EGR actuator consists of three major components, a valve, an actuator motor, and Integrated Circuit (IC). The IC has three Hall effect position sensors to monitor valve movement. The EGR actuator is located at the front of the engine on the mixer duct.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The EGR drive module controls the EGR actuator and is located on the left side of the engine on the ECM and Injector Driver Module (IDM).

The EGR actuator is a variable position valve that controls the amount of exhaust entering the intake system. The ECM uses sensor input from the BAP, EBP, MAT, MAP, APS, EOT, ECT, and VGT control to calculate the desired position of the EGR actuator. The EGR drive module receives the desired EGR actuator position from the ECM across the CAN 2 datalink to activate the valve for exhaust gas recirculation. The EGR drive module provides feedback to the ECM on the valve position. The EGR drive module interprets the ECM command and sends the command using three pulse width modulated signals to the valve actuator.

The system is closed loop control using the EGR position signals. The EGR drive module provides a 9 V supply and ground to the IC in the motor of the valve. When the EGR drive module directs the valve to move, the IC with three Hall effect sensors provides the EGR drive module with the valve position signals. The EGR drive module interprets the three signals to determine valve position and sends the information back to the ECM.

EGR Circuit Operation

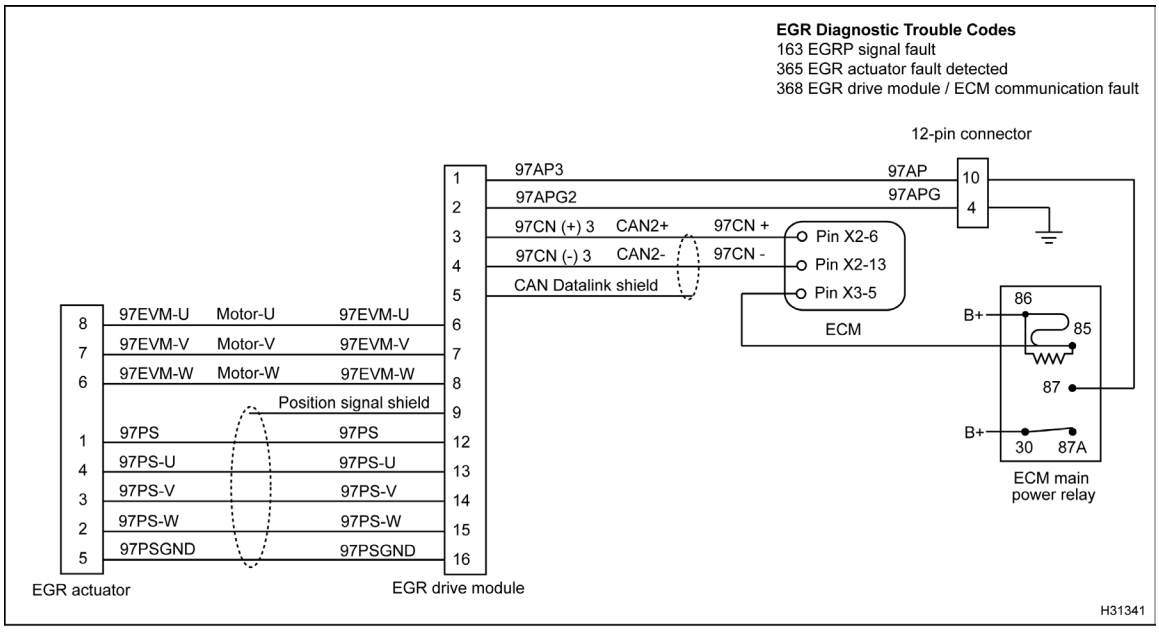


Figure 442 EGR circuit diagram

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The EGR drive module is supplied 12 V to Pin 1 from the ECM main power relay through Pin 10 of the 12-pin connector. Ground is supplied to Pin 2 from battery ground through Pin 4 of the 12-pin connector.

The ECM sends the desired position to the EGR drive module across the CAN 2 datalink. CAN 2 positive is ECM Pin X2-6 to EGR drive module Pin 3. CAN 2 negative is ECM Pin X2-13 to EGR drive module Pin 4.

The EGR drive module provides a 9 V supply to the IC from Pin 12 to Pin 1 of the EGR actuator. The EGR drive module provides ground to the IC from Pin 16 to Pin 5 of the EGR actuator. The IC in the EGR actuator produces the following valve position signals:

- Position U – EGR actuator Pin 4 to EGR drive module Pin 13
- Position V – EGR actuator Pin 3 to EGR drive module Pin 14
- Position W – EGR actuator Pin 2 to EGR drive module Pin 15

Depending on desired valve position from the ECM signal and position feedback signal from the IC, the EGR drive module drives the 3 phase DC motor to move the valve to the proper position using the following pulse width modulated signals:

- Motor U - EGR drive module Pin 6 to EGR actuator Pin 8
- Motor V - EGR drive module Pin 7 to EGR actuator Pin 7
- Motor W - EGR drive module Pin 8 to EGR actuator Pin 6

The EGR drive module provides two shields to suppress electrical noise. One shield is for the CAN 2 datalink (EGR drive module Pin 5). The other shield is for the valve position sensor signals used by the EGR drive module to monitor position (EGR drive module Pin 9).

Fault Detection / Management

The EGR drive module constantly monitors the EGR actuator. When an EGR control error is detected, the EGR drive module sends a message to the ECM, a DTC is set, and the amber ENGINE lamp is illuminated.

EGR Diagnostic Trouble Codes (DTCs)

DTCs are read using the Electronic Service Tool (EST) or by counting the flashes from the amber and red ENGINE lamp.

DTC 163
EGRP signal fault

- DTC 163 is set by the ECM when the EGR drive module detects a position signal failure.
- DTC 163 can be set due to an open or short to ground on the position sensor signal power supply circuit, an open ground circuit, an open or short to ground on any of the position signal circuits, or a failed IC.
- When DTC 163 is active the amber ENGINE lamp is illuminated.

DTC 365
EGR actuator fault detected

- DTC 365 is set by the ECM when the EGR drive module detects an EGR actuator fault.
- DTC 365 can be set due to an open, short to ground, short to a power source on any of the motor signal circuits, failure of EGR actuator motor, or a stuck valve assembly.
- When DTC 365 is active the amber ENGINE lamp is illuminated.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 368
EGR drive module/ECM communication fault

- DTC 368 is set by the ECM when CAN 2 datalink communications are not received from EGR drive module.
- DTC 368 can be set for the EGR drive module due to the following conditions:

  If engine starts and runs, the DTC is specific to the EGR drive module and ECM communications. The following are possible causes:

  - An open or short to ground on the power circuit exists.

  - An open or short to power on the ground circuit exists.

  - CAN 2 positive and CAN 2 negative are both open or high resistance exists.

  When CAN communication is not present from the EGR drive module, the ECM sends 100 percent EGR position to the EST.

  If a no start condition exists with DTC 368 and 543 active, check the CAN 2 wiring (EGR to ECM and IDM to ECM). See “ECM / IDM Communications” (page 373). One of the CAN 2 datalink wires (CAN 2 positive or negative) is open, short to ground, or short to power exists.
- When DTC 368 is active the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- EGR Valve Breakout Harness
- 12–pin Breakout Harness
- Breakout Box
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EGR Pin-Point Diagnostics

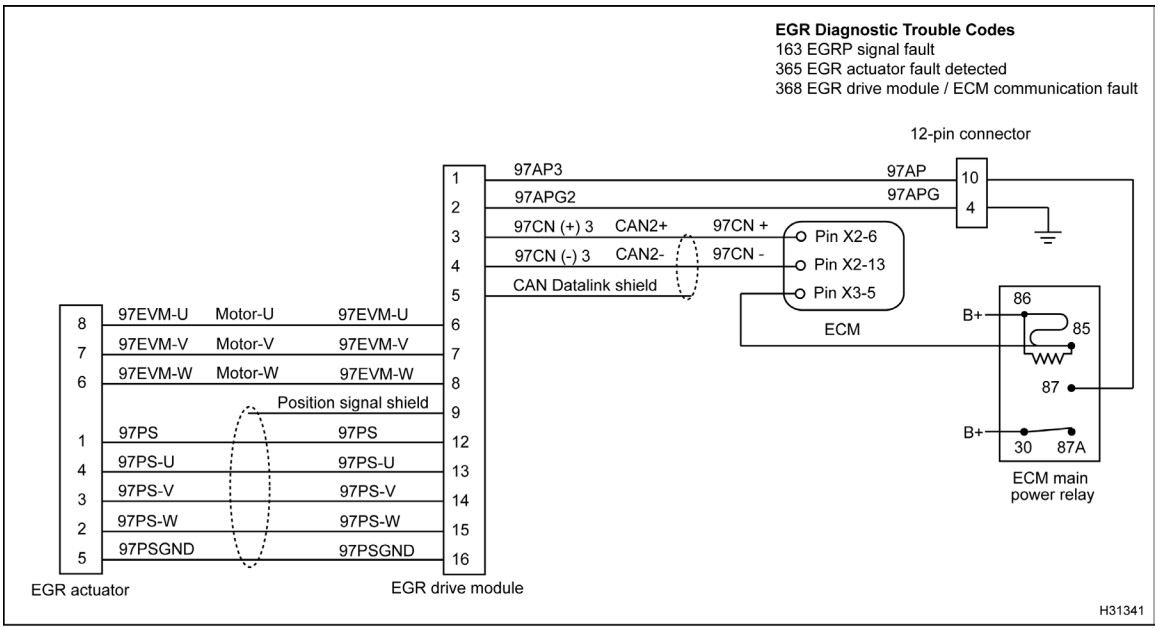
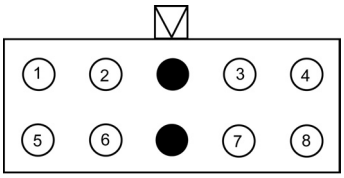


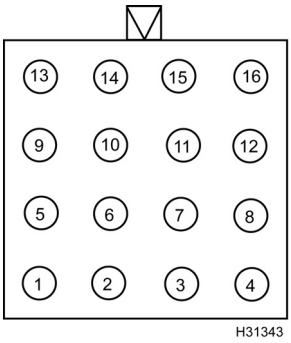
Figure 443 EGR circuit diagram

EGR Actuator Connector Pins



NOTE: Harness connectors shown with mating end view.

EGR Drive Module Connector Pins



Pin		Pin		Pin	
1	Position sensor power	1	Power	9	Ground shield
2	Position sensor W	2	Ground	10	Not used
3	Position sensor V	3	CAN high	11	Not used
4	Position sensor U	4	CAN low	12	Position sensor power
5	Position sensor ground	5	CAN shield	13	Position sensor U
6	Motor W	6	Motor U	14	Position sensor V

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

7	Motor V	7	Motor V	15	Position sensor W
8	Motor U	8	Motor W	16	Position sensor ground

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, make sure the transmission is in neutral, parking brake is set, and wheels are blocked before doing service bay diagnostics on engine or vehicle.

CAUTION: To avoid engine damage, *use utmost care* when:

1. **Disconnecting harness from EGR actuator or EGR drive module.**
2. **Inserting Terminal Test Adapter probe into connector to test for specifications.**
3. **Connecting harness to EGR actuator or EGR drive module.**

Failure to use care when disconnecting, testing, or connecting components may result in damaged or bent connector pins.

EGR Actuator Harness Connector Voltage Checks (Disconnect harness from actuator. Connect breakout harness. Turn the ignition switch to ON.)

Test Point	Spec	Comment
1 to gnd	8 V to 11 V	If not in spec, check for an open, short to ground or short to voltage source.
2 to gnd	5 V ± 0.5 V	If not in spec, check for an open, short to ground or short to voltage source.
3 to gnd	5 V ± 0.5 V	If not in spec, check for an open, short to ground or short to voltage source.
4 to gnd	5 V ± 0.5 V	If not in spec, check for an open, short to ground or short to voltage source.
5 to gnd	0 V	If not in spec, check for a short to voltage source.
6 to gnd	0 V	If not in spec, check for a short to voltage source.
7 to gnd	0 V	If not in spec, check for a short to voltage source.
8 to gnd	0 V	If not in spec, check for a short to voltage source.

©August 2008 Navistar, Inc.

EGR Actuator Resistance Checks Only (Turn the ignition switch to OFF. Disconnect harness from actuator. Connect breakout harness to actuator only. **Note:** Ensure DMM and leads are zeroed.)		
1 to 2	> 1 kΩ	If < 1 kΩ, short to sensor power exists.
1 to 3	> 1 kΩ	If < 1 kΩ, short to sensor power exists.
1 to 4	> 1 kΩ	If < 1 kΩ, short to sensor power exists.
1 to 5	> 1 kΩ	If < 1 kΩ, short to sensor power exists.
5 to 2	> 1 kΩ	If < 1 kΩ, short to sensor power exists.
5 to 3	> 1 kΩ	If < 1 kΩ, short to sensor power exists.
5 to 4	> 1 kΩ	If < 1 kΩ, short to sensor power exists.
6 to 7	2.1 Ω ±0.5 Ω	If not in spec, replace actuator.
6 to 8	2.1 Ω ±0.5 Ω	If not in spec, replace actuator.
7 to 8	2.1 Ω ±0.5 Ω	If not in spec, replace actuator.
EGR Actuator Harness Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect harness from actuator. Connect breakout harness to engine harness only. Disconnect chassis connector 9260[1].)		
1 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
3 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
4 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
5 to Pin A (9260)	< 5 Ω	If > 5 Ω, an open circuit exists or high resistance. Specification is based on 4300 chassis. For other applications, see *Chassis Electrical Circuit Diagram Manual* for complete chassis ground circuit information.
6 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
7 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
8 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

EGR Actuator Harness Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect harness from actuator. Disconnect negative battery cable. Connect breakout harness to engine harness only. Use disconnected negative battery cable for ground test point.)

1 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
3 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
4 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
5 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists. Specification is based on 4300 chassis. For other applications, see *Chassis Electrical Circuit Diagram Manual* for complete chassis ground circuit information.
6 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
7 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
8 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, make sure the transmission is in neutral, parking brake is set, and wheels are blocked before doing service bay diagnostics on engine or vehicle.

CAUTION: To avoid engine damage, *use utmost care* when:

1. **Disconnecting harness from EGR actuator or EGR drive module.**
2. **Inserting Terminal Test Adapter probe into connector to test for specifications.**
3. **Connecting harness to EGR actuator or EGR drive module.**

Failure to use care when disconnecting, testing, or connecting components may result in damaged or bent connector pins.

EGR Drive Module Connector Voltage Checks (Disconnect harness from the EGR drive module. Turn the ignition switch to ON.)

Test Point	Spec	Comment
1 to gnd	9 V to 16 V	If not in spec, check for an open, short to ground, or short to voltage source.
2 to gnd	0 V	If not in spec, check for a short to voltage source.
3 to gnd	1 V to 4 V	Digital signal. See “ECM / IDM Communications” (page 373).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4 to gnd	1 V to 4 V	Digital signal. See “ECM / IDM Communications” (page 373).
5 to gnd	0 V	If not in spec, check for a short to voltage source.
6 to gnd	0 V	If not in spec, check for a short to voltage source.
7 to gnd	0 V	If not in spec, check for a short to voltage source.
8 to gnd	0 V	If not in spec, check for a short to voltage source.
9 to gnd	0 V	If not in spec, check for a short to voltage source.
12 to gnd	0 V	If not in spec, check for a short to voltage source.
13 to gnd	0 V	If not in spec, check for a short to voltage source.
14 to gnd	0 V	If not in spec, check for a short to voltage source.
15 to gnd	0 V	If not in spec, check for a short to voltage source.
16 to gnd	0 V	If not in spec, check for a short to voltage source.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Resistance Checks – EGR Drive Module Only (Turn the ignition switch to OFF. Disconnect harness from EGR drive module. Measure at EGR drive module pins.)		
1 to 2	> 50 Ω	If < 50 Ω, short to ground exists.
2 to 3	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to 4	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to 5	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to 6	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to 7	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to 8	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to 9	< 5 Ω	If > 5 Ω, an open circuit or high resistance exists.
2 to 12	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to 13	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to 14	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to 15	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to 16	< 5 Ω	If > 5 Ω, an open circuit or high resistance exists.
9 to 16	< 5 Ω	If > 5 Ω, an open circuit or high resistance exists.
12 to 16	> 1 kΩ	If < 1 kΩ, short to ground exists.
13 to 16	> 1 kΩ	If < 1 kΩ, short to ground exists.
14 to 16	> 1 kΩ	If < 1 kΩ, short to ground exists.
15 to 16	> 1 kΩ	If < 1 kΩ, short to ground exists.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EGR Drive Module Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect harness from EGR drive module and disconnect chassis connector 9260[1].)		
1 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to Pin A (9260)	< 5 Ω	If > 5 Ω, an open circuit or high resistance exists. Specification is based on 4300 chassis. For other applications, see *Chassis Electrical Circuit Diagram Manual* for complete chassis ground circuit information.
3 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
4 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
5 to Pin A (9260)	< 5 Ω	If > 5 Ω, an open circuit or high resistance exists. Specification is based on 4300 chassis. For other applications, see *Chassis Electrical Circuit Diagram Manual* for complete chassis ground circuit information.
6 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
7 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
8 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
9 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
12 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
13 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
14 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
15 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.
16 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, short to ground exists.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

EGR Drive Module Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable and harness from EGR drive module. Use disconnected negative battery cable for ground test point.)

Test Point	Spec	Comment
1 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
2 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists. Specification is based on 4300 chassis. For other applications, see *Chassis Electrical Circuit Diagram Manual* for complete chassis ground circuit information.
3 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
4 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
5 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists. Specification is based on 4300 chassis. For other applications, see *Chassis Electrical Circuit Diagram Manual* for complete chassis ground circuit information.
6 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
7 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
8 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
9 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
12 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
13 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
14 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
15 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.
16 to gnd	> 1 kΩ	If < 1 kΩ, short to ground exists.

©August 2008 Navistar, Inc.

Harness Resistance Checks from EGR Drive Module to EGR Actuator (Turn the ignition switch to OFF. Disconnect harness from EGR drive module and EGR actuator. **NOTE:** Test points are EGR drive module to EGR actuator.)		
Pin 6 to Pin 8	< 5 Ω	If > 5 Ω, open circuit or high resistance to MTR U.
Pin 7 to Pin 7	< 5 Ω	If > 5 Ω, open circuit or high resistance to MTR V.
Pin 8 to Pin 6	< 5 Ω	If > 5 Ω, open circuit or high resistance to MTR W.
Pin 12 to Pin 1	< 5 Ω	If > 5 Ω, open circuit or high resistance to position sensor power.
Pin 13 to Pin 4	< 5 Ω	If > 5 Ω, open circuit or high resistance to position sensor U.
Pin 14 to Pin 3	< 5 Ω	If > 5 Ω, open circuit or high resistance to position sensor V.
Pin 15 to Pin 2	< 5 Ω	If > 5 Ω, open circuit or high resistance to position sensor W.
Pin 16 to Pin 5	< 5 Ω	If > 5 Ω, open circuit or high resistance to position sensor ground.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, make sure the transmission is in neutral, parking brake is set, and wheels are blocked before doing service bay diagnostics on engine or vehicle.

Harness Resistance Checks from EGR Drive Module to 12–pin Connector (Turn the ignition switch to OFF. Disconnect harness at EGR drive module and 12–pin connector.)

Test Point	Spec	Comment
Pin 1 to Pin 10	< 5 Ω	If > 5 Ω, open circuit or high resistance to actuator power.
Pin 2 to Pin 4	< 5 Ω	If > 5 Ω, open circuit or high resistance to actuator ground.
Harness Resistance Checks from EGR Drive Module to ECM (Turn the ignition switch to OFF. Disconnect harness at EGR drive module and ECM connector X2. Connect breakout box X2 to engine harness only.)		
Pin 3 to Pin X2–6	< 5 Ω	If > 5 Ω, open circuit or high resistance to CAN 2 positive.
Pin 4 to Pin X2–13	< 5 Ω	If > 5 Ω, open circuit or high resistance to CAN 2 negative.

EGR Actuator Diagnostic Trouble Codes (DTCs)

DTC 163 = EGR drive module detects position signal fault.

DTC 365 = EGR drive module detects actuator fault.

DTC 368 = ECM did not receive EGR drive module communication for more than one second.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EOP Sensor (Engine Oil Pressure)

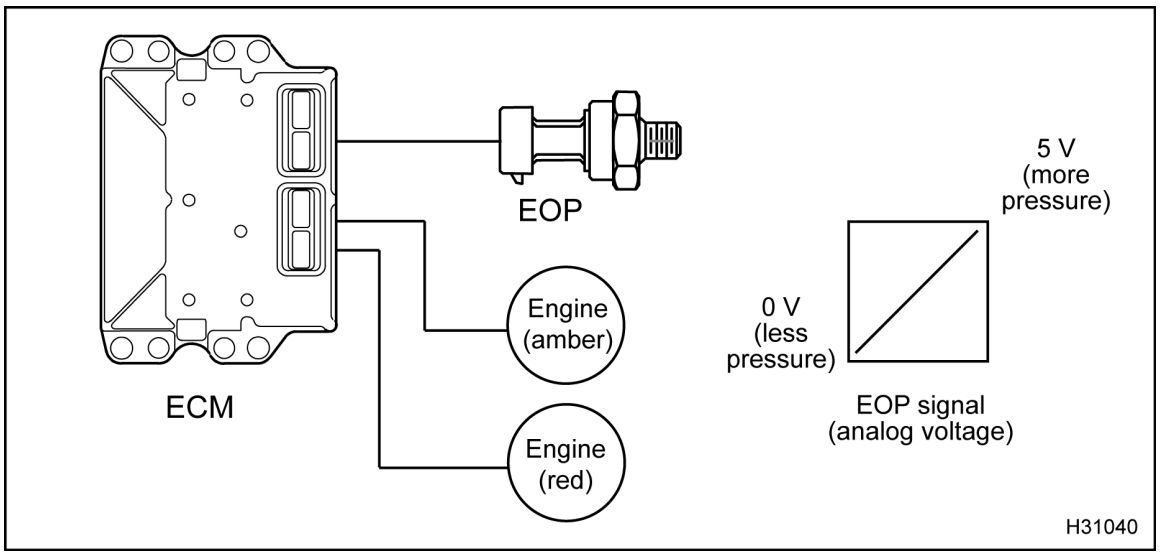


Figure 444 Function diagram for the EOP sensor

The function diagram for the EOP sensor includes the following:

- EOP sensor
- Electronic Control Module (ECM)
- ENGINE lamp (amber and red)

Function

The EOP sensor is a variable capacitance sensor installed in the left side of the crankcase below and left of the fuel filter housing. The ECM supplies a 5 V reference signal which the EOP sensor uses to produce a linear analog voltage that indicates oil pressure.

An optional feature, the Engine Warning and Protection System (EWPS), can be enabled to warn the engine operator and shut the engine down when a low engine oil pressure condition occurs.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EOP Circuit Operation

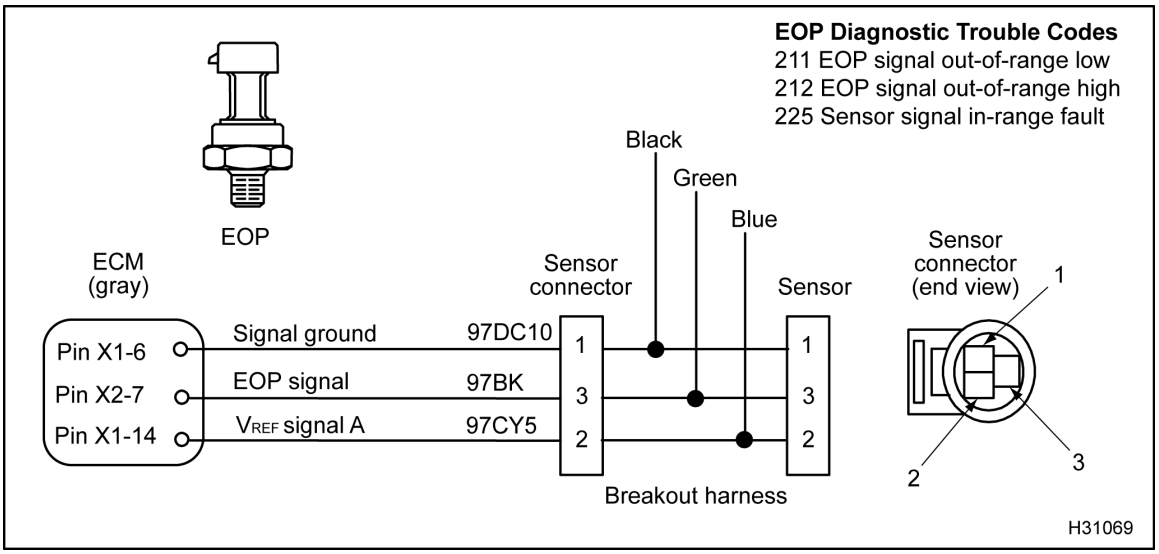


Figure 445 EOP circuit diagram

The EOP sensor is supplied with a 5 V reference voltage at Pin 2 from ECM Pin X1–14. The EOP sensor is grounded at Pin 1 from ECM Pin X1–6. The EOP sensor returns a variable voltage signal from Pin 3 to ECM Pin X2–7.

Fault Detection / Management

When the EOP signal voltage is detected out of range high or low, the ECM will cause the engine to ignore the EOP signal and disable the EWPS.

EOP Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 211
EOP signal out-of-range low

- DTC 211 is set by the ECM when the EOP signal is less than 0.039 V for more than 0.35 second.
- DTC 211 can be set due to an open or short to ground on the signal circuit, a failed ICP sensor or an open V_{REF} circuit or V_{REF} short to ground.
- When DTC 211 is active the amber ENGINE lamp is illuminated.

DTC 212
EOP signal out-of-range high

- DTC 212 is set by the ECM when the EOP signal is greater than 4.9 V for more than 0.35 second.
- DTC 212 can be set due to signal circuit short to V_{REF} or B+, or a failed EOP sensor.
- When DTC 212 is active the amber ENGINE lamp is illuminated.

DTC 225
EOP sensor signal in-range fault

- DTC 225 is set by the ECM when the EOP signal voltage is greater than 207 kPa (30 psi) for 8 seconds or more with the ignition key-on engine-off.
- DTC 225 can be set due to an open signal ground, V^{REF} shorted to voltage source above 5.5 V, biased circuit, failed EOP sensor.
- When DTC 225 is active the amber ENGINE lamp is illuminated.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- Breakout Box
- Breakout Harness
- Terminal Test Adapter Kit

EOP Operational Diagnostics

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the D_ContinuousMonitor.ssn.

©August 2008 Navistar, Inc.

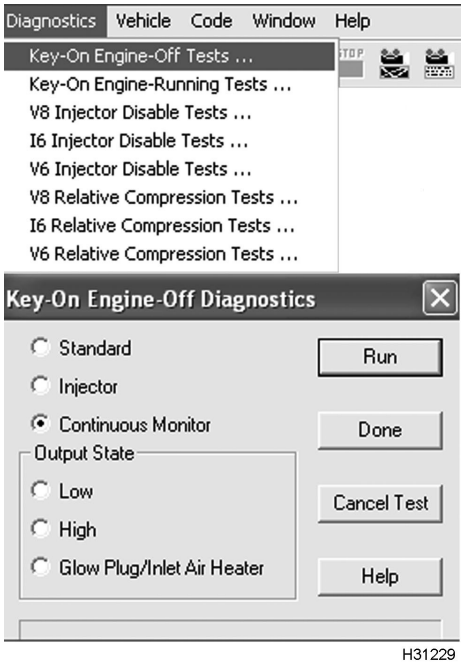


Figure 446 Continuous Monitor Test

2. To monitor signal voltage, run KOEO Continuous Monitor Test. For help, see “Continuous Monitor Test” in Section 3 (page 68).
3. Monitor EOP signal voltage. Verify an active DTC for the EOP circuit.
4. If code is active, do step 6 and 7 to check circuit for the EOP sensor using the following table.
   - Circuit Checks for EOP Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Disconnect engine harness from pressure sensor.

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

7. Connect Pressure Sensor Breakout Harness to engine harness only.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Circuit Checks for EOP Sensor (Use EST, DMM, breakout harness, and 500 Ohm Resistor Harness.)

Test Condition	Spec	Checks
Sensor disconnected using EST	0 V	If voltage > 0.039 V, check signal circuit for short to V_{REF} or B+.
Voltage from Pin 2 (Blue) to ground using DMM	5 V ± 0.5 V	If voltage > 5.5 V, check V_{REF} for short to B+. If voltage is < 4.5 V, check V_{REF} circuit for open or short to ground.
500 Ohm Resistor Harness connected between Pin 3 (Green) and Pin 2 (Blue) of breakout harness	5 V	If voltage < 4.9 V, check signal circuit for open or short to ground. — Disconnect connector 9260[1]. Measure resistance from Pin 3 to Pin A of connector 9260 (spec > 1 kΩ) to check for short to ground within wiring harness. — Disconnect negative battery cable. Measure resistance from Pin 3 to ground cable to check for short to ground. — Use a breakout box from Pin 3 to Pin X2–7 (spec < 5 Ω) to check for open in the harness.
Resistance from Pin 1 (Black) of breakout harness to ECM chassis ground Pin A of connector 9260 using DMM	< 5 Ω	If resistance is > 5 Ω, check for open or high resistance between ECM and sensor connector. Use a breakout box and measure resistance from between Pin 1 and Pin X1–6 (spec < 5 Ω).
Connect engine harness to sensor. Use the EST to clear DTCs. If an active code remains after checking test conditions, replace the EOP sensor.		

1 Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EOP Pin-Point Diagnostics

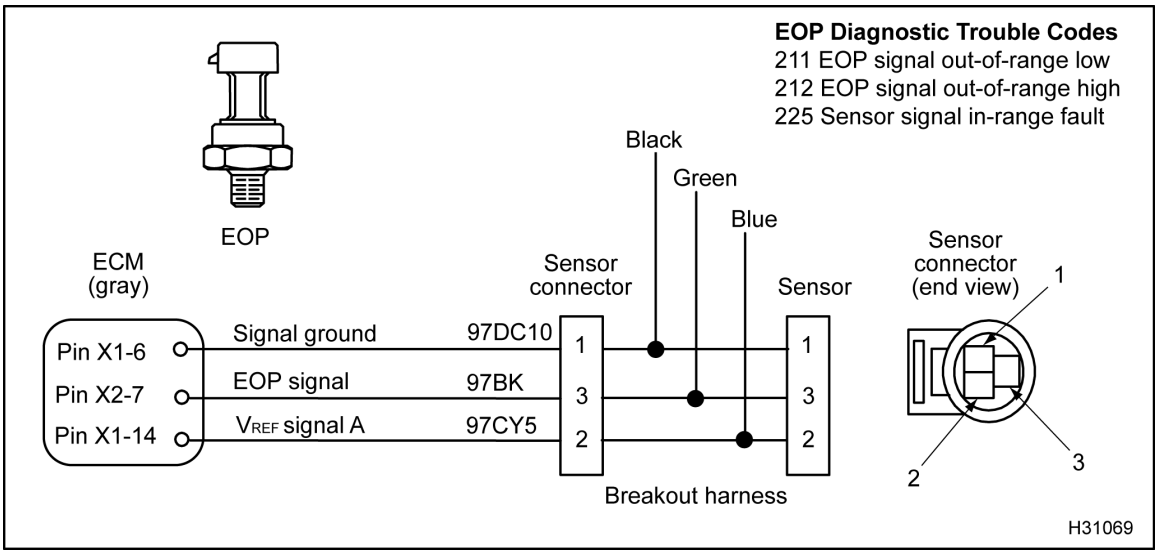


Figure 447 EOP circuit diagram

Connector Voltage Checks to Ground (Disconnect harness from sensor. Inspect for bent pins or corrosion. Connect breakout harness to engine harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
1 to gnd	0 V to 0.25 V	Signal ground (no voltage expected). If > 0.25 V, check ground circuit for open or high resistance and check signal ground for short to V_{REF} or B+.
2 to gnd	5 V ± 0.5 V	If voltage is not to spec, V_{REF} circuit is shorted to ground, shorted to B+, or open.
3 to gnd	0 V to 0.25 V	If > 0.25 V, signal circuit is shorted to V_{REF} or B+.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Connect breakout harness to engine harness only. Disconnect chassis connector 9260[1].)		
1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit.
2 to Pin A (9260)	> 500 Ω	If < 500 Ω, check for short to ground within wiring harness.
3 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)		
1 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
2 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.

©August 2008 Navistar, Inc.

3 to gnd cable	> 1 kΩ	If < 1 kΩ , check for short to ground.

Harness Resistance Checks (Connect breakout box [X1 and X2] to engine harness only. Connect breakout harness to engine harness only.)

X1–6 to 1	< 5 Ω	If > 5 Ω, check for open ground wire.
X1–14 to 2	< 5 Ω	If > 5 Ω, check for open V_{REF} wire.
X2–7 to 3	< 5 Ω	If > 5 Ω, check for open signal wire.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Operational Voltage Checks for EOP Sensor with Breakout Harness (Check with breakout harness connected to sensor and engine harness.)

Test Point	Voltage	Pressure	Comment
3 (Green) to 1 (Black)	0.89 V	34 kPa (5 psi)	Pressure will vary with engine speed and temperature.
3 (Green) to 1 (Black)	1.15 V	69 kPa (10 psi)	Pressure will vary with engine speed and temperature.
3 (Green) to 1 (Black)	2.40 V	241 kPa (35 psi)	Pressure will vary with engine speed and temperature.
3 (Green) to 1 (Black)	3.61 V	414 kPa (60 psi)	Pressure will vary with engine speed and temperature.

Operational Voltage Checks for EOP Sensor with Breakout Box (Check with breakout box connected [X1 and X2] to ECM and engine harness.)

X2–7 to X1–6	0.89 V	34 kPa (5 psi)	Pressure will vary with engine speed and temperature.
X2–7 to X1–6	1.15 V	69 kPa (10 psi)	Pressure will vary with engine speed and temperature.
X2–7 to X1–6	2.40 V	241 kPa (35 psi)	Pressure will vary with engine speed and temperature.
X2–7 to X1–6	3.61 V	414 kPa (60 psi)	Pressure will vary with engine speed and temperature.

EOP Diagnostic Trouble Codes

DTC 211 = Signal voltage was < 0.039 V for more than 0.35 second

DTC 212 = Signal voltage was > 4.9 V for more than 0.35 second

DTC 225 = Engine oil pressure was > 207 kPa (30 psi) for more than 8 seconds with key-on engine-off

DTC 313 = See “Engine Warning and Protection System” (page 440).

DTC 314 = See “Engine Warning and Protection System” (page 440).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EOT Sensor (Engine Oil Temperature)

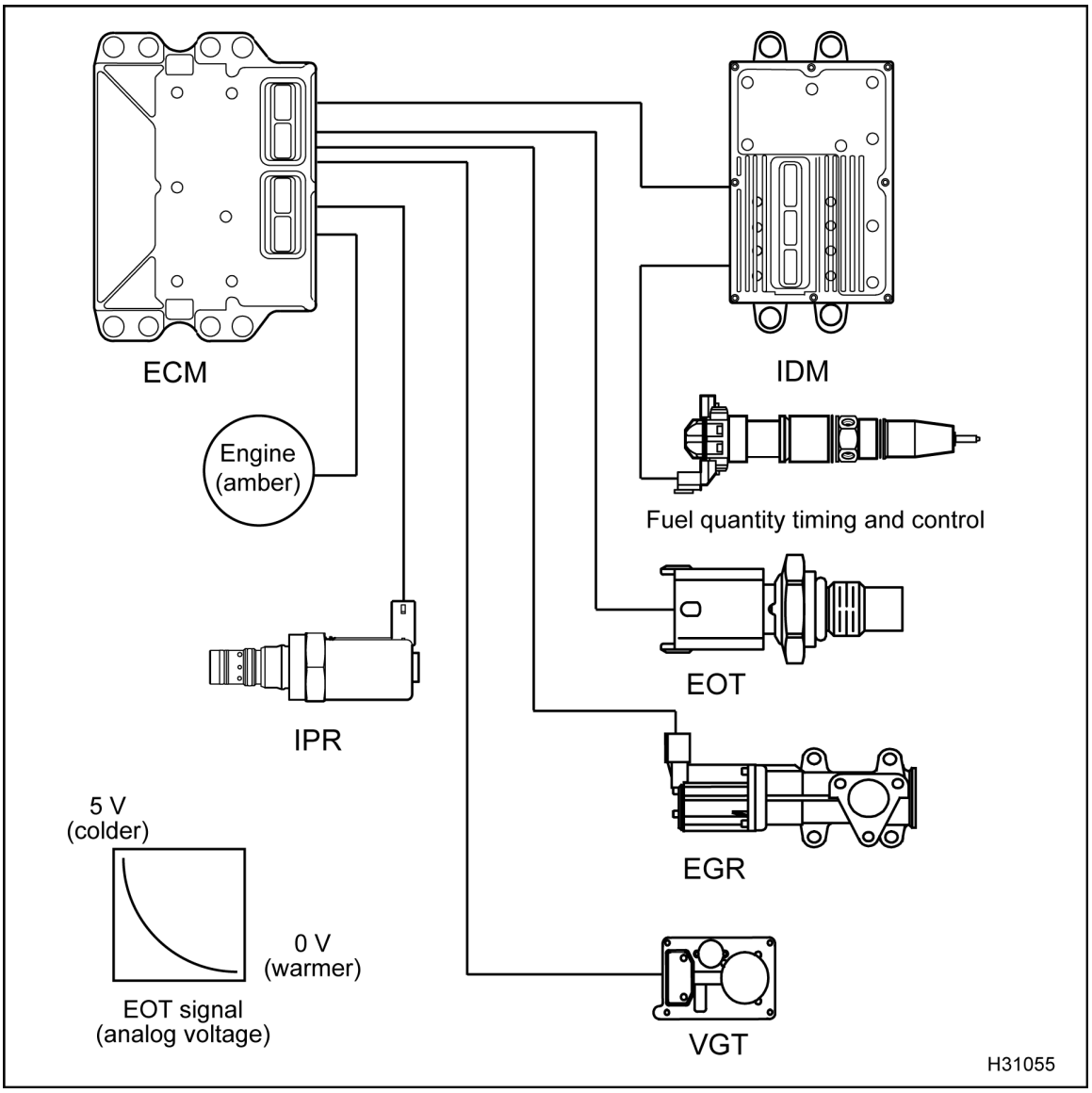


Figure 448 Function diagram for the EOT sensor

The function diagram for the EOT sensor includes the following:

- EOT sensor
- Electronic Control Module (ECM)
- Injection Driver Module (IDM)
- Fuel injector
- Exhaust Gas Recirculation Position (EGR)
- Variable Geometry Turbocharger (VGT)
- Injection Pressure Regulator (IPR)
- ENGINE lamp (amber)

Function

The EOT sensor is a thermistor sensor installed in the rear of the front cover, left of the high-pressure oil pump assembly. The ECM supplies a 5 V reference

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

signal which the EOT sensor uses to produce an analog voltage that indicates temperature.

The EOT changes resistance when exposed to different temperatures. As oil temperature decreases, the resistance of the thermistor increases. This causes the signal voltage to increase. As oil temperature increases, the resistance of the thermistor decreases. This causes the signal voltage to decrease.

The EOT sensor provides a feedback signal to the ECM indicating engine oil temperature. The ECM monitors the EOT signal to control fuel quantity and timing throughout the operating range of the engine. The EOT signal allows the ECM to compensate for oil viscosity variations due to temperature changes in the operating environment, ensuring that adequate power and torque are available for all operating conditions. During engine operation, if the ECM recognizes that the EOT signal is greater or less than the expected value it will set a DTC.

Fast Idle Advance

Fast idle advance increases engine cold idle speed up to 750 rpm (normally 700 rpm) for faster warm-up to operating temperature. This is accomplished by the ECM monitoring the EOT sensor input and adjusting the fuel injector operation accordingly.

Low idle speed is increased proportionally when the engine oil temperature is between 15 °C (59 °F) at 700 rpm to below -10 °C (14 °F) at 750 rpm.

EOT Circuit Operation

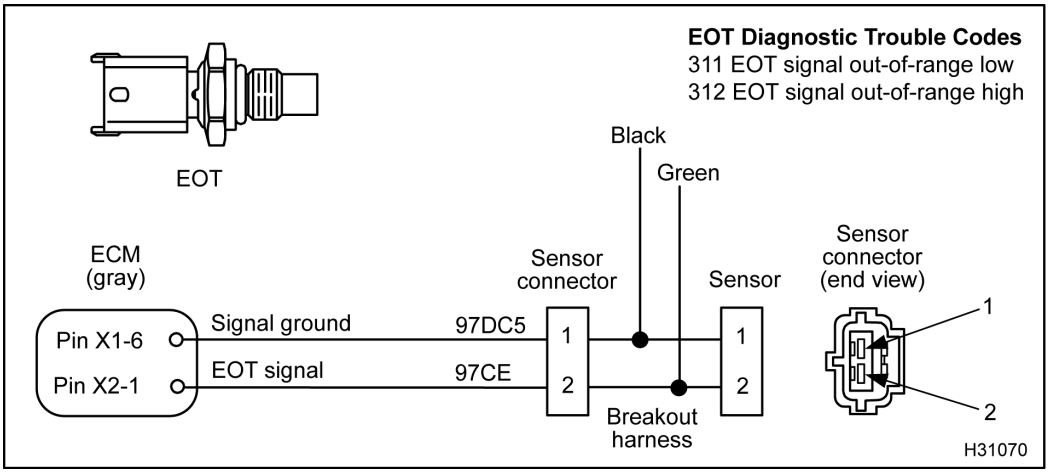


Figure 449 EOT circuit diagram

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The EOT sensor is supplied with a 5 V reference voltage at Pin 2 from ECM Pin X2–1. The sensor is grounded at Pin 1 through the signal ground at ECM Pin X1–6. As the oil temperature increases or decreases, the sensor changes resistance and provides the oil temperature signal voltage at the ECM. The signal voltage is monitored by the ECM to determine the temperature of the oil.

Fault Detection / Management

The ECM continuously monitors the signal of the EOT sensor to determine if the signal is within an expected range. If the ECM detects an out of range high or low, the ECM will ignore the EOT signal and assume an engine oil temperature of –20 °C (–4 °F) for starting and 100 °C (212 °F) for engine running conditions.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EOT Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 311
EOT signal out-of-range low

- DTC 311 is set by the ECM when the EOT signal is less than 0.2 V for more than 0.35 second.
- DTC 311 can be set due to a sensor signal wire short to ground or a failed EOT sensor.
- When DTC 311 is active the amber ENGINE lamp is illuminated.

DTC 312
EOT signal out-of-range high

- DTC 312 is set by the ECM when the EOT signal is greater than 4.78 V for more than 0.35 second.
- DTC 312 can be set due to a signal or ground circuit open, a short to a voltage source, or a failed EOT sensor.
- When DTC 312 is active the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- Breakout Box
- Breakout Harness
- Terminal Test Adapter Kit

EOT Operational Diagnostics

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the D_ContinuousMonitor.ssn.

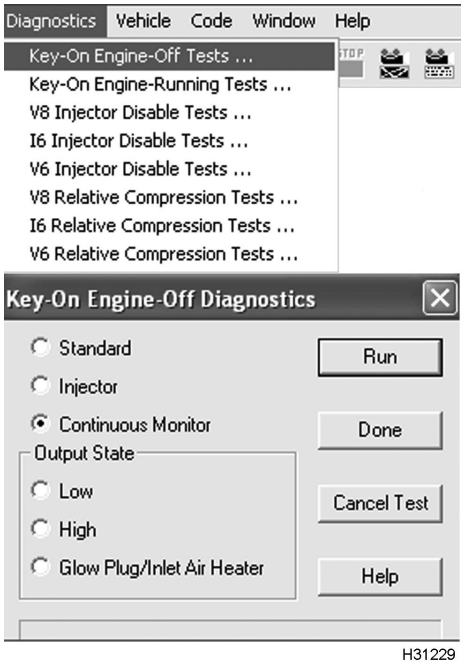


Figure 450 Continuous Monitor Test

2. To monitor signal voltage, run KOEO Continuous Monitor Test. For help, see “Continuous Monitor Test” in Section 3 (page 68).
3. Monitor EOT signal voltage. Verify an active DTC for the EOT circuit.
4. If code is active, do step 6 and 7 to check circuit for the EOT sensor using the following table.
   - Circuit Checks for EOT Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Disconnect engine harness from temperature sensor.

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

7. Connect Temperature Sensor Breakout Harness to engine harness only.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Circuit Checks for EOT Sensor (Use EST, breakout harness, 3-Banana Plug Harness, and 500 Ohm Resistor Harness.)

Test Condition	Spec	Checks
Sensor disconnected	> 4.78 V	If voltage < 4.78 V, check signal circuit for short to ground.
3-Banana Plug Harness connected between Pin 2 (Green) and Pin 1 (Black) of breakout harness	0 V	If voltage is > 0.2 V, check ground and signal circuit for open or high resistance. Use a breakout box and measure resistance from Pin 1 to Pin X1–6 and from Pin 2 to X2–1 (spec < 5 Ω).
500 Ohm Resistor Harness connected between Pin 2 (Green) and Pin 1 (Black) of breakout harness	< 1.0 V	If voltage > 1.0 V, check signal circuit for short to V_{REF}, B+, or another sensor's signal voltage.

Connect engine harness to sensor. Use the EST to clear DTCs. If an active code remains after checking test conditions, replace the EOT sensor.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EOT Pin-Point Diagnostics

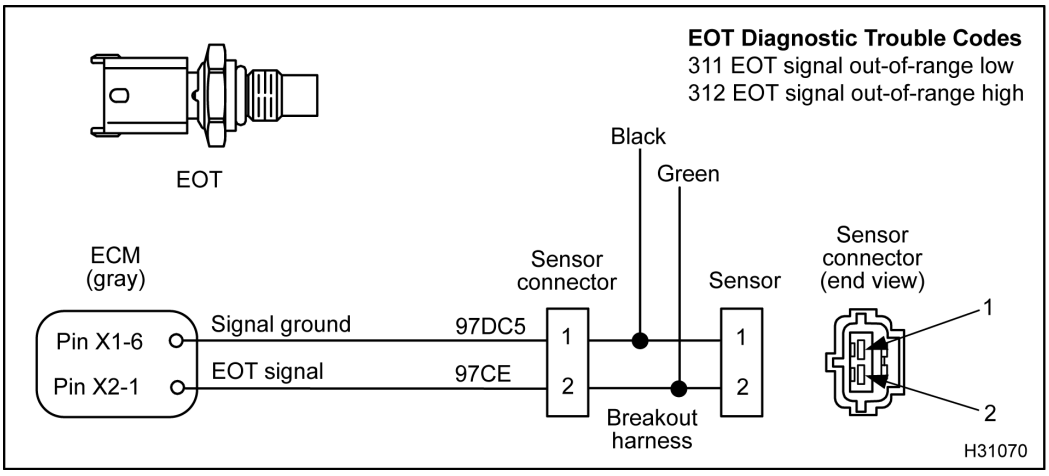


Figure 451 EOT circuit diagram

Connector Voltage Checks to Ground (Disconnect harness from sensor. Inspect for bent pins or corrosion. Connect breakout harness to engine harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
2 to gnd	4.8 V to 5.0 V	Pull up voltage, if low or no voltage, circuit has open, high resistance, or short to ground.
1 to gnd	0 V to 0.25 V	If > 0.25 V, signal ground wire is shorted to V_{REF} or B+.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect harness from sensor. Connect breakout harness to engine harness only. Disconnect chassis connector 9260[1].)		
1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit.
2 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Connect breakout harness to engine harness only. Use disconnected negative battery cable for ground test point.)		
1 to gnd cable	> 500 Ω	If < 500 Ω , check for short to ground.
2 to gnd cable	> 1 kΩ	If < 1 kΩ, check for signal short to ground.
Harness Resistance Checks (Connect breakout box to engine harness only.)		
X1–6 to 1	< 5 Ω	If > 5 Ω, check for open ground wire
X2–1 to 2	< 5 Ω	If > 5 Ω, check for open signal wire

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Operational Voltage Checks for EOT Sensor with Breakout Harness (Check with breakout harness connected to sensor and engine harness. Connect breakout harness to engine harness only.)			
Test Point	**Temp**	**Resistance**	**Voltage**
2 (Green) to 1 (Black)	0 °C (32 °F)	91.1 kΩ	4.348 V
2 (Green) to 1 (Black)	20 °C (68 °F)	35.5 kΩ	3.782 V
2 (Green) to 1 (Black)	100 °C (212 °F)	2.0 k Ω	0.819 V
Operational Voltage Checks for EOT Sensor with Breakout Box (Check with breakout box [X1 and X2 only] connected to the ECM and engine harness.)			
X2–1 to X1–6	0 °C (32 °F)	91.1 kΩ	4.348 V
X2–1 to X1–6	20 °C (68 °F)	35.5 kΩ	3.782 V
X2–1 to X1–6	100 °C (212 °F)	2.0 kΩ	0.819 V
EOT Diagnostic Trouble Codes			
DTC 311 = Signal voltage was < 0.2 V for more than 0.35 second			
DTC 312 = Signal voltage was > 4.78 V for more than 0.35 second			

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EWPS (Engine Warning and Protection System)

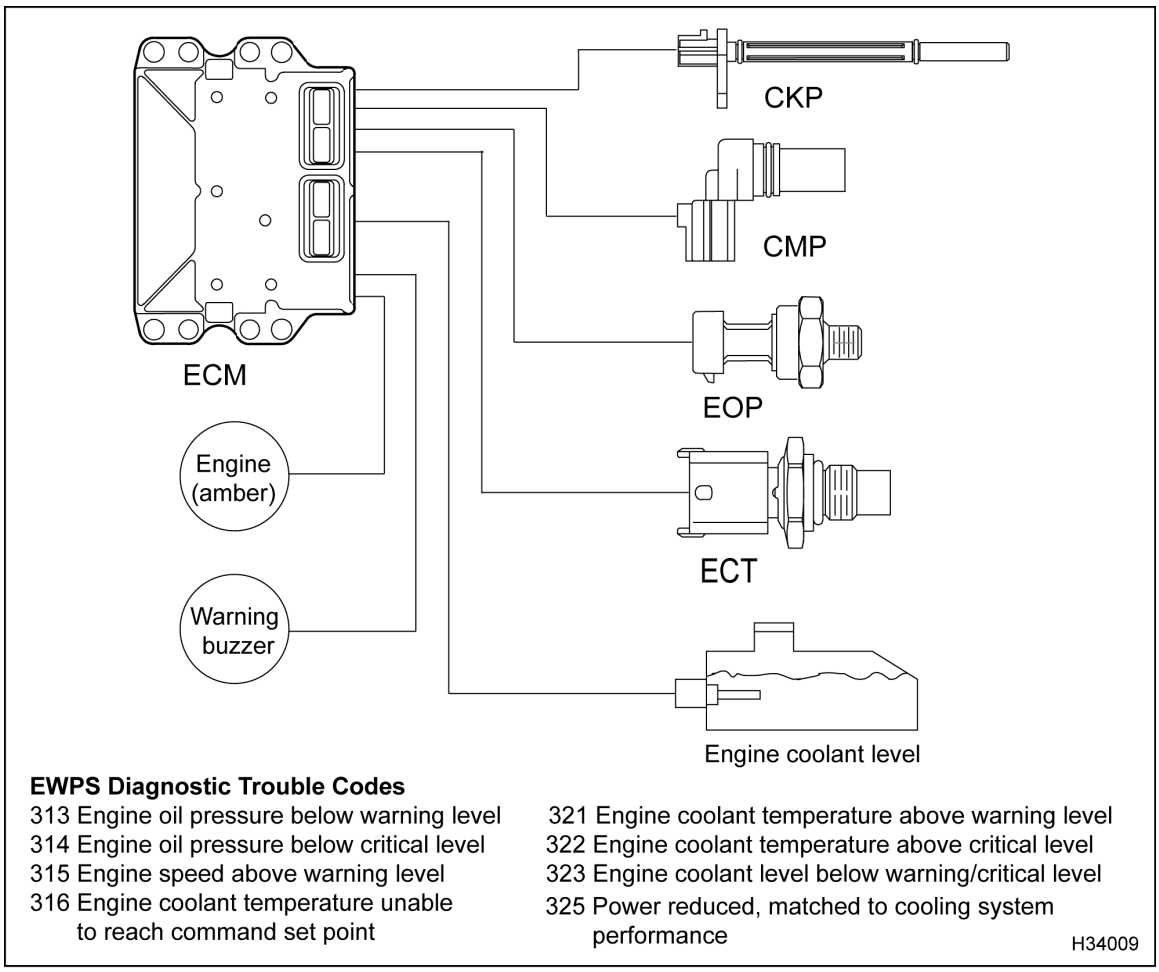


Figure 452 Function diagram for the EWPS

Function

The EWPS safeguards the engine from undesirable operating conditions to prevent engine damage and to prolong engine life. When a warning condition is detected, the on-board electronics will illuminate the red ENGINE lamp.

When a critical engine condition is detected, the on-board electronics will shut the engine down if the protection feature has been enabled. The critical engine condition will be recorded by a logging feature that records the event in engine hours and odometer readings. After the engine has shutdown, the engine may be restarted for a thirty second run time.

There are four options of EWPS:

- Standard
- 2–way warning
- 3–way warning
- 3–way protection

©August 2008 Navistar, Inc.

EWPS Operational Diagnostics

The EWPS includes the following features:

EWPS mode – This parameter indicates to the on-board electronics the desired mode of operation for the engine warning and protection feature.

Standard warning (rpm, ECT) – Engine overspeed and overheat are provided as the default operating mode. No engine shutdown is available.

2–way warning (rpm, ECT, EOP) – Engine overspeed, overheat, and low oil pressure are monitored in the engine warning operating mode. No engine shutdown is available.

3–way warning (rpm, ECT, EOP, ECL) – Engine overspeed, overheat, low oil pressure, and low coolant level are monitored in the engine warning operating mode. No engine shutdown is available.

3-way Protection (rpm, ECT, EOP, ECL) – Engine overspeed, overheat, low oil pressure, and low coolant level are monitored in the engine protection operating mode. Engine shutdown is available when a critical engine condition is detected. Critical engine conditions include overheat, low oil pressure and low coolant level.

ECT Warning Temperature – This parameter indicates when an engine overheat condition warrants the red ENGINE lamp to be illuminated and the warning buzzer to be activated.

ECT Critical Temperature – This parameter indicates when an engine overheat condition warrants an engine shutdown. The event logging feature will log when this event has occurred in both engine hours and odometer readings.

EOP RPM Boundary 1 – This parameter indicates the rpm range that engine oil pressure level 1 is used for the loss of engine oil pressure detection.

EOP RPM Boundary 2 – This parameter indicates the rpm range that engine oil pressure level 2 is used for the loss of engine oil pressure detection.

EOP RPM Boundary 3 – This parameter indicates the rpm range that engine oil pressure level 3 is used for the loss of engine oil pressure detection.

