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500 — Terms and Abbreviations

Backbone—The main J1939 datalink wiring that lies between the two terminating resistors. It does not include the branch circuits to each ECU or to the diagnostic connector.

CAN—Controller Area Network

CAN ID—The identifier for a specific message, which also contains the source address of the sending ECU communicating on the J1939 datalink.

CGW—Central Gateway

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Datalink Topology—The arrangement in which the nodes (ECUs) of a datalink are connected to each other.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

Diagnostic Connector—A 9-pin diagnostic connector is used for troubleshooting the electrical system.

MFJB—MEGA® Fuse Junction Block

MGJB—Main Ground Junction Block

SA—Source Address; indicates numeric assignment for a device that communicates on J1939.

SAM—Signal Detect and Actuation Module

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

501 — Electronic Power Distribution

The multiplexed system contains the following power distribution components:

- SAM Cab (relays and fuses), Module 32A
- SAM Chassis (relays and fuses), Module 32K

The SAM Cab and SAM Chassis are electronic control units (ECUs) that have power distribution components such as fuses and relays on them. Refer to **G02.04 — SAM Cab** and **G02.05 — SAM Chassis** for more information.

The SAM Chassis and SAM Cab may use self-resetting circuit protection instead of fuses for some circuits. When the temperature of the SAM is above 170°F (77°C), it is in the tripped state. When it cools off, the circuit will again be energized. See **704 — SAM Cab and SAM Chassis Self-Resetting Circuit Protection**.

IMPORTANT: Do not change the self-resetting circuit breakers without using the special removal tool, located inside the cover of the SAM device. See **Fig. 13**. Failure to use the special tool could result in component damage.

502 — Electrical Power Distribution

Standard electrical power distribution provides battery power to the electronics system, but it is not controlled by electronics.

The following modules are part of power distribution:

- Main Ground Junction Block (MGJB), Module 280
- MEGA Fuse Junction Block (MFJB), Module 285
- Powertrain PDM, Module 286
- PNDB, Module 33P
- Load Disconnect Switch, Module 293
- Trailer PDM, Module 296

503 — Powernet Distribution Box

The powernet distribution box (PNDB) distributes and fuses battery power to many of the vehicle loads. An optional cab load disconnect switch (CLDS) is available to disconnect selected circuits. The CLDS may be located on the chassis near the battery box or mounted so that it is operated from inside the cab. There is an LED in the CLDS that will illuminate when power is on. The LED will flash when certain faults are detected.

Some vehicles have an auxiliary PNDB in addition to the primary PNDB. If the vehicle is equipped with a CLDS, it controls both. An additional LED status indicator is in the CLDS on dual PNDB systems.

504 — Main Ground Junction Block (MGJB), Module 280

The MGJB is a main node for connecting a returning ground to the battery. Many of the ground circuits previously on the starter are now on the MGJB.

505 — MEGA Fuse Junction Block (MFJB), Module 285

The MFJB houses up to 5 MEGA fuses, and provides power to the engine harness, SAM Cab, SAM Chassis, chassis-mounted trailer PDM, and an inverter.

The advantage of using an MFJB is that it provides increased robustness in the engine control and cab control electronic systems during cranking. This is because the cab electrical system is fed from the battery through the MFJB, and no longer from the starter. Separate starter cables provide both higher voltage levels and cleaner power during cranking.

Additionally, there are improvements in circuit protection, and starter connection integrity (fewer circuits to connect at the starter stud).

506 — Powertrain PDM, Module 286

The Powertrain Power Distribution Module (PT-PDM) is dedicated to providing battery and ignition power to the engine (ECM), after treatment device (ATD), transmission (TCU), as well as other powertrain-related circuits. It is mounted in the engine compartment, above the quarter fender on the driver side of the vehicle.

507 — Load Disconnect Switch, Module 293

The load disconnect switch is used to disconnect (or open) the connection between the battery and the MFJB. Turning the load disconnect switch to the off position does not disconnect the batteries from the starter.

NOTE: If the engine is running, turning the load disconnect switch to the OFF position will not shut off the engine. The powertrain PDM still gets battery voltage from the emergency power feed on the SAM system.

The load disconnect switch is mounted on one of three locations:

- Inside the cab on the left side of the driver's seat on a left-hand-drive vehicle.
- On the battery box.
- Outboard-mounted on the left frame rail.

508 — Trailer PDM, Module 296

The trailer PDM is used to supply trailer power to the chassis-mounted trailer receptacles. The SAM Chassis supplies control outputs to the remote trailer PDM. The trailer PDM is powered through the vehicle's battery system. The SAM Chassis does not supply battery power to the trailer PDM. See **Fig. 1**.

509 — PDM Diagram

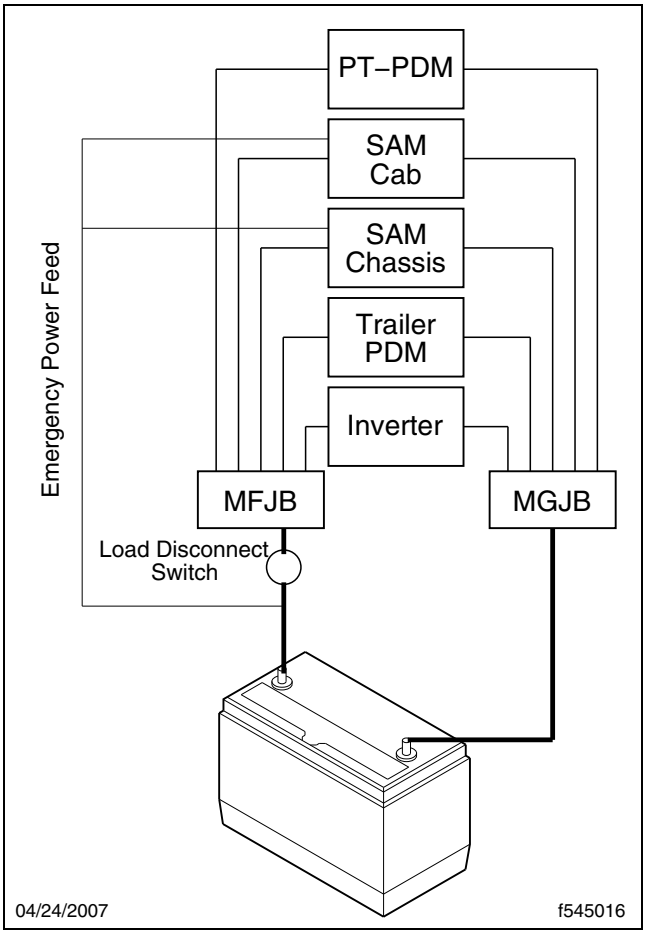