EOP Warning Level 1 – This parameter indicates when a loss of engine oil pressure warrants the red ENGINE lamp to be illuminated and the warning buzzer to be activated.

EOP Warning Level 2 – This parameter indicates when a loss of engine oil pressure condition warrants the red ENGINE lamp to be illuminated and the warning buzzer to be activated.

EOP Warning Level 3 – This parameter indicates when a loss of engine oil pressure condition warrants the red ENGINE lamp to be illuminated and the warning buzzer to be activated.

EOP Critical Level 1 – This parameter indicates when a loss of engine oil pressure condition warrants an engine shutdown. The event logging feature will log when this event has occurred in both engine hours and odometer readings.

EOP Critical Level 2 – This parameter indicates when a loss of engine oil pressure condition warrants an engine shutdown. The event logging feature will log when this event has occurred in both engine hours and odometer readings.

EOP Critical Level 3 – This parameter indicates when a loss of engine oil pressure condition warrants an engine shutdown. The event logging feature will log when this event has occurred in both engine hours and odometer readings.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

EWPS Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 323
ECT below warning/critical level

- DTC 323 is set by the ECM when coolant is low. When the EWPS mode is 3-way protection and DTC 323 is active, the engine will shutdown. The ECM will log the engine hours and odometer reading at the time of occurrence. After the shutdown, the engine can be restarted for thirty seconds. When the coolant has returned to correct levels, DTC 323 will become inactive.

NOTE: If coolant level is correct, see “ECL Sensor” (page 370). An ECL signal shorted to ground can cause DTC 323.

DTC 321
ECT above warning level

- DTC 321 is set by the ECM when the engine coolant temperature is above 110 °C (230 °F). The ECM illuminates the red ENGINE lamp and sounds the audible alarm. When the temperature drops below 110 °C (230 °F) the DTC will become inactive. For diagnostics, see “Engine Symptoms Diagnostics” – Section 4 (page 101).
- For high altitude applications (103 kPa [15 psi] radiator cap), DTC 321 is set by the ECM when the engine coolant temperature is above 113 °C (235 °F). When the temperature drops below 113 °C (235 °F) the DTC will become inactive.

DTC 322
ECT above critical level

- DTC 322 is set by the ECM when the engine coolant temperature is above 112 °C (234 °F). The ECM illuminates the red ENGINE lamp and sounds the audible alarm. When the temperature drops below 112 °C (234 °F) the DTC will become inactive. For diagnostics, see “Engine Symptoms Diagnostics” – Section 4 (page 101).
- For high altitude applications (103 kPa [15 psi] radiator cap), DTC 321 is set by the ECM when the engine coolant temperature is above 116 °C (241 °F). When the temperature drops below 116 °C (241 °F) the DTC will become inactive.

DTC 325
Power reduced, matched to cooling system performance

- DTC 325 is set by the ECM when the cooling system temperature exceeds 107 °C (225 °F). At this temperature the ECM will reduce the fuel delivered to the engine. When the temperature drops below 107 °C (225 °F) the DTC will become inactive and the engine will return to normal operation.

  For each Celsius degree of temperature the fuel will be reduced by 6 percent. For each Fahrenheit degree of temperature the fuel will be reduced by 3 percent. This reduces the heat produced by the engine and reduces the burden on the cooling system. The vehicle speed will also be reduced and allow the operator to downshift and increase the efficiency of the cooling system. As the temperature is reduced, the compensation level is reduced until the temperature drops below 107 °C (225 °F) and normal operation is resumed.

  For high altitude applications (103 kPa [15 psi] radiator cap), as the temperature is reduced, the compensation level is reduced until the temperature drops below 111 °C (232 °F) and normal operation is resumed.

  DTC 325 does not illuminate the ENGINE warning lamp.

DTC 316
ECT unable to reach commanded set point

NOTE: DTC 316 only indicates the engine has not been able to reach operating temperature. It does not indicate an electronic fault.

- DTC 316 is set if the engine does not reach operating temperature. DTC 316 will only be set with engines that have Cold Ambient Protection (CAP) strategy enabled. DTC 316 is set after the engine has run for more than 120 minutes and has not exceeded 66 °C (151 °F) for engine coolant temperature. DTC 316 can be cleared with the EST.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- DTC 316 can be set due to any of the following conditions:
  - Extended idle time
  - Cold ambient temperatures (may require use of winter front)
  - Thermostat stuck in open position
  - Incorrectly plumbed cooling system (thermostat bypassed)
  - Auxiliary heater cores cooling off engine (school bus application)
  - Fan clutch locked on

DTC 313
EOP below warning level

- DTC 313 is set by the ECM when the oil pressure has dropped below the warning level. The specification for the warning level is:
  - 34 kPa (5 psi) @ 700 rpm
  - 69 kPa (10 psi) @ 1400 rpm
  - 138 kPa (20 psi) @ 2000 rpm

  The ECM illuminates the red ENGINE lamp and sounds an audible alarm. For diagnostics, see “Engine Symptoms Diagnostics” – Section 4 (page 101).
- DTC 313 can be set due to a failed EOP sensor sending an incorrect signal. To confirm this, compare actual oil pressure to the reading on the data list of the EST. Low oil pressure due to inoperative mechanical components will also set DTC 313.

DTC 314

EOP below critical level

- DTC 314 is set by the ECM when the oil pressure has dropped below the critical level. The specification for the critical level is:
  - 14 kPa (2 psi) @ 700 rpm
  - 83 kPa (12 psi) @ 1400 rpm
  - 152 kPa (22 psi) @ 2000 rpm

  The ECM flashes the red ENGINE lamp and sounds an audible alarm. See “Engine Symptoms Diagnostics” – Section 4 (page 101).
- DTC 314 can be set due to a failed EOP sensor sending an incorrect signal. To confirm this, compare actual oil pressure to the reading on the data list of the EST. Low oil pressure due to inoperative mechanical components will also set DTC 313.

DTC 315
Engine speed above warning level

- DTC 315 is set by the ECM when the engine rpm has exceeded 3400 rpm.
- DTC 315 can be set due to any of the following conditions:
  - Excessive engine speed in an unintended downshift.
  - Steep acceleration downhill without correct brake application.
  - External fuel source being ingested into air intake system.
- When DTC 315 is active the amber ENGINE lamp is illuminated. The engine hours and miles of the last two over speed occurrences will be recorded in the engine event log.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IAH System (Inlet Air Heater)

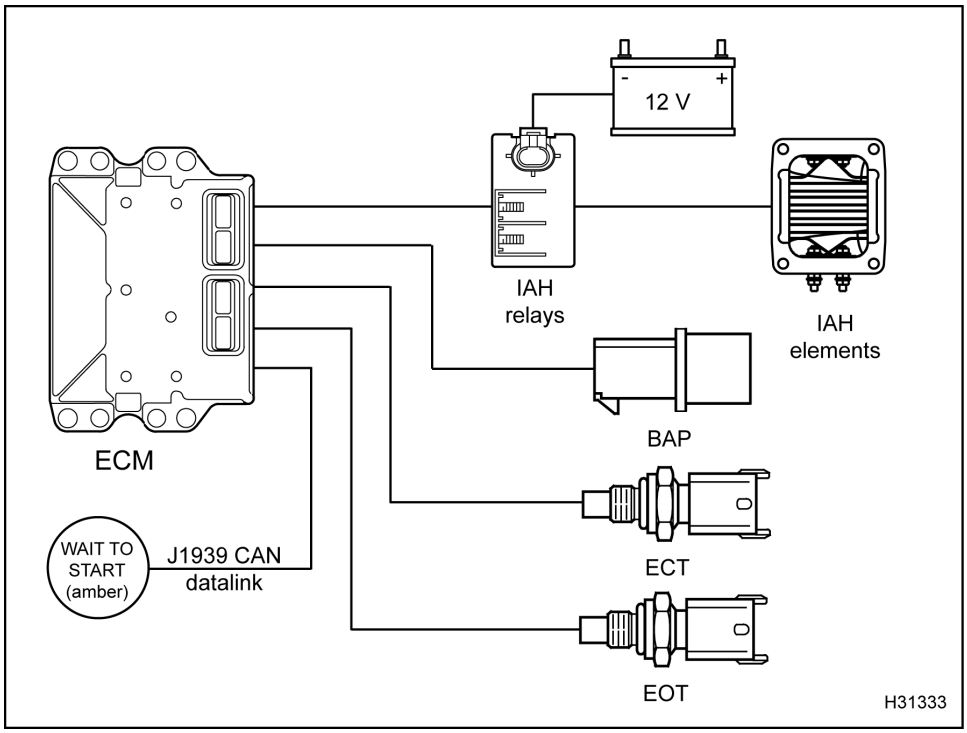


Figure 453 Function diagram for the IAH system

The function diagram for the IAH system includes the following:

- IAH relays
- IAH relay connectors
- IAH elements
- Electronic Control Module (ECM)
- Barometric Absolute Pressure (BAP) sensor
- Engine Coolant Temperature (ECT) sensor
- Engine Oil Temperature (EOT) sensor
- Battery
- WAIT TO START lamp (amber)

Function

The Inlet Air Heater (IAH) system warms the incoming air supply prior to cranking to aid cold engine starting and reduce white smoke during warm-up.

The ECM is programmed to energize the IAH elements through the IAH relays while monitoring certain programmed conditions for engine coolant temperature, engine oil temperature, and atmospheric pressure.

The ECM monitors battery voltage and uses readings from the ECT, EOT, and BAP sensor to determine the amount of time that the WAIT TO START lamp is on, as well as the activation of the IAH system. The WAIT TO START lamp indicates when the IAH relays are activated and the elements are heating. The IAH system on-time can vary between zero seconds to forty-five seconds, depending on the ECT, EOT, and BAP sensor readings.

IAH elements are activated for a longer time period if the engine is cold or the barometric pressure is low (high altitude).

The engine is ready to start when the WAIT TO START lamp is turned off by the ECM.

NOTE: The WAIT TO START lamp on-time is independent from the IAH system on-time.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IAH Circuit Operation

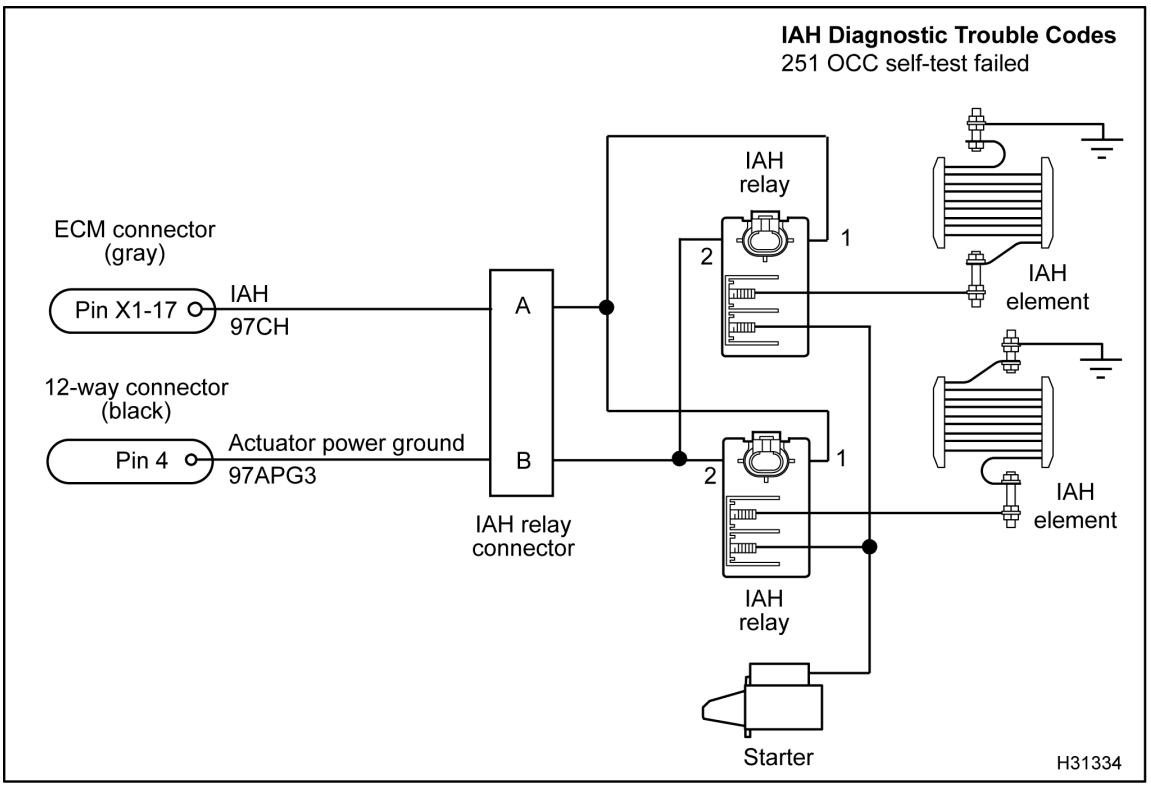


Figure 454 IAH circuit diagram

The IAH control system operation is dependent upon the ECT, EOT, BAP, and battery voltage. The IAH relays are activated by power supplied by the ECM through Pin X1–17 to circuit 97CH. The IAH relays are grounded through circuit 97APG3, Pin 4 on the 12-pin connector, and to negative battery terminal. Power is supplied to the switch side of the IAH relays from the starter motor. When the IAH relay is energized, power is supplied to the IAH elements that are grounded through the intake manifold.

The WAIT TO START lamp time is transmitted over the CAN 1 datalink. See truck *Chassis Electrical Circuit Diagram Manual* .

Fault Detection / Management

An open or short to ground in the IAH control circuit can be detected by doing an on-demand Output Circuit Check (OCC) during the KOEO Standard Test. When a fault is detected, a DTC will be set.

IAH Diagnostic Trouble Codes (DTCs)

DTC 251
IAH OCC self-test failed

- DTC 251 is set by the ECM when the OCC test has failed after the KOEO Standard Test has been run.
- DTC 251 can be set when a poor connection, an open or short to ground in the relay control circuit, or failed relay exists.

NOTE: For initial calibrations:

- If the system voltage is less than 13 volts, DTC 251 may become active.
- If the system is functioning properly, disregard DTC 251.

Later calibrations and current hardware levels do not support DTC 251.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 12-pin Breakout Harness
- Breakout Box
- Amp Clamp

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IAH Pin-Point Diagnostics

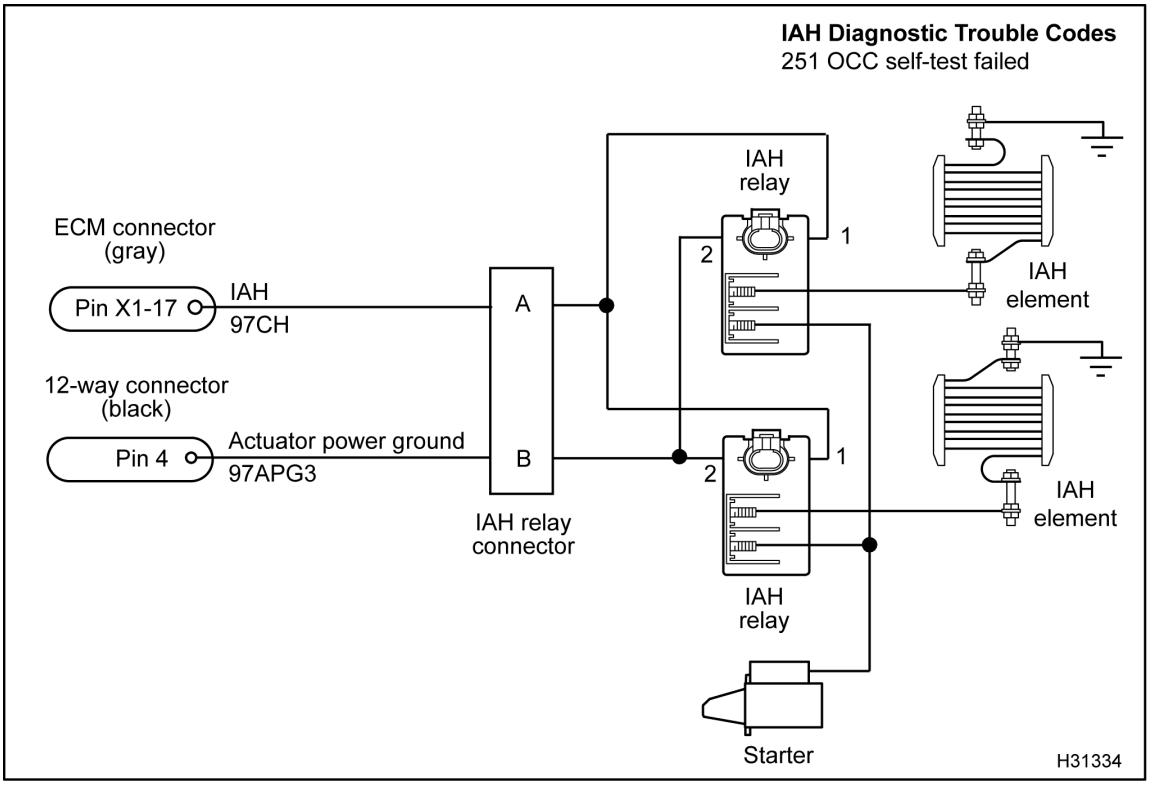


Figure 455 IAH circuit diagram

Voltage Check at Element – Output State Test (Turn the ignition switch to ON. Run Glowplug / Inlet Air Heater Output State Test. For help, see “Inlet Air Heater Output State Test” in Section 3 (page 68).)

Test Point	Spec	Comment
Element terminal 1 to gnd	B+	If < B+, check relay and circuit for element 1. Do Voltage Checks (page 449) and Harness Resistance Check (page 449).
		If equal to B+, do Amperage Draw Check.
Element terminal 2 to gnd	B+	If < B+, check relay and circuit for element 2. Do Voltage Checks (page 449) and Harness Resistance Check (page 449).
		If equal to B+, do Amperage Draw Check.

NOTE: When a single IAH circuit fails, suspect that circuit only. If both elements or circuits do not have voltage, verify the ECM programming. If the ECM programming is correct, do Actuator Voltage Checks at ECM (page 449) , Harness Resistance Checks – Relay to ECM (page 450), and Harness Resistance Check – Relay to 12–pin Connector (page 450).

Amperage Draw Check (Secure AMP Clamp around element feed wire. Turn the ignition switch to ON. Run Glowplug / Inlet Air Heater Output State Test. For help, see “Inlet Air Heater Output State Test” in Section 3 (page 68).)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Element 1	125 A ±30 A	If not within specification, do Element Continuity Check and Harness Resistance Checks (page 449).
Element 2	125 A ±30 A	If not within specification, do Element Continuity Check and Harness Resistance Checks (page 449).
Element Continuity Check (Turn the ignition switch to OFF. Disconnect harness from element post. Inspect for corrosion.)		
Element terminal 1 to gnd		If continuity is not present, check element for carbon build-up, corrosion, or open circuit.
Element terminal 2 to gnd		If continuity is not present, check element for carbon build-up, corrosion, or open circuit.

©August 2008 Navistar, Inc.

Harness Resistance Check – Element to Relay (Turn the ignition switch to OFF. Disconnect harness from element terminal. Check for corrosion. Trace wiring harness from element to IAH relay. Ensure the correct relay terminal is being tested.)		
Element terminal 1 to relay output terminal 1	< 5 Ω	If > 5 Ω, check for a corroded terminal or an open circuit.
Element terminal 2 to relay output terminal 2	< 5 Ω	If > 5 Ω, check for a corroded terminal or an open circuit.
Voltage Check at Relays – Battery Feed Wires (Starter)		
Relay 1: Battery feed terminal to gnd	B+	If < B+, check for dead battery, open in IAH harness, or open in truck battery harness.
Relay 2: Battery feed terminal to gnd	B+	If < B+, check for dead battery, open in IAH harness, or open in truck battery harness.
Voltage Check at Relays – Output (Output State Test) (Turn the ignition switch to ON. Run Glowplug / Inlet Air Heater Output State Test. For help, see “Inlet Air Heater Output State Test” in Section 3 (page 68).)		
Relay 1: Relay output post to gnd	B+	If < B+, check for dead battery, open IAH harness, open in truck battery harness, faulty IAH relay, ECM for IAH programming, or open relay control circuit from ECM.
Relay 2: Relay output post to gnd	B+	If < B+, check for dead battery, open IAH harness, open in truck battery harness, faulty IAH relay, ECM for IAH programming, or open relay control circuit from ECM.
Actuator Control Voltage Check at Relay Connection (Disconnect control wiring from relay. Turn the ignition switch ON. Run the Glow Plug / Air Heater Output State Test. For help, see “Inlet Air Heater Output State Test” in Section 3 (page 68).)		
Element 1: A to gnd	B+	If < B+, do Actuator Control Voltage Check at ECM (page 449).
Element 1: A to B	B+	If < B+, do Harness Resistance Check – Relay to 12-pin Connector. (page 450).
Element 2: A to gnd	B+	If < B+, do Actuator Control Voltage Check at ECM (page 449).
Element 2: A to B	B+	If < B+, do Harness Resistance Check – Relay to 12-pin Connector. (page 450).
NOTE: If both relays are < B+, check wiring back to the ECM and 12-pin connector. Verify ECM programming. The Glowplug / IAH parameter should be option 2 (IAH).		
Actuator Control Voltage Check at ECM (Connect breakout box [X1 only] to ECM. Turn the ignition switch to on. Run the Glow Plug / Inlet Air Heater Output State Test. For help, see “Inlet Air Heater Output State Test” in Section 3 (page 68).)		
Output State Test High		
X1–17 to gnd	B+	If < B+, and ECM is programmed correctly, replace the ECM.
Output State Test Low		
X1–17 to gnd	0 V	If > 0.25 V, and ECM is programmed correctly, replace the ECM.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Harness Resistance Check – Relay to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect control wiring from relay.)		
Relay 1: A to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.
Relay 1: B to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit. Specification is based on 4300 chassis. For other applications, see *Chassis Electrical Circuit Diagram Manual* for complete chassis ground circuit information.
Relay 2: A to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.
Relay 2: B to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit. Specification is based on 4300 chassis. For other applications, see *Chassis Electrical Circuit Diagram Manual* for complete chassis ground circuit information.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Harness Resistance Check – Relay to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect control wiring from relay. Use disconnected negative battery cable for ground test point.)		
Relay 1: A to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
Relay 1: B to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground. Specification is based on 4300 chassis. For other applications, see *Chassis Electrical Circuit Diagram Manual* for complete chassis ground circuit information.
Relay 2: A to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
Relay 2: B to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground. Specification is based on 4300 chassis. For other applications, see *Chassis Electrical Circuit Diagram Manual* for complete chassis ground circuit information.
Harness Resistance Check – Relay to ECM (Turn the ignition switch to OFF. Connect breakout box [X1 only] to engine harness.)		
Relay 1: Pin A to X1–17	< 5 Ω	If > 5 Ω, check for open in circuit.
Relay 2: Pin A to X1–17	< 5 Ω	If > 5 Ω, check for open in circuit.
Harness Resistance Check – Relay to 12–pin Connector (Turn the ignition switch to OFF. Connect 12–pin breakout harness to engine harness only.)		
Relay 1: Pin B to Pin 4 (12-pin)	< 5 Ω	If > 5 Ω, check for open in control wire.
Relay 2: Pin B to Pin 4 (12-pin)	< 5 Ω	If > 5 Ω, check for open in control wire.

IAH Diagnostic Trouble Codes (DTCs)

DTC 251 = OCC self-test failed

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. Refer to truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

©August 2008 Navistar, Inc.

IAT Sensor (Intake Air Temperature)

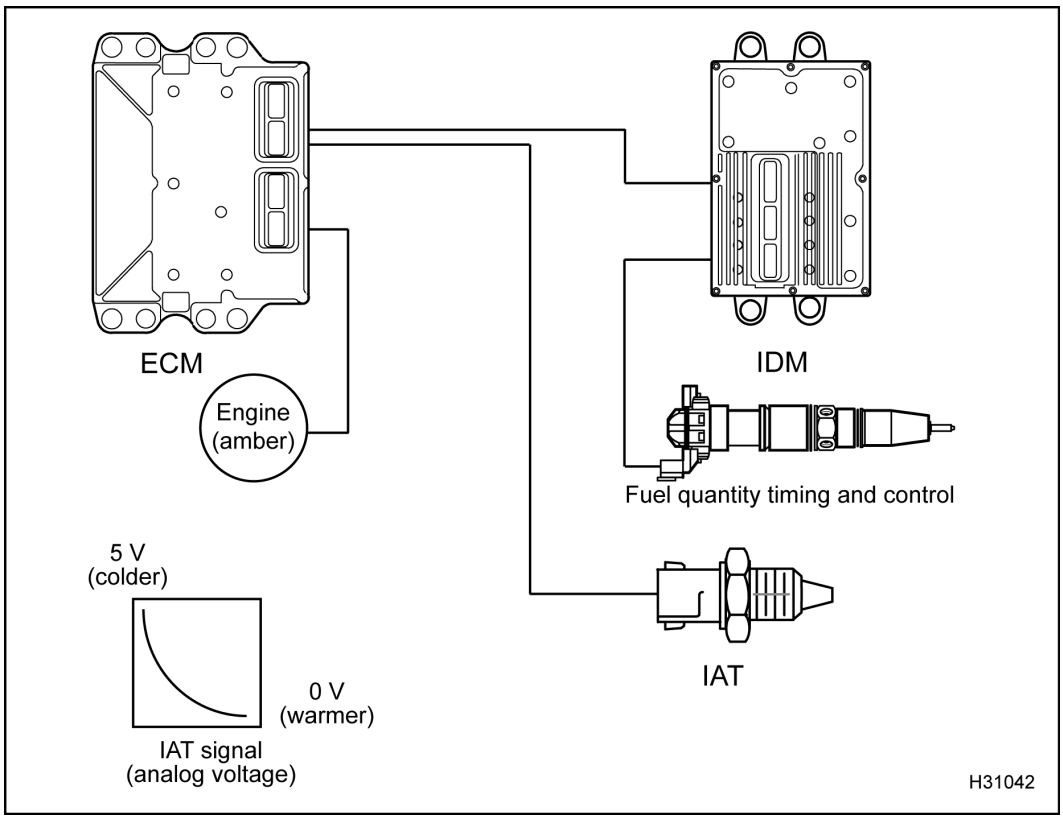


Figure 456 Function diagram for the IAT sensor

The function diagram for the IAT sensor includes the following:

- IAT sensor
- Electronic Control Module (ECM)
- Fuel injector
- ENGINE lamp (amber)

Function

The Intake Air Temperature (IAT) sensor is a thermistor sensor that is chassis mounted on the air filter housing. The ECM supplies a 5 V reference signal which the IAT sensor uses to produce an analog voltage that indicates the intake air temperature. The IAT sensor changes resistance when exposed to different temperatures. As air temperature decreases, the resistance of the thermistor increases. This causes the signal voltage to increase. As air temperature increases, the resistance of the thermistor decreases. This causes the signal voltage to decrease.

The IAT sensor provides a feedback signal to the ECM indicating intake air temperature. The ECM monitors the IAT signal to control the timing and fuel rate for cold starting. The continuous monitoring by the IAT sensor limits smoke emissions.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IAT Circuit Operation

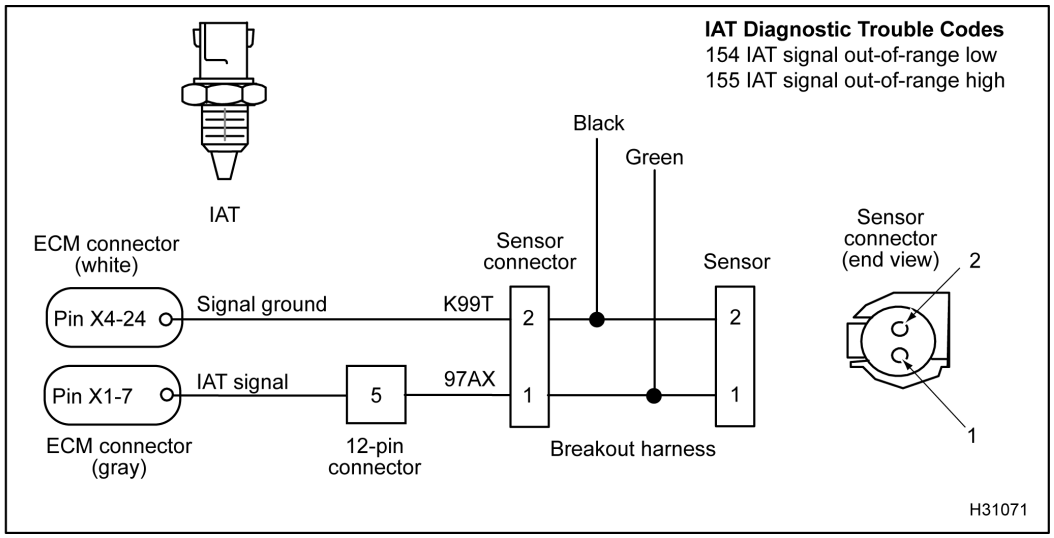


Figure 457 IAT circuit diagram

The IAT sensor is supplied with a 5 V reference signal at Pin 1 through 12–pin connector (Pin 5) from ECM Pin X1–7. The sensor is grounded at Pin 2 through the signal ground at ECM Pin X4–24. As the air temperature increases or decreases, the sensor changes resistance and provides the air temperature signal voltage at the ECM. The signal voltage is monitored by the ECM to determine the intake air temperature.

Fault Detection / Management

When the ECM detects an IAT signal out of range high or low, the ECM will ignore the IAT signal and assume an ambient temperature of 25 °C (77 °F).

IAT Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp on the vehicle dash.

DTC 154
IAT signal out-of-range low

- DTC 154 is set by the ECM if signal voltage is less than 0.127 V for more than 0.35 second.
- DTC 154 can be set due to a short to ground in the signal circuit or a failed IAT sensor.
- When DTC 154 is active, the amber ENGINE lamp is illuminated.

DTC 155
IAT signal out-of-range high

- DTC 155 is set by the ECM if signal voltage is more than 4.6 V for more than 0.35 second.
- DTC 155 can set due to an open signal or ground circuit, a short to a voltage source, or a failed IAT sensor.
- When DTC 155 is active, the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- Breakout Box
- Breakout Harness
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IAT Operational Diagnostics

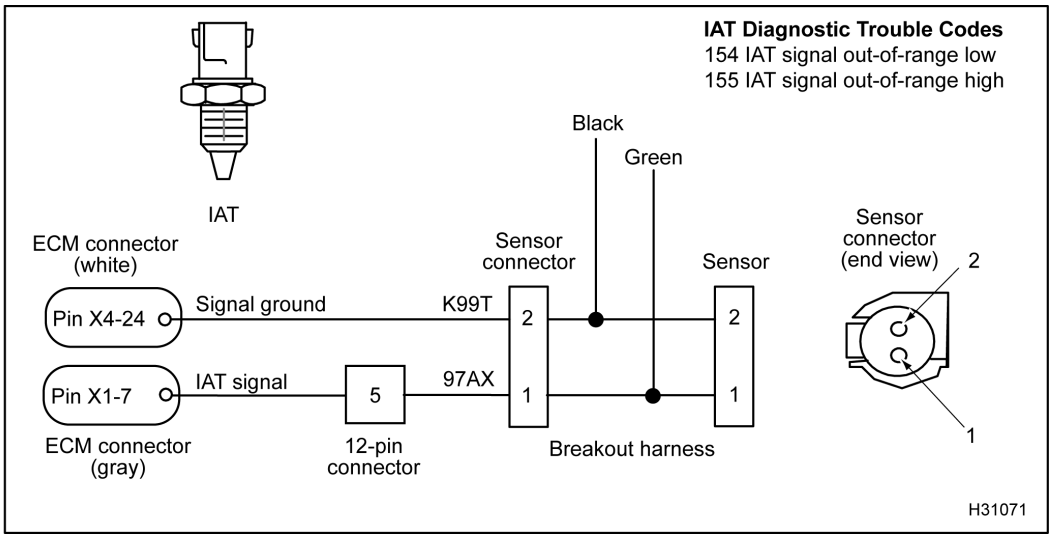


Figure 458 IAT circuit diagram

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the D_ContinuousMonitor.ssn.

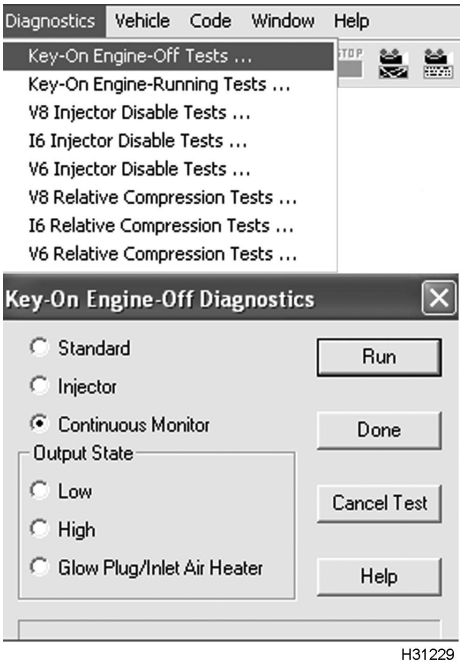


Figure 459 Continuous Monitor Test

2. To monitor signal voltage, run KOEO Continuous Monitor Test. For help, see “Continuous Monitor Test” in Section 3 (page 68).
3. Monitor IAT signal voltage. Verify an active DTC for the IAT circuit.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4. If code is active, do step 6 and 7 to check circuit for the IAT sensor using the following table.
   - Circuit Checks for IAT Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Disconnect chassis harness from temperature sensor.

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

7. Connect Temperature Sensor Breakout Harness to engine harness only.

Circuit Checks for IAT Sensor (Use EST, breakout harness, 3-Banana Plug Harness, and 500 Ohm Resistor Harness.)

Test Condition	Spec	Checks
Sensor disconnected	> 4.6 V	If voltage < 4.6 V, check signal circuit for short to ground.
3-Banana Plug Harness connected between Pin 1 (Green) and Pin 2 (Black) of breakout harness	0 V	If voltage is > 0.127 V, check ground and signal circuit for open or high resistance. Use a breakout box and measure resistance from Pin 2 to Pin X4–24 and from Pin 1 to X1–7 (spec < 5 Ω).
500 Ohm Resistor Harness connected between Pin 1 (Green) and Pin 2 (Black) of breakout harness	< 1.0 V	If voltage > 1.0 V, check signal circuit for short to V_{REF}, B+, or another sensor's signal voltage.

Connect engine harness to sensor. Use the EST to clear DTCs. If an active code remains after checking test conditions, replace the IAT sensor.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IAT Pin-Point Diagnostics

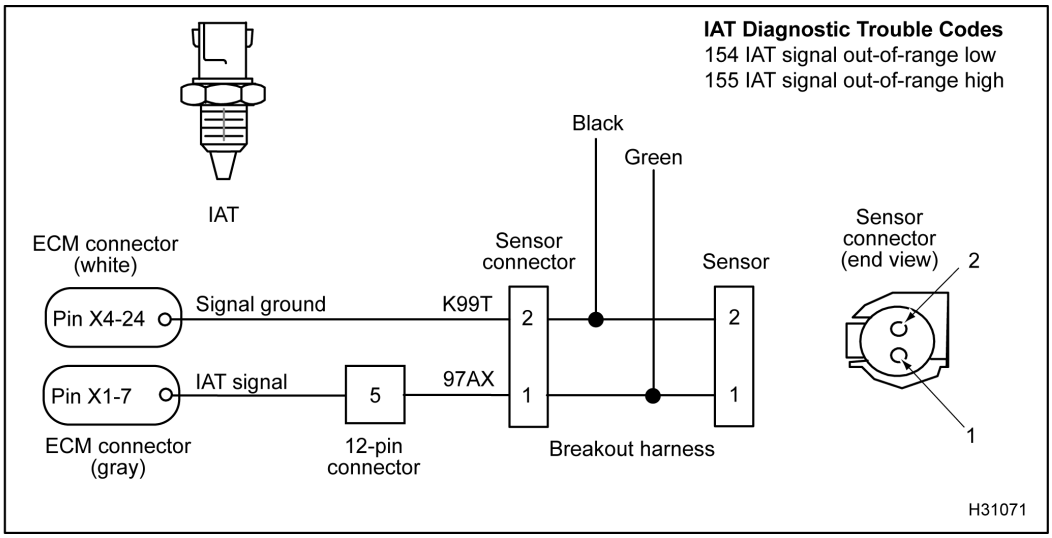


Figure 460 IAT circuit diagram

Connector Voltage Checks to Ground (Disconnect harness from sensor. Inspect for bent pins or corrosion. Connect breakout harness to engine harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
2 to gnd	0 V to 0.25 V	Signal ground (No voltage expected). If > 0.25 V, signal wire is shorted to V_{REF} or B+.
1 to gnd	4.6 V to 5.0 V	Pull up voltage, if no voltage, circuit has open, high resistance, or short to ground.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect harness from sensor. Connect breakout harness to engine harness only. Disconnect chassis connector 9260[1].)		
2 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit.
1 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Connect breakout harness to engine harness only. Use disconnected negative battery cable for ground test point.)		
2 to gnd cable	> 500 Ω	If < 500 Ω , check for short to ground.
1 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
Harness Resistance Checks (Connect breakout box to engine harness [X1 only] and chassis harness [X4 only].)		

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

X4–24 to 2	< 5 Ω	If > 5 Ω, check for open ground wire.
X1–7 to 1	< 5 Ω	If > 5 Ω, check for open signal wire.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Operational Voltage Checks for IAT Sensor with Breakout Harness (Check with breakout harness connected to sensor and engine harness.)

Test Point	Temp	Resistance	Voltage @ Resistance
2 (Black) to 1 (Green)	0 °C (32 °F)	91.1 kΩ	3.846 V
2 (Black) to 1 (Green)	20 °C (68 °F)	35.5 kΩ	3.041 V
2 (Black) to 1 (Green)	100 °C (212 °F)	2.0 kΩ	0.446 V

Operational Voltage Checks for IAT Sensor with Breakout Box (Check with breakout box connected [X1 and X4 only] to the ECM and engine harness.)

X4–24 to X1–7	0 °C (32 °F)	91.1 kΩ	3.846 V
X4–24 to X1–7	20 °C (68 °F)	35.5 kΩ	3.041 V
X4–24 to X1–7	100 °C (212 °F)	2.0 kΩ	0.446 V

IAT Diagnostic Trouble Codes

DTC 154 = Signal voltage was < 0.127 V for more than 0.35 second

DTC 155 = Signal voltage was > 4.6 V for more than 0.35 second

©August 2008 Navistar, Inc.

ICP Sensor (Injection Control Pressure)

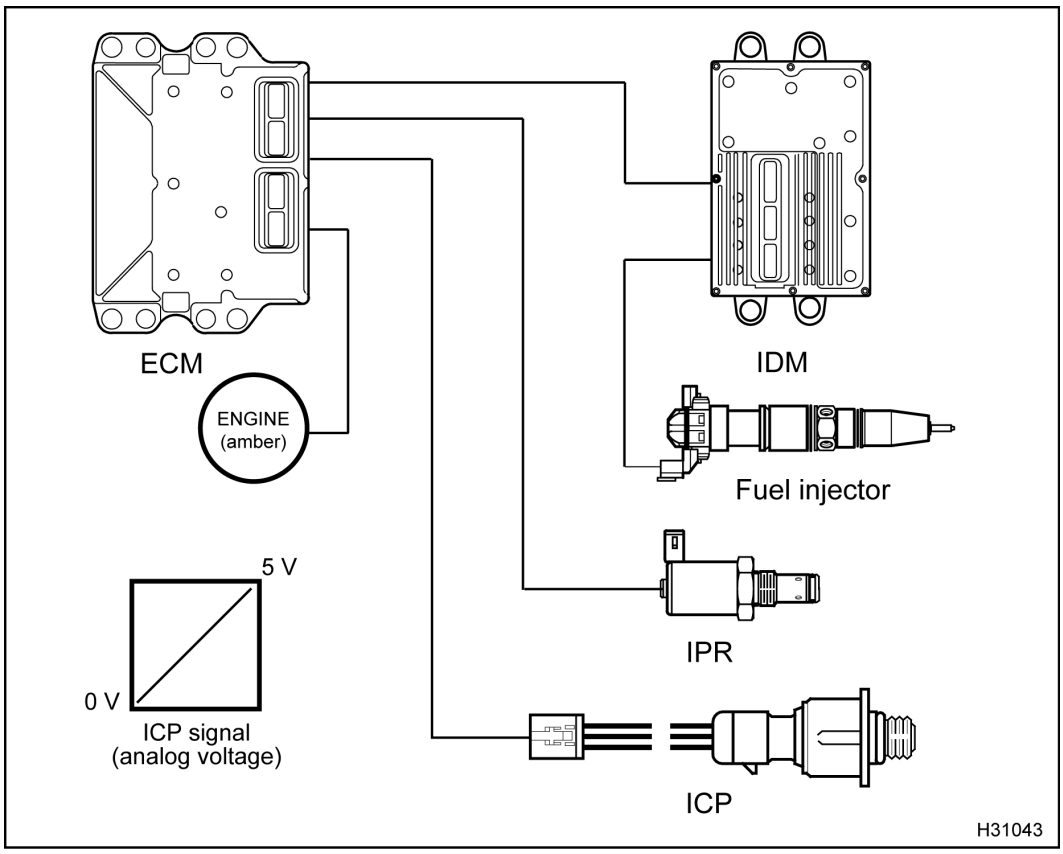


Figure 461 Function diagram for the ICP sensor

The function diagram for the ICP sensor includes the following:

- ICP sensor
- Electronic Control Module (ECM)
- Injector Drive Module (IDM)
- Fuel injector
- Injection Pressure Regulator (IPR)
- ENGINE lamp (amber)

Function

The ICP sensor is a Micro Strain Gauge (MSG) sensor. The ICP sensor is under the valve cover, forward of the No. 6 fuel injector in the high-pressure oil rail. The engine harness connection on the valve cover gasket for the ICP sensor is left of the No. 6 injector connector. The ECM supplies a 5 V reference signal which the ICP sensor uses to produce a linear analog voltage that indicates pressure.

The ICP sensor provides a feedback signal to the ECM indicating injection control pressure. The ECM monitors ICP as the engine is operating to modulate the IPR. This is a closed loop function which means the ECM continuously monitors and adjusts for ideal ICP determined by conditions such as load, speed, and temperature.

The ECM monitors the ICP signal to determine if the performance of the hydraulic system is satisfactory. During engine operation, if the ECM recognizes that the ICP signal is greater or less than the value that the IPR is trying to achieve the ECM will set a DTC and illuminate the amber ENGINE lamp.

The ICP signal from the ECM is one of the signals the IDM uses to command the correct injector timing.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ICP Circuit Operation

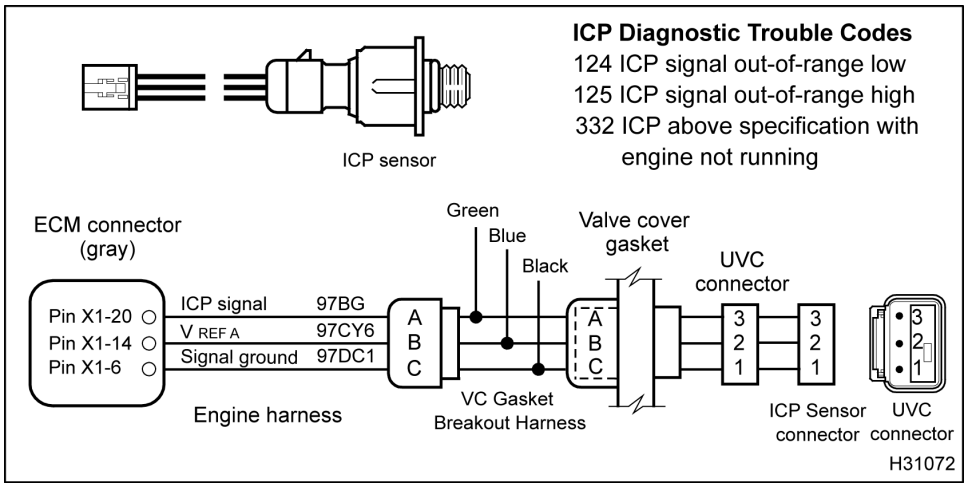


Figure 462 ICP circuit diagram

The ICP sensor is supplied a 5 V reference signal at Pin 2 through valve cover gasket Pin B from ECM Pin X1–14. The ICP sensor is supplied a signal ground at Pin 1 through valve cover gasket Pin C from ECM Pin X1–6. The ECM monitors the ICP signal from sensor Pin 3 through valve cover gasket Pin A to ECM Pin X1–20.

Fault Detection / Management

The ECM continuously monitors the signal of the ICP sensor to determine if the signal is within an expected range. If the ECM detects a voltage greater or less than expected, the ECM will set a DTC, illuminate the amber ENGINE lamp, ignore the ICP sensor signal, and use a preset value based on engine operating conditions.

ICP Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamps.

DTC 124
ICP signal out-of-range low

- DTC 124 is set by the ECM if signal voltage is less than 0.039 V for more than 0.1 second.
- DTC 124 can be set due to an open or short to ground on the signal circuit, a failed ICP sensor or an open V_{REF} circuit or V_{REF} short to ground.
- When DTC 124 is active the amber ENGINE lamp is illuminated.

DTC 125
ICP signal out-of-range high

- DTC 125 is set by the ECM if the signal voltage is greater than 4.9 V for more than 0.1 second.
- DTC 125 can be set due to a signal circuit shorted to V_{REF} or B+, or a failed ICP sensor.
- When DTC 125 is active the amber ENGINE lamp is illuminated.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 332
ICP above specification with engine not running

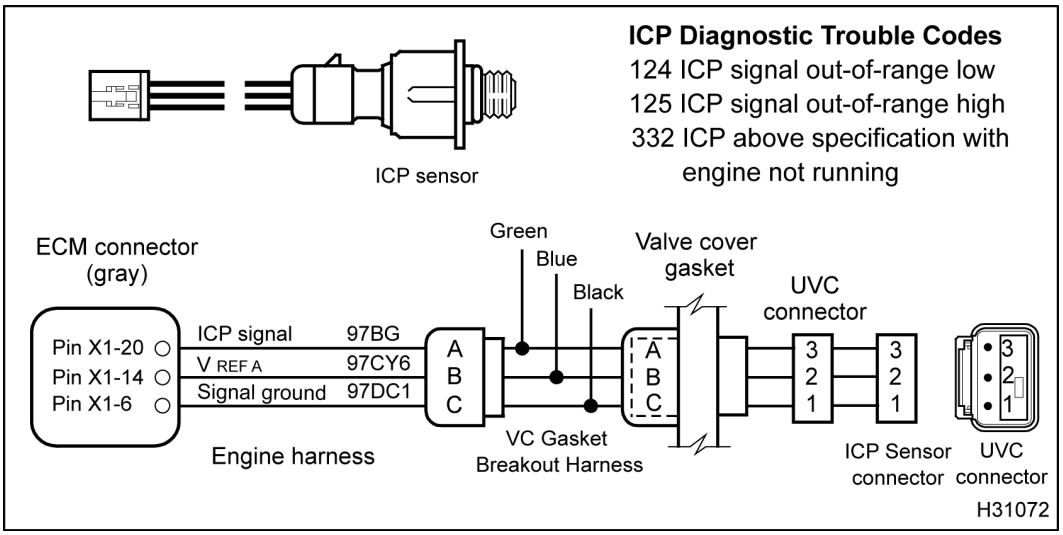
- DTC 332 is set by the ECM, if the voltage signal from the ICP sensor is greater than expected with the key-on engine-off. If the ECM sets DTC 332, the ECM will ignore the ICP signal and operate the IPR with fixed values based on engine operating conditions.
- DTC 332 can be caused by an open signal ground, V_{REF} shorted to voltage source greater than 5.5 V, a biased circuit, a failed ICP sensor, or a momentary loss of either the CMP or CKP signal.
- When DTC 332 is active the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- VC Gasket Breakout Harness
- UVC Pressure Breakout Harness
- Breakout Box
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

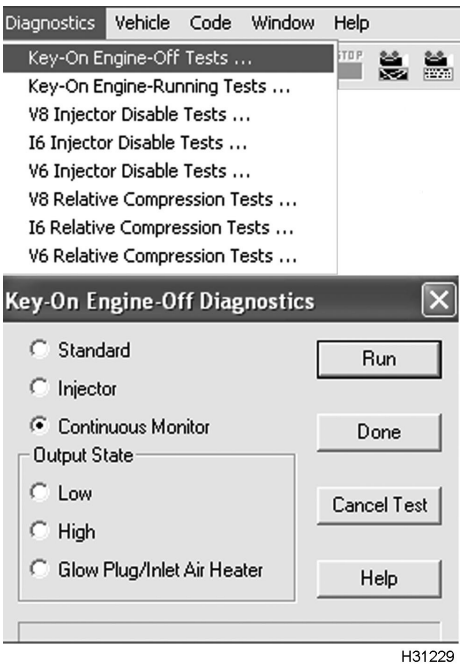
ICP Operational Diagnostics



⚠ WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the D_ContinuousMonitor.ssn.



2. To monitor signal voltage, run KOEO Continuous Monitor Test.
3. Monitor ICP signal voltage. Verify an active DTC for the ICP circuit.
4. If code is active, do step 6 and 7 to check circuit for the ICP sensor using the following tables.
   - Circuit Checks for ICP Sensor – ECM to Valve Cover Gasket Connector
   - Circuit Checks for ICP Sensor – ECM to ICP Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST display DTCs related to the condition.
6. Disconnect engine harness from valve cover gasket connector.

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

7. Connect VC Gasket Breakout Harness to engine harness only.

Figure 464 Continuous Monitor Test

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ICP Operational Diagnostics

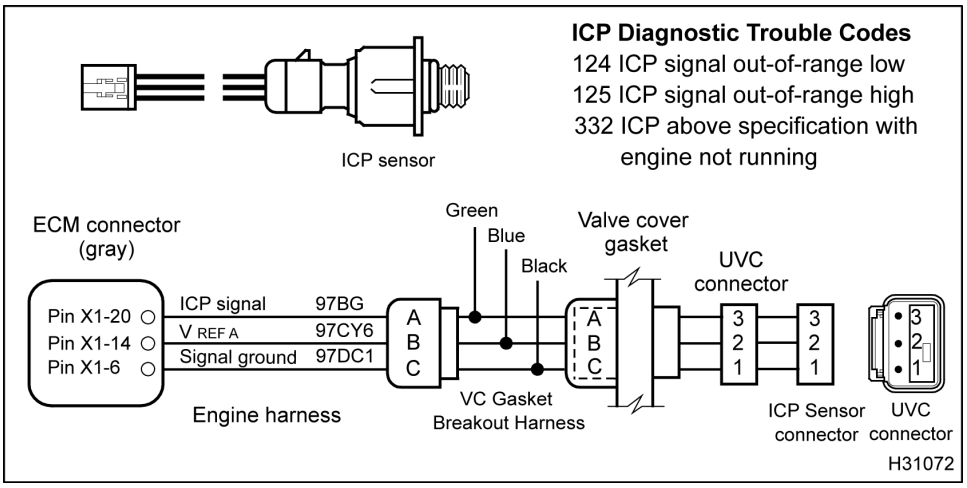


Figure 465 ICP circuit diagram with VC Gasket Breakout Harness

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Circuit Checks for ICP – ECM to Valve Cover Connector (Use EST, DMM, 500 Ohm Resistor Harness, and VC Gasket Breakout Harness connected to engine harness only.)

Test Condition	Spec	Checks
Harness disconnected from valve cover gasket connector using EST	0 V	If voltage > 0.039 V, check ICP signal for short to V_{REF} or B+.
Voltage from Pin B (Blue) of VC Gasket Breakout Harness to ground using DMM	5 V ±0.5 V	If voltage > 5.5 V, check V_{REF} for short to B+. If voltage is < 4.5 V, check V_{REF} for open or short to ground.
500 Ohm Resistor Harness connected between Pin A (Green) and Pin B (Blue) of VC Gasket Breakout Harness using EST	5 V	If voltage < 4.9 V, check ICP signal for open or short to ground. — Disconnect connector 9260[1]. Measure resistance from Pin A to Pin A of connector 9260 (spec > 1 kΩ) to check for short to ground within wiring harness. — Disconnect negative battery cable. Measure resistance from Pin A (spec > 1 kΩ) to ground cable to check for short to ground. — Use a breakout box to measure resistance from X1-20 to Pin A (spec < 5 Ω) to check for open circuit.
Resistance from Pin C (Black) of VC Gasket Breakout Harness to	< 5 Ω	If resistance is > 5 Ω, check for open or high resistance between ECM and VC Gasket Breakout Harness

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ECM chassis ground (Pin A of connector 9260) using DMM.	connector. Use a breakout box to measure resistance from X1-6 to Pin C (spec < 5 Ω).
Connect engine harness to valve cover gasket connector. Use the EST to clear DTCs. If test results are to spec for all test conditions, but an active code remains, remove valve cover and check between valve cover gasket connector and ICP sensor. (See Circuit Checks for ICP Sensor – ECM to ICP Sensor.)	

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ICP Operational Diagnostics

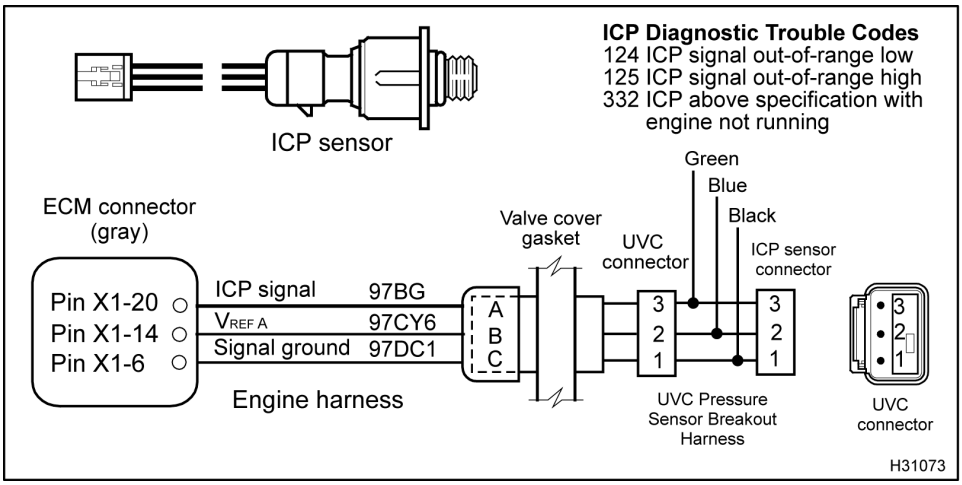


Figure 466 ICP circuit diagram with UVC Pressure Sensor Breakout Harness

Circuit Checks for ICP Sensor – ECM to ICP Sensor (If Circuit Checks for ICP Sensor – ECM to Valve Cover Gasket Connector are complete and test results are to specification for all test conditions, but an active code remains, remove valve cover following procedure in the *Engine Service Manual*. Use EST, DMM, 500 Ohm Resistor Harness, and UVC Pressure Sensor Breakout Harness to UVC connector only.)

Test Condition	Spec	Checks
ICP sensor connector removed from UVC connector using EST	0 V	If voltage > 0.039 V, check ICP signal for short to V_{REF} or B+.
Voltage from Pin 2 (Blue) of UVC Pressure Sensor Breakout Harness to ground using DMM.	5 V ± 0.5 V	If voltage > 5.5 V, check V_{REF} for short to B+. If voltage is < 4.5 V, check V_{REF} for open or short to ground.
500 Ohm Resistor Harness connected between Pin 3 (Green) and Pin 2 (Blue) of UVC Pressure Sensor Breakout Harness using EST	5 V	If voltage < 4.9 V, check ICP signal for open or short to ground. — Disconnect connector 9260[1]. Measure resistance from Pin 3 to Pin A of connector 9260 (spec > 1 kΩ) to check for short to ground within wiring harness. — Disconnect negative battery cable. Measure resistance from Pin A to ground cable to check for short to ground. — Use a breakout box to measure resistance from X1-20 to Pin 3 (spec < 5 Ω) to check for open circuit.
Resistance from Pin 1 (Black) of UVC Pressure Sensor Breakout Harness to ECM chassis ground ECM chassis ground (Pin A of	< 5 Ω	If resistance is > 5 Ω, check for open or high resistance between ECM and UVC connector. Use a breakout box to measure resistance from X1-6 to Pin 1 (spec < 5 Ω).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

connector 9260) using DMM
using DMM.

Connect ICP sensor to UVC connection. Use the EST to clear DTCs. If test results are to spec for all test conditions, but an active code remains, replace sensor.

NOTE: If all tests are to specification, but DTCs return after valve cover is torqued down, replace the valve cover gasket.

1 Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

©August 2008 Navistar, Inc.

ICP Pin-Point Diagnostics (ECM to valve cover gasket connector)

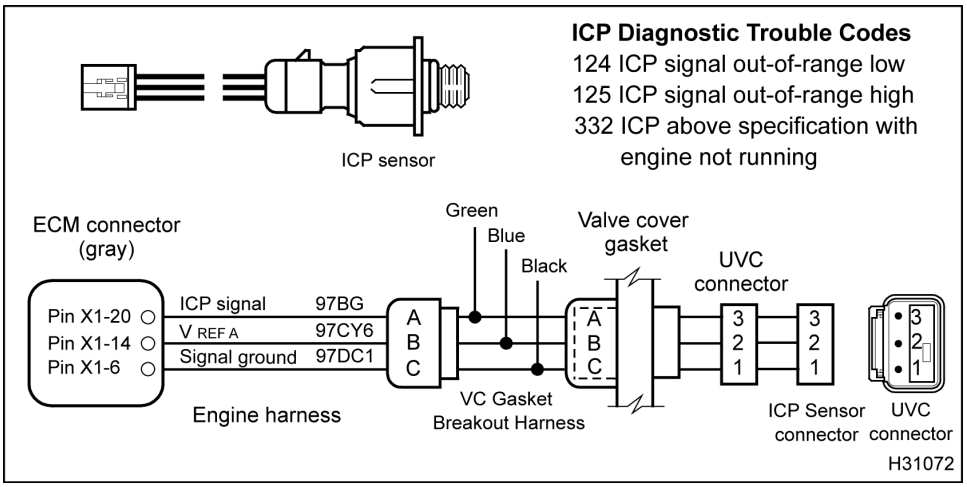


Figure 467 ICP circuit diagram with VC Gasket Breakout Harness

Connector Voltage Checks to Ground (Disconnect engine harness from valve cover gasket connector and connect VC Gasket Breakout Harness to engine harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
A to gnd	0 to 0.25 V	If > 0.25 V, signal circuit is shorted to V_{REF} or B+.
B to gnd	5 V ± 0.5 V	If voltage is not to spec, V_{REF} is shorted to ground, shorted to B+, or open.
C to gnd	0 V to 0.25 V	Signal ground (no voltage expected). If > 0.25 V, check ground circuit for open or high resistance and check signal ground for short to V_{REF} or B+.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect harness from valve cover gasket connector. Connect VC Gasket Breakout Harness to engine harness only. Disconnect chassis connector 9260[1].)		
A to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.
B to Pin A (9260)	> 500 Ω	If < 500 Ω, check for short to ground within wiring harness.
C to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)		
A to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
B to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

C to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
Harness Resistance Checks (Connect breakout box [X1] to engine harness only. Connect VC Gasket Breakout Harness to engine harness only.)		
X1–20 to A	< 5 Ω	If > 5 Ω, check for open ICP signal.
X1–14 to B	< 5 Ω	If > 5 Ω, check for open V_{REF}.
X1–6 to C	< 5 Ω	If > 5 Ω, check for open ground.

1 Connector 9260 is a 2-wire connector usually in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

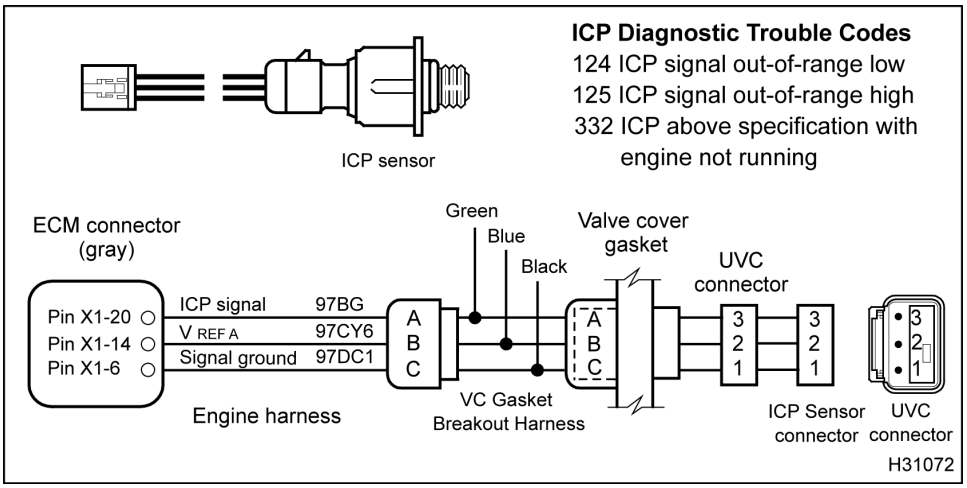


Figure 468 ICP circuit diagram with VC Gasket Breakout Harness

Operational Voltage Checks for ICP Sensor with VC Gasket Breakout Harness (These checks are done if an EST is not available and the valve cover is not removed. Check with VC Gasket Breakout Harness connected to valve cover gasket connector and engine harness.)			
Test Point	**EST voltage readings: Signal to ground**	**Spec**	**Checks**
A to C	0.15 V to 0.3 V	0 kPa (0 psi)	Atmospheric pressure with key-on engine-off
A to C	See Performance Specifications.		Minimum at engine cranking speed
A to C	See Performance Specifications.		Low idle, no load
A to C	See Performance Specifications.		High idle, no load
A to C	See Performance Specifications.		Rated speed, full load
Operational Voltage Checks for ICP Sensor with Breakout Box (Check with breakout box [X-1] connected to ECM and engine harness.)			
X1–20 to X1–6	0.15 V to 0.3 V	0 kPa (0 psi)	Atmospheric pressure with key-on engine-off
X1–20 to X1–6	See Performance Specifications.		Minimum at engine cranking speed
X1–20 to X1–6	See Performance Specifications.		Low idle, no load
X1–20 to X1–6	See Performance Specifications.		High idle, no load
X1–20 to X1–6	See Performance Specifications.		Rated speed, full load
ICP Diagnostic Trouble Codes			
DTC 124 = Signal voltage was < 0.039 V for more than 0.1 second			

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 125 = Signal voltage was > 4.9 V for more than 0.1 second

DTC 332 = Signal voltage was > 1.625 V, key-on engine-off 7.99 kPa (1160 psi)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ICP Pin-Point Diagnostics (ECM to ICP Sensor– valve cover removed)

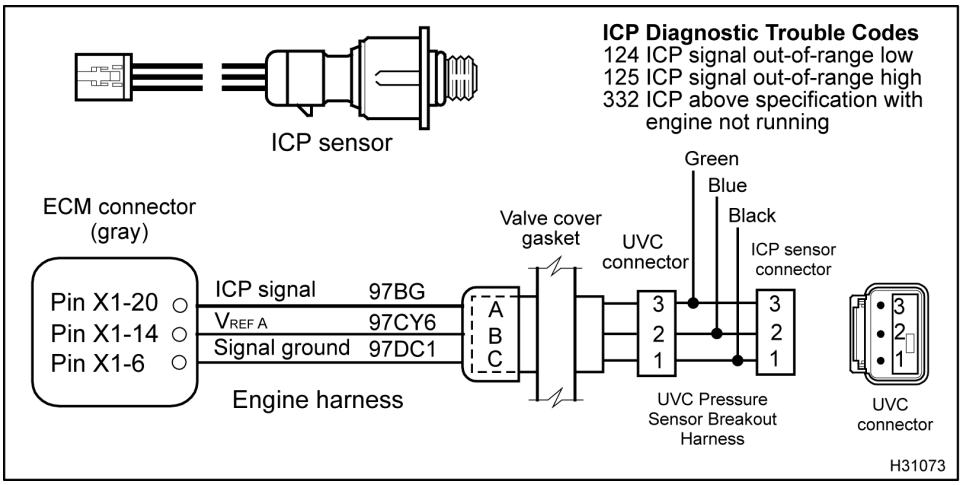


Figure 469 ICP circuit diagram with UVC Pressure Sensor Breakout Harness

Connector Voltage Checks to Ground with Valve Cover Removed (Disconnect sensor from UVC connector and connect UVC Pressure Sensor Breakout Harness to UVC connector only. Turn the ignition switch to ON.)

Test Point	Spec	Comment
1 to gnd	0 V to 0.25 V	Signal ground (no voltage expected). If > 0.25 V, check ground circuit for open or high resistance and check for short to V_{REF} or B+.
2 to gnd	5 V ± 0.5 V	If voltage is not to spec, V_{REF} circuit is shorted to ground, shorted to B+, or open.
3 to gnd	0 V to 0.25 V	If voltage > 0.25 V, signal circuit is shorted to V_{REF} or B+.

Connector Resistance Checks to ECM Chassis Ground with Valve Cover Removed (Turn the ignition switch to OFF. Disconnect sensor from UVC connector. Disconnect chassis connector 9260[1]. Connect UVC Pressure Sensor Breakout Harness to UVC connector only.)

1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit.
2 to Pin A (9260)	> 500 Ω	If < 500 Ω, check for short to ground within wiring harness.
3 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Connector Resistance Checks to Chassis Ground with Valve Cover Removed (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)		
1 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
2 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
3 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
Harness Resistance Checks With Valve Cover Removed (Connect breakout box [X1] to engine harness only. Connect UVC Pressure Sensor Breakout Harness to UVC connector only.)		
X1–6 to 1	< 5 Ω	If > 5 Ω, check for open ground.
X1–14 to 2	< 5 Ω	If > 5 Ω, check for open V_{REF}.
X1–20 to 3	< 5 Ω	If > 5 Ω, check for open ICP signal.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

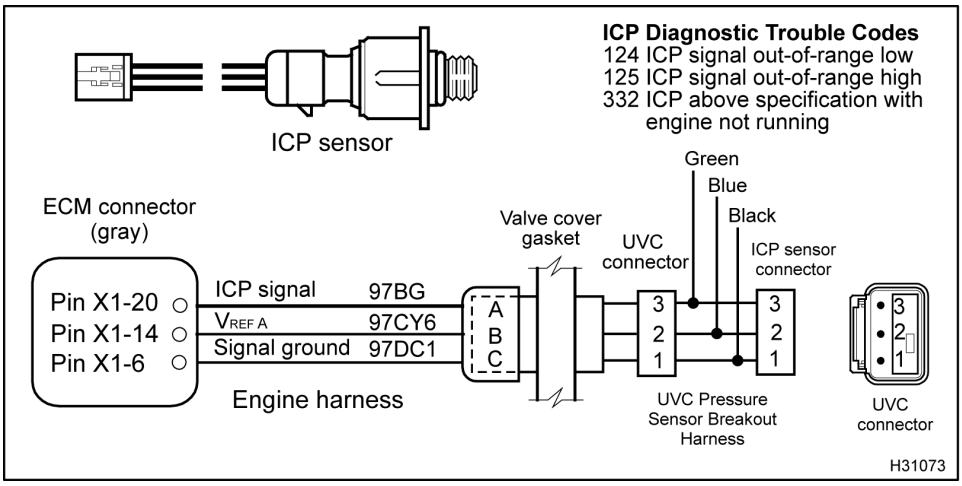


Figure 470 ICP circuit diagram with UVC Pressure Sensor Breakout Harness

Operational Voltage Checks for ICP Sensor with UVC Pressure Sensor Breakout Harness (Check with UVC Pressure Sensor Breakout Harness connected to UVC connector and sensor.)

NOTE: These check are done only if an EST is not available. Do not use this method to measure ICP while the engine is running.

Test Point	EST voltage readings: Signal to ground	Spec	Checks
3 to 1	0.15 V to 0.3 V	0 psi (0 kPa)	Atmospheric pressure with key-on engine-off
3 to 1	See Performance Specifications.		Minimum at engine cranking speed

ICP Diagnostic Trouble Codes

DTC 124 = Signal voltage was < 0.039 V for more than 0.1 second

DTC 125 = Signal voltage was > 4.9 V for more than 0.1 second

DTC 332 = Signal voltage was > 1.625 V, key-on engine-off 7.99 kPa (1160 psi)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

ICP System (Injection Control Pressure)

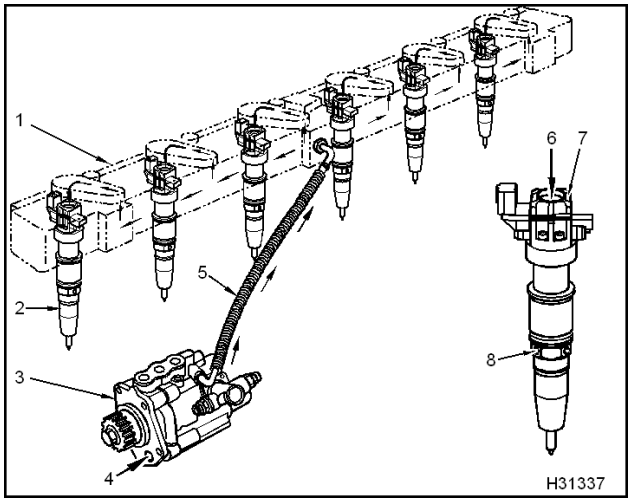


Figure 471 Function diagram for the ICP system

1. High-pressure oil manifold assembly
2. Fuel injector
3. High-pressure pump assembly
4. Oil inlet (lube oil)
5. High-pressure oil hose
6. High-pressure oil inlet (injector)
7. Oil exhaust port (2)
8. Fuel inlet (4)

The ICP system additionally consists of the following subsystems and components:

- Electronic Control Module (ECM)
- Injection Pressure Regulator (IPR)
- Injection Control Pressure (ICP) sensor
- Engine lubrication system
- Cylinder head passage
- High-pressure hydraulic pump
- High-pressure oil hose
- Associated wiring
- Diamond Logic® engine brake (optional)

Function

The function of the ICP system is to develop, maintain, and control the high-pressure injection control pressure to provide the force to actuate the injectors and provide fuel to the engine.

ICP System Operation

Fault Detection / Management

The Diagnostic Trouble Codes (DTCs) associated with this system may indicate an electrical or electronic control system failure, but **will most likely indicate a mechanical or hydraulic problem with the ICP system.**

The ECM continuously monitors the ICP in the system to assure the control system is providing the proper control pressure at all times. If the oil pressure feedback provided by the ICP sensor does not meet ECM desired values, the ECM will set a DTC, illuminate the amber engine lamp and control the operation of the ICP system by calculating the correct oil pressure for all engine operating conditions until the system is diagnosed and repaired.

The ECM monitors the injection control pressure developed while the engine is cranking. When pressure does not develop in an expected time frame, the ECM will set a DTC. The DTC will aid in identifying and diagnosing the hard start and no start condition.

The EST can be used to command the ECM to perform an engine running test on the ICP system. The ECM controls the IPR in a programmed sequence and evaluates system performance. When the test concludes, if a performance issue has been detected, the ECM will set a DTC for that system condition.

When an ICP fault is detected, the ECM will default to open loop of IPR control and the Electronic Service Tool (EST) will display N/A on ICP data. ICP desired will indicate default pressure.

ICP System Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

NOTE: Repair all injector, sensor, and actuator DTCs before doing ICP diagnostic checks and tests. See “Injection Control Pressure (ICP) System Components and High-Pressure Oil Flow” – Section 1 (page 27) for additional information.

NOTE: Engine brake components need to be considered during ICP diagnostics. See “Injection Control Pressure (ICP) System Components and High-Pressure Oil Flow” – Section 1 (page 27) for additional information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, when performing ICP system checks and tests – comply with the following:

- **Read all safety instructions in the foreword of this manual. Follow all warnings, cautions, and notes.**
- **When running the engine in the service bay, make sure the parking brake is set, the transmission is in neutral, and the wheels are blocked.**
- **Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.**

DTC 331 – ICP above system working range

DTC 331 is set by the ECM when the injection control pressure is above normal working range of 30 MPa (4351 psi) for 1.5 seconds. DTC 331 can be an indicator of a problem in the mechanical injection control pressure system, wiring, or ICP sensor.

When DTC 331 is active, the ECM will ignore feedback from the ICP sensor and control the IPR valve from programmed default values. The amber ENGINE lamp will be illuminated when DTC 331 is active.

Possible causes for DTC 331 include the following:

- Debris in engine
- Incorrect grade of oil
- Inoperative, stuck or plugged inlet on the IPR valve
- IPR control wire shorted to ground
- ICP sensor or circuit causing signal to be biased high

Checks and Tests	Comment
Check oil level and quality.	Check oil level and for contamination, debris, and correct API classification.
Check active and inactive DTCs.	Repair any ICP sensor codes. See “ICP Sensor” (page 457).
Do ICP Operational Voltage Checks.	Check KOEO pressure sensor value and voltage. See “ICP Sensor” (page 457).
Do IPR Pin-Point Diagnostics.	See “IPR” (page 494).
Do the KOEO Standard Test.	Test will verify IPR valve circuit continuity. See “Performance Diagnostics” – Section 6 (page 205).
Do KOER Standard Test and Injection Control Pressure Test.	See “Performance Diagnostics” – Section 6 (page 205).

©August 2008 Navistar, Inc.

DTC 333 – ICP above/below desired level

DTC 333 indicates an injection control system response time fault and may be set during normal engine operation through the continuous monitor function or during the KOER Standard Test.

DTC 333 is set by the ECM when the measured pressure does not match the pressure expected by the ECM. DTC 333 will be set if the measured value is less than or greater than 3 MPa (435 psi) of desired injection control pressure for a period greater than 7 seconds.

When DTC 333 is active, the ECM will ignore feedback from the ICP sensor and control the IPR valve from programmed default values. The amber ENGINE lamp will be illuminated when DTC 333 is active.

Possible causes for DTC 333 include the following:

- Low oil level in crankcase
- High oil level in crankcase
- Contaminated engine oil
- Debris in engine oil
- Aerated engine oil
- Trapped air in the ICP system (particularly after an injector or high-pressure pump replacement)
- Intermittent IPR valve wiring connection. Inspect engine wiring harness connector and IPR valve terminal for corrosion. Inspect terminal for bent or pushed back pins.
- Inoperative or stuck injection pressure regulator
- Leaks in ICP system
- Leaks in Brake Control Pressure (BCP) system or failed brake shut-off valve
- Problem with ICP sensor or sensor circuit, incorrect sensor, system biased high or low
- Inoperative high-pressure hydraulic pump

Checks and Tests	Comment
Check repair history – Determine if trapped air caused by ICP system disassembly.	If ICP system was serviced, vehicle should be operated 20 miles to validate system performance
Check oil level and quality.	Check oil level, API classification. Inspect for debris. If contamination is suspected, check oil filter element.
Check active and inactive DTCs.	Repair any ICP sensor codes. See “ICP Sensor” (page 457).
Do ICP Operational Voltage Checks.	Check KOEO pressure sensor values and voltage. See “ICP Sensor” (page 457).
Do IPR Pin-Point Diagnostics.	See “IPR” (page 494).
Do KOEO Standard Test.	Test will verify IPR circuit continuity. See “Performance Diagnostics” – Section 6 (page 205).
Do KOER Standard Test.	Test will verify major ICP system failure. See “Performance Diagnostics” – Section 6 (page 205).
Do KOER Continuous Monitor Test (intermittent DTC detected).	When running test, wiggle wires on ICP sensor, IPR valve, and all pass through connectors while engine is running.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Do Injection Control Pressure Test.	Verify if oil is aerated at high idle. See “Performance Diagnostics” – Section 6 (page 205).
Test ICP system for leaks.	See “Hard Start and No Start Diagnostics” – Section 5 (page 143).

DTC 334 – ICP unable to achieve set point in time (poor performance)

DTC 334 indicates an injection control system response time fault and may be set during normal engine operation through the continuous monitor function or during the KOER Standard Test.

DTC 334 compares measured ICP to desired ICP and looks for a large pressure difference of 9.5 MPa (1378 psi) for a period of 3 seconds.

When DTC 334 is active, the ECM ignores the ICP sensor and controls the IPR valve operation from programmed default values.

Possible causes for DTC 334 include the following:

- Low oil level in crankcase
- High oil level in crankcase
- Contaminated engine oil
- Debris in engine oil
- Aerated engine oil
- Trapped air in the ICP system (particularly after an injector or high-pressure pump replacement)
- Intermittent IPR valve wiring connection. Inspect engine wiring harness connector and IPR valve terminal for corrosion. Inspect terminal for bent or pushed back pins.
- Inoperative or stuck injection pressure regulator
- Leaks in ICP system
- Problem with ICP sensor or sensor circuit, incorrect sensor, system biased high or low
- Inoperative high-pressure hydraulic pump

Checks and Tests	Comment
Check repair history – Determine if trapped air caused by ICP system disassembly.	If ICP system was serviced, vehicle should be operated 20 miles to validate system performance
Check oil level and quality.	Check oil level, API classification. Inspect for debris. If contamination is suspected, check oil filter element.
Check active and inactive DTCs.	Repair any ICP sensor codes. See“ICP Sensor” (page 457).
Do ICP Operational Voltage Checks.	Check KOEO pressure sensor value and voltage. See “ICP Sensor” (page 457).
Do IPR Pin-Point Diagnostics.	Test will verify IPR circuit continuity. See “IPR” (page 494).
Do KOEO Standard Test.	Test will verify IPR circuit continuity. See “Performance Diagnostics” – Section 6 (page 205).
Do KOER Standard Test.	Test will verify major ICP system failure. See “Performance Diagnostics” – Section 6 (page 205).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Do KOER Continuous Monitor Test (intermittent DTC detected).	When running test, wiggle wires on ICP sensor, IPR valve, and all pass through connectors while engine is running.
Do Injection Pressure Control Test.	Verify if oil is aerated at high idle. See “Performance Diagnostics” – Section 6 (page 205).
Test ICP system for leaks.	See “Hard Start and No Start Diagnostics” – Section 5 (page 143).

DTC 335 – ICP unable to build pressure during cranking

DTC 335 is set after the ECM detects 8 to 10 seconds of engine cranking with less than 3.5 MPa (508 psi) of ICP. Engine cranking speed must be greater than 130 rpm before diagnostic trouble code detection can begin.

Engine cranking time varies with engine temperature.

NOTE: If DTC becomes active during Relative Compression Test, ignore and clear DTC.

Possible causes for DTC 335 include the following:

- Low oil level in crankcase
- No lube oil pressure or lube oil delivery (reservoir empty or not filling)
- Trapped air in the ICP system (particularly after an injector or high-pressure pump replacement)
- Leaks in ICP system
- Leaks in BCP system or failed brake shut-off valve
- Inoperative or stuck injection pressure regulator
- Intermittent IPR valve wiring connection. Inspect engine wiring harness connector and IPR valve terminal for corrosion. Inspect terminal for bent or pushed back pins.
- Loose high-pressure hydraulic pump gear
- Inoperative high-pressure hydraulic pump

Checks and Tests	Comment
Visual inspection	Verify ICP sensor and IPR wiring is connected. Check for oil leaks. Verify if system has been recently serviced (air entrapment). If ICP system was serviced, vehicle should be operated 20 miles to validate system performance.
Check oil level and pressure.	Inspect engine oil for debris. Verify lube oil pressure and delivery during engine cranking. Verify delivery by collecting oil from lube oil pressure tap. See “Hard Start and No Start Diagnostics” – Section 5 (page 143).
Check active and inactive DTCs.	Repair any ICP, CKP, or CMP sensor codes first. See“ICP Sensor” (page 457), “CKP Sensor” (page 351), and “CMP Sensor” (page 355) .
Do KOEO Standard Test.	Test will verify IPR valve circuit continuity. See “Hard Start and No Start Diagnostics” – Section 5 (page 143).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Do KOER Continuous Monitor Test.	When engine is running, enable test, wiggle wires on ICP sensor, IPR valve, and all pass through connectors. If DTC is set, or engine dies, check codes and inspect wires at connection point.
Do ICP pressure test.	Test will verify if oil is aerated at high idle. See “Performance Diagnostics” – Section 6 (page 205).
Test ICP system for leaks.	See “Hard Start and No Start Diagnostics” – Section 5 (page 143).
Do IPR Pin-Point Diagnostics.	See “IPR” (page 494).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IDM PWR (Injection Driver Module Power)

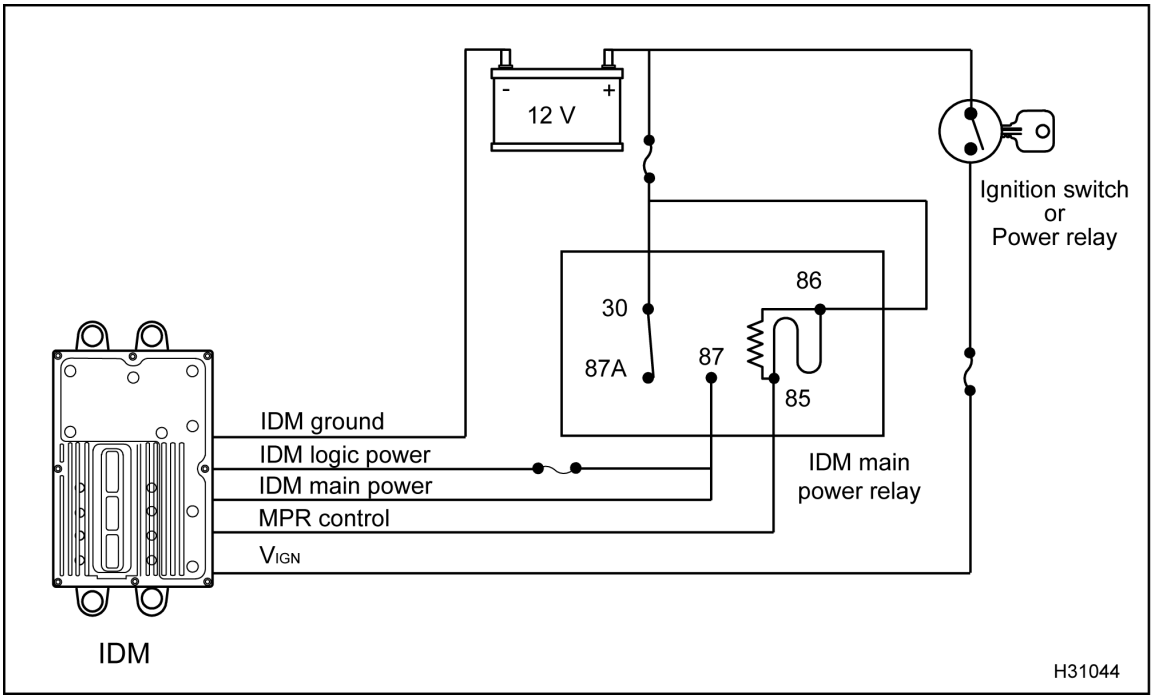


Figure 472 Function diagram for the IDM PWR supply

The function diagram for the IDM PWR includes the following:

- IDM
- IDM main power relay
- Ignition switch or power relay
- Battery
- Fuses

Function

The Injector Drive Module (IDM) requires a 12 V power source. The operating power is received from the vehicle batteries through the IDM main power relay contacts each time the ignition switch is turned ON.

When the ignition is turned ON, the IDM provides an internal ground to the coil side of the IDM main power relay. This closes the relay contacts and provides the IDM with necessary power.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IDM PWR Circuit Operation

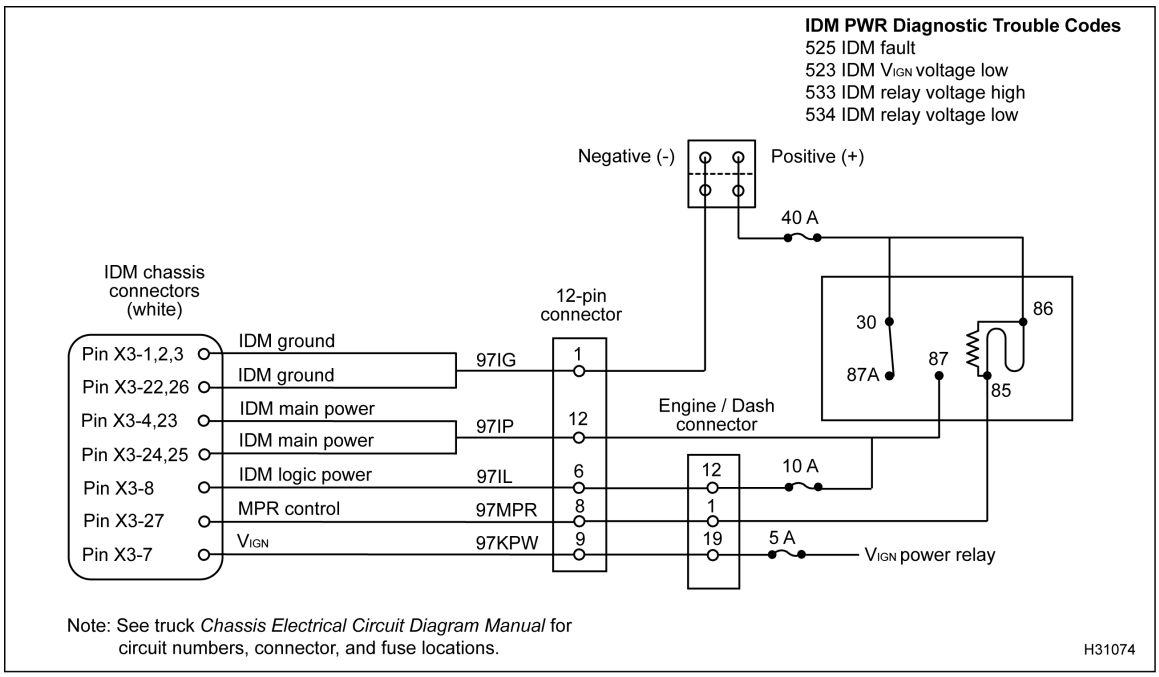


Figure 473 IDM PWR circuit diagram

The IDM is grounded to the battery negative terminal at IDM Pins X3-1, X3-2, X3-3, X3-22 and X3-26.

The IDM receives V_{IGN} power at Pin X3-7. The power signals the IDM to provide a ground path from Pin X3-27 to 85 to switch the IDM main power relay. Switching the relay provides power from the battery positive terminal through a fuse and relay contacts 30 and 87 to Pins X3-4, X3-23, X3-24 and X3-25. Switching the relay also supplies power through a fuse to Pin X3–8 logic power. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Fault Detection / Management

The IDM internally monitors battery voltage. When the IDM continuously receives less than 7 V or more than 16 V a Diagnostic Trouble Code (DTC) will be set.

IDM PWR Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 525
IDM fault

- DTC 525 is set by the ECM when there is an internal IDM failure. When DTC 525 is set, replace the IDM.
- When DTC 525 is active the amber ENGINE lamp is illuminated.

DTC 523
IDM V_{IGN} voltage low

- DTC 523 is set by the ECM when the voltage from V_{IGN} is less than 7 V.
- DTC 523 can be set due to poor connections between the IDM Pin X3-7 and the V_{IGN}.
- DTC 523 will not illuminate the amber ENGINE lamp

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 533
IDM relay voltage high

- DTC 533 is set by the ECM when the voltage from the IDM power relay exceeds 16 V.
- DTC 533 can be set due to an alternator voltage output of 16 V or more. DTC 533 can also be set when jump starting the engine or incorrect external battery connections exist.
- DTC 533 will not illuminate the amber ENGINE lamp.

DTC 534
IDM relay voltage low

- DTC 534 is set by the ECM when the voltage from the IDM main power relay is less than 7 V.
- DTC 534 can be set due to a poor connections between relay and batteries, poor connections between relay and IDM, a blown fuse, or a failed IDM main power relay, discharged batteries or increased resistance in the battery feed circuits.
- DTC 534 will not illuminate the amber ENGINE lamp.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box
- Relay Breakout Harness
- 12–pin Breakout Harness
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IDM PWR Pin-Point Diagnostics

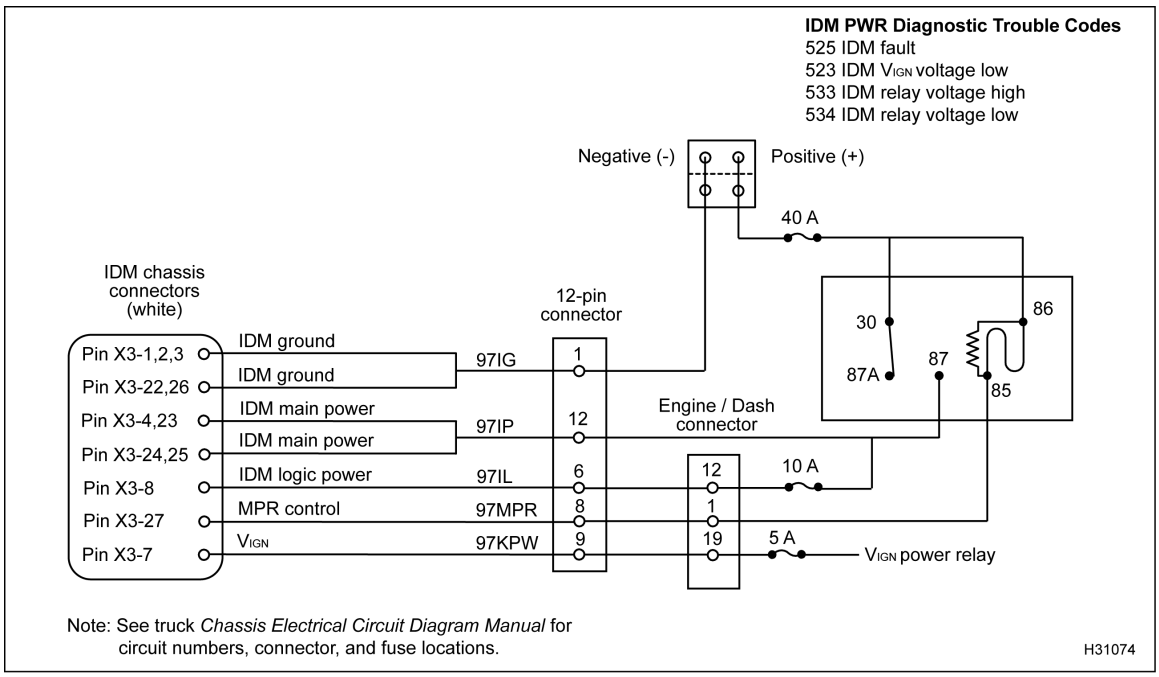


Figure 474 IDM PWR circuit diagram

The IDM PWR circuit requires the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before removing main power relay or any IDM connector supplying power to the IDM. Failure to turn the ignition switch to OFF will cause a voltage spike and damage to electrical components.

Voltage Checks at IDM Power Relay Socket – Key-On Engine-Off (Follow tests in order. Check with relay breakout harness connected to relay and power distribution center and turn the ignition switch on. If all tests are in spec, proceed to 12–pin voltage checks.)

Test Point	Spec	Comment
86 to gnd	12 V ±1.5 V	Continuous voltage. If no voltage, check power circuits from battery or fuse. If fuse is blown, check for short to ground. If fuse is good, check for open between Pin 86 and B+. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
30 to gnd	12 V ± 1.5 V	Continuous voltage. If no voltage, check power circuits from battery or fuse. If fuse is blown, check for short to ground. If fuse is good, check for open between Pin 30 and B+. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
85 to gnd	0.06 V to 2 V	If > 2 V, check for open circuit between IDM Pin X3-27 to Pin 85 on relay or V_{IGN} circuit – continue with 12–pin voltage checks.
87 to gnd	12 V ±1.5 V	Continuous voltage. If previous test points are in spec and no voltage is present, replace relay.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

12–Pin Breakout Harness

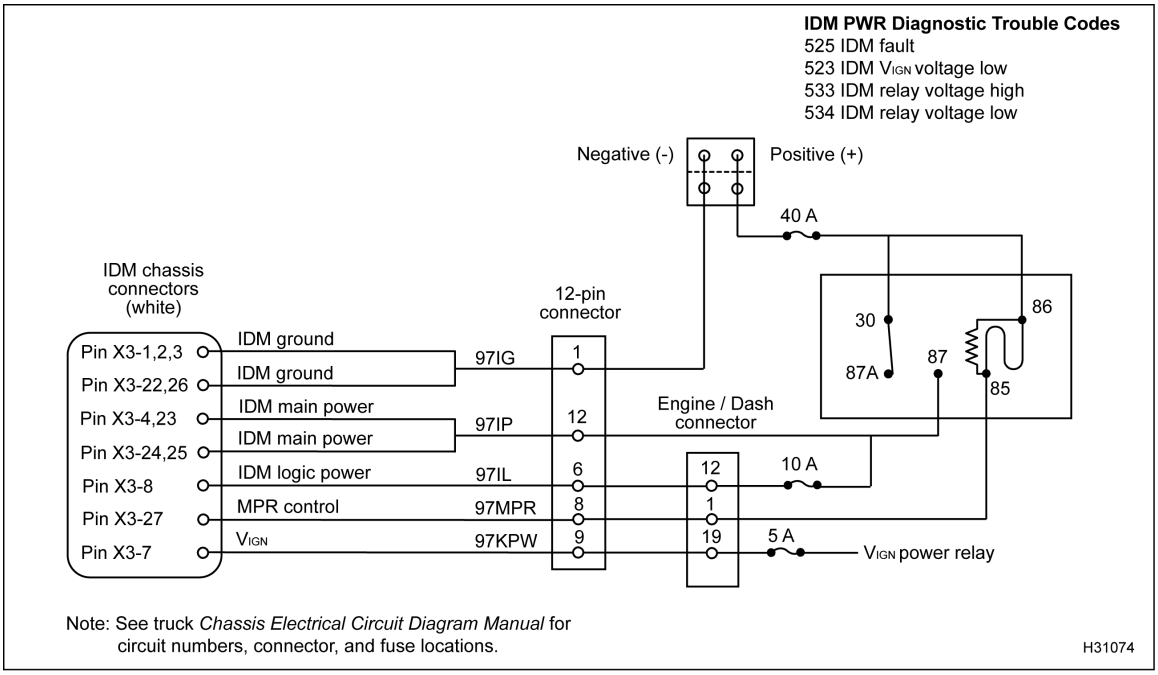


Figure 475 IDM PWR circuit diagram

CAUTION: To avoid engine damage, turn the ignition switch to OFF before removing IDM relay or disconnecting any connectors supplying power to the IDM. Failure to turn the ignition switch to OFF will cause a voltage spike and damage to electrical components.

Voltage Checks at 12-pin Connector – Key-On Engine-Off (Check with breakout harness connected to engine harness and chassis harness at 12–pin connector, IDM relay installed, and key-on engine-off. Follow tests in order. Inspect for bent pins or corrosion.)

Test Point	Spec	Comment
9 to gnd	12 V ±1.5 V	Power from ignition switch to IDM. If no voltage, see truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
8 to gnd	0.06 V to 2 V	IDM MPR – 12–pin connector. If > 2 V, check for open circuit between IDM Pin X3–27 to Pin 8.
12 to gnd	12 V ±1.5 V	IDM power from relay Pin 87. If no voltage, check from Pin 12 to Pin 87 on relay for open or short to ground.
6 to gnd	12 V ±1.5 V	IDM logic power from relay Pin 87 with fuse. If fuse is blown, check for short to ground. If fuse is good, check for open circuit between fuse to Pin 6. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
1 to gnd	0 V to 0.25 V	Ground – voltage reading indicates poor ground to battery. If voltage is present check for open or high resistance between battery (–) and IDM pins.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting the connector or relay for the IDM. Failure to turn the ignition switch to OFF will cause a voltage spike and damage to electrical components.

Voltage Checks at IDM – Key-On Engine-Off (Check with IDM power relay installed. Disconnect IDM X3 connector. Ground Pin X3–27 using Terminal Test Pin Adapter and harness to activate relay and check at harness connector. Inspect for bent pins or corrosion.)

Test Point	Spec	Comment
IDM X3–7 to gnd	12 V ± 1.5 V	Power from ignition switch to IDM. If no voltage, see truck *Chassis Electrical Circuit Diagram Manual*.
IDM X3–1 to gnd	0 V to 0.25 V	Ground – voltage reading indicates poor ground to battery. See truck *Chassis Electrical Circuit Diagram Manual*.
IDM X3–2 to gnd	0 V to 0.25 V	Ground – voltage reading indicates poor ground to battery. See truck *Chassis Electrical Circuit Diagram Manual*.
IDM X3–3 to gnd	0 V to 0.25 V	Ground – voltage reading indicates poor ground to battery. See truck *Chassis Electrical Circuit Diagram Manual*.
IDM X3–22 to gnd	0 V to 0.25 V	Ground – voltage reading indicates poor ground to battery. See truck *Chassis Electrical Circuit Diagram Manual*.
IDM X3–26 to gnd	0 V to 0.25 V	Ground – voltage reading indicates poor ground to battery. See truck *Chassis Electrical Circuit Diagram Manual*.
IDM X3–27 to gnd	0 V to 0.25 V	IDM grounds relay through internal transistor. Expect 0 V with X3–27 grounded. If voltage is present, check Terminal Test Pin Adapter and jumper.
IDM X3–8 to gnd	12 V ± 1.5 V	Power from relay to IDM. If no voltage, check fuses. If a fuse is blown, check for short to ground. If fuses are good, check for open circuit between 87 and X3–8. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–4 to gnd	12 V ± 1.5 V	Power from relay to IDM. If no voltage, check for open between Pin X3–4 and 87 on IDM relay. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–23 to gnd	12 V ± 1.5 V	Power from relay to IDM. If no voltage, check for open between Pin X3–23 and 87 on IDM relay. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3– 24 to gnd	12 V ± 1.5 V	Power from relay to IDM. If no voltage, check for open between Pin X3–24 and 87 on IDM relay. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–25 to gnd	12 V ± 1.5 V	Power from relay to IDM. If no voltage, check for open between Pin X3–25 and 87 on IDM relay. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

©August 2008 Navistar, Inc.

Harness Resistance Checks – Main Power Relay to Battery (Turn the ignition switch to OFF. Disconnect negative battery cable. Disconnect harness from sensor. Inspect for bent pins or corrosion. Connect relay breakout harness.)

30 (IDM relay) to B+ cable	< 5 Ω	If > 5 Ω, check connections for open between relay and positive battery cable. Check fuses. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.
86 (IDM relay) to B+ cable	< 5 Ω	If > 5 Ω, check connections for open between relay and positive battery cable. Check fuse. See truck *Chassis Electrical Circuit Diagram Manual* for relay and fuse locations.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting the connector relay for the IDM. Failure to turn the ignition switch to OFF will cause a voltage spike and damage to electrical components.

Harness Resistance Checks – IDM to Main Power Relay (Turn the ignition switch to OFF. Inspect for bent pins or corrosion. Connect relay breakout harness and use Terminal Test Adapter Kit to test.)

IDM X3–4 to 87	< 5 Ω	If > 5 Ω, check connection from IDM to relay. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–23 to 87	< 5 Ω	If > 5 Ω, check connection from IDM to relay. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–24 to 87	< 5 Ω	If > 5 Ω, check connection from IDM to relay. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–25 to 87	< 5 Ω	If > 5 Ω, check connection from IDM to relay. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–8 to 87	< 5 Ω	If > 5 Ω, check connection from IDM through fuse to relay.
IDM X3–27 to 85	< 5 Ω	If > 5 Ω, check connection from IDM to relay.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting the connector relay for the IDM. Failure to turn the ignition switch to OFF will cause a voltage spike and damage to electrical components.

Harness Resistance Checks – IDM to IDM Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1] and IDM X3 harness. IDM harness connector end is numbered at mating end. Use the Terminal Test Adapter Kit to test.)

Test Point	Spec	Comment
IDM X3–1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check connection to battery ground. See truck*Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–2 to Pin A (9260)	< 5 Ω	If > 5 Ω, check connection to battery ground. See truck*Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–3 to Pin A (9260)	< 5 Ω	If > 5 Ω, check connection to battery ground. See truck*Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–22 to Pin A (9260)	< 5 Ω	If > 5 Ω, check connection to battery ground. See truck*Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–26 to Pin A (9260)	< 5 Ω	If > 5 Ω, check connection to battery ground. See truck*Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–4 to Pin A (9260)	> 900 Ω	If < 900 Ω, check for short to ground within wiring harness.
IDM X3–23 to Pin A (9260)	> 900 Ω	If < 900 Ω, check for short to ground within wiring harness.
IDM X3–24 to Pin A (9260)	> 900 Ω	If < 900 Ω, check for short to ground within wiring harness.
IDM X3–25 to Pin A (9260)	> 900 Ω	If < 900 Ω, check for short to ground within wiring harness.
IDM X3–8 to Pin A (9260)	> 900 Ω	If < 900 Ω, check for short to ground within wiring harness.
IDM X3–27 to Pin A (9260)	> 900 Ω	If < 900 Ω, check for short to ground within wiring harness.
IDM X3–7 to Pin A (9260)	> 900 Ω	If < 900 Ω, check for short to ground within wiring harness.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Harness Resistance Checks – IDM to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1] Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)

Test Point	Spec	Comment
IDM X3–1 to gnd cable	< 5 Ω	If > 5 Ω, check connection to battery ground. See truck*Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–2 to gnd cable	< 5 Ω	If > 5 Ω, check connection to battery ground. See truck*Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–3 to gnd cable	< 5 Ω	If > 5 Ω, check connection to battery ground. See truck*Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–22 to gnd cable	< 5 Ω	If > 5 Ω, check connection to battery ground. See truck*Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–26 to gnd cable	< 5 Ω	If > 5 Ω, check connection to battery ground. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
IDM X3–4 to gnd cable	> 900 Ω	If < 900 Ω, check for short to ground.
IDM X3–23 to gnd cable	> 900 Ω	If < 900 Ω, check for short to ground.
IDM X3–24 to gnd cable	> 900 Ω	If < 900 Ω, check for short to ground.
IDM X3–25 to gnd cable	> 900 Ω	If < 900 Ω, check for short to ground.
IDM X3–8 to gnd cable	> 900 Ω	If < 900 Ω, check for short to ground.
IDM X3–27 to gnd cable	> 900 Ω	If < 900 Ω, check for short to ground.
IDM X3–7 to gnd cable	> 900 Ω	If < 900 Ω, check for short to ground.
Harness Resistance Checks – IDM to Ignition Power Relay (Turn the ignition switch to OFF. Inspect for bent pins or corrosion. Connect relay breakout harness and breakout box to [X3 and X4] to chassis harness only.)		
X3–7 to 87 (V_{IGN} - power relay)	< 5 Ω	If > 5 Ω, see truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations. Check connections in circuit.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IDM PWR Diagnostic Trouble Codes
DTC 525 = IDM fault
DTC 523 = IDM V_{IGN} voltage low
DTC 533 = IDM relay voltage high
DTC 534 = IDM relay voltage low

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

INJ Circuits (Injector Drive)

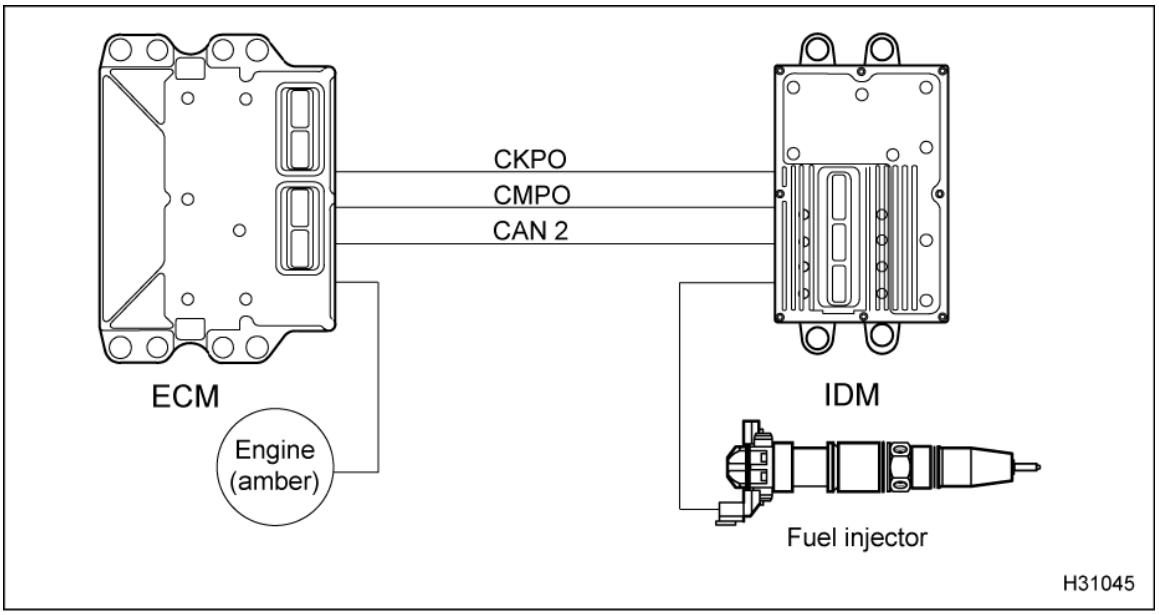


Figure 476 Function diagram for the INJ circuit

The function diagram for INJ circuit includes the following:

- Injectors
- Electronic Control Module (ECM)
- Injector Driver Module (IDM)
- Controller Area Network (CAN 1) link
- Camshaft Position Output (CMPO) signal
- Crankshaft Position Output (CKPO) signal

Function

The IDM is used to control the injectors. The IDM receives CMPO and CKPO signals and fueling information via CAN from the ECM. The IDM calculates injection timing and injector actuation time based on the fuel quantity requested for any engine operation condition.

INJ Circuit Operation

When a coil needs to be energized the IDM turns on both the high and low side driver.

High Side Drive Output

The IDM regulates the current at an average of 20 A. When the current reaches 24 A the IDM shuts off the high side driver. When the current drops to 16 A the IDM turns on the high side driver.

Low Side Drive Return

The injector solenoids are grounded through the low side return circuits. The ECM monitors the low side return circuits. The ECM monitors the low side return signal for diagnostic purposes and utilizes the fly-back current from the injector solenoids to help charge the drive capacitors internal to the ECM.

Fault Detection / Management

When the engine is running, the IDM can detect individual injector coil open and shorts to ground or battery. A KOEO Injector Test allows the operator to enable all injector coils when the engine is off to verify circuit operation. When the IDM detects a fault, Diagnostic Trouble Codes (DTCs) are transmitted over the CAN 2 line between the ECM and IDM.

The IDM transmits a high and low side drive output to the injectors. The high side output supplies the injectors with a power supply of 48 V DC at 20 A. The

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

low side output supplies a return circuit to each injector coil.

The injectors are under the valve covers. Each injector has a close and open coil. The IDM continuously monitors the amount of time (rising time) taken by each coil to draw 20 A. The time is compared to calibrated values and the IDM determines if a circuit or injector fault exists. Each injector has 6 failure modes and 3 DTCs. A failure can occur on the open or close coil circuit.

When a short to ground condition is detected on an injector (low or high side), the IDM discontinues power to the shorted injector and operates the engine on the remaining cylinders.

INJ Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp. The last digit in the injector DTC corresponds to the cylinder where a fault has been detected.

DTC 421-426
High side to low side open

- DTC 421–426 is set by the ECM when the rising time is too long for the open or close coil. DTC 421–426 usually indicates a harness or coil is open.
- DTC 421–426 does not set the amber ENGINE lamp.

DTC 431-436
High side shorted to low side

- DTC 431–436 is set by the ECM when the rising time to 20 A is short, but not zero for the open or close coil. DTC 431–436 usually indicates an internally shorted coil.
- DTC 431–436 does not set the amber ENGINE lamp.

DTC 451-456
High side short to ground or V_{BAT}

- DTC 451–456 is set by the ECM when the rising time to 20 A is zero for the open or close coil. DTC 451–458 usually indicates the harness or coil is shorted to ground.
- DTC 451–456 does not set the amber ENGINE lamp.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Terminal Test Adapter Kit

INJ Pin-Point Diagnostics

WARNING: To avoid serious personal injury or possible death, do not perform voltage checks with the engine running. Injector solenoid operating voltage of 48 V DC @ 20 A is present on injector circuits.

CAUTION: To avoid engine damage, turn the ignition switch to OFF before disconnecting the connector or relay for the IDM. Failure to turn the ignition switch to OFF will cause a voltage spike and damage to electrical components.

Before doing injector diagnostic testing:

1. Turn the ignition switch to OFF.
2. Disconnect IDM connectors (X1 and X2).

All tests are checked at harness end. Pin numbers are marked on all connector mating ends. After checking resistance through injector coils and resistance to chassis ground, if tests are within specification and DTC is active, replace the injector.

NOTE: Only diagnose injectors with active DTCs.

©August 2008 Navistar, Inc.

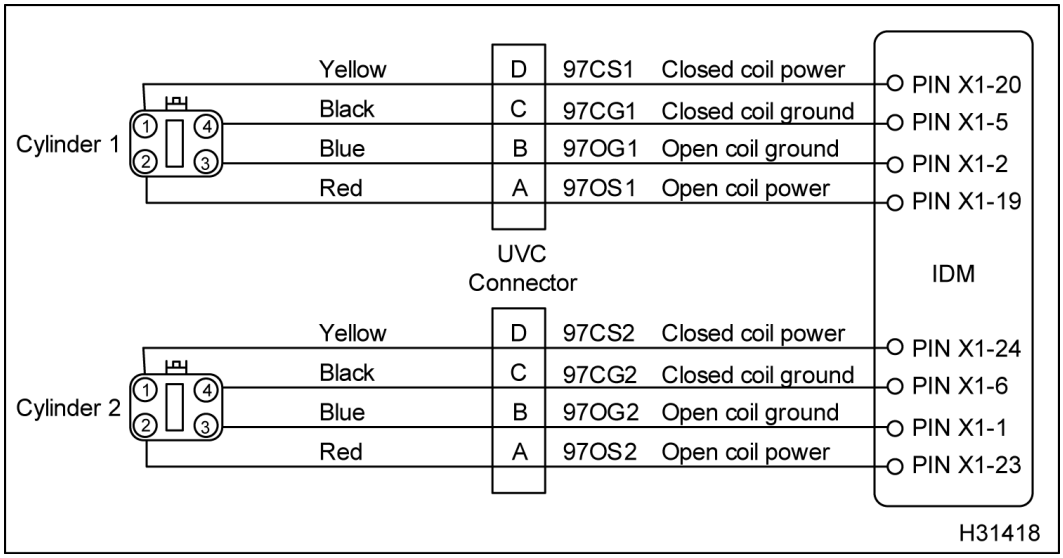


Figure 477 Cylinder 1 and 2 circuit diagram

Injector Cylinder 1

Test Point	Spec	Comment
X1–2 to X1–19	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil
X1–2 to gnd, X1–19 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.
X1–5 to X1–20	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil.
X1–5 to gnd, X1–20 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.

Injector Cylinder 2

Test Point	Spec	Comment
X1–1 to X1–23	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil
X1–1 to gnd, X1–23 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.
X1–6 to X1–24	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil
X1–6 to gnd, X1–29 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

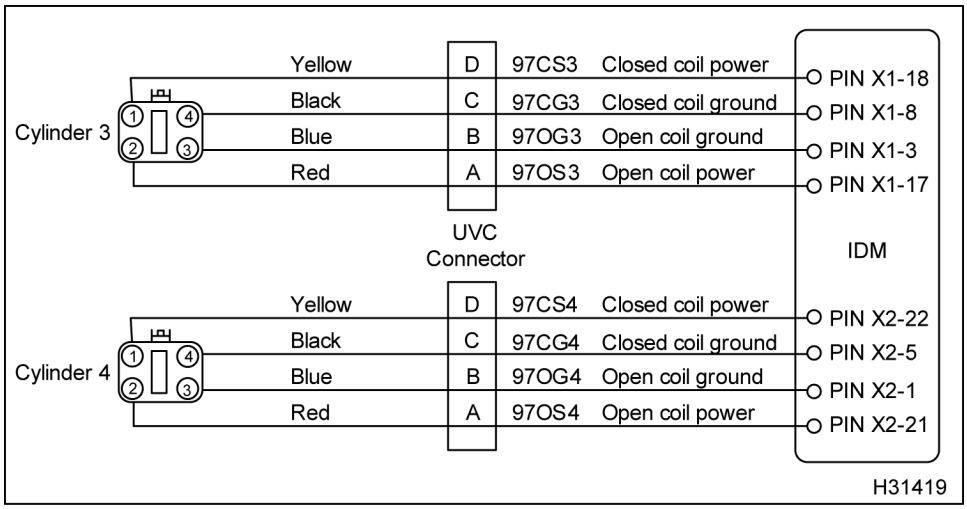


Figure 478 Cylinder 3 and 4 circuit diagram

Injector Cylinder 3

Test Point	Spec	Comment
X1–17 to X1–3	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil.
X1–17 to gnd, X1–3 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.
X1–18 to X1–8	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil
X1–18 to gnd, X1–8 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.

Injector Cylinder 4

Test Point	Spec	Comment
X2–1 to X2–21	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil
X2–1 to gnd, X2–21 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.
X2–5 to X2–22	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil
X2–5 to gnd, X2–22 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

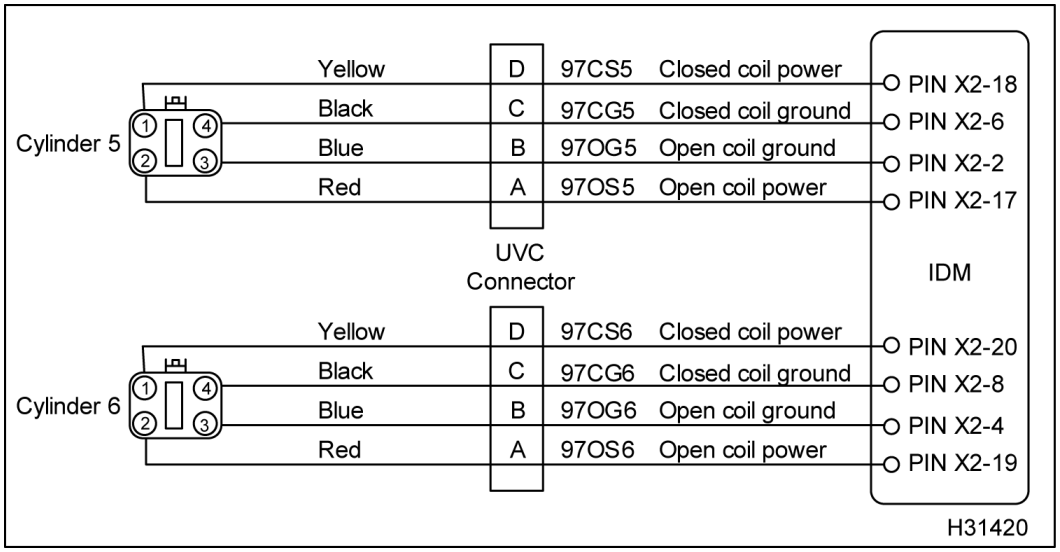


Figure 479 Cylinder 5 and 6 circuit diagram

Injector Cylinder 5

Test Point	Spec	Comment
X2–2 to X2–17	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil
X2–2 to gnd, X2–17 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.
X2–6 to X2–18	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil
X2–6 to gnd, X2–18 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.

Injector Cylinder 6

Test Point	Spec	Comment
X2–4 to X2–19	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil
X2–4 to gnd, X2–19 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.
X2–8 to X2–20	0.7 Ω to 1.5 Ω	If > 1.5 Ω, check for open or high resistance between IDM and injector, or open injector coil
X2–8 to gnd, X2–20 to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground in harness or injector coil. Disconnect injector and retest. If > 1 kΩ, the short is in the injector.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IPR (Injection Pressure Regulator)

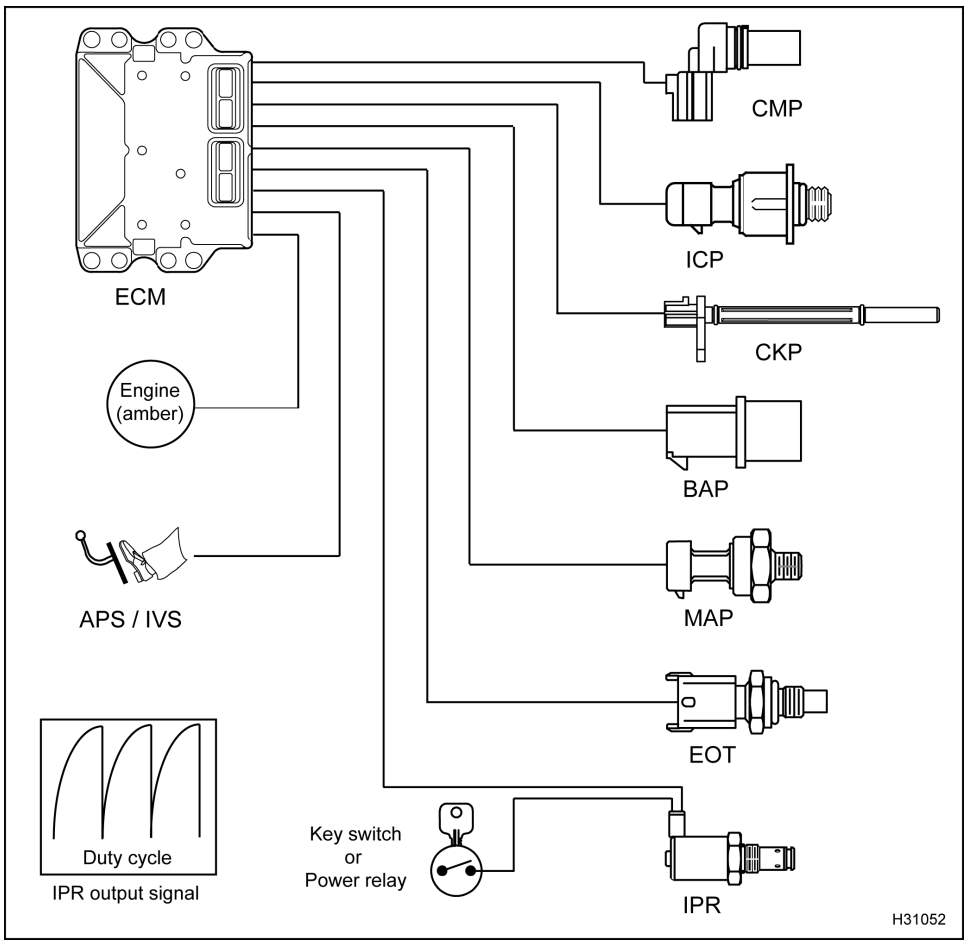


Figure 480 Function diagram for the IPR

The function diagram for the IPR includes the following:

- IPR
- Engine Oil Temperature (EOT) sensor
- Injection Control Pressure (ICP) sensor
- Manifold Absolute Pressure (MAP) sensor
- Barometric Absolute Pressure (BAP) sensor
- Camshaft Position (CMP) sensor
- Crankshaft Position (CKP) sensor
- Accelerator Position / Idle Validation (APS/IVS) sensor
- Electronic Control Module (ECM)

Function

The IPR valve controls oil pressure in the high-pressure injection control system that actuates the injectors. The IPR valve consists of a solenoid, poppet, and a spool valve assembly. The IPR is mounted in the body of the high-pressure pump. The ECM regulates ICP by controlling the ON/OFF time of the IPR solenoid. An increase or decrease in the ON/OFF time positions the poppet and spool valve inside the IPR and maintains pressure in the ICP system or vents pressure to the oil sump through the front cover.

NOTE: The engine may not operate with an IPR fault, depending on the mode of failure.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IPR Circuit Operation

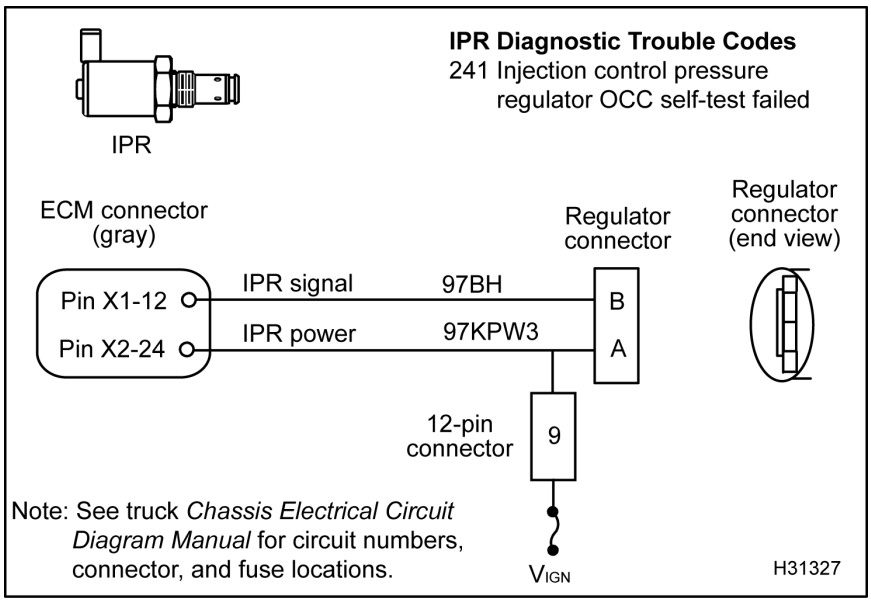


Figure 481 IPR circuit diagram

The IPR valve is supplied with voltage at Pin A of the IPR connector through 12–pin connector (Pin 9) from V_{IGN}. The control of the injection control system is gained by the ECM grounding Pin B of the IPR valve through Pin X1-12 of the ECM. Precise control is gained by varying the percentage of ON/OFF time of the IPR solenoid. A high duty cycle indicates a high amount of injection control pressure is being commanded. A low duty cycle indicates less pressure being commanded.

Fault Detection / Management

An open or short to ground in the ICP control circuit can be detected by an on demand output circuit check during KOEO Standard Test. If there is a circuit fault detected a Diagnostic Trouble Code (DTC) will be set. When the engine is running, the ECM can detect if the injection control pressure is equal to the desired pressure. When the measured injection control pressure does not compare to the desired pressure, the ECM will ignore the measured ICP signal and controls the engine with the desired value.

IPR Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 241
IPR OCC self-test failed

- DTC 241 is set by the ECM when the Output Circuit Check (OCC) test has failed after the KOEO Standard Test has been run.
- DTC 241 can be set when a poor connection to the IPR solenoid or inoperative IPR coil exists.
- When DTC 241 is active the engine will not run and the amber ENGINE lamp will not be illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box
- Actuator Breakout Harness
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IPR Pin-Point Diagnostics

The IPR circuit requires the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

IPR Voltage Checks (Disconnect regulator connector. Connect breakout harness to engine harness only. Turn the ignition switch to ON.)

Test Point	Spec	Comment
A to gnd	B+	IPR power from V_{IGN} – If no voltage, check from fuse to IPR connector. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.
B to gnd	0 V to 0.25 V	If > 0.25 V, control wire is shorted to V_{REF} or B+.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Connect breakout harness to engine harness only. Disconnect chassis connector 9260[1].)		
1 to Pin A (9260)	> 1 kΩ	Resistance to chassis ground. If < 1 kΩ, check for short to ground in circuit (check with fuse removed)
2 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground
Harness Resistance Checks - 12-pin Connector to IPR Connector (Turn the ignition switch to OFF. Connect 12- pin breakout harness to engine harness only. Connect actuator breakout harness to engine harness only. Check with fuse removed.)		
Pin 9 to A	< 5 Ω	If > 5 Ω check for open circuit.
Harness Resistance Checks - IPR Circuit Including Regulator (Turn the ignition switch to OFF. Connect Breakout Box X1 to engine harness only. Connect engine harness to IPR. Check with fuse remove.)		
X1-12 to fuse	5 Ω to 20 Ω	Resistance through entire IPR circuit including regulator. If not within specification do Actuator Resistance Check.
Actuator Resistance Checks (Turn the ignition switch to OFF. Disconnect the connector from the IPR, connect breakout harness to IPR only. Check resistance through the IPR only.)		
A to B	5 Ω to 20 Ω	Resistance through IPR coil only. If not within specification replace IPR.

IPR Diagnostic Trouble Codes

DTC 241 = Output Circuit Check detected during KOEO Standard Test, indicates high or low resistance in circuit.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

IST System (Idle Shutdown Timer)

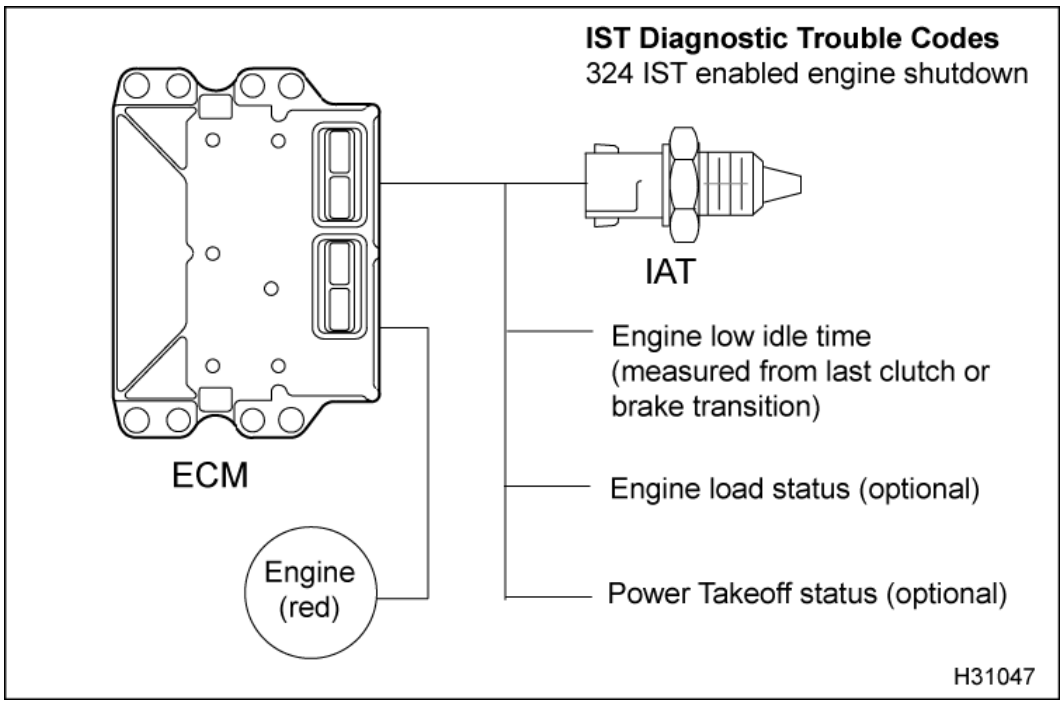


Figure 482 Function diagram for the IST system

The function diagram for the IST system includes the following:

- Electronic Service Tool (EST)
- Intake Air Temperature (IAT) sensor
- ENGINE lamp (red)

IST Operation

The IST is an optional feature that allows the ECM to shutdown the engine when an extended idle condition occurs. The idle timer can be programmed for the customer to automatically shut the engine down for idle times that range from 2 to 120 minutes.

Before engine shutdown, the red ENGINE lamp will illuminate. The lamp will flash for 30 seconds to warn the operator the engine is approaching shutdown. Idle time is measured from last clutch or brake pedal transition. The engine must be out of gear for the IST to work.

The IST feature can be programmed to operate at specific ambient air temperatures, allowing engine operation in cold or hot weather. Power Takeoff (PTO) applications can be programmed to disable the IST feature for load levels or when PTO features are active.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The resets for the IST include:

- PTO is active.
- Engine speed is not at idle speed (700 rpm).
- Vehicle movement or a Vehicle Speed Sensor (VSS) fault is detected.
- Engine coolant operating temperature is below 60 °C (140 °F).
- Ambient air temperature is below 16 °C (60 °F) or above 44 °C (110 °F).
- Brake pedal movement or a brake switch fault is detected.
- Clutch pedal is depressed or a fault for the clutch pedal switch is detected (manual transmissions, if equipped with clutch switch).
- Shift selector is moved from neutral or park (automatic transmissions).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The IST feature provides several advantages when enabled. Reduced emissions, fuel consumption, and engine wear are all direct results from the IST strategy.

There are four states of the IST electronic operation.

- **Idle shutdown timer** indicates to the on-board electronics that the vehicle has the following features:
  - OFF – turned off at all times.
  - PTO available – allows prolonged engine idle shutdown when engine is in low idle and PTO is disabled.
  - No engine load – allows prolonged engine idle shutdown when engine is in low idle / no load condition.
  - Tamper proof – prohibits operator over-ride.
- **Idle shutdown time** indicates the programmed value of engine idle time before engine will shutdown.
- **Maximum ambient intake air temperature** indicates maximum value of ambient intake air temperature programmed to shutdown engine. This feature prevents engine shutdown due to air conditioner usage.
- **Minimum ambient intake air temperature** – indicates minimum value of ambient intake air temperature programmed to shutdown engine. This feature prevents engine shutdown due to cold ambient temperature.

Fault Detection / Management

The IST feature is internal to the ECM. The subsystems that contribute to the IST strategy have their own fault codes. The fault code for the IST is not a system diagnostic trouble code. The IST fault code is only set to indicate that the IST has been activated and the engine has shutdown.

IST Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 324
IST enabled engine shutdown

- DTC 324 is set by the ECM when the engine has been shutdown due to exceeding the programmed idle time criteria. The IST feature must be enabled for DTC 324 to be displayed.

NOTE: DTC 324 does not indicate any system or circuit DTCs. Diagnostic checks are not required for DTC 324.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

MAP Sensor (Manifold Absolute Pressure)

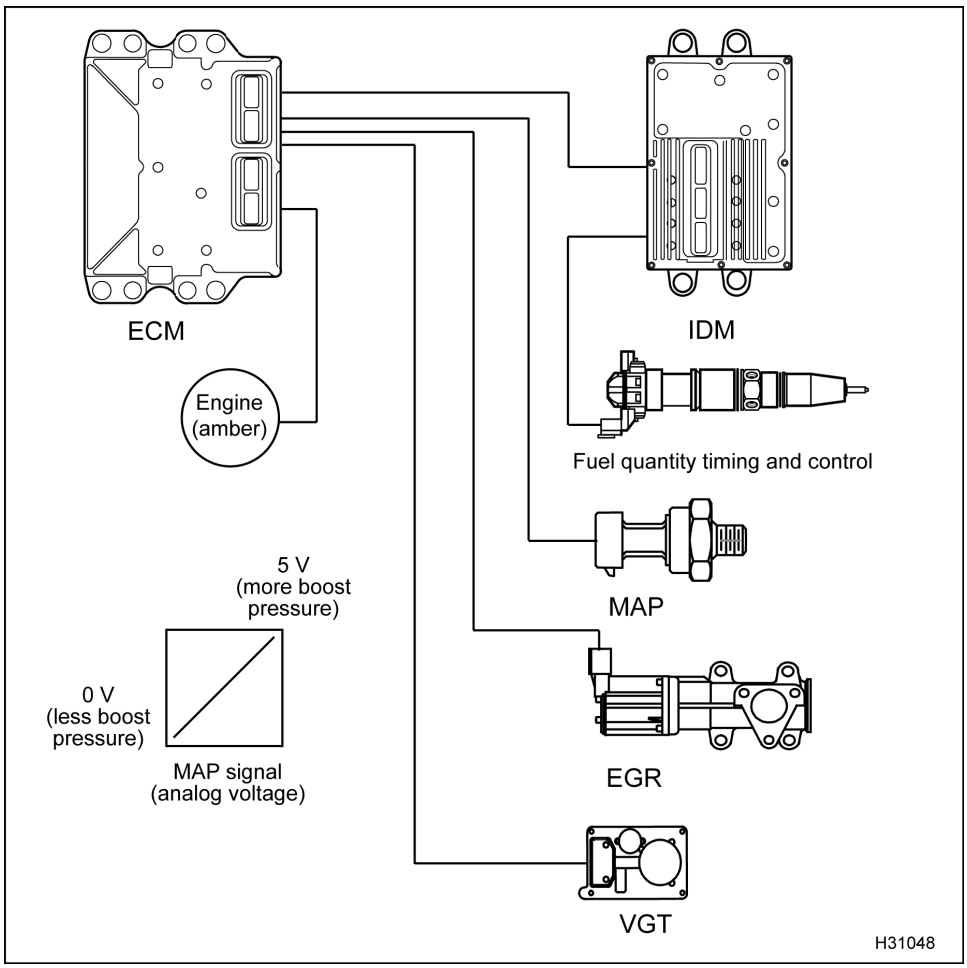


Figure 483 Function diagram for the MAP sensor

The function diagram for the MAP sensor includes the following:

- MAP sensor
- Electronic Control Module (ECM)
- Injector Drive Module (IDM)
- Exhaust Gas Recirculation (EGR)
- Variable Geometry Turbocharger (VGT)
- Fuel injector
- ENGINE lamp (amber)

Function

The MAP sensor is a variable capacitance sensor installed left of the MAT sensor in the intake manifold. The ECM supplies a 5 V reference signal which the MAP sensor uses to produce a linear analog voltage that indicates pressure. The ECM uses the MAP sensor signal to assist in the calculation of the EGR and VGT duty percentage. The ECM monitors the MAP signal to determine intake manifold (boost) pressure. From this information the ECM can optimize control of fuel rate and injection timing for all engine operating conditions.

©August 2008 Navistar, Inc.

MAP Circuit Operation

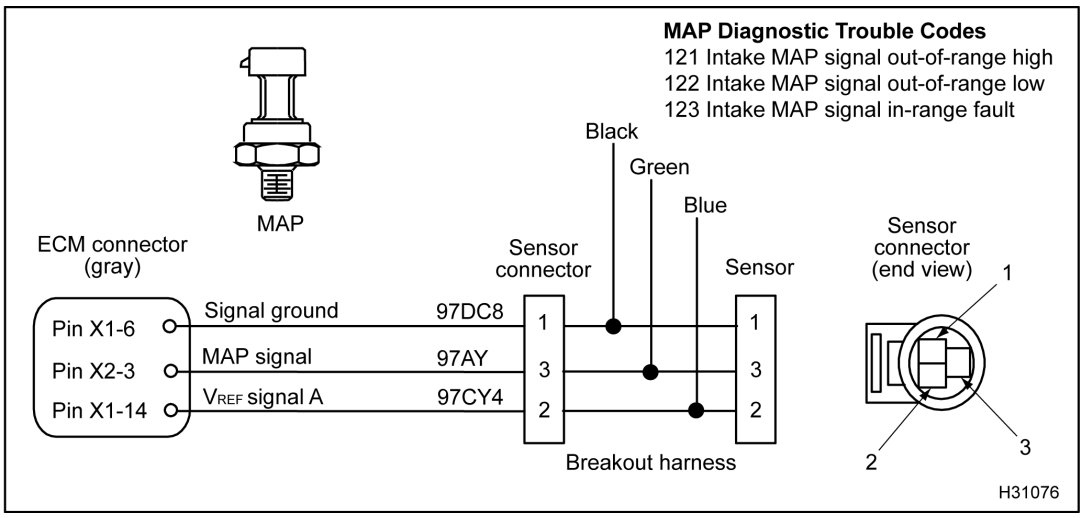


Figure 484 MAP circuit diagram

The MAP sensor is supplied with a 5 V reference voltage at Pin 2 from ECM Pin X1–14. The MAP sensor is grounded at Pin 1 from ECM Pin X1–6. The MAP sensor returns a variable voltage signal from Pin 3 to ECM Pin X2–3.

Fault Detection / Management

The ECM will ignore the MAP signal when the signal is detected to be out of range or an incorrect value is read. The engine will continue to operate based on estimated values.

MAP Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 121
Intake MAP signal out-of-range high

- DTC 121 is set by the ECM when the MAP signal is greater than 4.9 V for more than 0.4 second.
- DTC 121 can be set due to a signal circuit short to V_{REF} or B+ or a failed MAP sensor.
- When DTC 121 is active the amber ENGINE lamp is illuminated.

DTC 122

Intake MAP signal out-of-range low

- DTC 122 is set by ECM when the MAP signal is less than 0.039 V for more than 0.4 second.
- DTC 122 can be set due to an open or short to ground on the signal circuit, a failed MAP sensor or an open V_{REF} circuit or V_{REF} short to ground.
- When DTC 122 is active the amber ENGINE lamp is illuminated.

DTC 123
Intake MAP signal in-range fault

- DTC 123 is set by ECM when the MAP signal is greater than 115 kPa (17 psi) absolute at low idle.
- DTC 123 can be set due to a restricted or plugged sensor inlet, open signal ground, V_{REF} shorted to voltage source above 5.5 V, biased circuit, or a failed MAP sensor.
- When DTC 123 is active the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- Breakout Box
- Breakout Harness
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

MAP Operational Diagnostics

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the D_ContinuousMonitor.ssn.

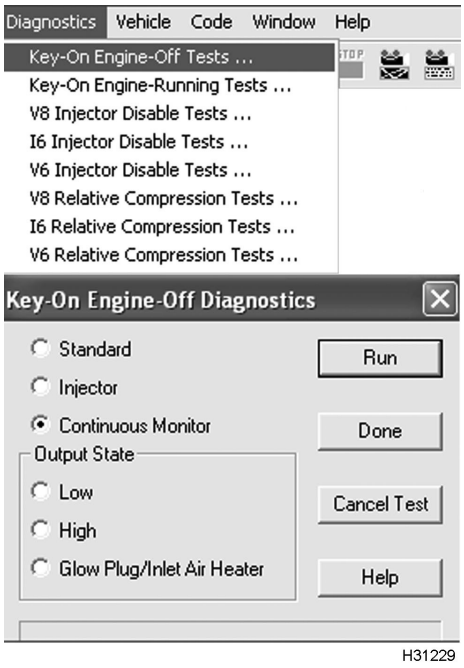


Figure 485 Continuous Monitor Test

2. To monitor signal voltage, run KOEO Continuous Monitor Test. For help, see “Continuous Monitor Test” in Section 3 (page 68).
3. Monitor MAP signal voltage. Verify an active DTC for the MAP circuit.
4. If code is active, do step 6 and 7 to check circuit for the MAP sensor using the following table.
   - Circuit Checks for MAP Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Disconnect engine harness from pressure sensor.

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

7. Connect Pressure Sensor Breakout Harness to engine harness only.

©August 2008 Navistar, Inc.

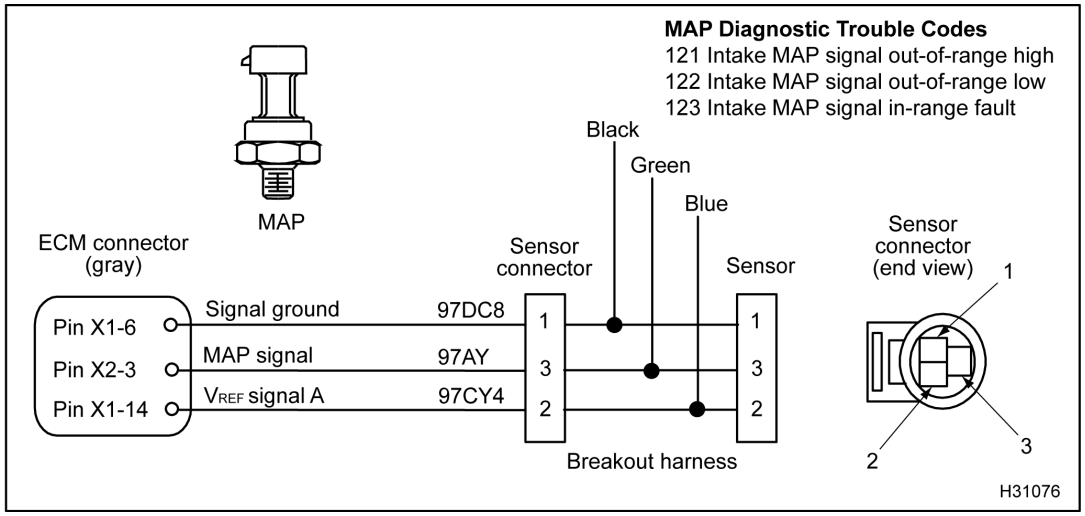


Figure 486 MAP circuit diagram

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Circuit Checks for MAP Sensor (Use EST, DMM, breakout harness, and 500 Ohm Resistor Harness.)

Test Condition	Spec	Checks
Sensor disconnected using EST	0 V	If voltage > 0.039 V, check signal circuit for short to V_{REF} or B+.
Voltage from Pin 2 (Blue) to ground using DMM	5 V ±0.5 V	If voltage > 5.5 V, check V_{REF} for short to B+. If voltage is < 4.5 V, check V_{REF} for open or short to ground.
500 Ohm Resistor Harness connected between Pin 3 (Green) and Pin 2 (Blue) of breakout harness using EST.	5 V	If voltage < 4.9 V, check signal circuit for open or short to ground. — Disconnect connector 9260[1]. Measure resistance from Pin 3 to Pin A of connector 9260 (spec > 1 kΩ) to check for short to ground within wiring harness. — Disconnect negative battery cable. Measure resistance from Pin 3 to ground cable to check for short to ground. — Use a breakout box from Pin 3 to Pin X2–8 (spec < 5 Ω) to check for open in the harness.
Resistance from Pin 1 (Black) of breakout harness to Pin A of connector 9260 using DMM	< 5 Ω	If resistance is > 5 Ω, check for open or high resistance between ECM and sensor connector. Use a breakout box and measure resistance from between Pin 1 and Pin X1–6 (spec < 5 Ω).

Connect engine harness to sensor. Use the EST to clear DTCs. If an active code remains after checking test conditions, replace the MAP sensor.

©August 2008 Navistar, Inc.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

MAP Pin-Point Diagnostics

Connector Voltage Checks to Ground (Disconnect harness from sensor. Inspect for bent pins or corrosion. Connect breakout harness to engine harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
1 to gnd	0 V to 0.25 V	Signal ground (no voltage expected). If > 0.25 V, check ground circuit for open or high resistance and check signal ground for short to V_{REF} or B+.
2 to gnd	5 V ± 0.5 V	If voltage is not to spec, V_{REF} circuit is shorted to ground, shorted to B+, or open.
3 to gnd	0 V to 0.25 V	If > 0.25 V, signal circuit is shorted to V_{REF} or B+.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Connect breakout harness to engine harness only. Disconnect chassis connector 9260[1].)		
1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit.
2 to Pin A (9260)	> 500 Ω	If < 500 Ω, check for short to ground within wiring harness.
3 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)		
1 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
2 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
3 to gnd cable	> 1 kΩ	If < 1 kΩ , check for short to ground.
Harness Resistance Checks (Connect breakout box to engine harness [X1 and X2 only] and breakout harness to engine harness only.)		
X1–6 to 1	< 5 Ω	If > 5 Ω, check for open ground wire.
X1–14 to 2	< 5 Ω	If > 5 Ω, check for open V_{REF} wire.
X2–3 to 3	< 5 Ω	If > 5 Ω, check for open signal wire.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

©August 2008 Navistar, Inc.

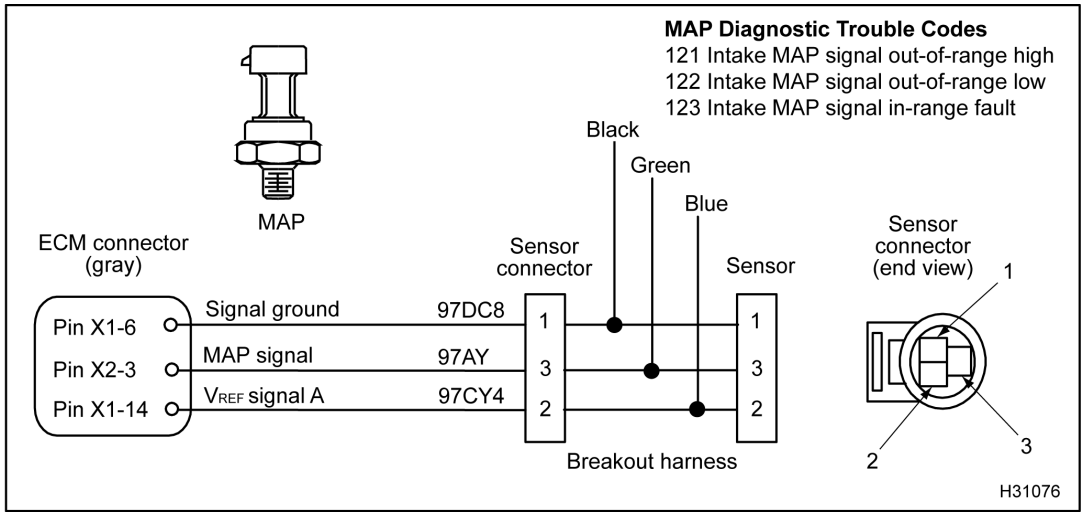


Figure 487 MAP circuit diagram

Operational Voltage Checks for MAP Sensor with Breakout Harness (Check with breakout harness connected to sensor and engine harness.)			
Test Point	**EST voltage readings: Signal to ground**	**Spec**	**Comment**
3 (Green) to 1 (Black)	0.92 V	0 kPa (psi)	Voltage with key-on engine-off. Atmospheric pressure dependent on altitude and BAP pressure.
3 (Green) to 1 (Black)	1.73 V	55 kPa (8 psi)	
3 (Green) to 1 (Black)	2.72 V	129 kPa (18 psi)	
3 (Green) to 1 (Black)	3.71 V	193 kPa (28 psi)	
3 (Green) to 1 (Black)	See appropriate performance specification below.		Rated speed, full load
Operational Voltage Checks for MAP Sensor with Breakout Box (Check with breakout box connected [X1 and X2 only] to the ECM and engine harness.)			
X2–3 to X1–6	0.92 V	0 kPa (psi)	Voltage with key-on engine-off. Atmospheric pressure dependent on altitude and BAP pressure.
X2–3 to X1–6	1.73 V	55 kPa (8 psi)	
X2–3 to X1–6	2.72 V	129 kPa (18 psi)	
X2–3 to X1–6	3.71 V	193 kPa (28 psi)	
X2–3 to X1–6	See appropriate performance specification below.		Rated speed, full load
“DT 466 Performance Specifications” – Appendix A (page 595)			
“DT 570 and HT 570 Performance Specifications – Appendix B (page 619)			
MAP Diagnostic Trouble Codes			

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC 121 = Signal voltage was > 4.9 V for more than 0.4 second

DTC 122 = Signal voltage was < 0.039 V for more than 0.4 second

DTC 123 = Detected boost signal voltage was > 115 kPa (17 psi) absolute at low idle.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

MAT Sensor (Manifold Air Temperature)

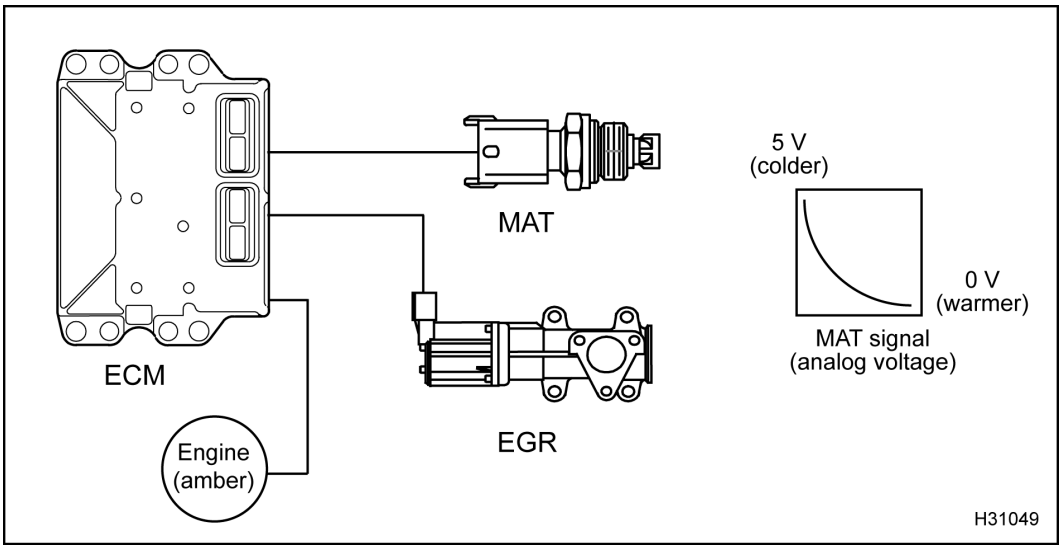


Figure 488 Function diagram for the MAT sensor

The function diagram for the MAT sensor includes the following:

- MAT sensor
- Exhaust Gas Recirculation (EGR)
- Electronic Control Module (ECM)
- ENGINE lamp (amber)

Function

The MAT sensor is a thermistor sensor installed right of the MAP sensor in the intake manifold. The ECM supplies a 5 V reference signal which the MAT sensor uses to produce an analog voltage that indicates temperature. The MAT sensor changes resistance when exposed to different temperatures. As air temperature decreases, the resistance of the thermistor increases. This causes the signal voltage to increase. As air temperature increases, the resistance of the thermistor decreases. This causes the signal voltage to decrease.

The MAT sensor provides a feedback signal to the ECM indicating manifold air temperature. The ECM monitors the MAT signal to determine if the temperature is satisfactory. During engine operation, if the ECM recognizes that the MAT signal is greater or less than the expected value it will set a Diagnostic Trouble Code (DTC).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

MAT Circuit Operation

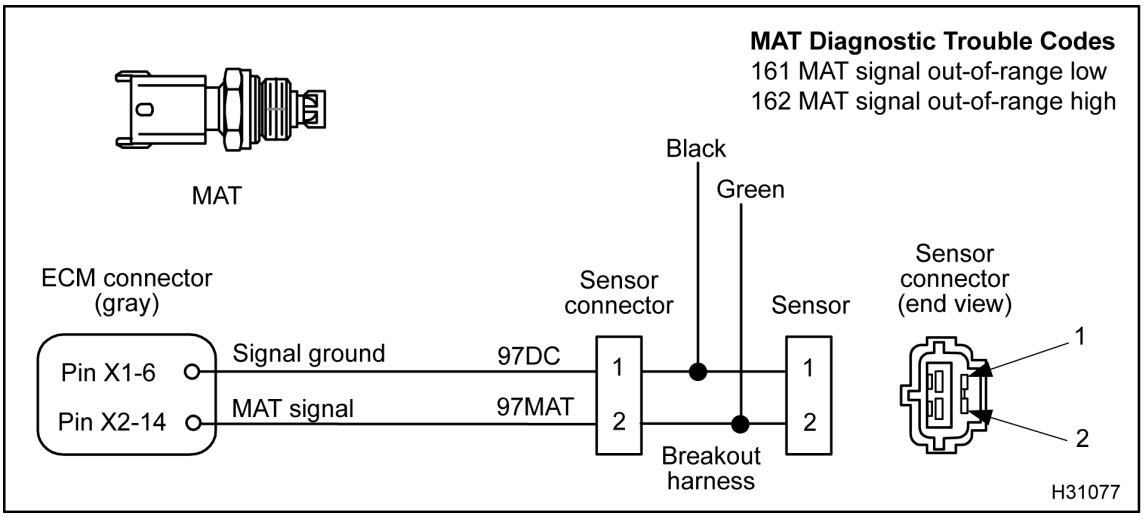


Figure 489 MAT circuit diagram

The MAT sensor is supplied with a 5 V reference voltage at Pin 2 from ECM Pin X2–14. The sensor is grounded at Pin 1 through the signal ground at ECM Pin X1–6. As the air temperature increases or decreases, the sensor changes resistance and provides the air temperature signal voltage at the ECM. The signal voltage is monitored by the ECM to determine the temperature of the air.

Fault Detection / Management

The ECM continuously monitors the signal of the MAT sensor to determine if the signal is within an expected range. If the ECM detects the signal voltage is greater or less than expected, the ECM will set a DTC.

MAT Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 161
MAT signal out-of-range low

- DTC 161 is set by the ECM when the signal voltage is less than 0.098 V for more than 0.35 second.
- DTC 161 can be set due to a short to ground in the signal circuit or a failed MAT sensor.
- When DTC 161 is active the amber ENGINE lamp is illuminated.

DTC 162
MAT signal out-of-range high

- DTC 162 is set by ECM when the signal voltage is greater than 4.58 V for more than 0.35 second.
- DTC 162 can be set due to an open signal or ground circuit , short to a voltage source, or a failed MAT sensor.
- When DTC 162 is active the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- 3-Banana Plug Harness
- 500 Ohm Resistor Harness
- Breakout Box
- Breakout Harness
- Terminal Test Adapter Kit

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

MAT Operational Diagnostics

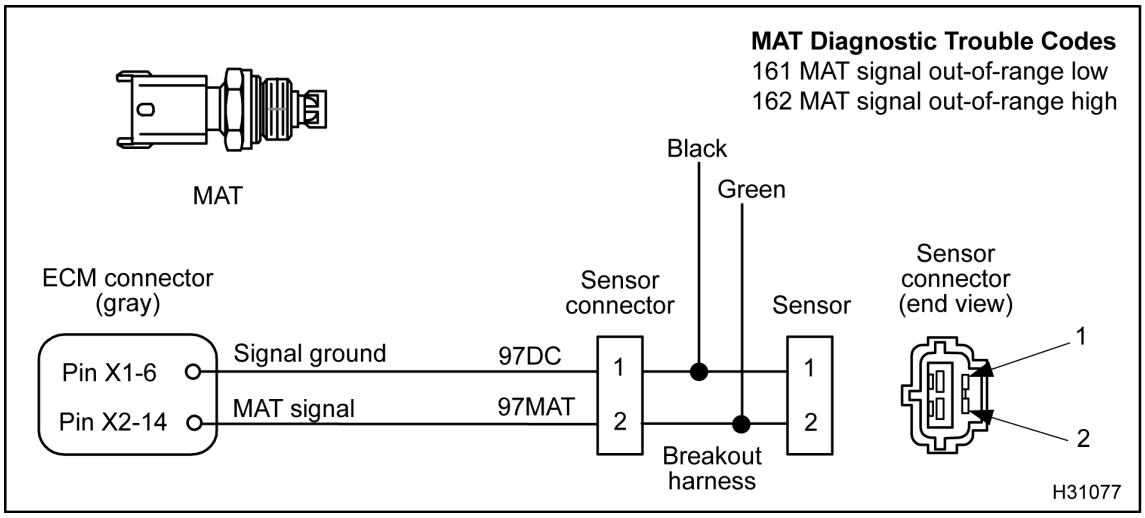


Figure 490 MAT circuit diagram

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle – comply with the following:

Be careful to avoid rotating parts (belts and fan) and hot engine surfaces.

1. Using EST, open the D_ContinuousMonitor.ssn.

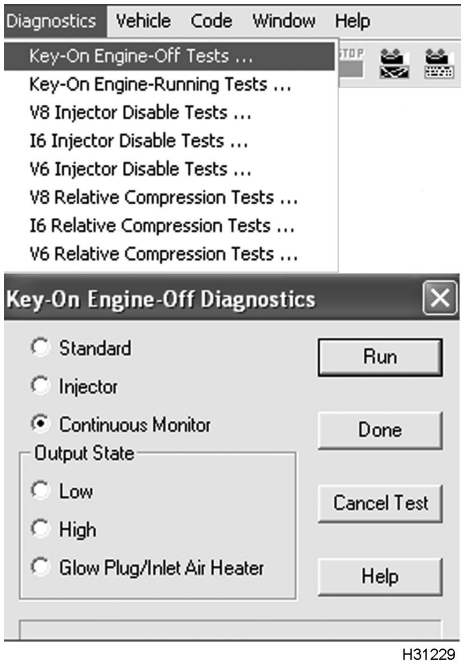


Figure 491 Continuous Monitor Test

2. To monitor signal voltage, run KOEO Continuous Monitor Test. For help, see “Continuous Monitor Test” in Section 3 (page 68).
3. Monitor MAT signal voltage. Verify an active DTC for the MAT circuit.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

4. If code is active, do step 6 and 7 to check circuit for the MAT sensor using the following table.
   - Circuit Checks for MAT Sensor
5. If code is inactive, wiggle connectors and wires at all suspected problem locations. If circuit continuity is interrupted, the EST will display DTCs related to the condition.
6. Disconnect engine harness from temperature sensor.

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

7. Connect Temperature Sensor Breakout Harness to engine harness only.

Circuit Checks for MAT Sensor (Use EST, breakout harness, 3-Banana Plug Harness, and 500 Ohm Resistor Harness.)

Test Condition	Spec	Checks
Sensor disconnected	> 4.58 V	If voltage < 4.58 V, check signal circuit for short to ground.
3-Banana Plug Harness connected between Pin 2 (Green) and Pin 1 (Black) of breakout harness	0 V	If voltage is > 0.098 V, check ground and signal circuit for open or high resistance. Use a breakout box and measure resistance from Pin 1 to Pin X1–6 and from Pin 2 to X2–14 (spec < 5 Ω).
500 Ohm Resistor Harness connected between Pin 2 (Green) and Pin 1 (Black) of breakout harness	< 1.0 V	If voltage > 1.0 V, check signal circuit for short to V_{REF}, B+, or another sensor's signal voltage.

Connect engine harness to sensor. Use the EST to clear DTCs. If an active code remains after checking test conditions, replace the MAT sensor.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

MAT Pin-Point Diagnostics

Connector Voltage Checks to Ground (Disconnect harness from sensor. Inspect for bent pins or corrosion. Connect breakout harness to engine harness only. Turn the ignition switch to ON.)		
Test Point	**Spec**	**Comment**
1 to gnd	0 V to 0.25 V	If > 0.25 V, signal wire is shorted to V_{REF} or battery.
2 to gnd	4.6 V to 5 V	Pull up voltage. If no voltage, circuit has open or high resistance or short to ground.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect harness from sensor. Connect breakout harness to engine harness only. Disconnect chassis connector 9260[1].)		
1 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit.
2 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Connect breakout harness to engine harness only. Use disconnected negative battery cable for ground test point.)		
1 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
2 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
Harness Resistance Checks (Connect breakout box [X1 and X2 only] to engine harness. Connect breakout harness to engine harness only.)		
X1–6 to 1	< 5 Ω	If > 5 Ω, check for open ground wire.
X2–14 to 2	< 5 Ω	If > 5 Ω, check for open signal wire.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. See truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Operational Voltage Checks for MAT Sensor with Breakout Harness (Check with breakout harness connected to sensor and engine harness.)			
Test Point	**Temp**	**Resistance**	**Voltage @ Resistance**
2 (Green) to 1 (Black)	0 °C (32 °F)	93.8 kΩ	4.36 V
2 (Green) to 1 (Black)	15 °C (59 °F)	47.6 kΩ	4.0 V
2 (Green) to 1 (Black)	40 °C (104 °F)	15.8 kΩ	2.98 V
2 (Green) to 1 (Black)	100 °C (212 °F)	2.3 kΩ	0.93 V

©August 2008 Navistar, Inc.

Operational Voltage Checks for MAT Sensor with Breakout Box (Check with breakout box connected [X1 and X2 only] to the ECM and engine harness.)			
X2–14 to X1–6	0 °C (32 °F)	93.8 kΩ	4.36 V
X2–14 to X1–6	15 °C (59 °F)	47.6 kΩ	4.0 V
X2–14 to X1–6	40 °C (104 °F)	15.8 kΩ	2.98 V
X2–14 to X1–6	100 °C (212 °F)	2.3 kΩ	0.93 V

MAT Diagnostic Trouble Codes
DTC 161 = Signal voltage was < 0.098 V for more than 0.35 second
DTC 162 = Signal voltage was > 4.58 V for more than 0.35 second

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

RSE (Radiator Shutter Enable)

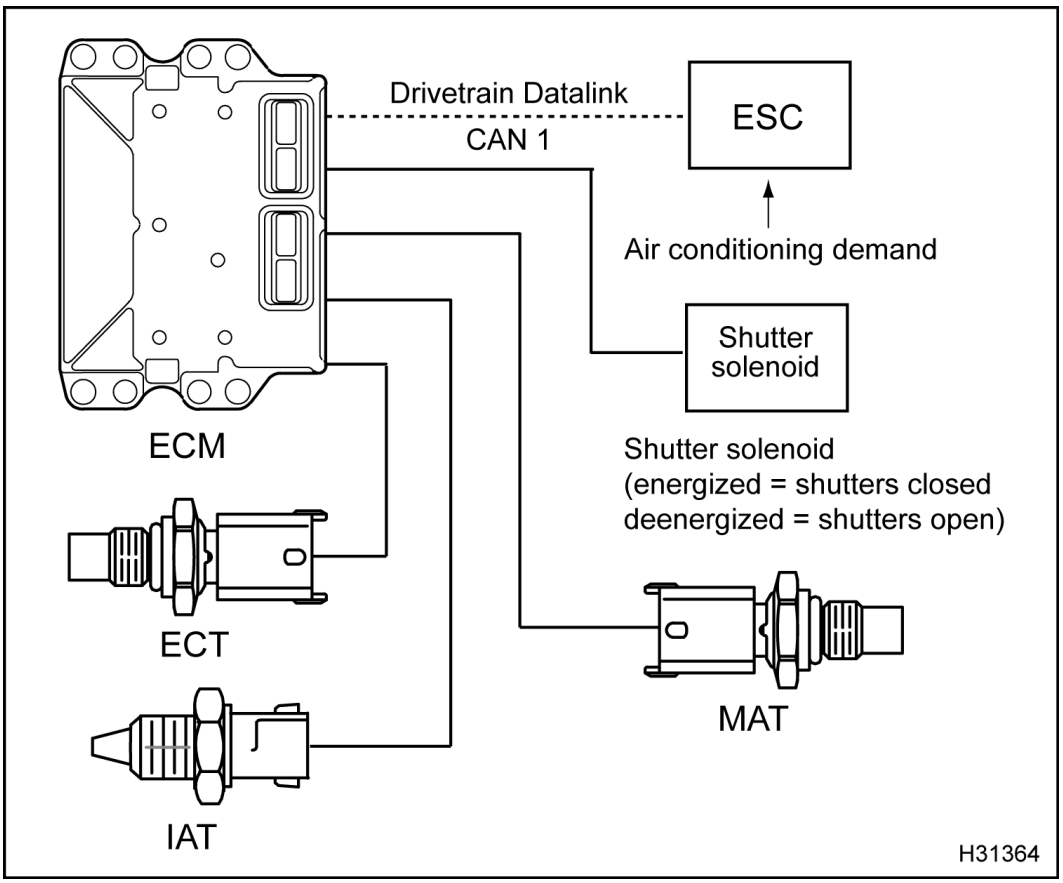


Figure 492 Function diagram for the RSE

The function diagram for the RSE includes the following:

- Electronic Control Module (ECM)
- Intake Air Temperature (IAT) sensor
- Engine Coolant Temperature (ECT) sensor
- Manifold Air Temperature (MAT) sensor
- Shutter solenoid
- Electronic System Controller (ESC)
- Drivetrain Datalink (CAN 1)

Function

The Radiator Shutter Enable (RSE) feature provides the correct logic to open or close the radiator shutters (energize or de-energize a solenoid). Closing the shutters will keep the engine warm during cold weather operation. This provides faster warm up of the passenger cab and enables faster windshield defrosting.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

RSE Circuit Operation

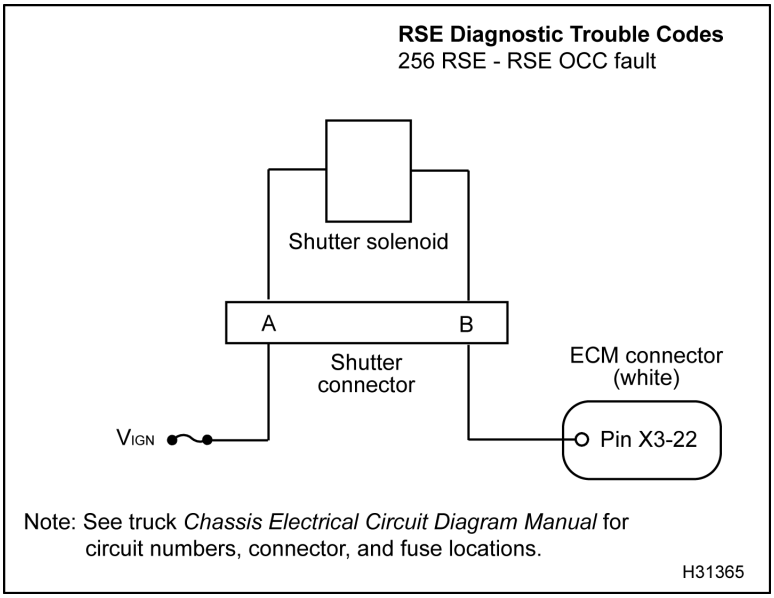


Figure 493 RSE circuit diagram

The RSE circuit provides control to open or close the radiator shutters (energize or deenergize a solenoid). Radiator shutters keep the engine warm during cold weather operation. When the ignition switch is ON, power is available to the shutter solenoid.

The shutters **will close when all** of the following conditions exist:

- MAT is less than 37 °C (99 °F)
- IAT is less than 7 °C (45 °F)
- ECT is less than 80 °C (176 °F)
- No transmission retarder request is present
- No engine fan request is present

The shutters **will open when any** of the following conditions exist:

- MAT is greater than 60 °C (140 °F)
- IAT is greater than 12 °C (54 °F)
- ECT is greater than 87 °C (189 °F)

  (**Note:** ECT is customer programmable)
- Transmission retarder request is present
- Engine fan request is present

The shutters will not close again until all closed conditions exist:

The ECM controls the shutter solenoid by providing a path to ground for the solenoid coil. When the shutters need to be activated, Pin X3–22 is grounded from the ECM. When the shutters need to be deactivated, the ground is removed from ECM Pin X3–22.

If all pin-point diagnostic tests are in specification, and the shutters are not operating in accordance with parameters, contact International® Technical Services.

Fault Detection / Management

An open or short to ground in the RSE control circuit can be detected by doing an on-demand Output Circuit Check (OCC) during the KOEO Standard Test. When a fault is detected, a DTC will be set.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

RSE Diagnostic Trouble Codes (DTCs)

DTC 256
RSE OCC fault

- DTC 256 is set by the ECM when the OCC test has failed after the KOEO Standard Test has been run.
- DTC 256 can be set when a poor connection, an open or short to ground in the relay control circuit, or failed relay exists.
- When DTC 256 is active the amber ENGINE lamp is illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)

RSE Pin-Point Diagnostics

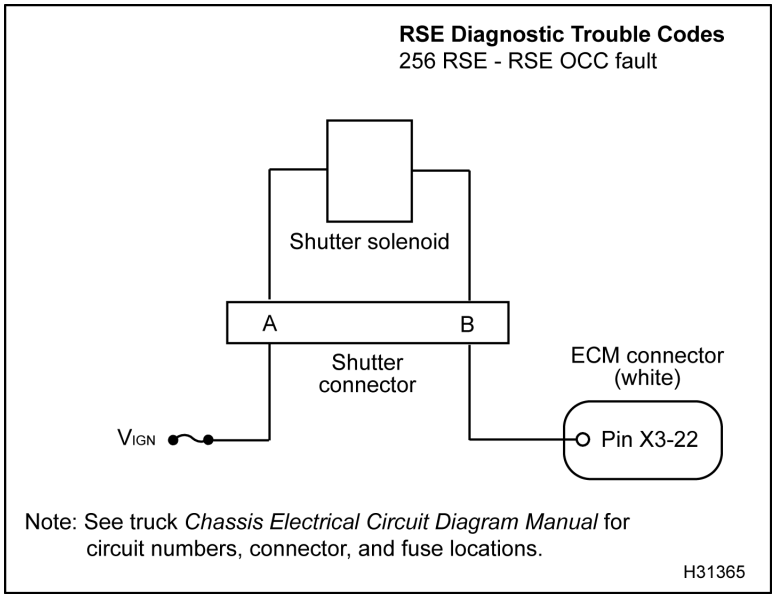


Figure 494 RSE circuit diagram

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The RSE circuit requires the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Voltage Checks at Solenoid Connector (Disconnect solenoid. Turn the ignition switch to ON.)

Test Point	Spec	Comment
KOEO		
A to gnd	B+ ± 0.5 V	If < B+, check for open circuit. Do Harness Resistance Checks.
B to gnd	0 V to 0.25 V	If > 0.25 V, check ECM programming or open circuit.

Output State Test - Voltage Check at Shutter Connector (Disconnect solenoid. Turn the ignition switch to ON. Run the Output State Tests. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests.)

Test State/Point	Spec	Comment
Output State Test - Low		
B+ to Pin B	B+ ± 0.5 V	If < B+, check ECM programming and check for open circuit.
Output State Test - High		
B+ to Pin B	0 V to 0.25 V	If > 0.25 V, check ECM programming and check for short to voltage source.

RSE Solenoid Continuity Check (Turn the ignition switch to OFF. Disconnect solenoid.)

B to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground.
A to gnd	> 1 kΩ	If < 1 kΩ, check for short to ground.
B to A	10 Ω to 30 Ω	Expected coil resistance for solenoid.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect negative battery cable. Disconnect solenoid. Use disconnected negative battery cable for ground test point.)

A to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
B to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.

Harness Resistance Checks (Turn the ignition switch to OFF. Disconnect solenoid. Connect breakout box X3 to chassis wiring harness only.)

X3–22 to B	< 5 Ω	If > 5 Ω, check for harness open between ECM and fan solenoid.
A to Fuse	< 5 Ω	If > 5 Ω, check for harness open between fuse and fan solenoid. See truck *Chassis Electrical Circuit Diagram Manual* for fuse information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Output State Test - Voltage Checks at ECM (Disconnect X3 and X4 from ECM. Connect breakout box X3 only to ECM and wiring harness. Turn the ignition switch to ON. Run the Output State Tests. For help, see “Diagnostic Software Operation” in Section 3 (page 68) for procedure to run the Low and High Output State Tests.)		
Output State Test - Low		
X3–3 to X3–22	B+ ± 0.5 V	If < B+, **verify that ECM is programmed correctly.** If ECM is programmed correctly, replace ECM.
Output State Test - High		
X3–3 to X3–22	0 V to 0.25 V	If > 0.25 V, **verify that ECM is programmed correctly.** If ECM is programmed correctly, replace ECM.
Operational Voltage Check to Shutter Solenoid (Check with solenoid connected and breakout box connected. **Note:** This test should only be done when no DTCs are present. Monitor engine parameters and voltage at ECM X3–22 while engine is running.)		
X3–3 to X3–22	B+ ± 0.5 V	The solenoid is energized and the shutters are closed. • MAT is less than 37 °C (99 °F) • IAT is less than 7 °C (45 °F) • ECT is less than 80 °C (176 °F) • No transmission retarder request is present • No engine fan request is present
X3–3 to X3–22	0 V to 0.25 V	The solenoid is deenergized and the shutters are open. • MAT is greater than 60 °C (140 °F) • IAT is greater than 12 °C (54 °F) • ECT is greater than 87 °C (189 °F) • Transmission retarder request is present • Engine fan request is present
RSE Diagnostic Trouble Codes		
DTC 256 = Output Circuit Check detected during KOEO Standard Test, indicates high or low resistance in circuit.		

©August 2008 Navistar, Inc.

SCCS (Speed Control Command Switches)

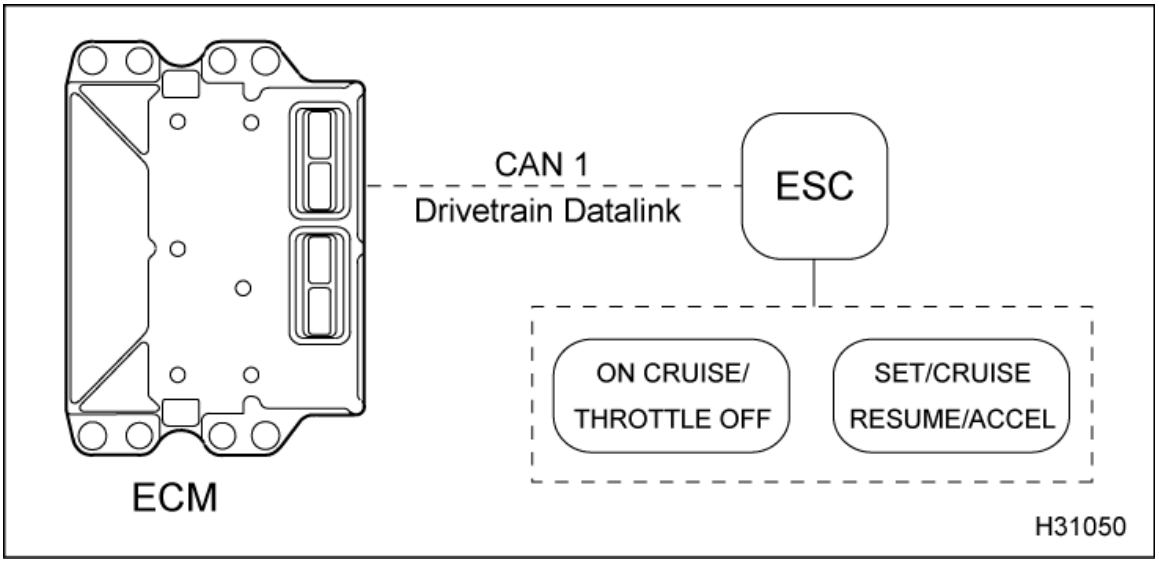


Figure 495 Function diagram for the SCCS

The function diagram for the SCCS includes the following:

- Electronic System Controller (ESC)
- Electronic Control Module (ECM)
- Steering wheel cruise control switches

Cruise Control

The ECM will control engine speed to maintain a constant road speed with cruise control. Pressing the set switch when the vehicle is at the desired speed with the CRUISE switch in the on position activates the cruise control. Speed is increased or decreased by pressing ACCEL/CRUISE switches. The cruise control is deactivated by pressing the off switch, applying the brake pedal, clutch pedal, or on vehicles equipped with automatic transmissions, by placing the transmission in neutral.

Power Takeoff (PTO) Control

Engine speed can be controlled by the SCCS switches if the PTO option has been programmed into the ECM and the vehicle is stationary. Variable as well as preset speeds are available depending on ECM programming. The PTO function is turned on by pressing the cruise switch on. Pressing the SET/CRUISE or RESUME/ACCEL switches will increase or decrease engine speed depending on PTO programming.

SCCS Circuit Operation

Cruise control allows the ECM to control the engines power delivery to maintain a constant vehicle speed. The speed set point is determined by the operator and the cruise high and low set points are programmed in the ECM. The minimum engine speed that the cruise control can be engaged is programmed in the ECM.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Cruise control features are enabled as follows:

Cruise ON/OFF button:	ON enables and OFF disables the cruise control functions.
SET / CRUISE:	If the cruise is enabled but a speed is not set, pressing the SET/CRUISE switch will select the current vehicle speed as the set speed. If the cruise is enabled and a speed is set, pressing the SET/CRUISE switch will cause the vehicle speed to decrease.
RESUME / ACCEL:	If the cruise is enabled, but has been deactivated by applying the brake or clutch, pressing the RESUME/ACCEL switch will cause the vehicle speed to resume to the last set speed. If the cruise is enabled and active, pressing the RESUME/ACCEL switch will cause the vehicle speed to accelerate.

In-Cab PTO

In-Cab PTO has three different modes of operation. These modes are selected by programming the ECM In-Cab PTO Mode. These modes are:

- In-Cab Preset
- In-Cab Variable
- In-Cab Mobile

In-Cab Preset

In-Cab Preset is selected by programming the ECM programmable parameters for In-Cab Mode to In-Cab Preset. This allows the operator to select one of two programmed values for engine speed. To operate, press the ON/OFF switch to the ON position. Then press either the SET/CRUISE or RESUME/ACCEL switch. This will cause the engine speed to run at the value programmed into PTO Set Speed.

Pressing the off switch, brake pedal, clutch pedal, placing the automatic transmission in gear, or a signal from the Vehicle Speed Sensor (VSS) (unless programmed for Mobile operation), will deactivate the PTO speed control. PTO speed control will not be functional if the VSS signal is in fault.

In-Cab Variable

In-Cab Variable is selected by programming the ECM Programmable Parameters for In-Cab Mode to In-Cab Variable. This option allows the operator to set the engine speed to a desired value. The control module will then maintain this speed over varying load conditions up to the engines rated power in the selected speed range.

To enable, press the ON/OFF switch to the ON position. Speed may be adjusted two ways. First the operator may adjust the engine speed with the accelerator and then press the SET/CRUISE switch. Second, the operator may press the RESUME/ACCEL to increase engine speed incrementally or press the SET/CRUISE switch to decrease the engine speed.

Engine set speed will be limited to the value programmed in the ECM for Maximum PTO speed.

Pressing the OFF switch, brake pedal, clutch pedal, placing the automatic transmission in gear, or a signal from the VSS, (unless programmed for Mobile operation), will deactivate the PTO speed control. PTO speed control will not be functional if the VSS signal is in fault.

In-Cab Mobile

In-Cab Mobile is selected by programming the ECM programmable parameters for the In-Cab mode to In-Cab Mobile. This allows the operator to use the engine speed control the same as In-Cab Variable, however, in this mode the vehicle can be moving while the mode is active. See In-Cab Variable for more details. The maximum speed of the vehicle is programmable up to 20 mph. This mode is the same as In-Cab Variable, however, a speed signal will not disable the speed control until the programmed maximum speed is exceeded.

Remote PTO

Remote PTO can be enabled by two means, Remote Preset and Remote Variable. Operation of the speed control depends on which signal is enabled.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Remote Preset

When in the preset mode, the set switch will cause the engine to run at the programmed set speed. The RESUME/ACCEL switch will allow the engine to run at the programmed resume speed.

With the remote preset enabled, the speed is adjusted as with In-Cab preset. See In-Cab preset for more details.

Turning the ON/OFF switch OFF, depressing the brake pedal, clutch pedal, placing the automatic transmission in gear, or a signal from the VSS will deactivate the PTO speed control. However, the programmed option of PTO Operation Disable will prevent the clutch and brake signals from interrupting the PTO speed control, as well as cause the Accelerator Position Sensor (APS) to be inoperative. PTO speed control will not be functional if the VSS signal is in fault.

Remote Variable

Enabling the remote variable signal allows for the engine speed to be adjusted to the desired level. Pressing the RESUME / ACCEL switch will cause the engine speed to increase, pressing the SET/CRUISE switch will cause the engine speed to decrease.

With remote variable enabled the speed is adjusted as with In-Cab Variable.

Opening the switch to Pin X3–20, pressing the ON/OFF switch to OFF, depressing the brake or clutch pedal or placing the automatic transmission in gear, or a signal from the VSS will deactivate the PTO speed control. However the programmed option of PTO Operation Disable will prevent the clutch and brake signals from interrupting the PTO speed control, as well as cause the APS to be inoperative. PTO speed control will not be functional if the VSS signal is in fault.

PTO Speed Ramp Rate

The rate at which the speed of the engine will change will depend on load conditions and on a programmed value called PTO speed ramp rate. A higher value will cause the engine to change speed more quickly.

Tools

- EST with INTUNE and MasterDiagnostics® software
- EZ-Tech® interface cable
- *Electrical System Troubleshooting Guide* (truck manual)
- Electrical Circuit Diagrams (truck manual)

Fault Detection / Management

The ECM does not monitor the SCCS system for faults. There are no Diagnostic Trouble Codes (DTCs) for this system.

Diagnostics

If the engine does not respond to the cruise control switches, use INTUNE to monitor cruise switch input to the ESC. If the switch state does not change when the cruise controls are pressed, diagnose the cruise switch circuits using the *Electrical System Troubleshooting Guide*. If the ESC is receiving the cruise switch input, use MasterDiagnostics® to view the cruise switch state. If the switch state does not change as the switch is pressed, verify communication exists between the ECM and the ESC (does the ECM respond to other ESC inputs). If the switch state does change, verify that other conditions do not exist that would stop or delay the reaction to the input. Examples include:

- rpm below minimum
- rpm above maximum
- Road speed below minimum / Road speed above maximum
- Brake pedal depressed
- Clutch / driveline disengaged

The EST can be used to monitor the status of the PTO controls. Comparing the data list reading to actual operation will indicate if the controls are operating correctly. Using the menu option of programmable parameters the programming can be verified to be sure the ECM is programmed correctly for the application. Also the data list can be used to monitor the parameters that cause interruption of PTO speed control.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Tachometer Output Circuit

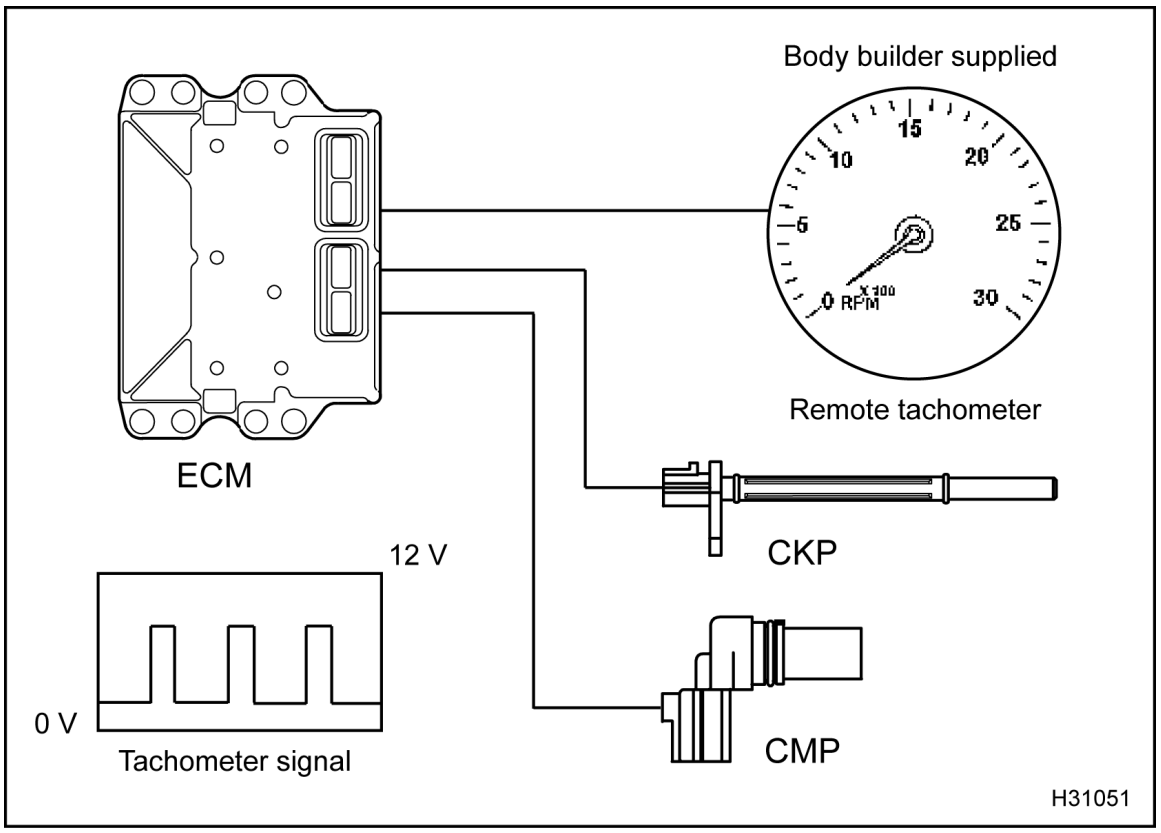


Figure 496 Function diagram for the tachometer output circuit

The function diagram for the tachometer output circuit consists of the following:

- Remote tachometer
- Electronic Control Module (ECM)
- Camshaft Position (CMP) sensor
- Crankshaft Position (CKP) sensor

The ECM provides an output for a remote tachometer with a 0 V to 12 V digital signal that indicates engine speed. The frequency sent by the ECM is 1/5th of the actual engine rpm (12 pulses per engine revolution).

Tachometer Input Signal

The ECM receives a signal from the CMP sensor and calculates engine speed (rpm). The ECM sends the calculated engine speed as a digital buffered TACH signal from the ECM connector to the owner installed tachometer.

Tachometer Diagnostic Trouble Codes (DTCs)

DTCs are not available for communication between the ECM and the remote tachometer.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Tachometer Pin-Point Diagnostics

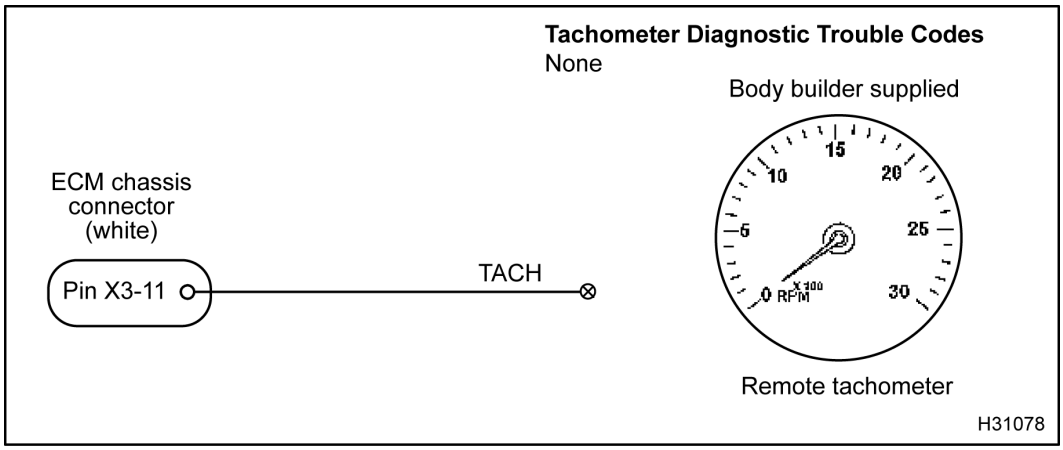


Figure 497 Tachometer circuit diagram

Key-On Engine-Off Voltage Checks at ECM (Check with key-on engine-off and breakout box connected [X3 only] to ECM and chassis harness.)			
Test Point	**Spec**	**Signal**	**Comment**
X3–11 to X3–7	12 V ±1.5 V	TACH	The signal is pulled up by the ECM with the key-on engine-off.
Connector Checks to Ground at ECM (Check with key-on engine-off and breakout box connected [X3 only] to ECM and chassis harness.)			
X3–11 to X3–7	> 1 kΩ	TACH	If < 1 kΩ, check for short to ground either through the harness or internal ECM. Disconnect the ECM from the breakout box and measure to ground again. If short is still present, repair harness.
Harness Resistance Checks (Check with key-on engine-off and breakout box connected [X3 only] to ECM and chassis harness.)			
X3–11 to tach	< 5 Ω	TACH	Resistance from ECM connector to TACH input – Optional owner / operator tach.
Key-On Engine-Running Signal Checks – TACH (Check with key-on engine-off and breakout box connected [X3 only] to ECM and chassis harness.)			
X3–11 to X3–7	140–700 Hz		Tach signal from the ECM is a frequency that is engine rpm divided 5. Multiply frequency by 5 to calculate rpm.
NOTE: The instrument cluster tachometer does not use these outputs. See truck *Electrical System Troubleshooting Guide*.			

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

VGT Actuator (Variable Geometry Turbocharger)

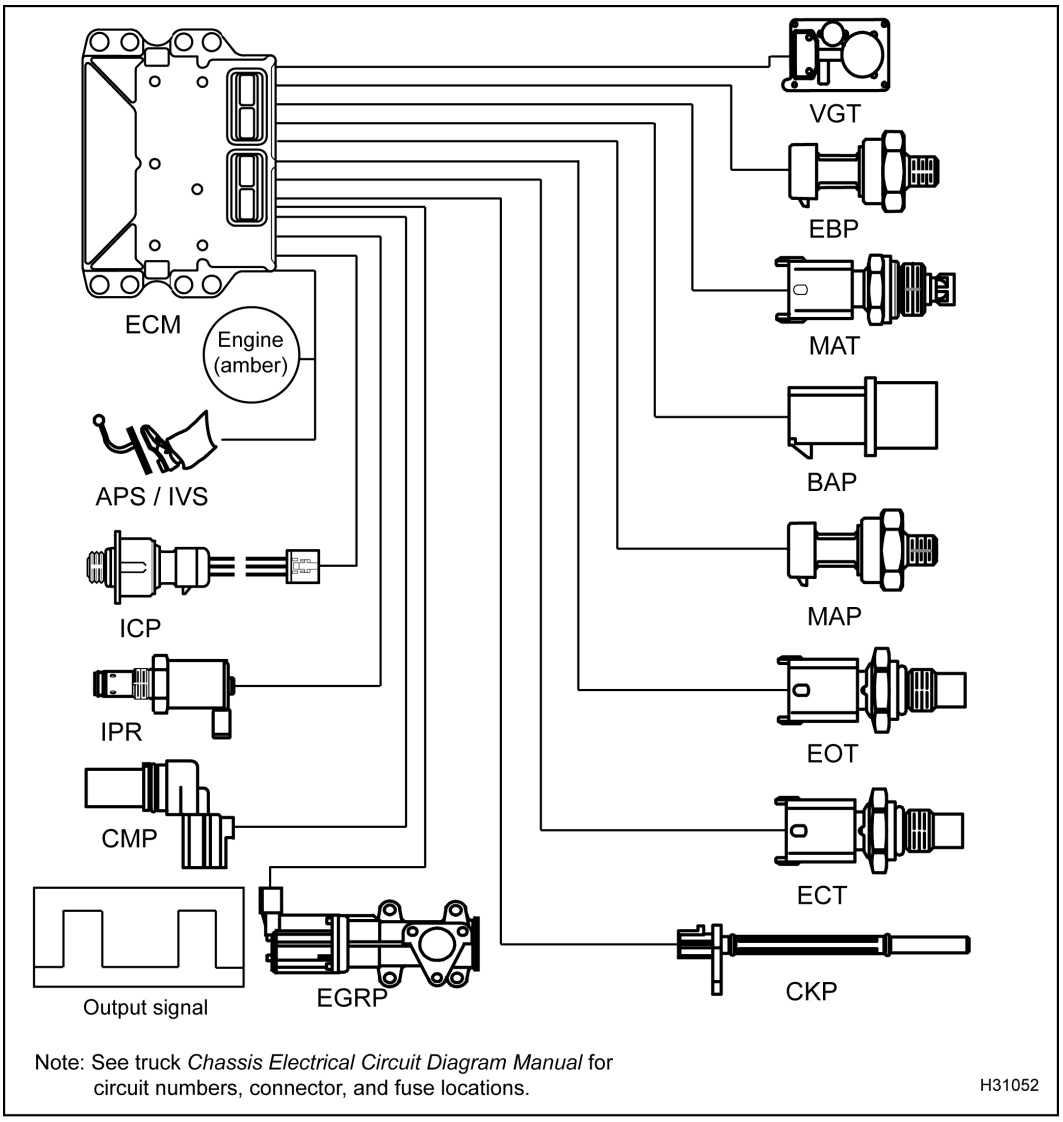


Figure 498 Function diagram for the VGT actuator

The function diagram for the VGT actuator includes the following:

- VGT actuator
- Electronic Control Module (ECM)
- Accelerator Pedal Position sensor and Idle Validation Switch (APS/IVS)
- Barometric Absolute Pressure (BAP) sensor
- Camshaft Position (CMP) sensor
- Crankshaft Position (CKP) sensor
- Engine Coolant Temperature (ECT) sensor
- Exhaust Gas Recirculation (EGR)
- Engine Oil Temperature (EOT) sensor
- Exhaust Back Pressure (EBP) sensor
- Injection Control Pressure (ICP) sensor
- Injection Pressure Regulator (IPR)
- Manifold Absolute Pressure (MAP) sensor

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- Manifold Air Temperature (MAT) sensor
- ENGINE lamp (amber)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Function

The VGT actuator is a control module that contains a microchip and a DC motor. The VGT actuator is located below the turbocharger. The microchip operates a DC motor which rotates a crank lever controlling the vane position in the turbine housing. The position of the vanes is based off the pulse width modulated signal sent from the ECM.

Actuator control for the vane position is achieved by setting a pulse width modulated signal from the ECM in response to the following:

- Engine speed
- Desired fuel quantity
- Boost (manifold air pressure)
- Exhaust back pressure and altitude

VGT Circuit Operation

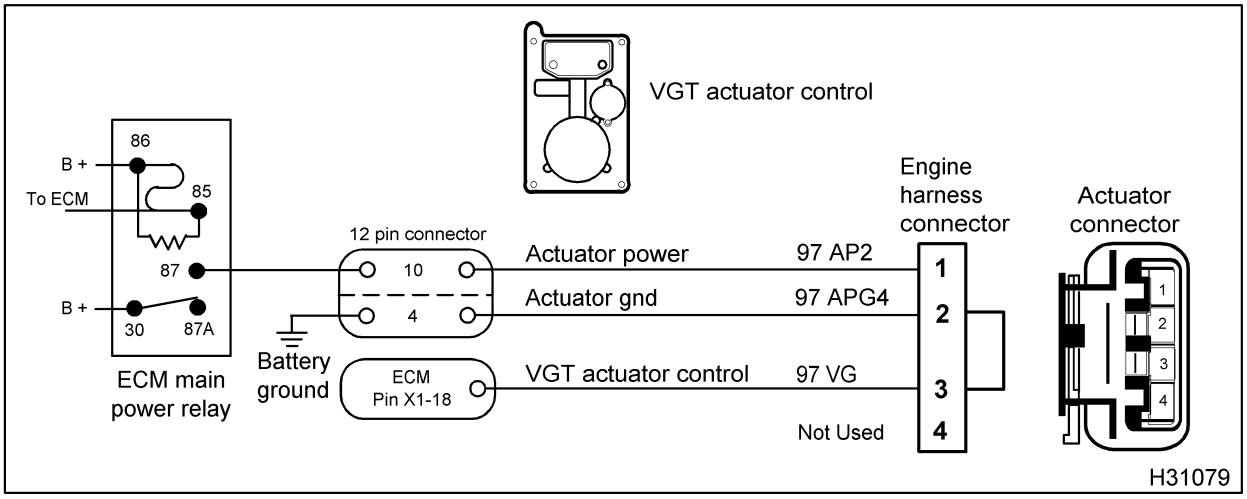


Figure 499 VGT circuit diagram

The VGT actuator receives power at Pin 1, through the 12-pin connector Pin 10, from the ECM main power relay Pin 87. Ground for the VGT actuator is supplied at Pin 2, through the 12-pin connector Pin 4 from battery ground. The ECM controls the VGT actuator by sending a pulse width modulated signal from the ECM, Pin X1-18 to the actuator harness connector Pin 3.

The VGT actuator is controlled by varying the percentage of ON/OFF time of the VGT actuator control signal to control module. A high duty cycle indicates a high amount of exhaust back pressure is being commanded. A low duty cycle indicates less pressure being commanded.

Fault Detection / Management

When the engine is running, the ECM can detect if exhaust back pressure equals the desired pressure. When measured exhaust back pressure does not equal the desired pressure, the ECM will ignore the EBP sensor signal and use a preset value based on engine operating conditions.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

If the VGT actuator is suspect, use the EST to run the Output State Test Low. See “Diagnostic Software Operation” in Section 3 (page 68). Check crank lever operation during this test.

VGT Diagnostic Trouble Codes (DTCs)

There are no specific DTCs relating to the wiring or Output Circuit Check (OCC) for the VGT actuator. When diagnosing the air management system, VGT wiring and operation can be tested with the following checks.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Turbo Breakout Harness
- 12-pin Breakout Harness
- Breakout Box
- Terminal Test Adapter Kit
- 500 Ohm Resistor Harness

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

VGT Pin-Point Diagnostics

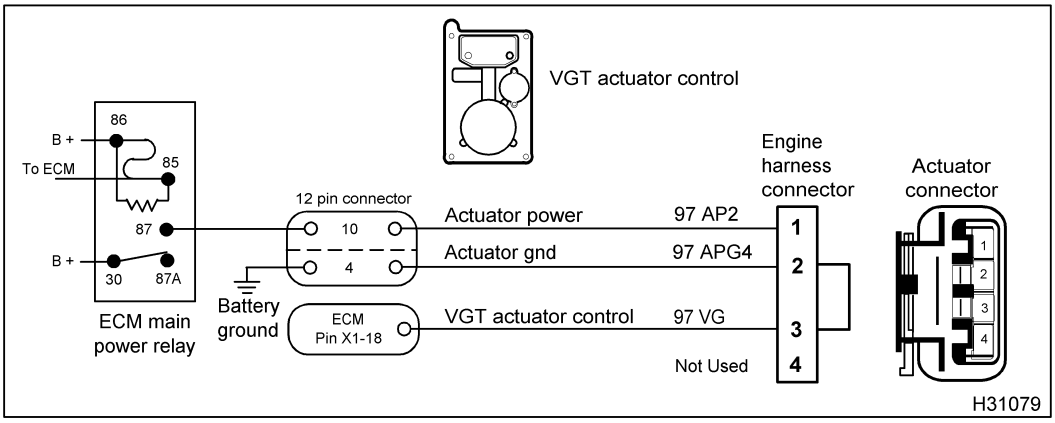


Figure 500 VGT circuit diagram

NOTE: Turn the ignition switch to OFF before disconnecting engine wiring harness connectors from components.

See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Actuator Control Voltage Check (Disconnect actuator harness from engine harness. Connect Turbo Breakout Harness to engine and actuator harness. Turn the ignition switch to ON.)

Test Point	Spec	Comment
1 to 2	B+ ± 0.5 V	If < B+, continue with next test point, 1 to chassis gnd. If equal to B+, check test point 3 to gnd (KOEO).
1 to chassis gnd	B+ ± 0.5 V	If equal to B+, but 1 to 2 did not equal B+, check for high resistance or open in ground circuit. Do Harness Resistance Checks – ECM to ECM Chassis Ground (page 537). If < B+, disconnect the actuator harness from Turbo Breakout Harness and retest. • If < B+, do 12-pin Actuator Power Voltage Check (page 532). • If equal to B+, the concern is either high resistance in wiring or the VGT actuator. Do Harness Resistance Checks (page 537) to confirm integrity of wiring. See truck *Chassis Electrical Circuit Diagram Manual*. If integrity of wiring is confirmed to be in good condition, replace VGT actuator.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

2 to chassis gnd	0 V to 0.25 V	If > 0.25 V disconnect the actuator harness and retest. • If > 0.25 V, do 12-pin Actuator Power Voltage Check (page 532). • If < 0.25 V, the concern is either high resistance in wiring or the VGT actuator. Do Harness Resistance Checks (page 537) to confirm integrity of wiring. See truck *Chassis Electrical Circuit Diagram Manual*. If integrity of wiring is confirmed to be in good condition, replace VGT actuator.
3 to gnd (KOEO)	DMM set to V - DC[1] DMM set to Duty Cycle[2]	If test point 1 to 2 is to specification and no voltage or duty cycle is measured, disconnect actuator harness. Connect 500 Ohm Resistor Harness between Pin 3 and Pin 2. Retest by measuring across Pin 3 and Pin 2. • If after retesting and values are not to specifications, do Actuator Control Voltage Check at ECM (page 534). • If values are to specifications, the concern is either high resistance in the wiring or the VGT actuator. Do Harness Resistance Checks (page 537) to confirm integrity of wiring. If integrity of wiring is confirmed to be in good condition, replace VGT actuator.

1 Values are calibration dependent. See “DT 466 Performance Specifications” – Appendix A (page 595) or “DT 570 and HT 570 Performance Specifications – Appendix B (page 619).

2 Use the EST with MasterDiagnostics® software to view VGT duty cycle with key-on engine-off. When using the Fluke 88 DMM, measurement is typically within 2% of what MasterDiagnostics® reads.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

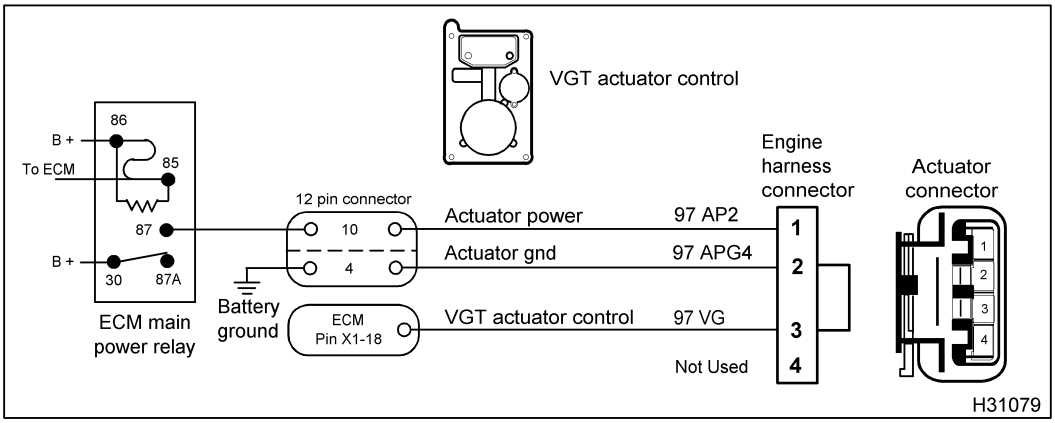


Figure 501 VGT circuit diagram

NOTE: Turn the ignition switch to OFF before disconnecting engine wiring harness connectors from components.

See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Output State Test - Signal Check (Actuator Control Voltage check has been completed. Pin 2 to ECM Chassis Ground is to specification. Connect Turbo Breakout Harness to engine harness and actuator harness. Run the Low and High Output State Tests. See “Diagnostic Software Operation” in Section 3 (page 68) for procedure to do the Low and High Output State Tests.)

Test State/Point	Setting/Spec	Comment
Output State Test - Low	DMM set to V - DC	Listen and observe to verify if crank lever of VGT actuator moves. Toggling between the Low and High Output State Tests can be done during this test.
3 to 2	0 V to 0.25 V	If > 0.25 V, disconnect actuator harness and connect 500 Ohm Resistor Harness between 3 and 2. Retest Output State Test - Low. • If > 0.25 V the concern is with engine harness or ECM, check for a short to B+ or V_{REF}. Do the Actuator Control Voltage Check at ECM (page 534) and Harness Resistance Checks (page 537). • If < 0.25 V, the concern is either high resistance in wiring or the VGT actuator. Do Harness Resistance Checks (page 537) to confirm integrity of wiring. See *Chassis Electrical Circuit Diagram Manual*. If integrity of wiring is confirmed to be in good condition, replace VGT actuator.
Output State Test - High	DMM set to V - DC	Listen and observe to verify if crank lever of VGT actuator moves. Toggling between the Low and High Output State Tests can be done during this procedure.
3 to 2	B+ ± 0.5 V	If < B+, disconnect actuator harness and connect 500 Ohm Resistor Harness between 3 and 2. Retest Output State Test - High.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- If < B+, the concern is with engine harness or ECM, check for a short to ground or open VGT actuator control. Do the Actuator Control Voltage Check at ECM (page 534) and Harness Resistance Checks (page 537).
- If equal to B+, the concern is either high resistance in wiring or the VGT actuator. Do Harness Resistance Checks (page 537) to confirm integrity of wiring. See *Chassis Electrical Circuit Diagram Manual* needs to be referenced to check wiring from BAT_{GND} to 12 - Pin Connector.

  If integrity of wiring is confirmed to be in good condition, replace VGT actuator.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

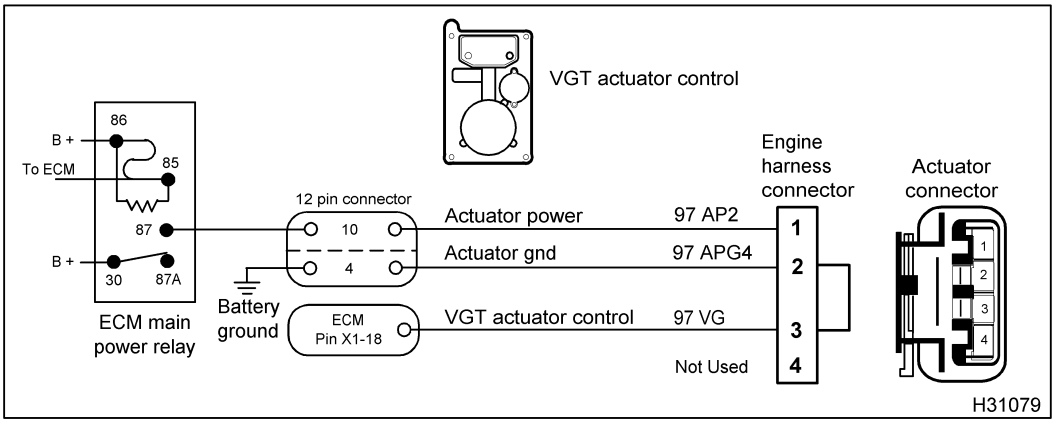


Figure 502 VGT circuit diagram

NOTE: If an Actuator Control Voltage Check was not to specification, continue with this check.

Turn the ignition switch to OFF when disconnecting engine wiring harness connectors from components.

See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

12-pin Actuator Power Voltage Check (Actuator Control Voltage Check has been completed and Turbocharger is not connected. Connect 12-pin Breakout Harness to engine and chassis wiring harness. Turn the ignition switch to ON.)

Test State/Point	Setting/Spec	Comment
10 to 4	B+ ± 0.5 V	If equal to B+, concern is within engine wiring harness. Do Harness Resistance Check – VGT Actuator to 12-Pin Connector (page 537). If < B+, continue with next test point, 10 to chassis ground.
10 to chassis gnd	B+ ± 0.5 V	If equal to B+, but 10 to 4 did not, the concern is between 12-pin connector and chassis ground. Check for high resistance or open in ground circuit. See truck *Chassis Electrical Circuit Diagram Manual*. If < B+, disconnect engine wiring harness from 12-pin Breakout Harness and retest. • If equal to B+, diagnose engine wiring harness to turbo. Do Harness Resistance Check – VGT Actuator to 12-Pin Connector (page 537). • If < B+, the concern is between 12-Pin Connector and ECM Main Power Relay. See truck *Chassis Electrical Circuit Diagram Manual*.
4 to chassis gnd	0 V to 0.25 V	If > 0.25 V disconnect engine wiring harness from 12 - Pin Breakout Harness and retest. • If < 0.25 V, diagnose engine wiring harness, do Harness Resistance Check – VGT Actuator to 12-Pin Connector (page 537).

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- If > 0.25 V, the concern is between 12-Pin Connector and battery ground terminal. See truck *Chassis Electrical Circuit Diagram Manual*.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

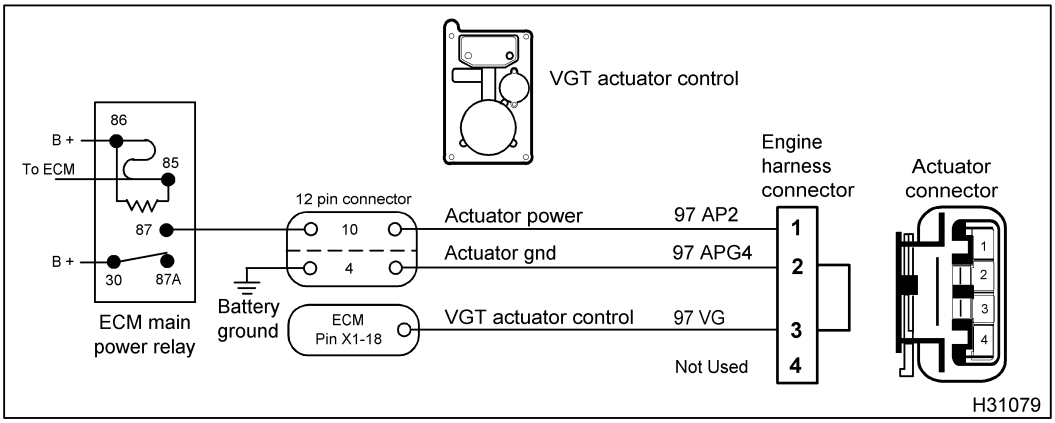


Figure 503 VGT circuit diagram

NOTE: If an Actuator Control Voltage Check was not to specification, continue with this check.

Turn the ignition switch to OFF when disconnecting engine wiring harness connectors from components.

See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Actuator Control Voltage Check at ECM (Connect breakout box X-1 only to ECM and engine harness. Engine harness is not connected to actuator harness. Connect 500 Ohm Resistor Harness between X1-18 and X1-6. Turn the ignition switch to ON. See “Diagnostic Software Operation” in Section 3 (page 68) for procedure to do the Low and High Output State Tests.)

Test State/Point	Setting/Spec	Comment
KOEO	DMM set to V - DC	
X1–18 to X1– 6	DMM set to V - DC[1] DMM set to duty cycle[2]	If in specification, run the Low and High Output State Tests. If not in specification, disconnect engine harness from breakout box harness and retest. • If not in specification, run the Low and High Output State Tests. • If in specification, diagnose engine wiring harness. Do Harness Resistance Check – VGT Actuator to ECM (page 538).
Output State Test - Low	DMM set to V - DC	Listen and observe to verify if crank lever of VGT actuator moves. Toggling between the Low and High Output State Tests can be done during this test.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

X1–18 to X1–6	0 V to 0.25 V	If > 0.25 V, disconnect engine harness from breakout box harness and retest. • If < 0.25 V, diagnose engine wiring harness. Do Harness Resistance Check – VGT Actuator to ECM (page 538). • If > 0.25 V, with breakout box only connected to ECM, replace ECM.
Output State Test - High	DMM set to V - DC	Listen and observe to verify if crank lever of VGT actuator moves. Toggling between the Low and High Output State Tests can be done during this test.
X1–18 to X1–6	B+ ± 0.5 V	If value is not in specification, disconnect engine harness from breakout box harness and retest. • If equal to B+, diagnose engine wiring harness. Do Harness Resistance Check – VGT Actuator to ECM (page 538). • If < B+ with breakout box only connected to ECM, replace ECM.

1 Values are calibration dependent. See “DT 466 Performance Specifications” – Appendix A (page 595) or “DT 570 and HT 570 Performance Specifications – Appendix B (page 619).

2 Use the EST with MasterDiagnostics® software to view VGT duty cycle with key-on engine-off. When using the Fluke 88 DMM, measurement is typically within 2% of what MasterDiagnostics® reads.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

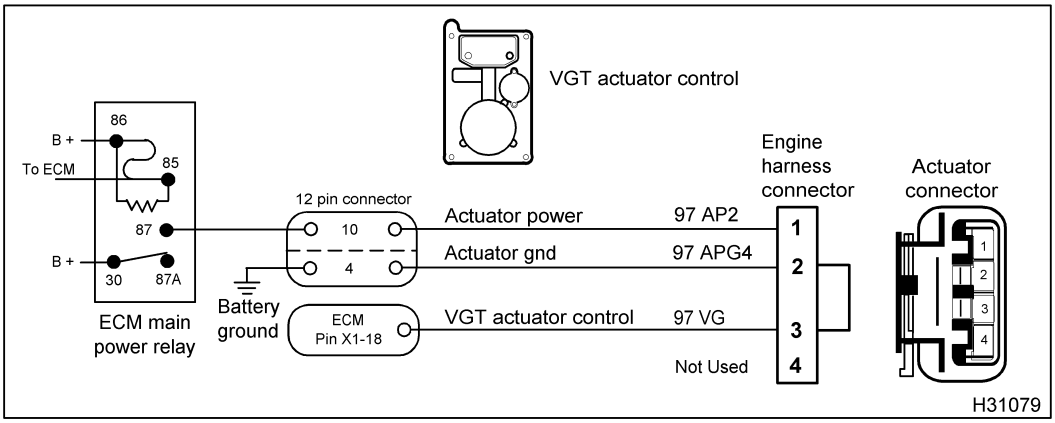


Figure 504 VGT circuit diagram

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NOTE: Turn the ignition switch to OFF when disconnecting engine wiring harness connectors from components.

See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Harness Resistance Checks – ECM to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Connect Turbo Breakout Harness to engine wiring harness only.

Test Point	Spec	Comment
1 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground on actuator power within wiring harness.
2 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for an open circuit.
3 to Pin A (9260)	>1 kΩ	If < 1 kΩ, check for short to ground on VGT actuator control within wiring harness.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Harness Resistance Checks – ECM to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect engine harness from actuator. Use disconnected negative battery cable for ground test point.

Test Point	Spec	Comment
1 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground on actuator power.
2 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.
3 to gnd cable	>1 kΩ	If < 1 kΩ, check for short to ground on VGT actuator control.
Harness Resistance Checks – VGT Actuator to 12-pin Connector (Turn the ignition switch to OFF. Connect Turbo Breakout Harness to engine wiring harness only. Connect 12-pin Breakout Harness to engine wiring harness only. Checks are from VGT actuator to 12-pin connector.)		
1 to 10	< 5 Ω	If > 5 Ω, check for open in actuator power.
2 to 4	< 5 Ω	If > 5 Ω, check for open in actuator ground.
Harness Resistance Checks – 12-pin Connector to ECM Chassis Ground (Turn the ignition switch to OFF. Connect 12-pin Breakout Harness to chassis wiring harness only. Disconnect chassis connector 9260[1].)		
10 to Pin A (9260)	> 1 kΩ	If < 1 kΩ, check for short to ground on chassis wiring harness ground circuit.
4 to Pin A (9260)	< 5 Ω	If > 5 Ω, check for open circuit in chassis wiring harness ground circuit.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Harness Resistance Checks – 12-Pin Connector to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect 12-pin connector and use chassis side for test point. Use disconnected negative battery cable for ground test point.)

10 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
4 to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Harness Resistance Checks – VGT Actuator to ECM (Connect Turbo Breakout Harness to engine wiring harness only. Connect breakout box X1 to engine wiring harness only.)		
3 to X1-18	< 5 Ω	If > 5 Ω, check for open in VGT actuator control.

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. Refer to truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

V_{REF} (Reference Voltage)

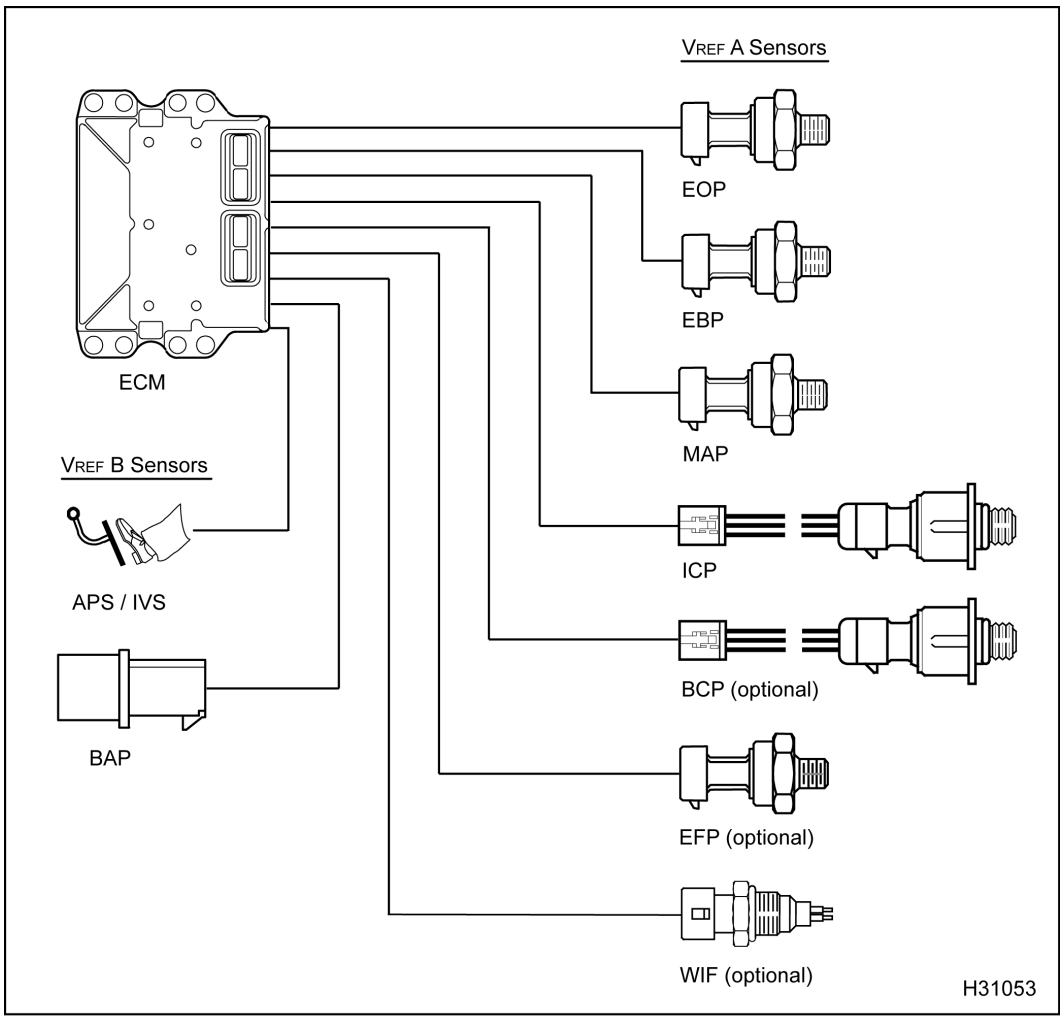


Figure 505 Function diagram for the V_{REF}

The function diagram for the V_{REF} includes the following:

- Engine Oil Pressure (EOP) sensor
- Exhaust Back Pressure (EBP) sensor
- Manifold Absolute Pressure (MAP) sensor
- Injection Control Pressure (ICP) sensor
- Brake Control Pressure (BCP) sensor (optional)
- Engine Fuel Pressure (EFP) sensor (optional)
- Water in Fuel (WIF) sensor (optional)
- Accelerator Position Sensor (APS)
- Barometric Absolute Pressure (BAP) sensor
- Electronic Control Module (ECM)

Function

The ECM contains a regulated 5 V DC voltage reference source to power engine and vehicle sensors. The sensor signals are compared to the V_{REF} to determine actual sensor output signal values. These values are processed by the ECM for engine operation.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The system has two V_{REF} circuits:

- V_{REF} A for engine sensors
- V_{REF} B for chassis sensors

NOTE: See truck *Chassis Electrical Circuit Diagram Manual* for APS and BAP sensor circuit diagrams.

V_{REF} Circuit Operation

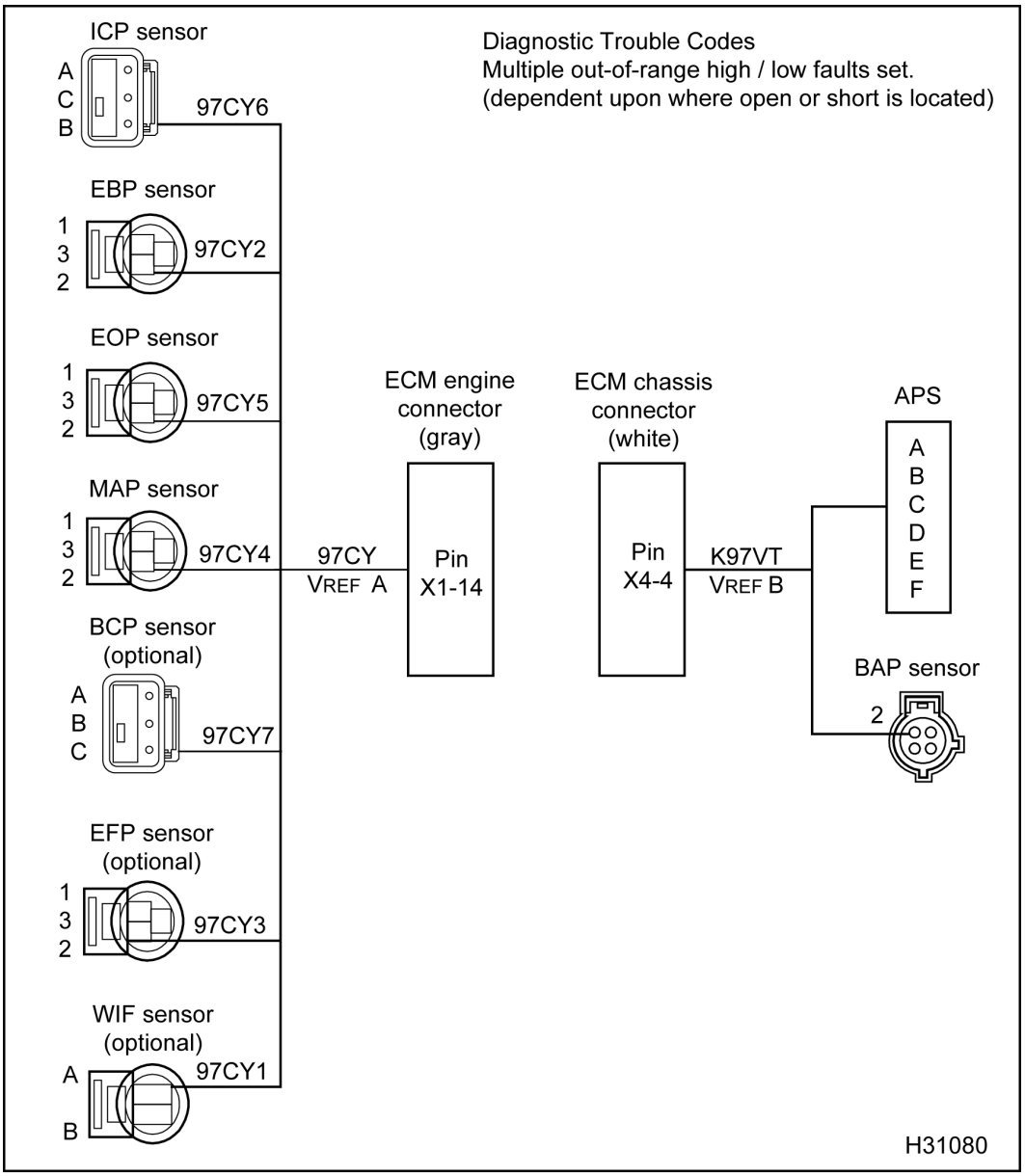


Figure 506 V_{REF} circuit diagram

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The ECM supplies V_{REF} at Pin X1–14 (engine connector) and at X4–4 (chassis connector) when the ignition switch is on.

Fault Detection / Management

There are no DTCs for V_{REF}. When a V_{REF} circuit fault occurs in a sensor, the ECM may set an out of range high or low code. Multiple high or low codes are indicators of a V_{REF} or signal ground fault condition. When a V_{REF} signal is shorted to ground, shorted to ground occurs, the ECM will reset and cause a stumble.

When the ECM sets multiple sensor DTCs, the V_{REF} circuit is open or shorted, or the signal ground circuit is open. To determine if the V_{REF} circuits are the cause, complete the pin-point diagnostics check.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Harness
- Breakout Box
- Terminal Test Adapter Kit

NOTE: After removing connector, inspect for damaged pins, corrosion, or loose pins. Repair as required.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

V_{REF} Pin-Point Diagnostics

Voltage Reference Connector Checks (If multiple DTCs are set, remove harness connections and measure V_{REF} at suspected sensor circuits.)

Sensor	Test Point	Spec	Comment
EBP	2 to gnd	5 V ±0.5 V	Check V_{REF} at each sensor. To isolate area of short or open circuit, identify sensors without V_{REF} and sensors that share a common V_{REF}. If disconnecting a sensor causes V_{REF} to be present in the circuit that had no previous V_{REF}, it is likely that the disconnected sensor had shorted V_{REF} to ground.
MAP	2 to gnd	5 V ±0.5 V	
ICP	B to gnd[1]	5 V ±0.5 V	
APS	C to gnd	5 V ±0.5 V	
BAP	2 to gnd	5 V ±0.5 V	
EOP	2 to gnd	5 V ±0.5 V	
BCP (optional)	B to gnd[1]	5 V ±0.5 V	
EFP (optional)	2 to gnd	5 V ±0.5 V	
WIF (optional)	B to gnd	5 V ±0.5 V	

[1] Test point Pin B is at vavle cover pass through connector. If additional testing is needed, test point Pin 2 should be used at under valve cover connector.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect sensors and negative battery cable.)

Sensor	Test Point	Spec	Comment
EBP	2 to gnd	>500 Ω	If resistance is < spec, check for short to ground. If a short to ground condition exists, remove all sensor connectors that are connected to V_{REF} and ECM. Inspect to determine if short is in sensor, ECM, or wiring harness. Spec is >1 kΩ with all common sensors disconnected from harness.
MAP	2 to gnd	>500 Ω	
ICP	B to gnd[1]	>500 Ω	
APS	C to gnd	>1 kΩ	
BAP	2 to gnd	>1 kΩ	
EOP	2 to gnd	>500 Ω	
BCP (optional)	B to gnd[1]	>500 Ω	
EFP (optional)	2 to gnd	>500 Ω	
WIF (optional)	B to gnd	>500 Ω	

©August 2008 Navistar, Inc.

Harness Resistance Checks (Turn the ignition switch to OFF. Ensure that all accessories are turned off. Disconnect sensors and connect breakout box to engine harness only.)

Sensor	Test Point	Spec	Comment
EBP	2 to X1–14	< 5 Ω	
MAP	2 to X1–14	< 5 Ω	
ICP	B to X1–14[1]	< 5 Ω	
APS	C to X4–4	< 5 Ω	Measure resistance with DMM from sensor connector to breakout box pins. If resistance is > 5 Ω, check for high resistance or an open in the V_{REF} supply circuit.
BAP	2 to X4–4	< 5 Ω	
EOP	2 to X1–14	< 5 Ω	
BCP (optional)	B to X1–14[1]	< 5 Ω	
EFP (optional)	2 to X1–14	< 5 Ω	
WIF (optional)	B to X1–14	< 5 Ω	

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

VSS (Vehicle Speed Sensor)

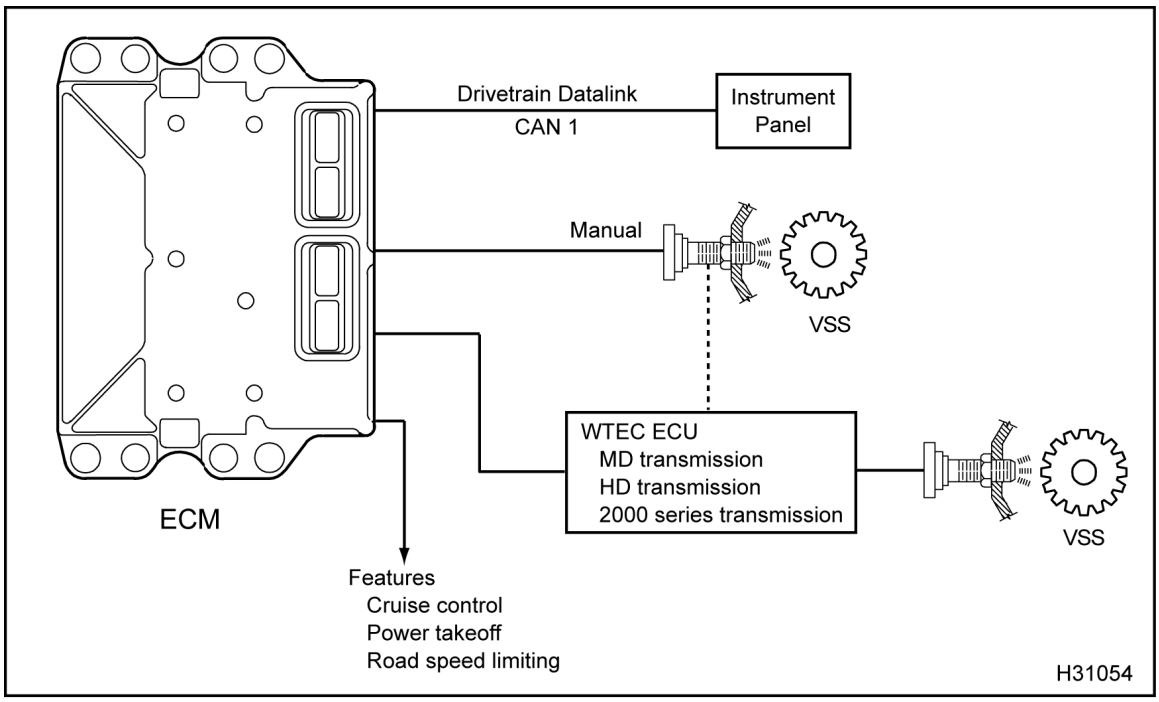


Figure 507 Function diagram for the VSS

The function diagram for the VSS includes the following:

- VSS
- Electronic Control Module (ECM)
- World Transmission Electronic Control (WTEC) ECM
- Cruise Control
- Power Takeoff
- Road Speed Limit

Function

The VSS is on the left side of the transmission. The VSS reads the rotation of a 16 toothed gear and produces a sine wave signal. The ECM processes the sine wave signal to calculate vehicle speed. The Drivetrain Datalink (CAN 1) transmits the calculated speed to the speedometer. The calculated speed also assists in control strategies that include Cruise Control, Power Takeoff, and Road Speed Limiting.

Allison WTEC MD, HD, and 2000 series transmissions use an internal VSS that sends a signal to the transmission module. The transmission module processes the signal and sends a square wave signal to the engine ECM.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

VSS Circuit Operation (Manual and Allison Transmissions)

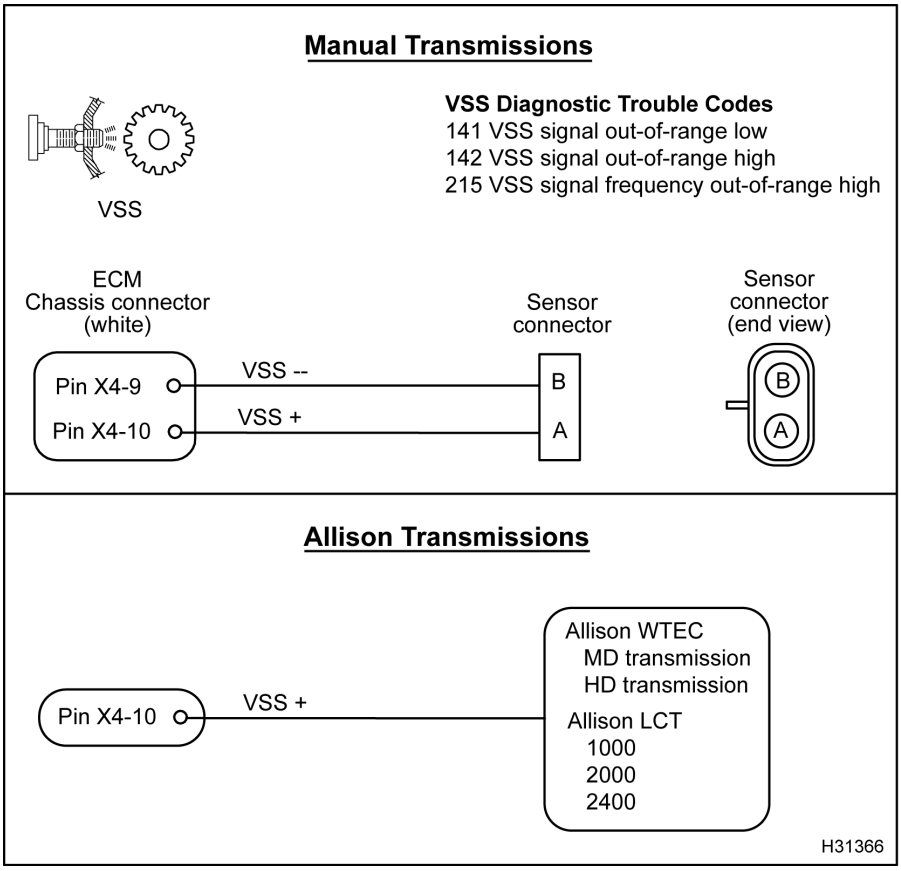


Figure 508 VSS circuit diagram (manual and Allison transmissions)

Fault Detection / Management

The ECM performs diagnostic checks on the VSS circuit when the engine is operating at 0 mph. The ECM transmits a voltage signal on the VSS circuit and determines if the return voltage is out of range high or low. When a fault condition is detected, the ECM disables the cruise control and power takeoff. If the road speed limiting option is enabled, the ECM will limit engine rpm for all gears.

The ECM will not set DTCs for VSS circuit failure for vehicles equipped with Allison transmissions.

NOTE: See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations. To diagnose Allison transmission VSS sensor problems, see truck *Electrical System Troubleshooting Guide* and Allison maintenance and diagnostic manuals.

VSS Diagnostic Trouble Codes (DTCs)

DTCs are read using the EST or by counting the flashes from the amber and red ENGINE lamp.

DTC 141
VSS signal out-of-range low

- DTC 141 is set by the ECM when an out of range low condition is detected in the VSS circuit.
- When DTC 141 is active the amber ENGINE lamp is not illuminated.

DTC 142
VSS signal out-of-range high

- DTC 142 is set by the ECM when an out of range high condition is detected in the VSS circuit.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

- When DTC 142 is active the amber ENGINE lamp is not illuminated.

DTC 215
VSS signal frequency out-of-range high

- DTC 215 is set by the ECM when the ECM detects a VSS signal greater than 4365 Hz.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- *Electrical System Troubleshooting Guide* (truck manual)
- Electrical Circuit Diagrams (truck manual)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

VSS Pin-Point Diagnostics (Manual Transmissions)

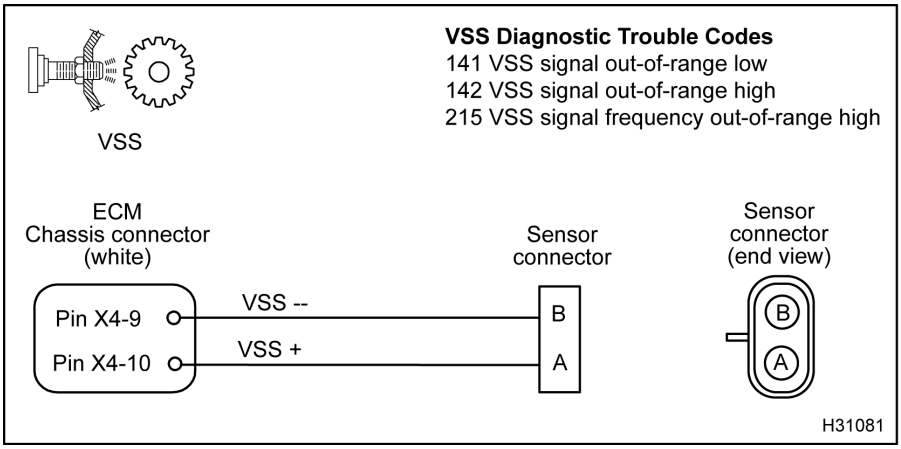


Figure 509 VSS circuit diagram (manual transmissions)

The VSS circuit requires the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Connector Voltage Checks (Disconnect harness from sensor. Inspect for bent pins or corrosion. Turn the ignition switch to ON.)

Test Point	Spec	Comment
B to gnd	2 V to 3 V	ECM pull up voltage when sensor disconnected. If no voltage present, check for open or short to ground.
A to gnd	2 V to 3 V	
Sensor Resistance Checks (Check with sensor disconnected and ignition switch OFF.)		
B to A	600 Ω to 800 Ω	Manual transmission (measure resistance through sensor)
Sensor and Circuit Resistance Checks (Check with breakout box connected [X4 only] to engine harness only with VSS connected. Inspect for bent pins or corrosion.)		
X4–10 to X4–9	600 Ω to 800 Ω	Manual transmission (measure resistance through sensor)

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)

A to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.
B to gnd cable	> 500 Ω	If < 500 Ω, check for short to ground.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Harness Resistance Checks (Check with breakout box connected to chassis harness only. Check from ECM to sensor harness connector.)		
X4–10 to A	< 5 Ω	If > 5 Ω, check for open circuit.
X4–9 to B	< 5 Ω	If > 5 Ω, check for open circuit.
Operation Checks for VSS (Check with breakout box connected to ECM and chassis harness. Turn the ignition switch to ON.)		
X4–10 to X4–9	> 2 V AC	If < 2 V AC, check sensor adjustment or replace failed sensor.
Note: If circuit checks are within specification and condition remains, see transmission manual for sensor inspection and adjustment.		
VSS Diagnostic Trouble Codes		
DTC 141 = ECM detected low voltage across VSS circuit for > 0.5 seconds		
DTC 142 = ECM detected high voltage across VSS circuit for > 0.5 seconds		
DTC 215 = ECM detected VSS frequency signal > 4365 Hz		

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. Refer to truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

VSS Pin-Point Diagnostics (Allison Transmissions)

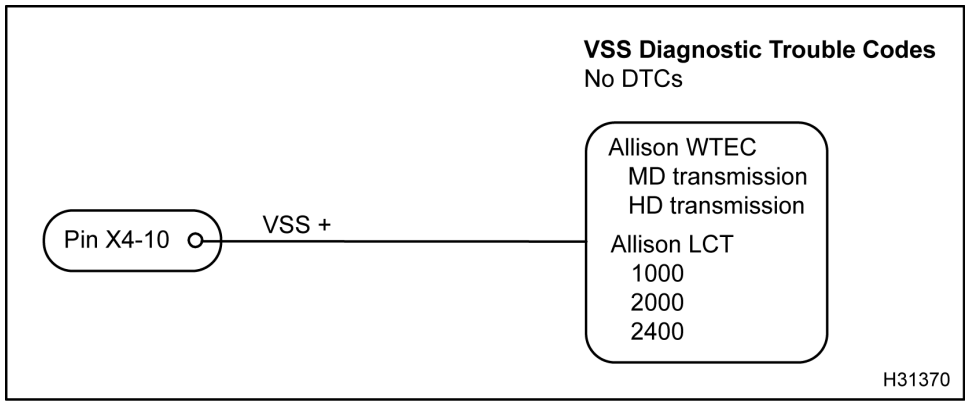


Figure 510 VSS circuit diagram (Allison transmissions)

The VSS circuit requires the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Connector Voltage Checks (Disconnect harness from sensor. Inspect for bent pins or corrosion. Turn the ignition switch to ON.)

Test Point	Spec	Comment
ECU transmission Pin to gnd	2 V to 3 V	ECM pull up voltage when sensor disconnected. If no voltage present, check for open or short to ground.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Resistance Checks to Chassis Ground with Breakout Box (Turn the ignition switch to OFF. Connect breakout box X4 only to chassis harness. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Use disconnected negative battery cable for ground test point.)

X4–10 to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to ground.

Harness Resistance Checks (Check with breakout box connected to engine harness only. Check from ECM to sensor harness connector.)

X4–10 to ECU transmission Pin	< 5 Ω	If > 5 Ω, check for open circuit.

Note: If circuit checks are within specification and condition remains, see transmission manual for sensor inspection and adjustment.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WIF Sensor (Water in Fuel)

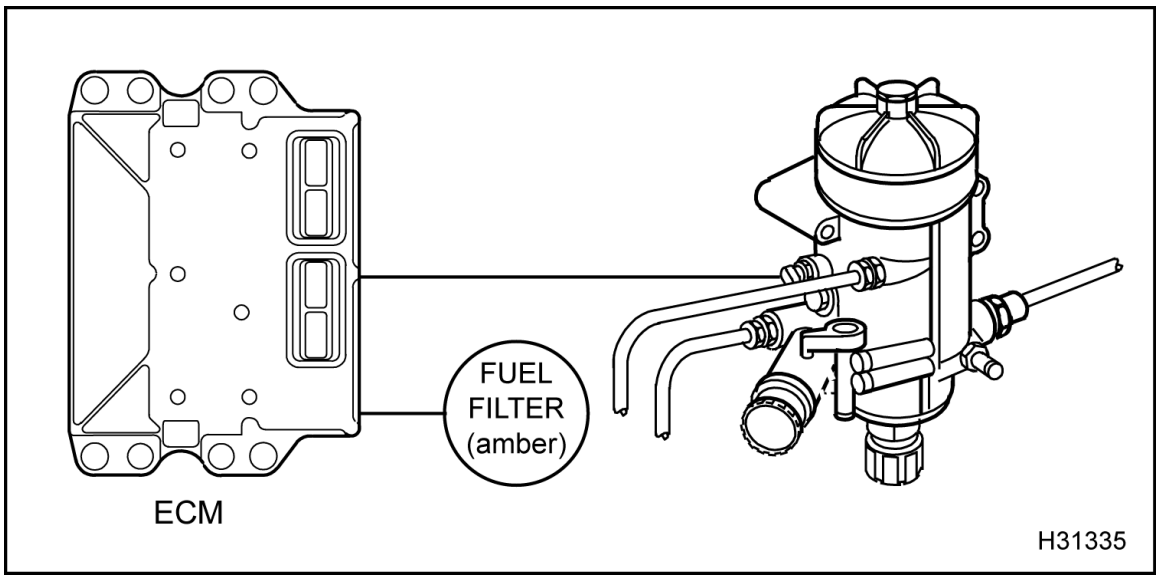


Figure 511 Function diagram for the WIF system

The function diagram for the WIF system includes the following:

- Electronic Control Module (ECM)
- Fuel filter assembly
- FUEL FILTER lamp (amber)

The Electronic Control Module (ECM) monitors the fuel filter header and alerts the operator when water is present in the fuel supply. When water is detected, the ECM will set a Diagnostic Trouble Code (DTC) and the amber FUEL FILTER lamp will illuminate.

The WIF system includes the ECM and the fuel filter assembly with a WIF sensor. The WIF sensor is used in the fuel filter assembly.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WIF Circuit Operation

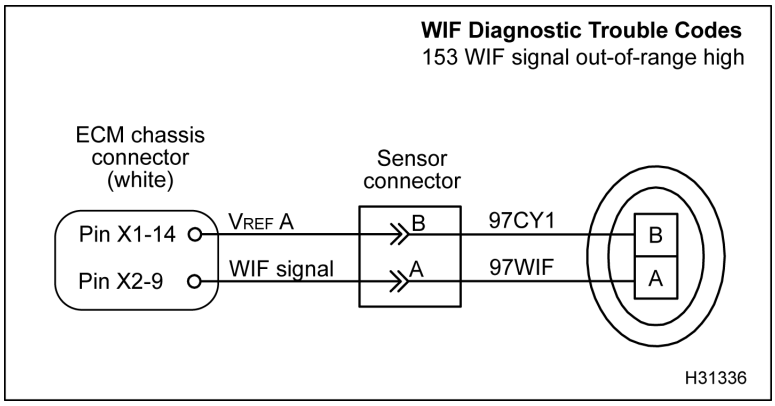


Figure 512 WIF circuit diagram

The WIF sensor uses two electrical contacts exposed to the fuel supply. When water is present in the fuel supply, the circuit between the contacts is closed. This allows a 5 V signal at ECM Pin X2–9. When water is not present, the circuit is open and ECM Pin X2–9 will be 0 V.

Fault Detection / Management

The ECM continuously monitors the WIF circuit for in-range faults. The ECM does not detect open or short circuits in the WIF circuit. When the ECM detects an in-range fault, DTC 153 will be set.

WIF Diagnostic Trouble Codes (DTCs)

DTCs are read using the Electronic Service Tool (EST) or by counting the flashes from the amber and red ENGINE lamp.

DTC 153
WIF signal out-of-range high

- DTC 153 is set when the ECM detects an in-range voltage at or above 4.5 V at ECM Pin X2–9.
- DTC 153 is set when the WIF signal circuit is shorted to V_{REF} or V_{BAT}.
- When DTC 153 is active, the FUEL FILTER lamp is not illuminated.

Tools

- EST with MasterDiagnostics® software
- EZ-Tech® interface cable
- Digital Multimeter (DMM)
- Breakout Box

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

WIF Pin-Point Diagnostics

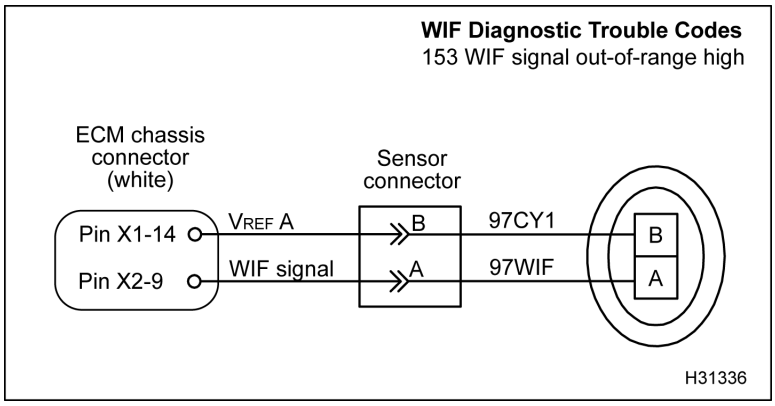


Figure 513 WIF system circuit diagram

The WIF circuit may require the use of vehicle circuit diagrams. See truck *Chassis Electrical Circuit Diagram Manual* for circuit numbers, connector and fuse locations.

Voltage Checks at WIF Sensor Connector (Disconnect harness from sensor and turn the ignition switch to ON.) **Note:** After removing connector, inspect for damaged pins, corrosion, or loose pins. Repair as required.		
Test Point	**Spec**	**Comment**
A to gnd	5 V ±0.5 V	If voltage < 5 V, check for open V_{REF} circuit or failed ECM.
B to gnd	0 V	If voltage > 0 V, check for signal circuit shorted to another circuit
Sensor Resistance Check (Disconnect connector from sensor and measure across sensor.)		
A to B	> 1 kΩ	If < 1 kΩ, check for water in fuel, failed sensor, or shorted sensor harness.
Connector Resistance Checks to ECM Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect harness from sensor.)		
A to Pin B (9260)	> 1 kΩ	If < 1 kΩ, check for short to signal ground.
B to Pin B (9260)	> 1 kΩ	If < 1 kΩ, check for short to signal ground.

WARNING: To avoid serious personal injury, possible death, or damage to the engine or vehicle, always disconnect main negative battery cable first. Always connect the main negative battery cable last.

Connector Resistance Checks to Chassis Ground (Turn the ignition switch to OFF. Disconnect chassis connector 9260[1]. Disconnect negative battery cable. Disconnect harness from sensor. Use disconnected negative battery cable for ground test point.)		
A to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to chassis ground.
B to gnd cable	> 1 kΩ	If < 1 kΩ, check for short to chassis ground.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Harness Resistance Check – WIF Connector to ECM (Turn the ignition switch to OFF. Connect breakout box to chassis harness only. Disconnect sensor.)		
X1–14 to B	< 5 Ω	If > 5 Ω, check for open V_{REF} circuit.
X2–9 to A	< 5 Ω	If > 5 Ω, check for open signal wire.
Operational Voltage Checks for WIF Sensor (Check with breakout box connected to ECM and engine harness and WIF sensor connected. Turn the ignition switch to ON.)		
X2–9 to gnd	0 V to 2.5 V	Voltage is 2.5 V with water in fuel. Voltage 0 V without water in fuel (use breakout box).
WIF Diagnostic Trouble Codes		
DTC 153 = Signal voltage was > 4.5 V		

[1] Connector 9260 is a 2-wire connector usually located in the battery box. Pin A is the chassis ground connection for the ECM and IDM. Refer to truck Chassis Electrical Circuit Diagram Manual for complete chassis side ECM and IDM ground circuit information.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Table of Contents

Tools and Accessories.....557
- **EZ-Tech® Electronic Service Tool (EST).....557**
- **EZ-Tech® Interface Kit.....557**
- **MasterDiagnostics® Software.....557**
- **Digital Multimeter (Fluke 88).....558**
- **Amp Clamp.....558**
- **96-Pin Breakout Box – DLC II.....559**
- **Breakout Harness Kit.....559**
- **3-Banana Plug Harness.....560**
- **VC Gasket Breakout Harness.....560**
- **UVC Sensor Breakout Harness.....560**
- **4-Pin Injector Harness.....560**
- **12-Pin Breakout Harness.....561**
- **500 Ohm Resistor Harness.....561**
- **Actuator Breakout Harness 561**
- **APS/IVS Sensor Breakout Harness.....561**
- **Pressure Sensor Breakout Harness 562**
- **Relay Breakout Harness.....562**
- **Relay Breakout Harness.....562**
- **Temperature Sensor Breakout Harness.....562**
- **Temperature Sensor Breakout Harness.....563**
- **Turbo Breakout Harness.....563**
- **EGR Valve Breakout Harness.....563**
- **Terminal Test Adapter Kit.....564**
- **Gauge Bar Tool.....564**
- **Fuel Pressure Gauge.....565**
- **Slack Tube Manometer.....565**
- **Fuel Pressure Test Kit.....566**
- **Fuel/Oil Pressure Test Coupler.....566**
- **Fuel Test Fitting.....567**
- **ICP System Test Adapter.....567**
- **ICP Test Kit.....567**
- **Inline Shut-off Valve.....568**
- **Vacuum Pump and Gauge.....568**
- **Charge Air Cooler Test Kit.....568**
- **Crankcase Pressure Test Adapter.....569**
- **UV Leak Detection Kit.....569**

Electronic Circuit Testing.....570
- **Electrical Theory.....570**
  - **Voltage.....570**
  - **Ohm's Law 570**
- **Using the Digital Multimeter.....571**
  - **Test Meters.....571**
  - **Jumper Wires.....572**
  - **Voltmeter.....572**

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Ammeter.....574
Ohmmeter.....575
Measuring Duty Cycle with FLUKE 88.....576
Troubleshooting.....578

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Tools and Accessories

EZ-Tech® Electronic Service Tool (EST)

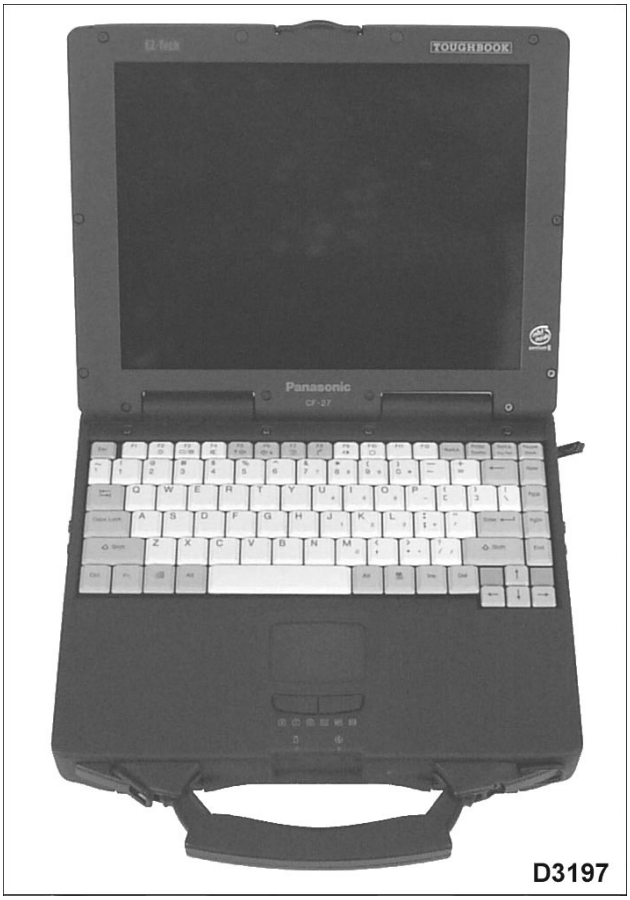


Figure 514 J-45067

The EST is used to run MasterDiagnostics® software for diagnosing and troubleshooting engine and vehicle problems.

EZ-Tech® Interface Kit



Figure 515 ZTSE4444B

These interface cables, included with the EZ-Tech®, connect the EST to Electronic Control Module (ECM).

MasterDiagnostics® Software

MasterDiagnostics® 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.

©August 2008 Navistar, Inc.

Digital Multimeter (Fluke 88)

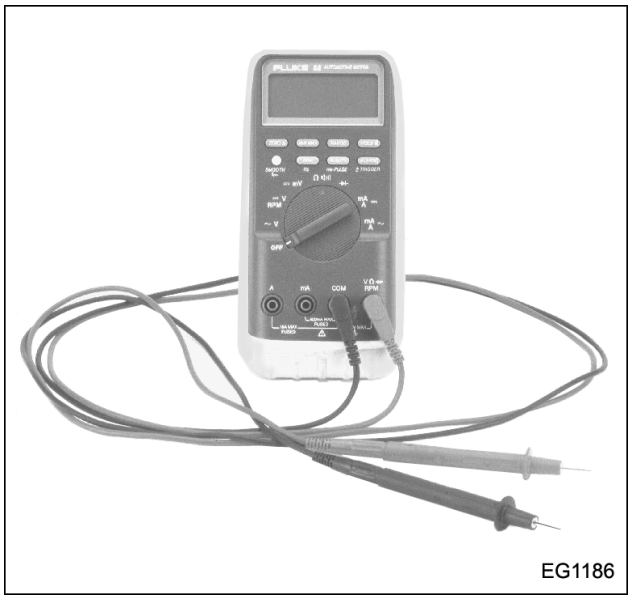


Figure 516 ZTSE4357

The Fluke 88 Digital Multimeter (DMM) 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 that the signal voltage measurement will not be affected by the voltmeter.

Amp Clamp

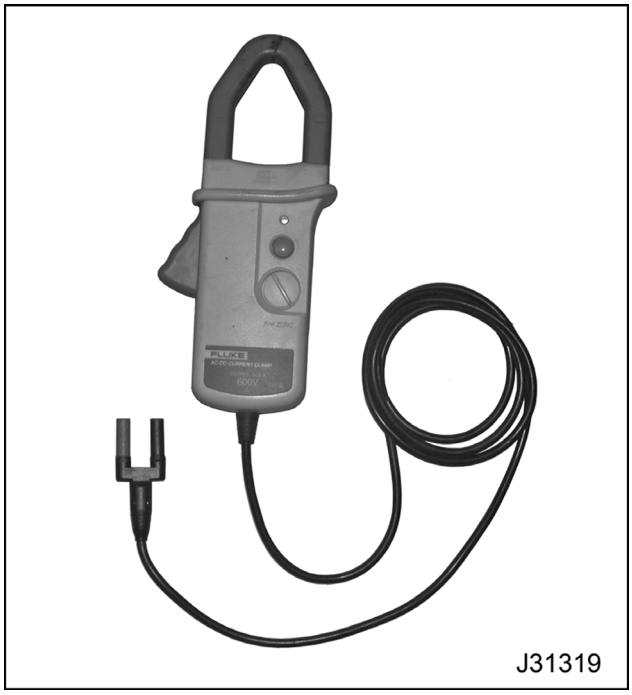


Figure 517 ZTSE4575

The Amp Clamp is to measure amperage draw for the glow plug and inlet air heater systems.

©August 2008 Navistar, Inc.

96-Pin Breakout Box – DLC II



Figure 518 ZTSE4582

The Breakout Box allows testing of the electronic control system components without disturbing connections or piercing wire insulation to access various signal voltages in the electronic control system.

CAUTION: The Breakout Box is used for measurement only, not to activate or control circuits. High current levels passing through the breakout box will burn out the internal circuitry.

Breakout Harness Kit



Figure 519 ZTSE4505A

The Breakout Harness Kit contains the following breakout harnesses and test leads:

- 3-Banana Plug Harness (ZTSE4498)
- VC Gasket Breakout Harness (ZTSE4658A)
- UVC Sensor Breakout Harness (ZTSE4686)
- 4-Pin Injector Harness (ZTSE4662)
- 12-Pin Breakout Harness (ZTSE4665)
- 500 Ohm Resistor Harness (ZTSE4497)
- Actuator Breakout Harness (ZTSE4484)
- APS/IVS Breakout Harness (ZTSE4485)
- Pressure Sensor Breakout Harness (ZTSE4347)
- Relay Breakout Harness (ZTSE4596)
- Relay Breakout Harness (ZTSE4674)
- Temperature Sensor Breakout Harness (ZTSE4483)
- Temperature Sensor Breakout Harness (ZTSE4602)
- Turbo Breakout Harness (ZTSE4659)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

3-Banana Plug Harness

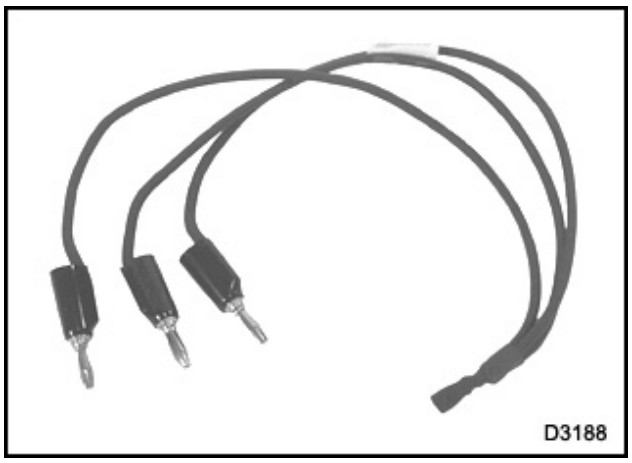


Figure 520 ZTSE4498

The 3-Banana Plug Harness is used for operational diagnostics of sensor circuits.

VC Gasket Breakout Harness

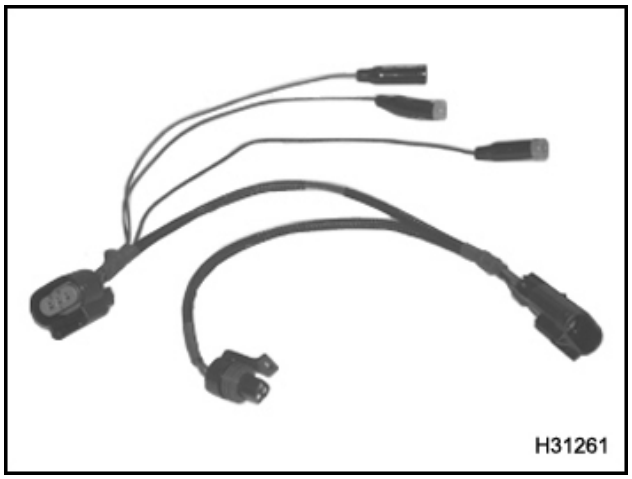


Figure 521 ZTSE4658A

The VC Gasket Breakout Harness is used to access V_{REF}, signal ground, and signal voltage circuits, before removing valve cover, for the following sensors:

- Injection Control Pressure (ICP)
- Brake Control Pressure (BCP)

The VC Gasket Breakout Harness is also used to check actuator ground and control for the brake shutoff valve circuit and ICP system diagnostics.

UVC Sensor Breakout Harness

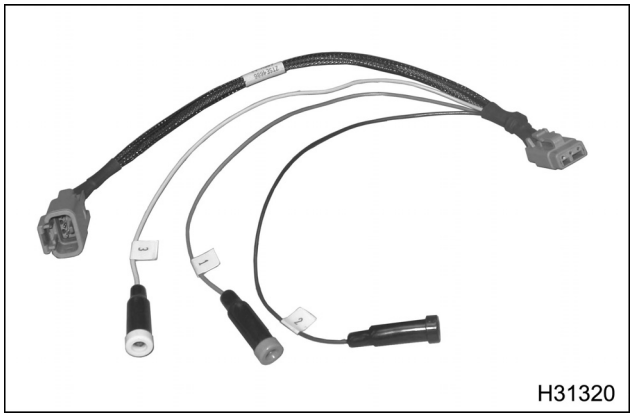


Figure 522 ZTSE4686

The UVC Sensor Breakout Harness is used to access V_{REF}, signal ground, and signal voltage circuits, after removing valve cover, for the following sensors:

- Injection Control Pressure (ICP)
- Brake Control Pressure (BCP)

4-Pin Injector Harness

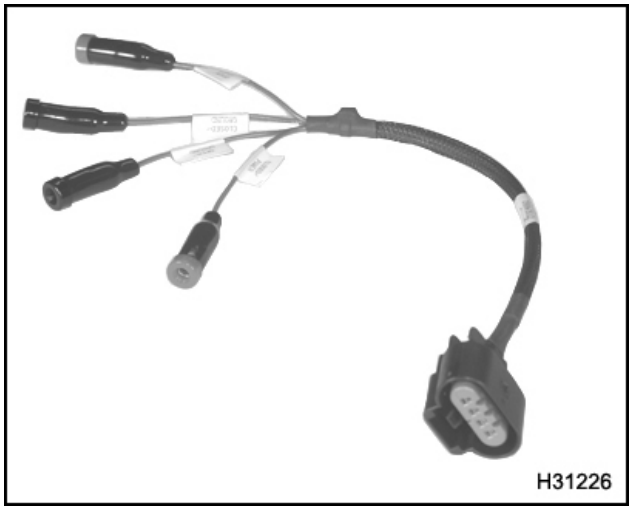


Figure 523 ZTSE4662

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The 4-Pin Injector Harness is used to measure continuity of the UVC wiring and injector solenoids.

12-Pin Breakout Harness

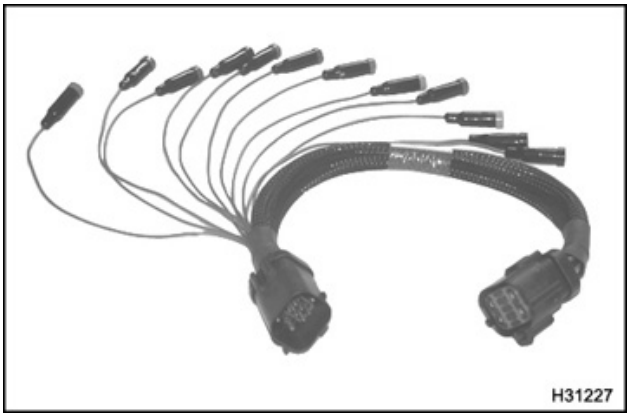


Figure 524 ZTSE4665

The 12-Pin Breakout Harness is used for circuit diagnostics for the Injector Drive Module (IDM) powers and ground, actuator power and ground (EGR and VGT), in addition to some applications (IAT, service brake switch signals to the ECM, and ATA data link to and from the IDM).

500 Ohm Resistor Harness

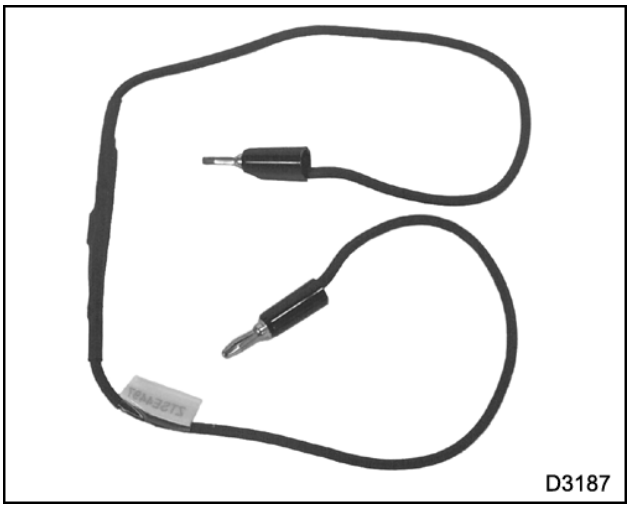


Figure 525 ZTSE4497

The 500 Ohm Resistor Harness is used for operational diagnostics of sensor circuits and Output State Tests for actuator control circuits.

Actuator Breakout Harness

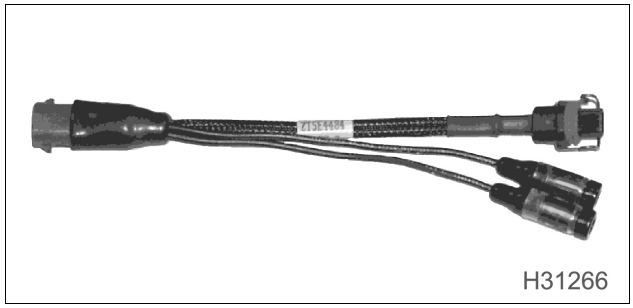


Figure 526 ZTSE4484

The Actuator Breakout Harness is used to measure the voltage supplied to the Injection Pressure Regulator (IPR).

For electrical circuit diagnostics, install the breakout harness between the electrical harness and the valve. For Injection Control Pressure (ICP) system diagnostics, plug the Actuator Breakout Harness into the IPR valve only.

APS/IVS Sensor Breakout Harness

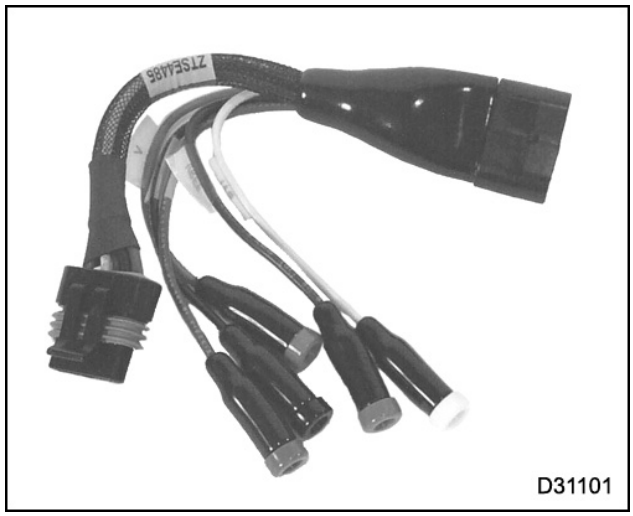


Figure 527 ZTSE4485

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The Accelerator Position Sensor (APS) / Idle Validation Switch (IVS) harness is used to measure V_{REF}, APS signal, signal ground, IVS signal, and IVS power at the APS/IVS sensor.

Pressure Sensor Breakout Harness

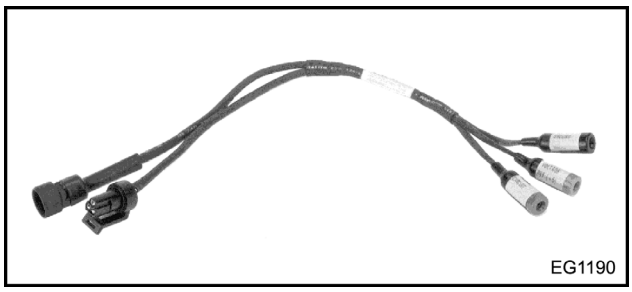


Figure 528 ZTSE4347

The Pressure Sensor Breakout Harness is used to access V_{REF}, signal ground, and signal voltage circuits for the following sensors:

- Manifold Absolute Pressure (MAP)
- Exhaust Back Pressure (EBP)
- Engine Oil Pressure (EOP)

Relay Breakout Harness

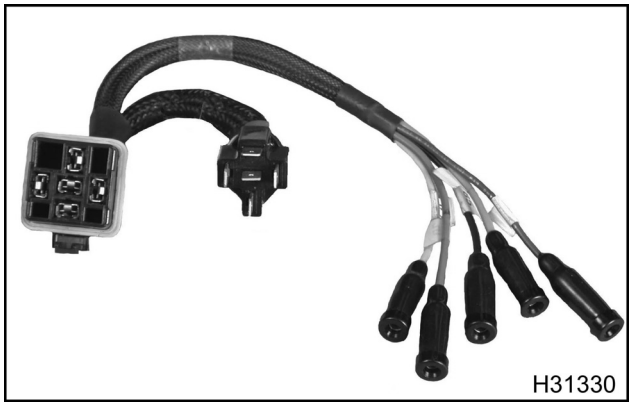


Figure 529 ZTSE4596

The Relay Breakout Harness is used to measure power from the IDM main power relay or ECM main power relay to check the operation of the relay in the circuit.

Relay Breakout Harness

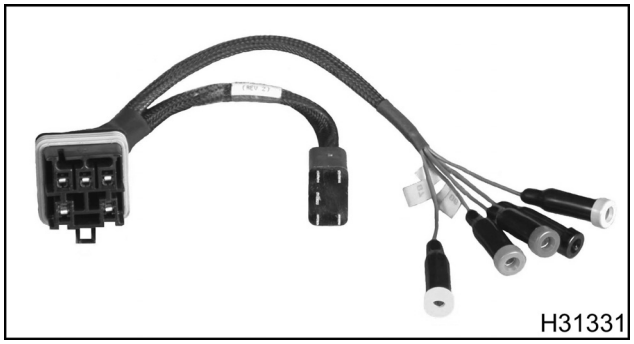


Figure 530 ZTSE4674

The Relay Breakout Harness is used to measure power from the IDM main power relay or ECM main power relay to check the operation of the relay in the circuit.

Temperature Sensor Breakout Harness

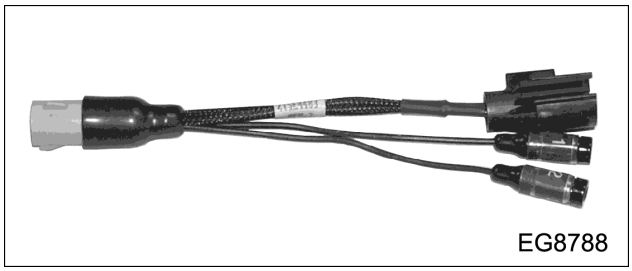


Figure 531 ZTSE4483

The Temperature Sensor Breakout Harness enables the technician to quickly connect a voltmeter and read voltage signals for the Intake Air Temperature (IAT) sensor.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Temperature Sensor Breakout Harness

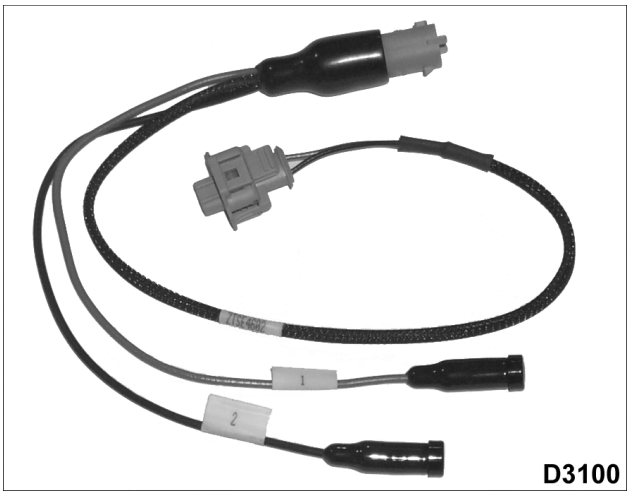


Figure 532 ZTSE4602

The Temperature Sensor Breakout Harness enables the technician to quickly connect a voltmeter and read voltage signals for the following sensors:

- Engine Coolant Temperature (ECT)
- Engine Oil Temperature (EOT)
- Manifold Absolute Temperature (MAT)

Turbo Breakout Harness

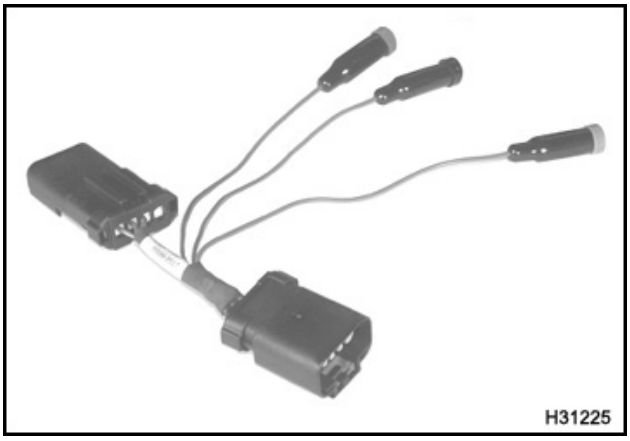


Figure 533 ZTSE4659

Turbo Breakout Harness is used to measure VGT actuator power, ground, and control.

EGR Valve Breakout Harness

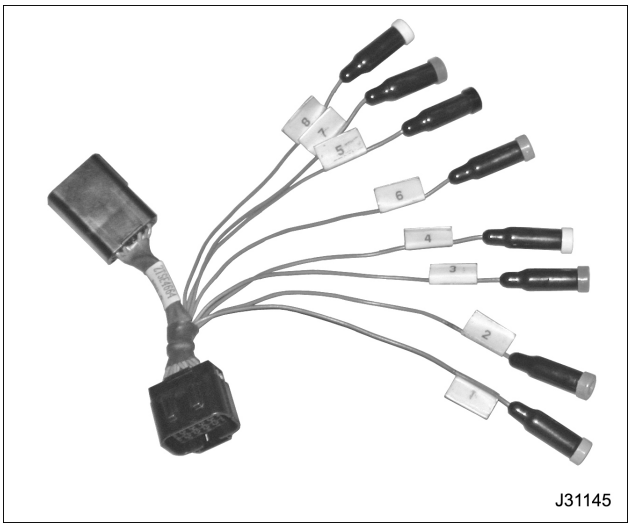


Figure 534 ZTSE4664

The EGR Breakout Harness is primarily used to pin out the harness to look for opens and shorts. The EGR Breakout Harness is also used to access supply voltage and ground to the EGR valve, as well as to monitor drive signals and position sensor signals.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Terminal Test Adapter Kit



Figure 535 ZTSE4435A

The Terminal Test Adapter 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.

Gauge Bar Tool

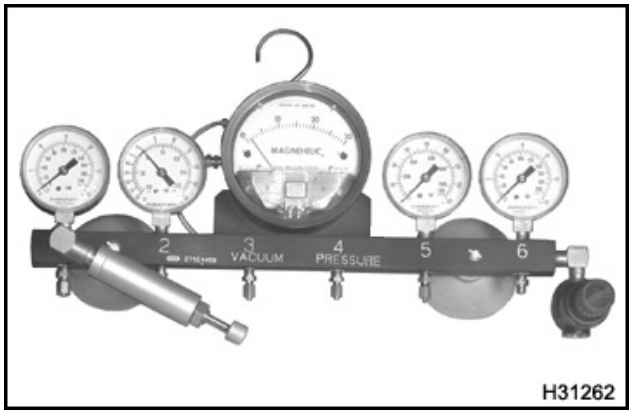


Figure 536 ZTSE4409

The Gauge Bar Tool is used to measure intake manifold (boost) pressure, fuel system inlet restriction, fuel pressure, oil pressure, air cleaner intake restriction, and crankcase pressure.

- 0 kPa to 200 kPa (0 psi to 30 psi) measures intake manifold pressure.
- 0-30 in Hg vacuum /0 kPa to 200 kPa (0 psi to 30 psi) compound gauge measures fuel system inlet restriction and intake manifold pressure.

  0-30 in H_2O 0 kPa to 7.5 kPa (0 psi to 1 psi) maximum pressure magnehelic gauge measures crankcase pressure and air inlet restriction.
- 60 kPa to 1100 kPa (0 psi to 160 psi) gauge may be used to check the fuel pressure and oil pressure.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fuel Pressure Gauge

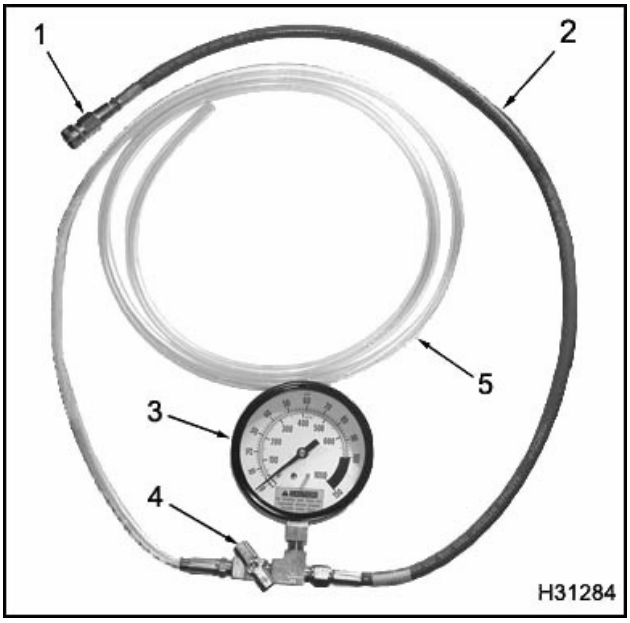


Figure 537 ZTSE4681

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 aerated fuel at the fuel rail.

Slack Tube Manometer

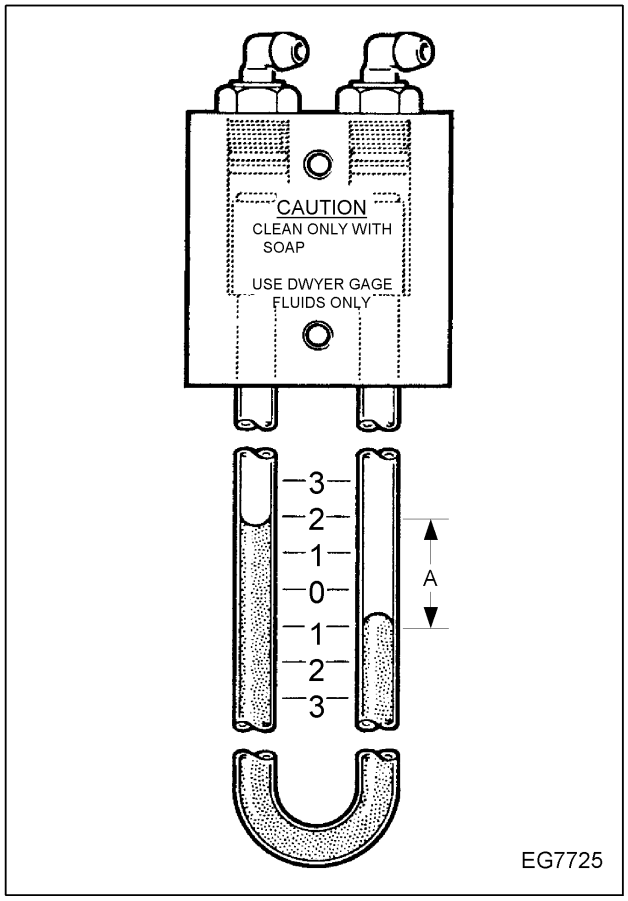


Figure 538 ZTSE2217A

The Slack Tube Manometer is a U-shaped tube with a scale mounted between the legs of the tube. When the portability of the gauge bar tool is not required, this manometer is used to measure low vacuum for intake restriction or low pressure for crankcase.

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

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

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.

Fuel Pressure Test Kit

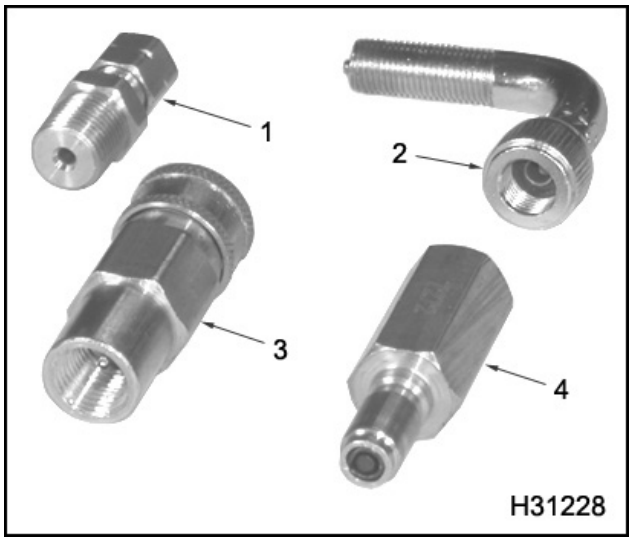


Figure 539 ZTSE4657

1. Compression fitting 1/8 NPT
2. 90° elbow
3. Quick disconnect check valve
4. Fuel pressure test adapter

The Fuel Pressure Test Kit includes a quick disconnect check valve and fittings that can be used to make a test line to check fuel pressure at the high-pressure fuel rail.

Fuel/Oil Pressure Test Coupler



Figure 540 ZTSE4526

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The Fuel/Oil Pressure Test Coupler is used with the fuel pressure test fitting for an easy connection to measure fuel pressure.

Fuel Test Fitting



Figure 541 ZTSE4692

The fuel test fitting is used to measure fuel inlet restriction or fuel pressure.

When measuring fuel inlet restriction, the fitting is installed at the diagnostic port (inlet-side) of the fuel filter housing.

When measuring fuel pressure, the fitting can be installed on the fuel rail instead of the Shrader valve.

The Fuel/Oil Pressure Test Coupler can then be connected to the fuel test fitting to measure fuel pressure or fuel inlet restriction.

ICP System Test Adapter

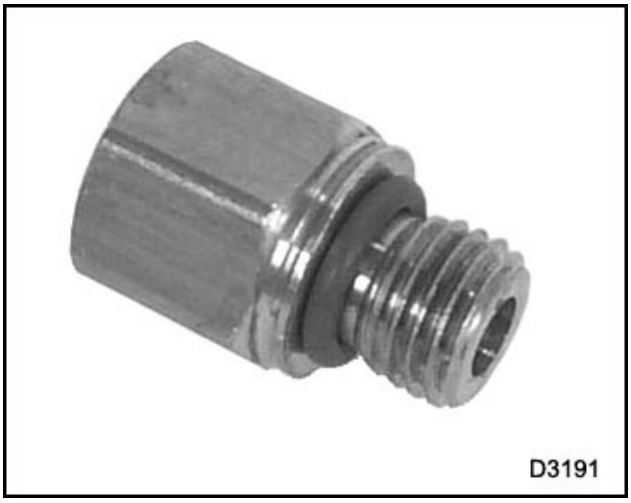


Figure 542 ZTSE4594

The Injection Control Pressure (ICP) System Test Adapter was first used to pressurize the ICP system for the International® VT 365 diesel engine to test ICP system integrity with the influence of the Injection Pressure Regulator (IPR) valve. This adapter is used to take an oil sample or measure oil pressure at the Engine Oil Temperature (EOT) sensor port for the International® DT 466, DT 570, and HT 570 diesel engine.

ICP Test Kit

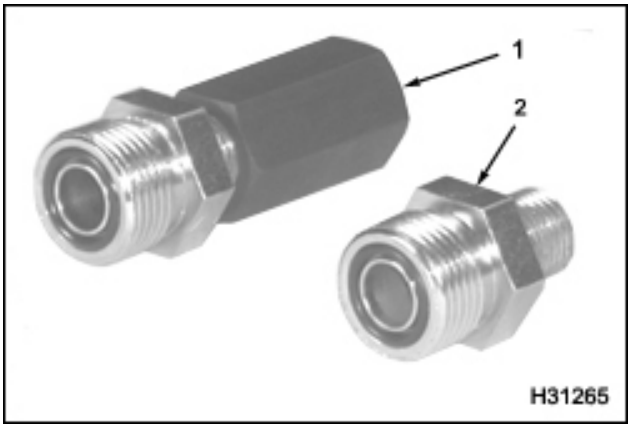


Figure 543 ZTSE4655

1. Fitting 13/16 - 16 NPT
2. ICP sensor adapter

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

The ICP Test Kit is used to check ICP system diagnostics. The ICP adapter is used with an ICP sensor and the VC Gasket Breakout Harness to check the integrity of the high-pressure pump and IPR. The fitting is adapted to an air line to pressurize the UVC components and check for leaks.

Inline Shut-off Valve

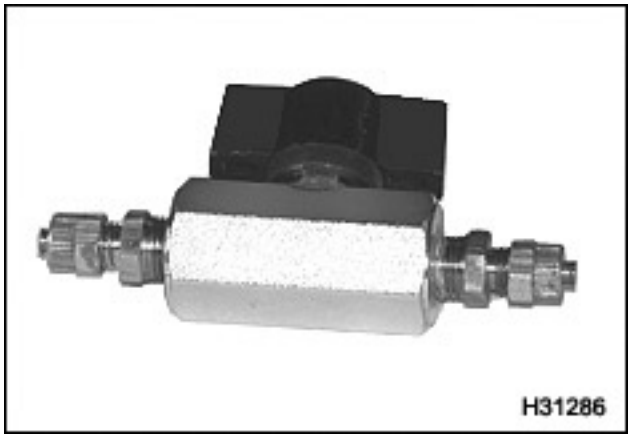


Figure 544 Part No. 221406

The Inline Shut-off Valve is used to make a test line assembly that connects to the ICP system test adapter to check for aerated oil specifically at the EOT sensor port. The shut-off valve can also be used to make a test line assembly to check for aerated fuel.

Vacuum Pump and Gauge



Figure 545 ZTSE2499

The Vacuum Pump and Gauge is used to test the operation of the fuel pump.

Charge Air Cooler Test Kit

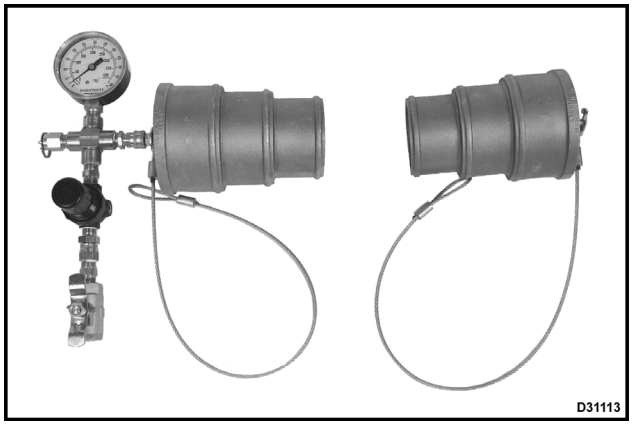


Figure 546 ZTSE4341

The Charge Air Cooler (CAC) Test Kit is used to pressurize the charge air cooler and piping to check for leaks.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Crankcase Pressure Test Adapter

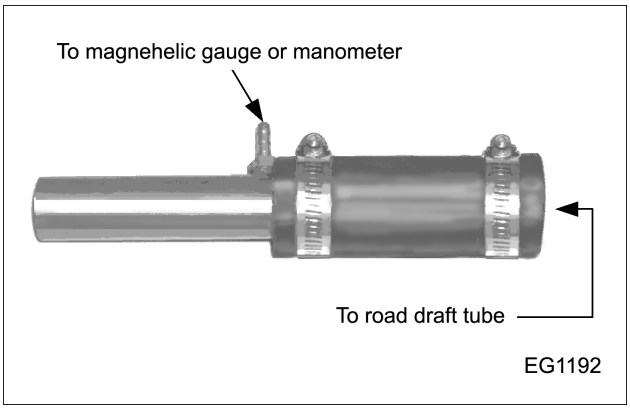


Figure 547 ZTSE4039

The Crankcase Pressure Test Adapter is used to measure combustion gas flow from the engine breather and may be used with the magnehelic gauge or slack tube manometer.

Pressure readings obtained with this adapter must be used as the main source of engine condition. Oil consumption trend data must also be used 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.

UV Leak Detection Kit



Figure 548 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.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Electronic Circuit Testing

Electrical Theory

Voltage

Voltage is electrical pressure or force that pushes current through a circuit. The pressure is measured in volts. The symbol V (for example, 12 V) is used in circuit diagrams to denote voltage. The letter E (Electromotive force) is also used for voltage. Voltage can be compared to the pressure necessary to push water through a metering valve.

Low voltage to a lamp will cause the lamp to glow dimly. This can be caused by low source voltage (discharged battery or low alternator output) or by high circuit resistance resulting from a poor connection. Resistance from a poor connection or poor ground is an additional load in the circuit. The additional load reduces voltage available to push current through the load device. Before making any meter measurements, review Ohm's Law.

Ohm's Law

Ohm's Law describes the relationship between current, voltage, and resistance in an electrical circuit. Ohm's Law also provides the basic formula for calculations.

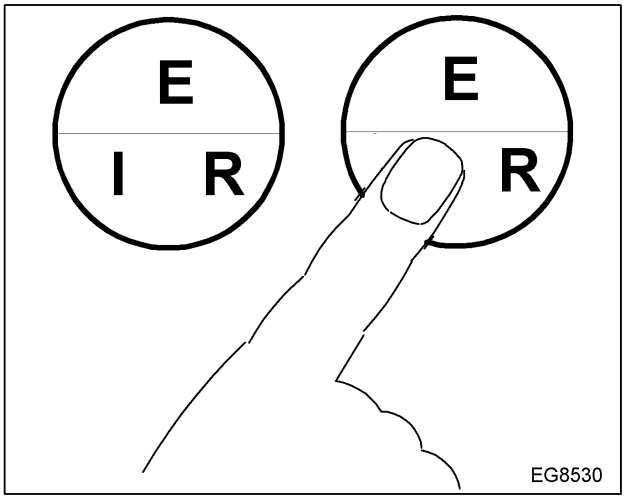


Figure 549 Ohm's Law

Memorize the formula in the circle. Cover the letter with a finger for the desired formula. For example, I is covered, the formula is I = E ÷ R.

If two values are known for a given circuit, the missing one can be found by substituting the values in amperes, volts, or ohms.

The three basic formulas for Ohm's Law are as follows:
I = Current (amperes)
E = Voltage (volts)
R = Resistance (ohms)

- I = E ÷ R

  This formula states that the current flow (I) in the circuit equals the voltage (E) applied to the circuit divided by the total resistance (R) in the circuit. This shows that an increase in voltage or a decrease in resistance increases the current flow.

- E = I × R

  This formula states that the voltage (E) applied to the circuit equals the current flow (I) in the circuit multiplied by the total resistance (R) in the circuit. The voltage drop is caused by resistance across a particular load device in a series of load devices.

- R = E ÷ I

  This formula states that the total resistance (R) in the circuit equals the voltage (E) applied to the circuit divided by the current flow (I) in the circuit. Resistance can be calculated for a specific current flow when a specific voltage is applied.

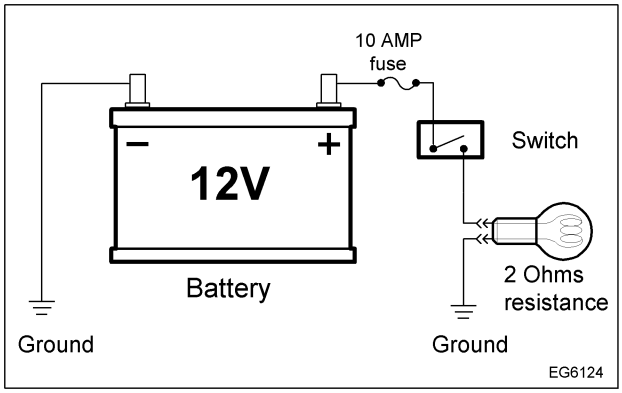


Figure 550 Simple electrical circuit

In a typical circuit, battery voltage is applied to a bulb through a 10 amp fuse and a switch. Closing the switch turns on the bulb.

To find the current flow, use the formula I = E ÷ R:

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Fill in the numbers for the formula:

I = 12 V ÷ 2 ohms

I = 6 amps

The bulb in this circuit operates at 6 amps and is rated at 6 amps. With 12 volts applied, the bulb will glow at the rated output level (candlepower rating). However,

- If the voltage applied is low (low battery), the value of E is lower, current flow will be less, and the bulb will glow less brightly.
- If connections are loose or the switch is corroded, the circuit resistance will be greater (value of R will be larger), the current flow will be reduced, and the bulb will glow less brightly.

Voltage drops are important for the following reasons:

- High voltage drops indicate excessive resistance. For example, if a blower motor runs too slowly or a light glows too dimly, the circuit may have excessive resistance. Voltage drop readings can isolate problems in parts of a circuit (corroded or loose terminals, for example).
- Too low of a voltage drop indicates low resistance. For example, if a blower motor runs too fast, the problem could be low resistance in a resistor pack.
- Maximum allowable voltage drop under load is critical, especially for more than one high resistance problem. All voltage drops in a circuit are cumulative. Corroded terminals, loose connections, damaged wires or other similar conditions create undesirable voltage drops that decrease the voltage available across the key components in the circuit. Increased resistance will decrease current flow in the circuit, preventing other components from operating at peak efficiency. A small drop across wires (conductors), connectors, switches, etc., is normal because all conductors have some resistance, but the total should be less than 10% of the total voltage drop in the circuit.

Using the Digital Multimeter

The following electrical test equipment should be available for testing electronic circuits:

- Voltmeter
- Ohmmeter
- Ammeter
- Jumper wires
- Test lights

Test Meters

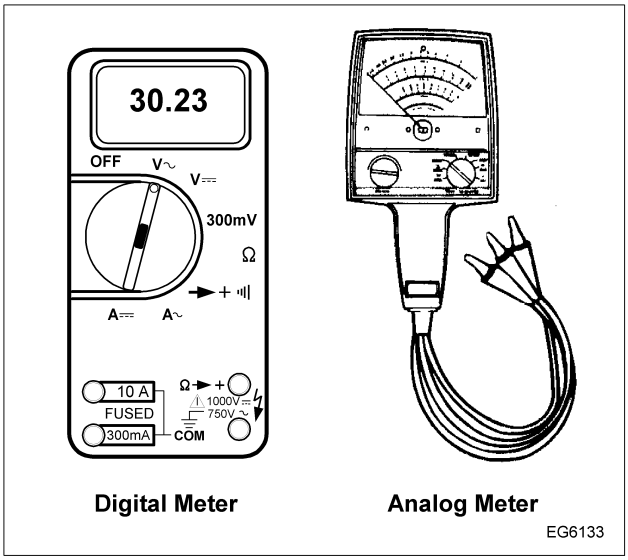


Figure 551 Typical Test Meters

Test meters come in a variety of models. Any working model will be adequate for simple tests. However, accurate readings are important. Make sure the test meter is of high quality. The Fluke 88 Digital Multimeter (DMM) is recommended because it has very little current and a high impedance (resistance) of 10 megaohms (10 MΩ).

CAUTION: Only use a high impedance digital multimeter when troubleshooting an electronic circuit. Do not use any kind of battery powered test light. Battery test lights can damage an electronic control circuit.

NOTE: Some devices in an electronic control system are not capable of carrying an appreciable amount of current. Therefore, test equipment must be designed to not damage any part the electronic control system. Do not use analog meters unless specified. Analog meters use too much current to test an electronic control system.

©August 2008 Navistar, Inc.

Jumper Wires

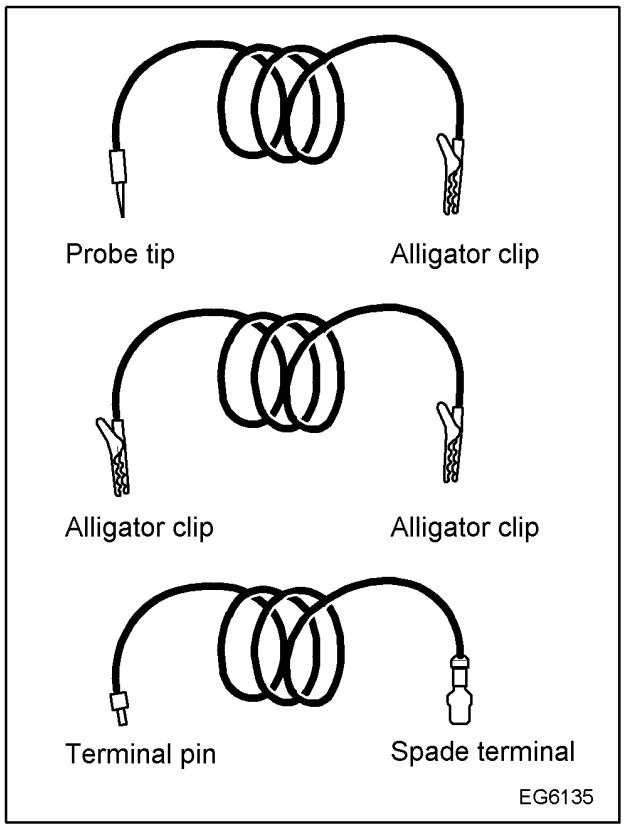


Figure 552 Jumper wires

Jumper wires allow a circuit to by-pass a suspected opening or break in a circuit. Use a jumper wire to check for open relay contacts, wire breaks and poor ground connections. Several jumper wires with different tips should be available.

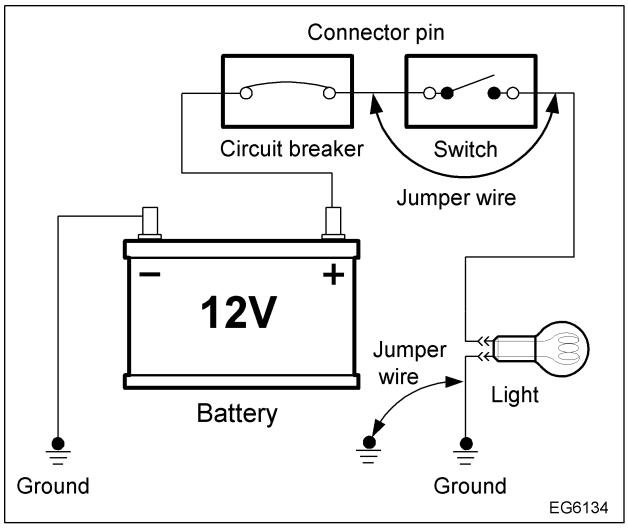


Figure 553 Troubleshooting with jumper wires

If the circuit works correctly with the jumper wire in place, but does not work when the jumper wire is removed, the circuit is open.

A circuit with no openings or breaks has continuity (uninterrupted current flow) and needs no further testing.

An opening in the ground circuit exists for the following:

- A switch is closed but the light does not illuminate.
- Jumping the switch does not illuminate the light.
- Jumping the light to the ground causes the light to illuminate.

Voltmeter

Use a voltmeter to answer the following questions:

- Does the circuit have voltage?
- What is the voltage reading?
- What is the voltage drop across a load device?

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

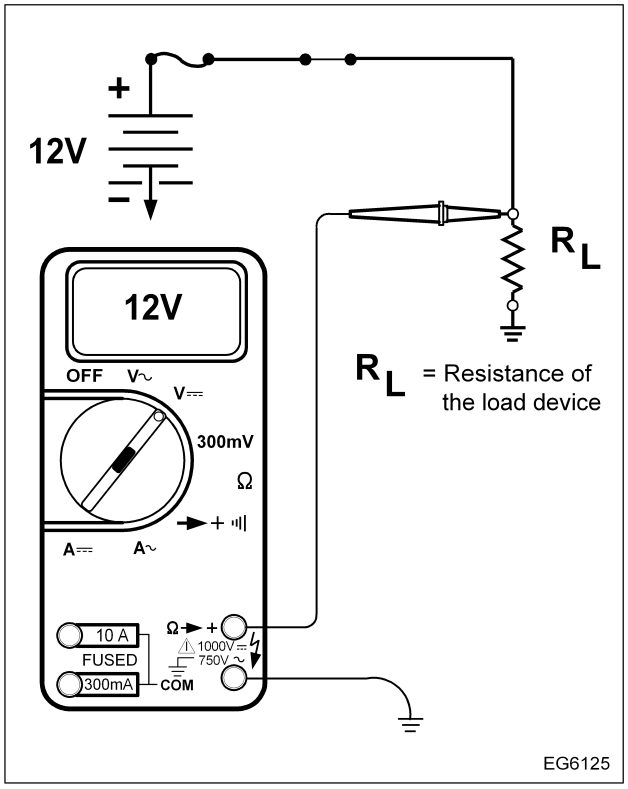


Figure 554 Checking power to a load device

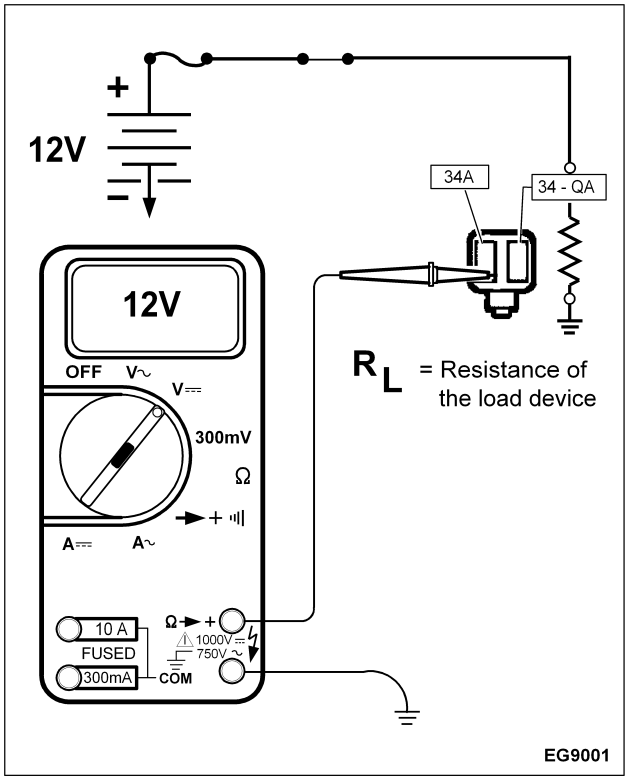


Figure 555 Checking power to a connector

To check for voltage to a load device, connect the positive meter lead to the input connection of the device (positive side) and connect the negative meter lead to a good vehicle ground.

Voltage to a device can also be measured by disconnecting the harness connector and using the correct tool in the Terminal Test Adapter Kit.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

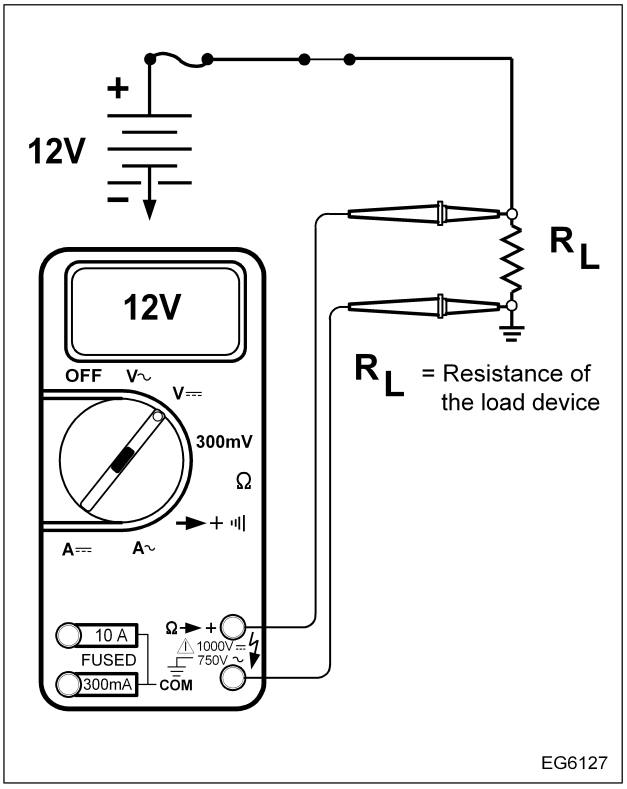


Figure 556 Checking voltage drop

To check the voltage drop across a load device, connect the positive lead of the voltmeter to the positive side of the device and the negative meter lead to the negative side of the device.

With the device operating, this will measure the voltage drop across the device. With only one device, all of the voltage should be dropped at the device. In any circuit, the voltage applied will equal the voltage dropped in the circuit. If this circuit only dropped 9 V across the load, it indicates the wires and connections dropped 3 V, indicating excessive circuit resistance.

Ammeter

An ammeter measures current flow (amperage) in a circuit. Amperes (or amps) are units of electron flow that indicate how many electrons are passing through the circuit. An amp is the unit of measurement for the current flow in the circuit.

Ohm's Law states that the current flow is equal to the circuit voltage divided by the total circuit resistance (I = E ÷ R). Therefore, increasing the voltage also increases the current flow. Any decrease in resistance will also increase the current flow.

At normal operating voltage, most circuits have a characteristic amount of current flow (current draw). Current draw can be measured with an ammeter. Valuable diagnostic information can be provided by referring to a specified current draw rating for a component (electrical device), measuring the current flow in the circuit, and then comparing the two measurements (the specified current draw versus the actual measurement).

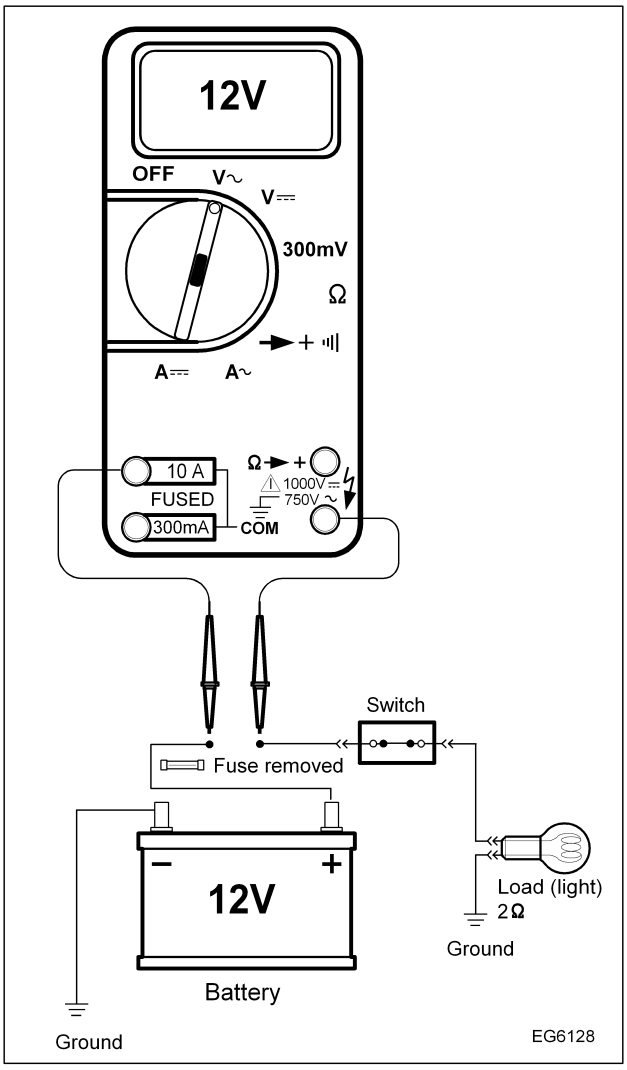


Figure 557 Installing the ammeter

An ammeter is connected in series with the load, switches, resistors, etc., so that all of the current

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

flows through the meter. The ammeter measures current flow only when the circuit is powered up and operating. The DMM is fused to measure up to 10 amps using the 10 A connection point.

Before measuring current flow, determine approximately how many amps are in the circuit to correctly connect the ammeter. The estimate of current flow can easily be calculated. The resistance of the light bulb is 2 ohms. Applying Ohm's law, current flow will be 6 amps (6 amps = 12 V ÷ 2 ohms). If the fuse is removed and an ammeter is installed with the switch closed, 6 amps of current will be measured flowing in the circuit. Notice that the ammeter is installed in series so that all the current in the circuit flows through it.

WARNING: To avoid serious personal injury or possible death, always make sure the power is off before cutting, soldering, removing circuit components, or before inserting the digital multimeter for current measurements. Even small amounts of current can be dangerous.

Excessive current draw means that more current is flowing in a circuit than the fuse and circuit were designed to handle. Excessive current draw will open fuses and circuit breakers, and will also quickly discharge batteries. An ammeter can diagnose these conditions.

Reduced current draw will cause a device (an electric window motor, for example) to operate poorly. Increased circuit resistance will cause lower current flow (often due to loose or corroded connections).

Ohmmeter

CAUTION: To prevent damage to the test meter, only use the ohmmeter on circuits when the power is OFF. Power from 12 V systems may damage the meter.

The ohmmeter measures resistance (ohms) in a circuit. Ohmmeters use a small battery to supply voltage and current flow through the circuit being tested. Based on Ohm's Law, the ohmmeter calculates resistance in the circuit by measuring the voltage of the meter battery and the amount of current flow in the circuit. Range selection and meter adjustment are not necessary with the DMM.

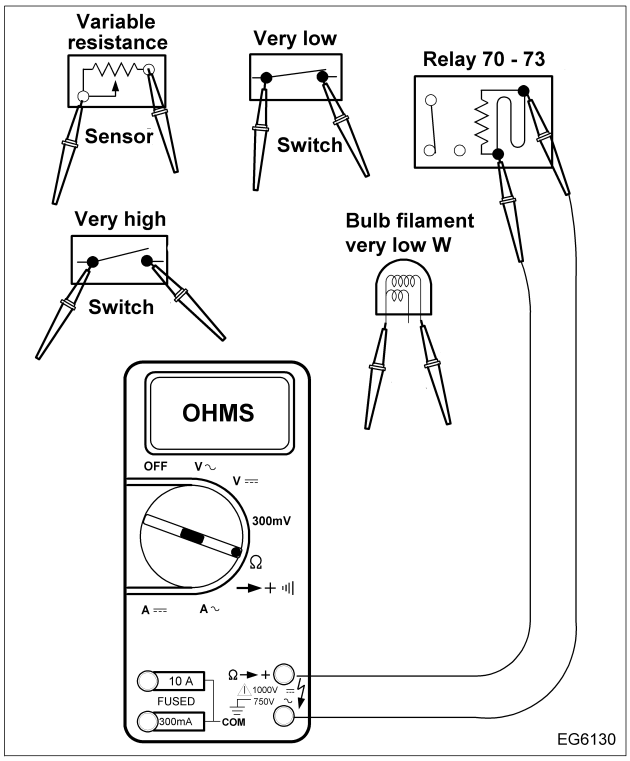


Figure 558 Measuring resistance

Resistance measurements are used to determine the resistance of a load or conductors, the value of resistors and the operation of variable resistors.

To measure the resistance of a component or a circuit, remove power from the circuit. Isolate the component or circuit from other components and circuits so that the meter current (from probe to probe) only flows through the selected component or circuit. When measuring the resistance of the load, most of the current flow from the meter will go through the indicator lamp because it has less resistance.

Remove one connector to the load. It is not always apparent when a component must be isolated, so it is a good practice to isolate a component or circuit by disconnecting one circuit. Place the ohmmeter leads across the component or circuit to display the resistance in ohms. When checking a sensor or variable resistor such as the fuel level gauge, heating the element or moving the arm should move the meter through a range of resistance that can be compared to a specification.

©August 2008 Navistar, Inc.

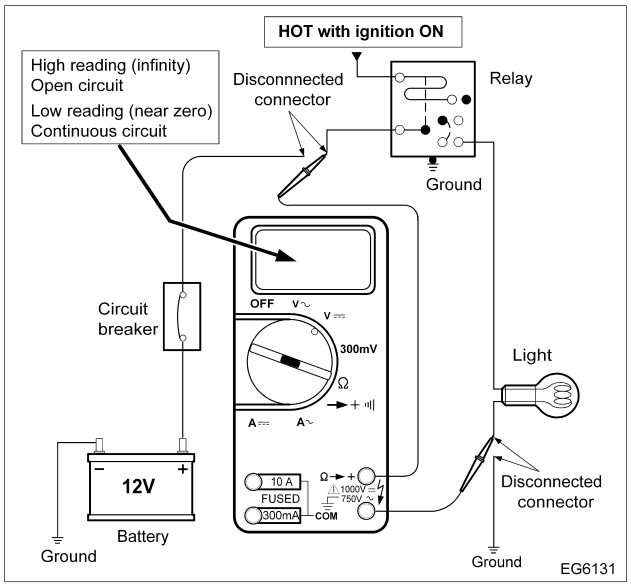


Figure 559 Checking for open circuits

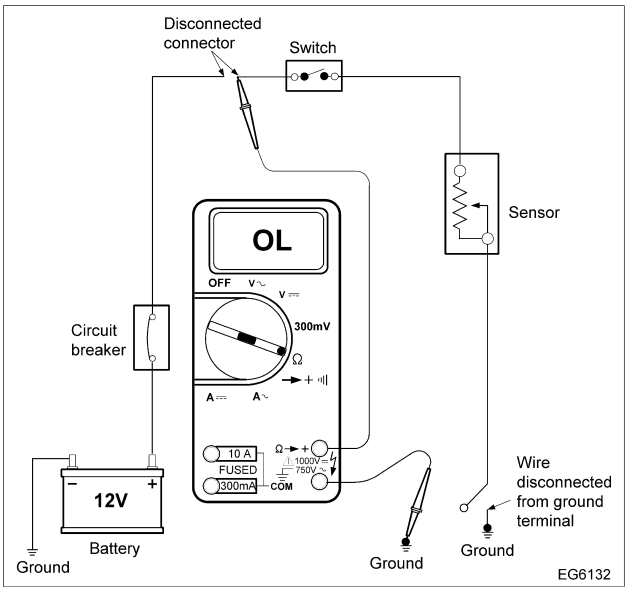


Figure 560 Checking for short circuits

Open electrical circuits can be diagnosed using an ohmmeter. Disconnect the power supply to the circuit and isolate the circuit from all other circuits. The circuit between the light and the ground is disconnected to prevent reading a circuit that may be shorted to ground ahead of the load device as a continuous circuit. Connect the ohmmeter to the open ends of the circuit. A high reading (infinity) indicates an open circuit. A reading near zero indicates a continuous circuit. With the Fluke 88 Digital Multimeter (DMM), an open circuit will read OL (over limit).

Checks for short circuits are similar to checks for open circuits. Isolate the circuit from the power source and the ground point. Connect the ohmmeter between an isolated circuit and a good ground point to check the circuit for a short to ground. A short to ground will be indicated by a reading near zero. A circuit that is not shorted to ground will cause a high meter reading.

Measuring Duty Cycle with FLUKE 88

When measuring duty cycle, ensure that the large dial on the meter is pointing to volts DC, the DUTY button is set to the Duty Cycle function, and the trigger has a positive slope.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Use the following procedure to check duty cycle:

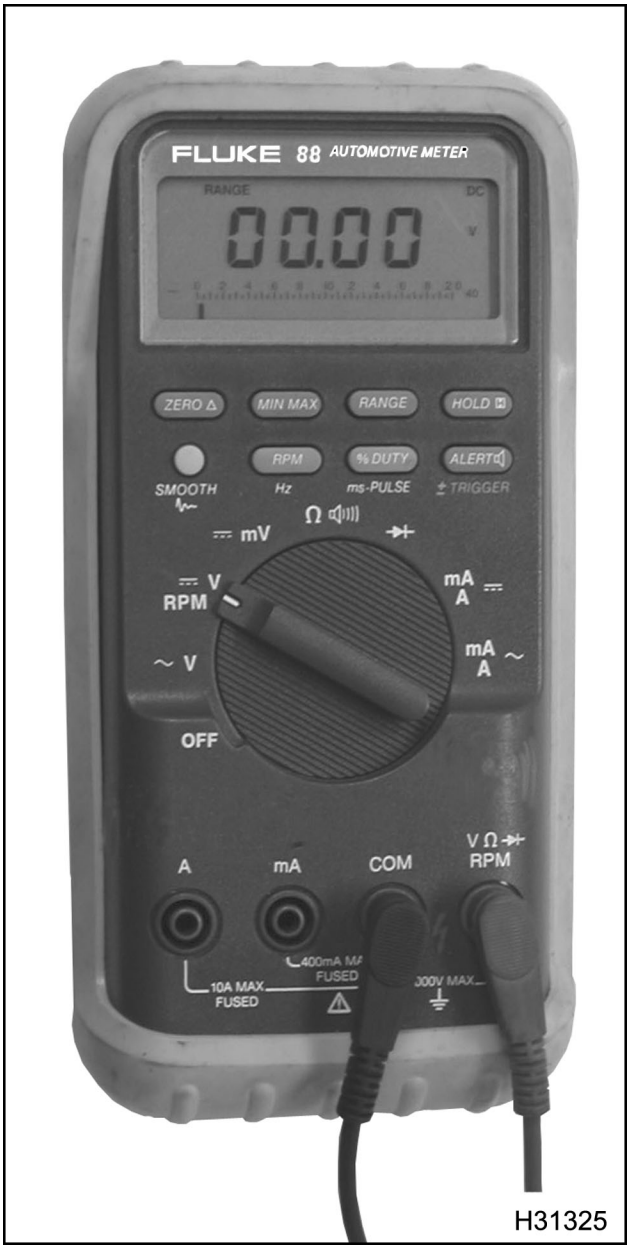


Figure 561 FLUKE 88 in volts dc mode

1. Turn the large dial on the meter to volts DC, indicated by **V RPM**.

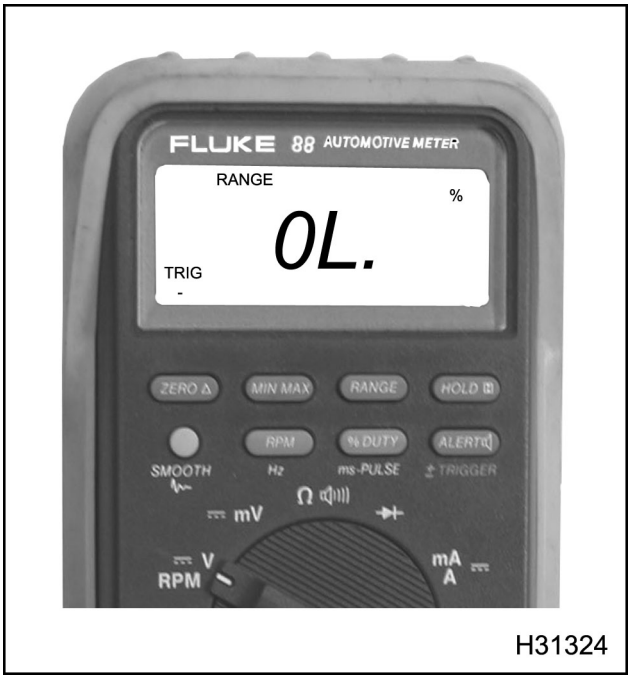


Figure 562 FLUKE 88 with negative trigger slope in duty cycle mode

2. Press the **% DUTY** button to select duty cycle mode. The screen on the meter will show TRIG (with a _ under the TRIG) in the lower left hand corner of the screen. A percent sign will appear on the upper right hand corner of the screen.

©August 2008 Navistar, Inc.



Figure 563 FLUKE 88 in duty cycle mode with positive trigger slope

3. In duty cycle mode, press the **ALERT** button to change from negative to positive trigger slope. The slope is indicated by a plus or minus sign below TRIG in the lower left hand corner of the screen. A percent sign will appear on the upper right hand corner of the screen.
4. After the meter has been set to the correct settings, connect meter as indicated in Pin-Point Diagnostics.

Troubleshooting

1. Verify the problem.

   Operate the complete system and list all symptoms as follows:

   - Check the accuracy and completeness of the complaint.
   - Learn more that might give a clue to the nature and location of the problem.
   - Analyze what parts of the system are working.

2. See Section 7 in this manual or the correct chassis manual.

   Read the electrical operation for the problem circuit and review the circuit diagram. Understanding electrical operation and the circuit diagram can narrow the cause of the problem to one component or certain parts of the circuit.

3. Check the circuit diagram.

   Check the circuit diagram for possible clues to the problem. Location of specific components in the circuit will help identify the source of the problem.

   Circuit diagrams are designed to make it easy to identify common points in circuits. This helps to narrow the problem to a specific area. For example, if several circuits fail at the same time, check for a common power source or common ground connection (i.e., V_{REF}, signal ground, actuator power, actuator ground).

   If part of a circuit fails, check the connections between the part that works and the part that does not work. For example, if the low-beam headlights work, but both high-beam headlights and the high-beam indicator do not work, the power and ground paths must be good. Since the dimmer switch is the component that switches the power to the high-beam headlights, it is probably the cause of failure.

4. Determine the cause of the problem and follow diagnostic procedures in Section 7.
5. Make the repair.

   Repair the problem circuit as directed in the diagnostic tables

6. Verify that the repair is complete.

   Operate the system. Check that the repair has removed all symptoms and that the repair has not caused new symptoms.

©August 2008 Navistar, Inc.

Table of Contents

Abbreviations and Acronyms.....581

©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Abbreviations and Acronyms

ABS – Antilock Brake System
AC – Alternating Current
ACCEL – Accelerate
amp – Ampere
AMS – Air Management System
API – American Petroleum Institute
APS – Accelerator Position Sensor
ATA – American Trucking Association
AWA – Acoustic Wave Attenuator

BAP – Barometric Absolute Pressure
BCP – Brake Control Pressure
BDC – Bottom Dead Center
bhp – Brake horsepower

C – Celsius
CAC – Charge Air Cooler
CAN – Controller Area Network
CAN 1 – Controller Area Network (public)
CAN 2 – Controller Area Network (private)
CAP – Cold Ambient Protection
cc – Cubic centimeter
CDPF – Catalyzed Diesel Particulate Filter
cfs – Cubic feet per second
CKP – Crankshaft Position
CKPO – Crankshaft Position Output
cm – Centimeter
CMP – Camshaft Position
CMPO – Camshaft Position Output
CPU – Central Processing Unit
CTC – Coolant Temperature Compensation

DC – Direct Current
DDS – Driveline Disengagement Switch
DLC – Data Link Control
DMM – Digital Multimeter
DT – Diesel Turbocharged
DTC – Diagnostic Trouble Code

ECL – Engine Coolant Level
EBP – Exhaust Back Pressure
ECI – Engine Crank Inhibit
ECM – Electronic Control Module
ECT – Engine Coolant Temperature
EFAN – Engine Fan
EFRC – Engine Family Rating Code
EGR – Exhaust Gas Recirculating
EGRP – Exhaust Gas Recirculating Position
EOP – Engine Oil Pressure
EOT – Engine Oil Temperature
EPA – Environmental Protection Agency
EPR – Engine Pressure Regulator
ESC – Electronic System Controller
ESN – Engine Serial Number
EST – Electronic Service Tool
EURO – Eurpoean
EVRT™ – Electronic Variable Response Turbocharger
EWPS – Engine Warning Protection System

F – Fahrenheit
ft – Feet
FMI – Failure Mode Indicator

gal – Gallon
gph – Gallons Per Hour
GVW – Gross Vehicle Weight

H_2O – Water
Hg – Mercury
hp – Horsepower
HT – High Torque

IAT – Intake Air Temperature
ICP – Injector Control Pressure
IDM – Injector Drive Module
IGN – Ignition
in – Inch
in Hg – Inches of mercury
in H_2O – Inches of water
INJ – Injector drive
IPR – Injection Pressure Regulator
ISIS® – International® Service Information Solutions
IST – Idle Shutdown Timer
IVS – Idle Validation Switch

kg – Kilogram
km – Kilometer
KOEO – Key-On Engine-Off
KOER – Key-On Engine-Running
kPa – Kilopascal

L – Liter
lb – Pound
lbf – Pounds of force
lbf•ft – Pounds of force per foot
lbf•in – Pounds of force per inch

m – Meter
m/s – Meters per second
MAP – Manifold Absolute Pressure
MAT – Manifold Air Temperature
mm – Millimeter
mph – Miles per hour
MY – Model Year

N – Newton

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

NEG – Negative
NETS – Navistar Electronics Technical Support
N•m – Newton meter
NO – Nitrogen Oxide
NO_x – Nitrogen Oxides
NSBU – Neutral Start Backup Switch

OCC – Output Circuit Check
OL – Over Limit

PID – Parameter Identifier
P/N – Part Number
POS – Positive
POSE – Positive On Shaft Excluder
PROM – Programmable Read Only Memory
psi – Pounds per square inch
pt – Pint
PTO – Power Take Off

RAM – Random Access Memory
rev – Revolution
rpm – Revolutions per minute
ROM – Read Only Memory
RSE – Radiator Shutter Enable

SAE – Society of Automotive Engineers
SCCS – Speed Control Command Switches
SID – Subsystem Identifier
SO_2 – Sulfur Dioxide
SYNC – Synchronization

TACH – Tachometer output signal
TCAPE – Truck Computer Analysis of Performance and Economy
TDC – Top Dead Center

UVC – Under Valve Cover

V – Volt
V_{BAT} – Battery Voltage
V_{IGN} – Ignition Voltage
V_{REF} – Reference Voltage
V_{REF} A – Reference Voltage (engine)
V_{REF} B – Reference Voltage (chassis)
VGT – Variable Geometry Turbocharger
VIN – Vehicle Identification Number
VOP – Valve Opening Pressure
VSS – Vehicle Speed Sensor

WIF – Water In Fuel
WTEC – World Transmission Electronically Controlled automatic transmissions (Allison)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Table of Contents

Terminology.....585

©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Terminology

Accelerator Position Sensor (APS) – A potentiometer sensor that indicates the position of the accelerator 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.

Aeration – The entrainment of gas (air or combustion gas) in the coolant, lubricant, or fuel.

After cooler (Charge Air Cooler) – A heat exchanger mounted in the charge air path between the turbocharger and engine intake manifold. The after cooler reduces the charge air temperature by transferring heat from the charge air to a cooling medium (usually air).

Air Management System (AMS) – The AMS controls and directs air through the intake and exhaust which affects engine performance and controls emissions.

Alternating Current (AC) – An electric current that reverses its direction at regularly recurring intervals.

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)

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 circuit in the ECM processing section that converts an analog signal (DC or AC) to a usable digital signal for the microprocessor.

American Trucking Association (ATA) Data link – A serial data link specified by the American Trucking Association and the SAE.

Acoustic Wave Attenuator – A component of the high-pressure oil rail designed to reduce hydraulic fluctuations resulting in a decrease of acoustic energy.

Barometric Absolute Pressure (BAP) sensor – A variable capacitance sensor which, when supplied with a 5 volt reference signal from the ECM, produces a linear analog voltage signal indicating atmospheric pressure.

Boost pressure – 1. The pressure of the charge air leaving the turbocharger.

2. Inlet manifold pressure that is greater than atmospheric pressure. Obtained by turbocharging.

Bottom Dead Center (BDC) – The lowest position of the piston during the stroke.

Brake Control Pressure (BCP) sensor – The BCP sensor is a variable capacitance sensor that senses the oil pressure in the brake gallery of the high-pressure oil rail.

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 – The data values used by the strategy to solve 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 – The CMP sensor is a magnetic pickup sensor which indicates engine position. Speed is indicated by the number of vanes counted per revolution of the camshaft. Camshaft position is indicated by a single position peg that indicates Cylinder Number 1.

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.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

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 (autoignites) at high compression temperature.

Diesel fuel with a high cetane number autoignites shortly after injection into the combustion chamber. Therefore, it has a short ignition delay time. Diesel fuel with a low cetane number resists autoignition. Therefore, it has a longer ignition delay time.

Charge air – Dense, pressurized, heated air discharged from the turbocharger.

Charge Air Cooler (CAC) – See **After cooler**.

Closed crankcase – Crankcase ventilation system that recycles crankcase gases through a breather, then back to the clean air intake.

Closed loop operation – A system that uses a sensor to provide feedback to the ECM. The ECM uses the sensor to continuously monitor variables and it make adjustments 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.

Continuous Monitor Test – An ECM function that continuously monitors the inputs and outputs to ensure that readings are within set limits.

Controller Area Network (CAN) – This is a J1939 high speed communication link. **CAN 1** is a public drive train data link between the vehicle modules and ECM. **CAN 2** is a private link between the ECM and IDM.

Coolant – A fluid used to transport heat from one point to another.

Coolant level switch – A switch used to indicate coolant level.

Cooling system capacity (volume) – The amount of coolant that completely fills a cooling system to its designated cold level mark. (SAE J1004 SEP81)

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 pressure – The force of air inside the crankcase against the crankcase housing.

Crankshaft (CKP) sensor – The CKP sensor is a magnetic pickup sensor that indicates crankshaft speed and position.

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) entrapped in coolant or lubricating oil.

Deaeration tank – A separate tank in the cooling system used for one or more of the following functions:

- Deaeration
- Coolant reservoir (fluid expansion and after boil)
- Coolant retention
- Filling
- Fluid level indication (visible)

Diagnostic Trouble Code (DTC) – Formerly called a Fault Code or Flash Code. A DTC is a three digit numeric code used for troubleshooting.

Diamond Logic® Engine Brake – The Diamond Logic® Engine Brake is a compression release braking system that uses a high-pressure oil rail components together with the VGT for additional braking. The operator controls the engine brake for different operating conditions.

Diamond Logic® Exhaust Brake – The Diamond Logic® Exhaust Brake is an exhaust brake system that uses only the VGT to restrict exhaust flow for additional braking. The operator controls the exhaust brake for different operating conditions.

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.

©August 2008 Navistar, Inc.

Direct Current (DC) – An electric current flowing in one direction only and substantially constant in value.

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.

Driveline Disengagement Switch (DDS) – A switch that indicates when the driveline is disengaged from the engine.

Driver (high side) – A transistor in an electronic module that controls the power to an actuator circuit.

Driver (low side) – A transistor in an electronic module that controls the ground to an actuator circuit.

Drivetrain data link (CAN 1) J1939 – The primary communication link for the ECM, ESC, and instrument cluster.

Duty cycle – A control signal that has a controlled on/off time measurement from 0 to 100%. Normally used to control solenoids.

Elastomer – An elastic, rubber like substance such as natural or synthetic rubber material. (SAE J111 MAR85)

Electronic Control Module (ECM) – The Electronic Control Module is an electronic microprocessor that monitors and controls engine performance, exhaust emissions, and vehicle system performance (cruise control, transmission control, starter engagement, etc.). The ECM provides diagnostic information for engine and vehicle systems and can be programmed at different levels for engine protection, warning, and shutdown.

Electronic Service Tool (EST) – A computer diagnostic and programming tool for the ECM and ESC. The hardware is typically a laptop computer or notebook computer. The diagnostic and programming software includes International Master Diagnostics, ISIS on-line documentation, and NETS for factory programming.

Electronic System Controller (ESC) – An electronic module that provides multiple analog and switched input interfaces to monitor vehicle functions through solid state switches, relay driver outputs, and serial data communication.

Engine Control Module (ECM) power relay – An ECM controlled relay that supplies power to the ECM.

Engine Coolant Temperature (ECT) sensor – A thermistor sensor that senses engine coolant temperature.

Engine Fuel Pressure (EFP) sensor – A variable capacitance sensor that senses fuel pressure.

Engine Family Rating Code (EFRC) – A readable code in the calibration list of the EST that identifies engine horsepower and emission calibrations.

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 key ON and the engine OFF.

Engine RUNNING tests – Tests done with the engine running.

Engine Oil Pressure (EOP) sensor – A variable capacitance sensor that senses engine oil pressure.

Engine Oil Temperature (EOT) sensor – A thermistor sensor that senses engine oil temperature.

Exhaust brake – A brake device using engine exhaust back pressure as a retarding medium.

Exhaust Gas Recirculation (EGR) – The Exhaust Gas Recirculation is a system that recycles a controlled portion of exhaust gas back into the combustion chamber to reduce Nitrogen Oxide exhaust emissions.

Exhaust Gas Recirculation (EGR) drive module – The EGR drive module controls the position of the EGR valve.

Exhaust Gas Recirculation (EGR) cooler – The exhaust gas is cooled in the EGR cooler and flows through the EGR control valve to the EGR mixer duct.

Exhaust Gas Recirculation (EGR) valve – The EGR valve, when open, will mix exhaust gas with filtered intake air which flows into the intake manifold. The EGR valve, when closed, only allows filtered air to flow into the intake manifold.

Exhaust manifold – Exhaust gases flow through the exhaust manifold to the turbocharger exhaust inlet and are directed to the EGR cooler or out the exhaust system.

©August 2008 Navistar, Inc.

EVRT® electronic controlled turbocharger – International's version of a Variable Geometry Turbocharger (VGT).

EZ-Tech® inerface cable – The EZ-Tech® inerface cable connects to the EST to communicate with the Electronic Controlled Module (ECM).

Fault detection and 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 or red instrument panel lamp signals that the vehicle needs service.

Filter restriction – A blockage, usually from contaminants, that prevents the flow of fluid through a filter.

Flash code – See **Diagnostic Trouble Code (DTC)**.

Fuel inlet restriction – A blockage, usually from contaminants, that prevents the flow of fluid through the fuel inlet line.

Fuel pressure – The force that the fuel exerts on the fuel system as it is pumped through the fuel system.

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 add 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 brake horsepower – The power of a complete basic engine, with air cleaner, without fan, and alternator and air compressor not charging.

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 – Generates a digital on or off signal that indicates speed or position.

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**.

Hydrocarbons – Unburned or partially burned fuel molecules.

Idle speed – Low idle is the minimum engine speed. High idle is the maximum governed engine speed with no load.

Idle Validation Switch (IVS) – An On/Off switch that senses when the accelerator pedal is in the idle position. There is also a cold idle advance that increases low idle speed for a short period to aid in engine warm-up in cold temperatures.

Injector Drive Module (IDM) power relay – An IDM controlled relay that supplies power to the IDM.

Indicated horsepower – The theoretical power transmitted to the pistons by gas in the cylinders.

Injection Control Pressure (ICP) – High lube oil pressure generated by a high-pressure pump/pressure regulator used to hydraulically actuate the fuel injectors and the optional Diamond Logic® engine brake.

Injection Pressure Regulator (IPR) – A Pulse Width Modulated (PWM) regulator valve, controlled by the ECM, that regulates injection control pressure.

Injection Control Pressure (ICP) sensor – A variable capacitance sensor that senses injection control pressure.

Intake Air Temperature (IAT) sensor – A thermistor sensor that senses intake air temperature.

Intake manifold – A plenum through which the air mixture flows from the charged air cooler piping to the intake passages of the cylinder head.

International NGV Tool Utilized for Next Generation Electronics (INTUNE) – The

©August 2008 Navistar, Inc.

diagnostics software for chassis related components and systems.

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).

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 operating at or below maximum torque speed.

Manifold Absolute Pressure (MAP) – Intake manifold pressure (boost pressure).

Manifold Absolute Pressure (MAP) sensor – A variable capacitance sensor that senses intake manifold 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.

Master Diagnostics (MD) – The diagnostics software for engine related components and systems to use on the electronic service tool or personal computer.

Manifold Air Temperature (MAT) – Intake manifold air temperature

Manifold Air Temperature (MAT) sensor – A thermistor style sensor housed in the intake manifold used to indicate air temperature after passing through the charge air cooler.

Microprocessor – An integrated circuit in a microcomputer that controls information flow.

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.

Ohm (Ω) – The unit of 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 that the technician initiates using the EST. It is run from a program in the processor.

Output Circuit Check (OCC) – An On demand test done during an Engine OFF self test to check the continuity of selected actuators.

Output State Check (OSC) – An On demand test that forces the processor to activate actuators (High or Low) for additional diagnostics.

pH – A measure of the acidity or alkalinity of a solution.

Particulate matter – Particulate matter includes mostly burned particles of fuel and engine oil.

Piezometer – An instrument for measuring fluid pressure.

Positive On Shaft Excluder (POSE) – It is a separate piece from the rest of the front or rear seal used to keep out dust / debris.

Potentiometer – 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.

Power – Power is a measure of the rate at which work is done. Compare with **Torque**.

Power Take Off (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) – The time that an actuator, such as an injector, remains energized.

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)

©August 2008 Navistar, Inc.

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.

Read Only Memory (ROM) – Computer memory that stores permanent information for calibration tables and operating strategies. Permanently stored information in ROM cannot be changed or lost by turning the engine off or when ECM power is interrupted.

Reference voltage (V_{REF}) – A 5 volt reference supplied by the ECM to operate the engine and chassis sensors.

Reserve capacity – Time in minutes that a fully charged battery can be discharged to 10.5 volts at 25 amperes.

Signal ground – The common ground wire from 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 – Stroke is 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.

Sulfur dioxide (SO_2) – Sulfur dioxide is caused by oxidation of sulfur contained in fuel.

Switch sensors – Switch sensors indicate position. They operate open or closed, allowing or preventing the flow of current. A switch sensor can be a voltage input switch or a grounding switch. A voltage input switch supplies the ECM with a voltage when it is closed. A grounding switch grounds the circuit closed, causing a zero voltage signal. Grounding switches are usually installed in series with a current limiting resistor.

System restriction (air) – The static pressure differential that occurs at a given air flow 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 thermistor sensor changes its electrical resistance to temperature. Resistance in the thermistor decreases as temperature increases, and increases as temperature decreases. Thermistors works with a resistor that limits current in the ECM 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.

Top Dead Center (TDC) – The highest position of the piston during the stroke.

Top Dead Center (compression) – Top Dead Center (compression) is when the piston is at the highest position and both intake and exhaust valves are closed.

Torque – Torque is a measure of force producing torsion and rotation around an axis. Torque is the product of the force, usually measured in pounds, and radius perpendicular to the axis of the force extending to the point where the force is applied or where it originates, usually measured in feet.

Truck Computer Analysis of Performance and Economy (TCAPE) – Truck Computer Analysis of Performance and Economy is a computer program that simulates the performance and fuel economy of trucks.

Turbocharger – A turbine driven compressor mounted to the exhaust manifold. The turbocharger increases the pressure, temperature and density of intake air to charge air.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Valve cover gasket – A valve cover gasket that contains the pass through electronic wiring harness connectors for the ICP and BCP sensors, the brake shutoff valve, and six fuel injectors.

Variable capacitance sensor – A variable capacitance sensor is a sensor that measures 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.

Variable Geometry Turbocharger (VGT) – The VGT is a turbocharger with actuated vanes inside the turbine housing. The vanes modify flow characteristics of exhaust gases through the turbine housing for boast pressure control at various engine speeds and load conditions.

(VGT) control module – The VGT control module is an electronic microprocessor that converts a pulse width modulated signal from the ECM to control a DC motor that controls the VGT vane position.

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.

Vehicle Speed Sensor (VSS) – A magnetic pickup sensor mounted in the tail shaft housing of the transmission, used to calculate ground 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.

Water In Fuel (WIF) switch – The WIF switch detects water in the fuel.

Water supply housing (Freon bracket) – The water supply housing (Freon Bracket) is a coolant supply housing with a deaeration port and a connection for cab heat.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Table of Contents

DT 466 (Standard and High Torque - all ratings)....595
Temperature, Fuel, and Lubrication....595

DT 466 (Standard Torque)....597
210 hp @ 2300 rpm (12NPL)....597
220 hp @ 2300 rpm (12NPM)....599
225 hp @ 2300 rpm (12NPN)....601
245 hp @ 2300 rpm (12NPP)....603

DT 466 (High Torque)....605
225 hp @ 2300 rpm (12NPR)....605
245 hp @ 2300 rpm (12NPS)....607
255 hp @ 2300 rpm (12NPT)....609
260 hp @ 2300 rpm (12NPU)....611
285 hp @ 2300 rpm (12NPV)....613
300 hp @ 2300 rpm (12NPX)....615

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

11 APPENDIX A: DT 466 PERFORMANCE SPECIFICATIONS 2004 MODEL YEAR

©August 2008 Navistar, Inc.

DT 466 (Standard and High Torque - all ratings)

Temperature, Fuel, and Lubrication

International® DT 466 diesel engine specifications	
Measure water temperature differential across the radiator with engine on a chassis dynamometer, at full load and ambient temperature of 26.7 °C (80 °F) or above.	
Water temperature differential across radiator	3 to 7 °C (6 to 12 °F)
Thermostat	
Type	Balanced pressure, wax pellet
Minimum recommended coolant operating temperature	60 °C (140 °F)
Nominal opening temperature, 0.38 mm (0.015 in)	86 °C (187 °F) Minimum
	88 °C (192 °F) Maximum
Full open temperature, 8 mm (0.315 in) stroke	96 °C (205 °F)
Diesel fuel (maximum sulfur content of 0.05%)	
Minimum fuel requirements	42 cetane
Expected temperature	**Preferred fuel grade**
Above -1 °C (30 °F)	Grade 2-D
Below -17 °C (0 °F)	Grade 1-D
NOTE: If Grade 1-D is not available, use a winterized or climatized Grade 2-D fuel. This is made by blending Grade 1-D with 2-D fuel to match the temperature conditions in your area.	
Between -1 and -17 °C (30 and 0 °F)	1-D / 2-D Blended
Lubrication	
Oil quality	API category CI-4, CI-4 PLUS
Oil viscosity recommendations	15W-40 preferred above -6 °C (20 °F)
	10W-30 preferred between -6 and -17 °C (20 and 0 °F)
	5W-40 synthetic or 0W-30 synthetic below -17 °C (0 °F)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Cold Start Component Guidelines	
Battery Requirements	1300 CCA minimum above -12 °C (10 °F)
	1950 CCA minimum below -12 °C (10 °F)
Starting Aid Recommendations	Below -12 °C (10 °F) use block heater
	Below -17 °C (0 °F) use fuel heater
	Below -17 °C (0 °F) use oil pan heater

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DT 466 (Standard Torque)

210 hp @ 2300 rpm (12NPL)

DT 466/210 hp @ 2300 rpm / 520 ft•lb @ 1400 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPL	
International® DT 466 diesel engine specifications	
Engine model	International® DT 466/210
Engine rating	210 bhp @ 2300 rpm
Engine Family Rating Code (EFRC)	1121
Injector part number, original equipment	1842576C91
Turbocharger part number	1842216C92, 1842218C92, 1842219C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2770 rpm
High idle speed - automatic transmission	2770 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	65 %
Engine cranking	
Minimum recommended battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	5 MPa (725 psi) / 1.0 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	4.5 ± 0.5 MPa (650 ± 70 psi) / 0.925 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	15 ± 2 MPa (2175 ± 300 psi) / 2.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	23 ± 1 MPa (3335 ± 145 psi) / 3.7 V @ 2300 rpm
Injection Control Pressure/voltage (full load, peak torque)	17 ± 1 MPa (2466 ± 145 psi) / 2.8 V @ 1400 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.95 V
Intake manifold pressure/voltage (full load, rated speed)	152 ± 14 kPa (22 ± 2 psi) / 3.27 ± 0.2 V @ 2300 rpm
Intake manifold pressure/voltage (full load, peak torque)	90 ± 14 kPa (13 ± 2 psi) / 2.2 ± 0.2 V @ 1400 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	170 kPa (25 psi) / 2.4 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	95 kPa (14 psi) / 1.6 V
Exhaust restriction (after turbocharger), maximum	16.1 kPa (4.75 in Hg) @ 2300 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	2200 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

220 hp @ 2300 rpm (12NPM)

DT 466/220 hp @ 2300 rpm / 540 ft•lb @ 1400 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPM	
International® DT 466 diesel engine specifications	
Engine model	International® DT 466/220
Engine rating	220 bhp @ 2300 rpm
Engine Family Rating Code (EFRC)	1131
Injector part number, original equipment	1842576C91
Turbocharger part number	1842216C92, 1842218C92, 1842219C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2770 rpm
High idle speed - automatic transmission	2770 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	65 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	5 MPa (725 psi) / 1.0 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	4.5 ± 0.5 MPa (650 ± 70 psi) / 0.93 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	15 ± 2 MPa (2175 ± 300 psi) / 2.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	23 ± 1 MPa (3335 ± 145 psi) / 3.7 V @ 2300 rpm
Injection Control Pressure/voltage (full load, peak torque)	17 ± 1 MPa (2466 ± 145 psi) / 2.8 V @ 1400 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.9 V
Intake manifold pressure/voltage (full load, rated speed)	152 ± 14 kPa (22 ± 2 psi) / 3.2 ± 0.2 V @ 2300 rpm
Intake manifold pressure/voltage (full load, peak torque)	88 ± 14 kPa (13 ± 2 psi) / 2.2 ± 0.2 V @ 1400 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	172 kPa (25 psi) / 2.4 V @ 2300 rpm
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	105 kPa (15 psi) / 1.75 V @ 1400 rpm
Exhaust restriction (after turbocharger), maximum	16.1 kPa (4.75 in Hg) @ 2300 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	2300 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

225 hp @ 2300 rpm (12NPN)

DT 466/225 hp @ 2300 rpm / 560 ft•lb @ 1400 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPN	
International® DT 466 diesel engine specifications	
Engine model	International® DT 466/225
Engine rating	225 bhp @ 2300 rpm
Engine Family Rating Code (EFRC)	1141
Injector part number, original equipment	1842576C91
Turbocharger part number	1842216C92, 1842218C92, 1842219C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2770 rpm
High idle speed - automatic transmission	2770 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	65 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	5 MPa (725 psi) / 1.0 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	4.5 ± 0.5 MPa (650 ± 70 psi) / 0.925 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	15 ± 2 MPa (2175 ± 300 psi) / 2.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	23 ± 1 MPa (3335 ± 145 psi) / 3.7 V @ 2300 rpm
Injection Control Pressure/voltage (full load, peak torque)	17 ± 1 MPa (2466 ± 145 psi) / 2.8 V @ 1400 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.95 V
Intake manifold pressure/voltage (full load, rated speed)	144 ± 14 kPa (21 ± 2 psi) / 3.7 ± 0.2 V @ 2300 rpm
Intake manifold pressure/voltage (full load, peak torque)	98 ± 14 kPa (14 ± 2 psi) / 2.3 ± 0.2 V @ 1400 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	159 kPa (23 psi) / 2.3 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	103 kPa (15 psi) / 1.7 V
Exhaust restriction (after turbocharger), maximum	16.1 kPa (4.75 in Hg) @ 2300 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	2300 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

245 hp @ 2300 rpm (12NPP)

DT 466/245 hp @ 2300 rpm / 620 ft•lb @1400 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPP	
International® DT 466 diesel engine specifications	
Engine model	International® DT 466/245
Engine rating	245 bhp @ 2300 rpm
Engine Family Rating Code (EFRC)	2131
Injector part number, original equipment	1842577C91
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2770 rpm
High idle speed - automatic transmission	2770 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	65 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	5 MPa (725 psi) / 1.0 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	4.5 ± 0.5 MPa (650 ± 70 psi) / 0.925 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	15 ± 2 MPa (2175 ± 300 psi) / 2.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	25 ± 1 MPa (3625 ± 145 psi) / 4.0 V @ 2300 rpm
Injection Control Pressure/voltage (full load, peak torque)	16 ± 1 MPa (2320 ± 145 psi) / 2.7 V @ 1400 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.9 V
Intake manifold pressure (full load, rated speed)	171 ± 14 kPa (25.3 ± 2 psi) / 3.5 ± 0.2 V @ 2300 rpm
Intake manifold pressure (full load, peak torque)	128 ± 14 kPa (18.5 ± 2 psi) / 2.8 ± 0.2 V @ 1400 rpm
Exhaust Back Pressure/voltage (sensor), maximum (full load, rated speed)	200 kPa (29 psi) / 2.7 V
Exhaust Back Pressure/voltage (sensor), maximum (full load, peak torque)	145 kPa (21 psi) / 2.2 V
Exhaust restriction (after turbocharger), maximum	16.1 kPa (65 in H_2O) @ 2300 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	2300 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

DT 466 (High Torque)

225 hp @ 2300 rpm (12NPR)

DT 466/225 hp @ 2300 rpm / 620 ft•lb @ 1400 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPR	
International® DT 466 diesel engine specifications	
Engine model	International® DT 466/225
Engine rating	225 bhp @ 2300 rpm
Engine Family Rating Code (EFRC)	1122
Injector part number, original equipment	1842576C91
Turbocharger part number	1842216C92, 1842218C92, 1842219C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2600 rpm
High idle speed - automatic transmission	2600 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	65 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	5 MPa (725 psi) / 1.0 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	4.5 ± 0.5 MPa (650 ± 70 psi) / 0.925 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	15 ± 2 MPa (2175 ± 300 psi) / 2.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	23 ± 1 MPa (3335 ± 145 psi) / 3.7 V @ 2300 rpm
Injection Control Pressure/voltage (full load, peak torque)	17 ± 1 MPa (1466 ± 145 psi) / 2.8 V @ 1400 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.9 V
Intake manifold pressure/voltage (full load, rated speed)	145 ± 14 kPa (21 ± 2 psi) / 3.0 ± 0.2 V @ 2300 rpm
Intake manifold pressure/voltage (full load, peak torque)	110 ± 14 kPa (16 ± 2 psi) / 2.5 ± 0.2 V @ 1400 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	165 kPa (24 psi) / 2.4 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	110 kPa (16 psi) / 1.8 V
Exhaust restriction (after turbocharger), maximum	16.1 kPa (65 in H_2O) @ 2300 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	2300 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	1187 °C (245 °F)

©August 2008 Navistar, Inc.

245 hp @ 2300 rpm (12NPS)

DT 466/245 hp @ 2300 rpm / 660 ft•lb @ 1400 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPS	
International® DT 466 diesel engine specifications	
Engine model	International® DT 466/245
Engine rating	245 bhp @ 2300 rpm
Engine Family Rating Code (EFRC)	2132
Injector part number, original equipment	1842577C91
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2600 rpm
High idle speed - automatic transmission	2600 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	65 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	5 MPa (725 psi) / 1.0 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	4.5 ± 0.5 MPa (650 ± 70 psi) / 0.925 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	15 ± 2 MPa (2175 ± 300 psi) / 2.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	25 ± 1 MPa (3625 ± 145 psi) / 4.0 V @ 2300 rpm
Injection Control Pressure/voltage (full load, peak torque)	16 ± 1 MPa (2320 ± 145 psi) / 2.7 V @ 1400 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.9 V
Intake manifold pressure/voltage (full load, rated speed)	173 ± 14 kPa (25 ± 2 psi) 3.4 ± 0.2 V @ 2300 rpm
Intake manifold pressure/voltage (full load, peak torque)	142 ± 14 kPa (20.6 ± 2 psi) 3.0 ± 0.2 V @ 1400 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	200 kPa (29 psi) / 2.7 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	165 kPa (24 psi) / 2.4 V
Exhaust restriction (after turbocharger), maximum	16.1 kPa (65 in H_2O) @ 2300 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1900 rpm or greater @ / 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

255 hp @ 2300 rpm (12NPT)

DT 466/255 hp @ 2300 rpm / 660 ft•lbs @ 1400 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPT	
International® DT 466 diesel engine specifications	
Engine model	International® DT 466/255
Engine rating	255 bhp @ 2300 rpm
Engine Family Rating Code (EFRC)	2141
Injector part number, original equipment	1842577C91
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2775 rpm
High idle speed - automatic transmission	2775 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	65 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	5 MPa (725 psi) / 1.0 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	4.5 ± 0.5 MPa (650 ± 70 psi) / 0.925 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	15 ± 2 MPa (2175 ± 300 psi) / 2.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	25 ± 1 MPa (3625 ± 145 psi) / 4.0 V @ 2300 rpm
Injection Control Pressure/voltage (full load, peak torque)	16 ± 1 MPa (2320 ± 145 psi) / 2.65 V @ 2300 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.9 V
Intake manifold pressure/voltage (full load, rated speed)	173 ± 14 kPa (25 ± 2 psi) / 3.4 ± 0.2 V @ 2300 rpm
Intake manifold pressure/voltage (full load, peak torque)	139 ± 14 kPa (20.1 ± 2 psi) 2.9 ± 0.2 V @ 1400 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	205 kPa (30 psi) / 2.8 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	165 kPa (24 psi) / 2.4 V
Exhaust restriction (after turbocharger), maximum	16.1 kPa (65 in H_2O) @ 2300 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1900 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

260 hp @ 2300 rpm (12NPU)

DT 466/260 hp @ 2300 rpm / 800 ft•lbs @ 1400 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPU	
International® DT 466 diesel engine specifications	
Engine model	International® DT 466/260
Engine rating	260 bhp @ 2300 rpm
Engine Family Rating Code (EFRC)	2152
Injector part number, original equipment	1842577C91
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2600 rpm
High idle speed - automatic transmission	2600 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	65 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	5 MPa (725 psi) / 1.0 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	4.5 ± 0.5 MPa (650 ± 70 psi) / 0.925 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	15 ± 2 MPa (2175 ± 300 psi) / 2.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	25 ± 1 MPa (3625 ± 145 psi) / 4.0 V @ 2300 rpm
Injection Control Pressure/voltage (full load, peak torque)	16 ± 1 MPa (2320 ± 145 psi) / 2.65 V @ 1400 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.9 V
Intake manifold pressure/voltage (full load, rated speed)	189 ± 14 kPa (27.5 ± 2 psi) 3.5 ± 0.2 V @ 2300 rpm
Intake manifold pressure/voltage (full load, peak torque)	179 ± 14 kPa (26 ± 2 psi) 3.5 ± 0.2 V @ 1400 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	215 kPa (31 psi) / 2.9 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	193 kPa (28 psi) / 2.7 V
Exhaust restriction (after turbocharger), maximum	16.1 kPa (65 in H_2O) @ 2300 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

285 hp @ 2300 rpm (12NPV)

DT 466/285 hp @ 2300 rpm / 800 ft•lbs @ 1400 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPV	
International® DT 466 diesel engine specifications	
Engine model	International® DT 466/285
Engine rating	285 bhp @ 2300 rpm
Engine Family Rating Code (EFRC)	2162
Injector part number, original equipment	1842577C91
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2600 rpm
High idle speed - automatic transmission	2600 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	65 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	5 MPa (725 psi) / 1.0 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	4.5 ± 0.5 MPa (650 ± 70 psi) / 0.925 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	15 ± 2 MPa (2175 ± 300 psi) / 2.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	25 ± 1 MPa (3625 ± 145 psi) / 4.0 V @ 2300 rpm
Injection Control Pressure/voltage (full load, peak torque)	15.6 ± 1 MPa (2260 ± 145 psi) / 2.6 V @ 1400 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.9 V
Intake manifold pressure/voltage (full load, rated speed)	191 ± 14 kPa (27.7 ± 2 psi) / 3.79 ± 0.2 V @ 2300 rpm
Intake manifold pressure/voltage (full load, peak torque)	174 ± 14 kPa (25.2 ± 2 psi) / 3.4 ± 0.2 V @ 1400 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	225 kPa (32.5 psi) / 3.0 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	193 kPa (28 psi) / 2.7 V
Exhaust restriction (after turbocharger), maximum	16.1 kPa (65 in H_2O) @ 2300 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

300 hp @ 2300 rpm (12NPX)

DT 466/300 hp @ 2300 rpm / 860 ft•lbs @ 1400 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPX	
International® DT 466 diesel engine specifications	
Engine model	International® DT 466/300
Engine rating	300 bhp @ 2300 rpm
Engine Family Rating Code (EFRC)	2172
Injector part number, original equipment	1842577C91
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2600 rpm
High idle speed - automatic transmission	2600 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	65 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	5 MPa (725 psi) / 1.0 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	4.5 ± 0.5 MPa (650 ± 70 psi) / 0.925 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	15 ± 2 MPa (2175 ± 300 psi) / 2.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	25 ± 1 MPa (3625 ± 145 psi) / 4.0 V @ 2300 rpm
Injection Control Pressure/voltage (full load, peak torque)	17.2 ± 1 MPa (2495 ± 145 psi) / 2.8 V @ 1400 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.95 V
Intake manifold pressure/voltage (full load, rated speed)	202 ± 14 kPa (29.2 ± 2 psi) / 3.8 ± 0.2 V @ 2300 rpm
Intake manifold pressure/voltage (full load, peak torque)	187 ± 14 kPa (27.2 ± 2 psi) / 3.6 ± 0.2 V @ 1400 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	230 kPa (33.5 psi) / 3.0 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	213 kPa (31 psi) / 2.9 V
Exhaust restriction (after turbocharger), maximum	16.1 kPa (65 in H_2O) @ 2300 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

Table of Contents

DT 570 and HT 570 (all ratings)....619
Temperature, Fuel, and Lubrication....619

DT 570 (Standard Torque)....621
12NPW (285 hp @ 2000 rpm)....621
12NPZ (310 hp @ 2000 rpm)....623
12NRB (330 hp @ 2000 rpm)....625

HT 570 (High Torque)....627
12NRC (295 hp @ 2000 rpm)....627
12NRD (295 hp @ 2000 rpm)....629
12NRE (310 hp @ 2000 rpm)....631
12NRA 300 hp @ 2000 rpm....633
12NRG (310 hp @ 2000 rpm)....635
12NRH (330 hp @ 2000 rpm)....637
12NRZ (340 hp @ 2000 rpm)....639

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

12 APPENDIX B: DT 570 AND HT 570 PERFORMANCE SPECIFICATIONS 2004 MODEL YEAR

©August 2008 Navistar, Inc.

DT 570 and HT 570 (all ratings)

Temperature, Fuel, and Lubrication

International® DT 570 and HT 570 diesel engine specifications	
Measure water temperature differential across the radiator with engine on a chassis dynamometer, at full load and ambient temperature of 26.7 °C (80 °F) or above.	
Water temperature differential across radiator	3 to 7 °C (6 to 12 °F)
Thermostat	
Type	Balanced pressure, wax pellet
Minimum recommended coolant operating temperature	60 °C (140 °F)
Nominal opening temperature, 0.38 mm (0.015 in)	86 °C (187 °F) Minimum
	88 °C (192 °F) Maximum
Full open temperature, 8 mm (0.315 in) stroke	96 °C (205 °F)
Diesel fuel (maximum sulfur content of 0.05%)	
Minimum fuel requirements	42 cetane
Expected temperature	**Preferred fuel grade**
Above -1 °C (30 °F)	Grade 2-D
Below -17 °C (0 °F)	Grade 1-D
NOTE: If Grade 1-D is not available, use a winterized or climatized Grade 2-D fuel. This is made by blending Grade 1-D with 2-D fuel to match the temperature conditions in your area.	
Between -1 and -17 °C (30 and 0 °F)	1-D / 2-D Blended
Lubrication	
Oil quality	API category CI-4, CI-4 PLUS
Oil viscosity recommendations	15W-40 preferred above -6 °C (20 °F)
	10W-30 preferred between -6 and -17 °C (20 and 0 °F)
	5W-40 synthetic or 0W-30 synthetic below -17 °C (0 °F)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Cold Start Component Guidelines	
Battery Requirements	1300 CCA minimum above -12 °C (10 °F)
	1950 CCA minimum below -12 °C (10 °F)
Starting Aid Recommendations	Below -12 °C (10 °F) use block heater
	Below -17 °C (0 °F) use fuel heater
	Below -17 °C (0 °F) use oil pan heater

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DT 570 (Standard Torque)

12NPW (285 hp @ 2000 rpm)

DT 570/285 hp @ 2000 rpm / 800 ft•lbs @ 1200 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPW	
International® DT 570 diesel engine specifications	
Engine model	International® DT 570/285
Engine rating	285 bhp @ 2000 rpm
Engine Family Rating Code (EFRC)	5121
Injector part number, original equipment	1842578C94
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2425 rpm
High idle speed - automatic transmission	2425 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	73 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	6 MPa (670 psi) / 1.2 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	6 ± 0.5 MPa (670 ± 73 psi) / 1.2 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	7.0 ± 2 MPa (1015 ± 290 psi) / 1.3 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	24 ± 1 MPa (3481 ± 145 psi) / 3.85 V @ 2000 rpm
Injection Control Pressure/voltage (full load, peak torque)	12 ± 1 MPa (1740 ± 145 psi) / 2.0 V @1200 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	420 kPa (61 psi) / 2.95 V
Intake manifold pressure/voltage (full load, rated speed)	193 ± 14 kPa (28 ± 2 psi) / 3.7 ± 0.2 V @ 2000 rpm
Intake manifold pressure/voltage (full load, peak torque)	193 ± 14 kPa (28 ± 2 psi) / 3.7 ± 0.2 V @ 1200 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	230 kPa (33 psi) / 3.0 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	170 kPa (25 psi) / 2.4 V
Exhaust restriction (after turbocharger), maximum	20 kPa (82 in H_2O) @ 2000 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), max.	118 °C (245 °F)

©August 2008 Navistar, Inc.

12NPZ (310 hp @ 2000 rpm)

DT 570/310 hp @ 2000 rpm / 950 ft•lbs @ 1200 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NPZ	
International® DT 570 diesel engine specifications	
Engine model	International® DT 570/310
Engine rating	310 bhp @ 2000 rpm
Engine Family Rating Code (EFRC)	5151
Injector part number, original equipment	1842578C94
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2425 rpm
High idle speed - automatic transmission	2425 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	73 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	6 MPa (870 psi) / 1.2 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	6 ± 0.5 MPa (870 ± 73 psi) / 1.2 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	7.0 ± 2 MPa (1015 ± 290 psi) / 1.3 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	24 ± 1 MPa (3481 ± 145 psi) / 3.85 V @ 2000 rpm
Injection Control Pressure/voltage (full load, peak torque)	13.9 ± 1 MPa (2016 ± 145 psi) / 2.4 V @ 1200 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Intake manifold pressure/voltage (full load, rated speed)	206 ± 14 kPa (30 ± 2 psi) / 3.9 ± 0.2 V @ 2000 rpm
Intake manifold pressure/voltage (full load, peak torque)	163 ± 14 kPa (23 ± 2 psi) / 1.8 ± 0.2 V @ 1200 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	240 kPa (35 psi) / 3.1 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	190 kPa (28 psi) / 2.6 V
Exhaust restriction (after turbocharger), maximum	20 kPa (82 in H_2O) @ 2000 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

12NRB (330 hp @ 2000 rpm)

DT 570/330 hp @ 2000 rpm / 950 ft•lbs @ 1200 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NRB	
International® DT 570 diesel engine specifications	
Engine model	International® DT 570/330
Engine rating	330 bhp @ 2000 rpm
Engine Family Rating Code (EFRC)	6161
Injector part number, original equipment	1842579C94
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2425 rpm
High idle speed - automatic transmission	2425 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	75 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	6 MPa (870 psi) / 1.2 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	6 ± 0.5 MPa (870 ± 73 psi) / 1.2 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	8.5 ± 2 MPa (1230 ± 290 psi) / 1.53 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	26 ± 1 MPa (3770 ± 145 psi) / 4.15 V @ 2000 rpm
Injection Control Pressure/voltage (full load, peak torque)	13.8 ± 1 MPa (2000 ± 145 psi) / 2.3 V @ 1200 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Intake manifold pressure/voltage (full load, rated speed)	193 ± 14 kPa (28 ± 2 psi) / 2.3 ± 0.2 V @ 2000 rpm
Intake manifold pressure/voltage (full load, peak torque)	165 ± 14 kPa (24 ± 2 psi) 1.8 ± 0.2 V @ 1200 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	214 kPa (31 psi) / 2.9 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	207 kPa (30 psi) / 2.8 V
Exhaust restriction (after turbocharger), maximum	20 kPa (82 in H_2O) @ 2000 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

HT 570 (High Torque)

12NRC (295 hp @ 2000 rpm)

HT 570/295 hp @ 2000 rpm / 950 ft•lbs @ 1200 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NRC	
International® HT 570 diesel engine specifications	
Engine model	International® HT 570/295
Engine rating	295 bhp @ 2000 rpm
Engine Family Rating Code (EFRC)	5122
Injector part number, original equipment	1842578C94
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2325 rpm
High idle speed - automatic transmission	2425 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	73 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	6 MPa (870 psi) / 1.2 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	6 ± 0.5 MPa (870 ± 73 psi) / 1.2 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	8.5 ± 2 MPa (1231 ± 290 psi) / 1.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	24 ± 1 MPa (3480 ± 145 psi) / 3.9 V @ 2000 rpm
Injection Control Pressure/voltage (full load, peak torque)	13 ± 1 MPa (1885 ± 145 psi) / 2.2 V @ 1200 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Intake manifold pressure/voltage (full load, rated speed)	200 ± 14 kPa (29 ± 2 psi) / 2.4 ± 0.2 V @ 2000 rpm
Intake manifold pressure/voltage (full load, peak torque)	169 ± 14 kPa (24.5 ± 2 psi) / 1.9 ± 0.2 V @ 1200 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	230 kPa (33 psi) / 3.0 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	207 kPa (30 psi) / 2.8 V
Exhaust back pressure/voltage (after turbocharger), maximum	20 kPa (82 in H_2O) @ 2000 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

12NRD (295 hp @ 2000 rpm)

HT 570/295 hp @ 2000 rpm / 950 ft•lbs @ 1200 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NRD	
International® HT 570 diesel engine specifications	
Engine model	International® HT 570/295
Engine rating	295 bhp @ 2000 rpm
Engine Family Rating Code (EFRC)	5122
Injector part number, original equipment	1842578C94
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2325 rpm
High idle speed - automatic transmission	2425 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	73 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	6 MPa (870 psi) / 1.2 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	6 ± 0.5 MPa (870 psi ± 73 psi) / 1.2 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	8.5 ± 2 MPa (1231 ± 290 psi) / 1.5 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	24 ± 1 MPa (3480 ± 145 psi) / 3.9 V @ 2000 rpm
Injection Control Pressure/voltage (full load, peak torque)	13 ± 1 MPa (1885 ± 145 psi) / 2.2 V @ 1200 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Intake manifold pressure/voltage (full load, rated speed)	200 ± 14 kPa (29 ± 2 psi) 2.4 ± 0.2 V @ 2000 rpm
Intake manifold pressure/voltage (full load, peak torque)	169 ± 14 kPa (24.5 psi ± 2 psi) 1.9 ± 0.2 V @ 1200 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	207 kPa (30 psi) / 2.8 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	207 kPa (30 psi) / 2.8 V
Exhaust restriction (after turbocharger), maximum	20 kPa (82 in H_2O) @ 2000 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

12NRE (310 hp @ 2000 rpm)

HT 570/310 hp @ 2200 rpm / 1050 ft•lbs @ 1200 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NRE	
International® HT 570 diesel engine specifications	
Engine model	International® HT 570/310
Engine rating	310 bhp @ 2000 rpm
Engine Family Rating Code (EFRC)	5151
Injector part number, original equipment	1842578C94
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2325 rpm
High idle speed - automatic transmission	2425 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	73 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	6 MPa (870 psi) / 1.2 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	6 ± 0.5 MPa (870 ± 73 psi) / 1.2 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	7 ± 2 MPa (1015 ± 290 psi) / 1.3 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	24 ± 1 MPa (3481 ± 145 psi) / 3.85 V @ 2000 rpm
Injection Control Pressure/voltage (full load, peak torque)	13.9 ± 1 MPa (2016 ± 145 psi) / 2.3 V @ 1200 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Intake manifold pressure/voltage (full load, rated speed)	206 ± 14 kPa (30 ± 2 psi) / 2.44 ± 0.2 V @ 2000 rpm
Intake manifold pressure/voltage (full load, peak torque)	163 ± 14 kPa (23 ± 2 psi) / 1.81 ± 0.2 V @ 1200 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	240 kPa (35 psi) / 3.1 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	193 kPa (28 psi) / 2.7 V
Exhaust restriction (after turbocharger), maximum	20 kPa (82 in H_2O) @ 2000 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

12NRA 300 hp @ 2000 rpm

HT 570/300 hp @ 2000 rpm / 950 ft•lbs @ 1000 rpm	
US Non-road 2004 Model Year (MY)	
Engine unit code 12NRA	
International® HT 570 diesel engine specifications	
Engine model	International® HT 570/310
Engine rating	310 bhp @ 2000 rpm
Engine Family Rating Code (EFRC)	5132
Injector part number, original equipment	1842578C94
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2425 rpm
High idle speed - automatic transmission	2425 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	73 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	6 MPa (870 psi) / 1.2 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	6 ± 0.5 MPa (870 ± 73 psi) / 1.2 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	24 ± 1 MPa (3481 ± 145 psi) / 3.85 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	25 ± 1 MPa (3625 ± 145 psi) / 4.0 V @ 2000 rpm
Injection Control Pressure/voltage (full load, peak torque)	15.7 ± 1 MPa (2275 ± 145 psi) / 2.6 V @ 2000 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Intake manifold pressure/voltage (full load, rated speed)	203 ± 14 kPa (29 ± 2 psi) / 2.39 ± 0.2 V @ 2000 rpm
Intake manifold pressure/voltage (full load, peak torque)	183 ± 14 kPa (27 ± 2psi) / 2.1 ± 0.2 V @ 1200 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	234 kPa (34 psi) / 3.1 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	220 kPa (32 psi) / 2.9 V
Exhaust restriction (after turbocharger), maximum	20 kPa (52 in H_2O) @ 2000 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

12NRG (310 hp @ 2000 rpm)

HT 570/310 hp @ 2000 rpm / 1050 ft•lbs @ 1200 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NRG	
International® HT 570 diesel engine specifications	
Engine model	International® HT 570/310
Engine rating	310 bhp @ 2000 rpm
Engine Family Rating Code (EFRC)	5132
Injector part number, original equipment	1842578C94
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2325 rpm
High idle speed - automatic transmission	2425 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	73 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	6 MPa (870 psi) / 1.2 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	6 ± 0.5 MPa (870 ± 73 psi) / 1.2 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	7 ± 2 MPa (1015 ± 290 psi) / 1.3 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	25 ± 1 MPa (3626 ± 145 psi) / 4.0 V @ 2000 rpm
Injection Control Pressure/voltage (full load, peak torque)	15.7 ± 1 MPa (2275 ± 145 psi) / 2.6 V @ 1200 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Intake manifold pressure/voltage (full load, rated speed)	203 ± 14 kPa (29 ± 2 psi) / 2.39 ± 0.2 V @ 2000 rpm
Intake manifold pressure/voltage (full load, peak torque)	183 ± 14 kPa (27 ± 2psi) / 2.1 ± 0.2 V @ 1200 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	234 kPa (34 psi) / 3.1 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	220 kPa (32 psi) / 2.9 V
Exhaust restriction (after turbocharger), maximum	20 kPa (82 in H_2O) @ 2000 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

12NRH (330 hp @ 2000 rpm)

HT 570/330 hp @ 2000 rpm / 1150 ft•lbs @ 1200 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NRH	
International® HT 570 diesel engine specifications	
Engine model	International® HT 570/330
Engine rating	330 bhp @ 2000 rpm
Engine Family Rating Code (EFRC)	6122
Injector part number, original equipment	1842579C94
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2325 rpm
High idle speed - automatic transmission	2325 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	75 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	6 MPa (870 psi) / 1.2 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	6 ± 0.5 MPa (870 ± 73 psi) / 1.2 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	8.5 ± 2 MPa (1233 ± 290 psi) / 1.53 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	26 ± 1 MPa (3771 ± 145 psi) / 4.15 V @ 2000 rpm
Injection Control Pressure/voltage (full load, peak torque)	15 ± 1 MPa (2175 ± 145 psi) / 2.5 V @ 1200 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Intake manifold pressure/voltage (full load, rated speed)	200 ± 14 kPa (29 ± 2 psi) / 2.4 ± 0.2 V @ 2000 rpm
Intake manifold pressure/voltage (full load, peak torque)	214 ± 14 kPa (31 ± 2psi) / 2.6 ± 0.2 V @ 1200 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	230 kPa (33 psi) / 3.0 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	248 kPa (36 psi) / 3.2 V
Exhaust restriction (after turbocharger), maximum	20 kPa (82 in H_2O) @ 2000 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

12NRZ (340 hp @ 2000 rpm)

HT 570/340 hp @ 2000 rpm / 1150 ft•lbs @ 1200 rpm	
50 state 2004 Model Year (MY)	
Engine unit code 12NRZ	
International® HT 570 diesel engine specifications	
Engine model	International® HT 570/340
Engine rating	340 bhp @ 2000 rpm
Engine Family Rating Code (EFRC)	6132
Injector part number, original equipment	1842579C94
Turbocharger part number	1842337C92, 1842338C92, 1842339C92
Injection timing	Nonadjustable
High idle speed - manual transmission	2325 rpm
High idle speed - automatic transmission	2325 rpm
Low idle speed	700 rpm
KOEO	
VGT Duty Cycle	75 %
Engine cranking	
Minimum battery voltage	10 V
Minimum cranking rpm	130 rpm
Minimum ICP pressure/voltage	6 MPa (870 psi) / 1.2 V
Minimum oil pressure/voltage	138 kPa (20 psi) / 0.9 V
EGRP starting	0%
Minimum fuel pressure/voltage	138 kPa (20 psi) / 0.9 V after 10 second crank

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

Data taken at low idle, no load, stabilized operating temperature	
Injection Control Pressure/voltage	6 ± 0.5 MPa (870 ± 73 psi) / 1.2 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	205 kPa (30 psi) / 1.4 V
Data taken at high idle, no load, stabilized operating temperature	
Air cleaner restriction, maximum	3.1 kPa (12.5 in H_2O)
Injection Control Pressure/voltage	8.5 ± 2 MPa (1231 ± 290 psi) / 1.53 V
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Data taken at full load, rated speed on chassis dynamometer or highway, stabilized operating temperature	
Air cleaner restriction, maximum	6.2 kPa (25 in H_2O)
Injection Control Pressure/voltage (full load, rated speed)	26 ± 1 MPa (3771 ± 145 psi) / 4.15 V @ 2000 rpm
Injection Control Pressure/voltage (full load, peak torque)	15 ± 1 MPa (2175 ± 145 psi) / 2.5 V @ 1200 rpm
Fuel pressure/voltage, minimum	345 kPa (50 psi) / 2.4 V
Fuel inlet restriction, maximum	152 mm Hg (6 in Hg)
Oil pressure/voltage, minimum	480 kPa (70 psi) / 4.1 V
Intake manifold pressure/voltage (full load, rated speed)	200 ± 14 kPa (29 ± 2 psi) 2.35 ± 0.2 V @ 2000 rpm
Intake manifold pressure/voltage (full load, peak torque)	207 ± 14 kPa (30 ± 2psi) 2.45 ± 0.2 V @ 1200 rpm
Exhaust Back Pressure/voltage (sensor), (full load, rated speed)	230 kPa (33 psi) / 3.0 V
Exhaust Back Pressure/voltage (sensor), (full load, peak torque)	241 kPa (35 psi) / 3.2 V
Exhaust restriction (after turbocharger), maximum	20 kPa (82 in H_2O) @ 2000 rpm
Data taken after engine reaches stabilized operating temperature	
Torque converter stall (rpm/time)	1700 rpm or greater @ 5 seconds or less
Lube oil temperature (oil gallery), maximum	118 °C (245 °F)

©August 2008 Navistar, Inc.

Table of Contents

Diagnostic Trouble Code Index.....643

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Diagnostic Trouble Code Index

DTC	PID	SID	FMI	Circuit	Condition Description
111				ECM (page 388)	No errors detected - flash code only
112†	168	0	3	ECM PWR (page 381)	Electrical system voltage B+ out-of-range high
113†	168	0	4	ECM PWR (page 381)	Electrical system voltage B+ out-of-range low
114*	110	0	4	ECT (page 391)	Engine Coolant Temperature signal out-of-range low
115*	110	0	3	ECT (page 391)	Engine Coolant Temperature signal out-of-range high
121*	102	0	3	MAP (page 500)	Intake Manifold Absolute Pressure signal out-of-range high
122*	102	0	4	MAP (page 500)	Intake Manifold Absolute Pressure signal out-of-range low
123*	102	0	2	MAP (page 500)	Intake Manifold Absolute Pressure signal in-range fault
124*	164	0	4	ICP (page 457)	Injection Control Pressure signal out-of-range low
125*	164	0	3	ICP (page 457)	Injection Control Pressure signal out-of-range high
126*	118	4	N/A	BCP (page 318)	Engine Brake Control Pressure signal out-of-range low
127*	118	3	N/A	BCP (page 318)	Engine Brake Control Pressure signal out-of-range high
131*†	91	0	4	APS/IVS (page 300)	APS signal out-of-range low
132*†	91	0	3	APS/IVS (page 300)	APS signal out-of-range high
133*†	91	0	2	APS/IVS (page 300)	APS signal in-range DTC
134*†	91	0	7	APS/IVS (page 300)	APS signal and IVS disagree
135*†	0	230	11	APS/IVS (page 300)	Idle Validation Switch circuit fault
136	94	0	4	EFP (page 406)	Engine Fuel Pressure signal out-of-range low
137	94	0	3	EFP (page 406)	Engine Fuel Pressure signal out-of-range high
141†	84	0	4	VSS (page 544)	Vehicle Speed Sensor signal out-of-range low
142†	84	0	3	VSS (page 544)	Vehicle Speed Sensor signal out-of-range high
143	0	21	2	CMP (page 355)	Incorrect CMP signal signature
145	0	21	12	CMP (page 355)	CMP signal inactive
146	0	64	12	CKP (page 351)	CKP signal inactive

† See chassis circuit diagrams and *Engine Diagnostics Manual* for more information.

* Indicates amber ENGINE lamp on when a Diagnostic Trouble Code (DTC) is set.

** Indicates red ENGINE lamp on if the Engine Warning Protection System (EWPS) is enabled and a DTC is set.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC	PID	SID	FMI	Circuit	Condition Description
147	0	64	2	CKP (page 351)	Incorrect CKP signal signature
151*†	108	0	3	BAP (page 314)	Barometric Absolute Pressure signal out-of-range high
152*†	108	0	4	BAP (page 314)	Barometric Absolute Pressure signal out-of-range low
153†	97	0	4	WIF(page 550)	Water In Fuel signal out-of-range low
154	171	0	4	IAT (page 451)	Inlet Air temperature signal out-of-range low
155	171	0	3	IAT (page 451)	Inlet Air temperature signal out-of-range high
161*	105	0	4	MAT (page 508)	Manifold Air Temperature Signal out-of-range low
162*	105	0	3	MAT (page 508)	Manifold Air Temperature Signal out-of-range high
163*	27	0	4	EGR (page 413)	Exhaust Gas Recirculation Valve Position Signal out-of-range low
211*	100	0	4	EOP (page 426)	Engine Oil Pressure signal out-of-range low
212*	100	0	3	EOP (page 426)	Engine Oil Pressure signal out-of-range high
215†	84	0	8	VSS (page 544)	Vehicle Speed Sensor signal frequency out-of-range high
225	100	0	0	EOP (page 426)	EOP sensor signal in-range fault
231†	0	250	2	ATA (page 309)	ATA data communication link error
236†	111	0	2	ECL (page 370)	ECL switch circuit fault
241†	0	42	11	IPR (page 494)	Injection Control Pressure regulator OCC self test failed
246†	0	56	11	EFAN (page 398)	Engine Fan - OCC self test fault
247†	121	0	11	BSV (page 334)	Engine Brake enable OCC self test failed
251†	0	38	11	IAH (page 444)	Inlet Air Heater OCC self test failed
256†	0	55	11	RSE (page 514)	Radiator Shutter Enable OCC fault
261†	0	27	11	VGT (page 526)	Variable Geometry Turbo control OCC self test failed
267†	0	39	11	ECI (page 366)	Engine Crank Inhibit OCC self test failed
311*	175	0	4	EOT (page 433)	Engine Oil Temperature signal out-of-range low
312*	175	0	3	EOT (page 433)	Engine Oil Temperature signal out-of-range high
313**	100	0	1	EWPS (page 440)	Engine Oil Pressure below warning level

† See chassis circuit diagrams and *Engine Diagnostics Manual* for more information.

* Indicates amber ENGINE lamp on when a Diagnostic Trouble Code (DTC) is set.

** Indicates red ENGINE lamp on if the Engine Warning Protection System (EWPS) is enabled and a DTC is set.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC	PID	SID	FMI	Circuit	Condition Description
314**	100	0	7	EWPS (page 440)	Engine Oil Pressure below critical level
315*	190	0	0	EWPS (page 440)	Engine speed above warning level
316	110	0	1	EWPS (page 440)	Engine Coolant Temperature unable to reach commanded set point
321**	110	0	0	EWPS (page 440)	Engine Coolant Temperature above warning level
322**	110	0	7	EWPS (page 440)	Engine Coolant Temperature above critical level
323**	111	0	1	EWPS (page 440)	Engine Coolant Level below warning/critical level
324**	71	0	14	IST (page 497)	Idle Shutdown Timer enabled engine shutdown
325	110	0	14	EWPS (page 440)	Power reduced, matched to cooling system performance
331*	164	0	0	ICP SYS (page 472)	Injection Control Pressure above system working range
332*	164	0	13	ICP (page 457)	Injection Control Pressure above spec. with engine not running
333*	164	0	10	ICP SYS (page 472)	Injection Control Pressure above/below desired level
334	164	0	7	ICP SYS (page 472)	ICP unable to achieve setpoint in time (poor performance)
335	164	0	1	ICP SYS (page 472)	ICP unable to build pressure during cranking
341*	0	34	4	EBP (page 359)	Exhaust Back Pressure signal out-of-range low
342*	0	34	3	EBP (page 359)	Exhaust Back Pressure signal out-of-range high
343*	0	34	0	AMS (page 294)	Excessive exhaust back pressure (gauge)
344*	0	34	13	EBP (page 359)	Exhaust back pressure above spec. when engine off
345	0	27	2	AMS (page 294)	Faults detected during VGT portion of the AMS Test
346	27	0	2	AMS (page 294)	Faults detected during EGR portion of the AMS Test
351	0	34	7	AMS (page 294)	Change in exhaust back pressure did not occur when expected
353	0	27	5	AMS (page 294)	Variable Geometry Turbo control over duty cycle
354	0	27	6	AMS (page 294)	Variable Geometry Turbo control under duty cycle

† See chassis circuit diagrams and *Engine Diagnostics Manual* for more information.

* Indicates amber ENGINE lamp on when a Diagnostic Trouble Code (DTC) is set.

** Indicates red ENGINE lamp on if the Engine Warning Protection System (EWPS) is enabled and a DTC is set.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC	PID	SID	FMI	Circuit	Condition Description
355	103	0	0	AMS (page 294)	Variable Geometry Turbo overspeed
361	0	27	10	AMS (page 294)	VGT control input (MAP/EBP) above/below desired level
365*	27	0	10	AMS (page 294)	EGR Valve Position above/below desired level
368*	0	146	7	AMS (page 413)	EGR driver module/ECM2 communication fault
371	94	0	0	EFP (page 406)	Engine Fuel Pressure is above normal operating range
372	94	0	1	EFP (page 406)	Engine Fuel Pressure is below normal operating range
421-426	0	1-6	5	INJ (page 489)	High side to low side open (cylinder number indicated)
431-436	0	1-6	4	INJ (page 489)	High side shorted to low side (cylinder number indicated)
451-456	0	1-6	6	INJ (page 489)	High side short to ground or V_{BAT} (cylinder number indicated)
523†	0	233	4	IDM (page 479)	IDM V_{IGN} voltage low
525*	0	254	6	IDM (page 479)	IDM fault
533†	0	221	3	IDM (page 479)	IDM relay voltage high
534†	0	221	4	IDM (page 479)	IDM relay voltage low
546*	121	0	1	BCP (page 318)	Engine Brake Contol Pressure is below expected range
547*	121	0	0	BCP (page 318)	Engine Brake Contol Pressure is above expected range
543*	0	155	7	ECM/IDM (page 373)	ECM/IDM communications fault
551	0	22	12	ECM/IDM (page 373)	IDM/CMPO signal inactive
552	0	22	2	ECM/IDM (page 373)	IDM incorrect CMPO signal signature
553	0	22	11	ECM/IDM (page 373)	IDM CKPO signal inactive
554	0	22	8	ECM/IDM (page 373)	IDM incorrect CKPO signal signature
613*	0	252	1	ECM (page 388)	ECM/IDM software not compatible
614*	0	252	13	ECM (page 388)	EFRC/ECM configuration mismatch
621*	0	253	1	ECM (page 388)	Engine using mfg. default rating
622*	0	253	0	ECM (page 388)	Engine using field default rating
623*	0	253	13	ECM (page 388)	Invalid Engine Family Rating Code (EFRC)
624	0	240	14	ECM (page 388)	Field default active

† See chassis circuit diagrams and *Engine Diagnostics Manual* for more information.

* Indicates amber ENGINE lamp on when a Diagnostic Trouble Code (DTC) is set.

** Indicates red ENGINE lamp on if the Engine Warning Protection System (EWPS) is enabled and a DTC is set.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

DTC	PID	SID	FMI	Circuit	Condition Description
626†	0	254	8	ECM PWR (page 381)	Unexpected reset fault
631	0	240	2	ECM (page 388)	Read Only Memory (ROM) self test fault
632	0	254	12	ECM (page 388)	Random Access Memory (RAM) - CPU self test fault
655	0	240	13	ECM (page 388)	Programmable parameter list level incompatible
661	0	240	11	ECM (page 388)	RAM programmable parameter list corrupt
664	0	253	14	ECM (page 388)	Calibration level incompatible
665	0	252	14	ECM (page 388)	Programmable parameter memory content corrupt

† See chassis circuit diagrams and *Engine Diagnostics Manual* for more information.

* Indicates amber ENGINE lamp on when a Diagnostic Trouble Code (DTC) is set.

** Indicates red ENGINE lamp on if the Engine Warning Protection System (EWPS) is enabled and a DTC is set.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Table of Contents

Description.....651

©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Description

Technical Service Information (TSI) letters are periodically published to inform service technicians of product enhancements and field service issues. File TSIs in this section for supplemental reference.

Read all safety instructions in the "Safety Information" section of this manual before doing any procedures.
Follow all warnings, cautions, and notes.
©August 2008 Navistar, Inc.

©August 2008 Navistar, Inc.

Printed in the United States of America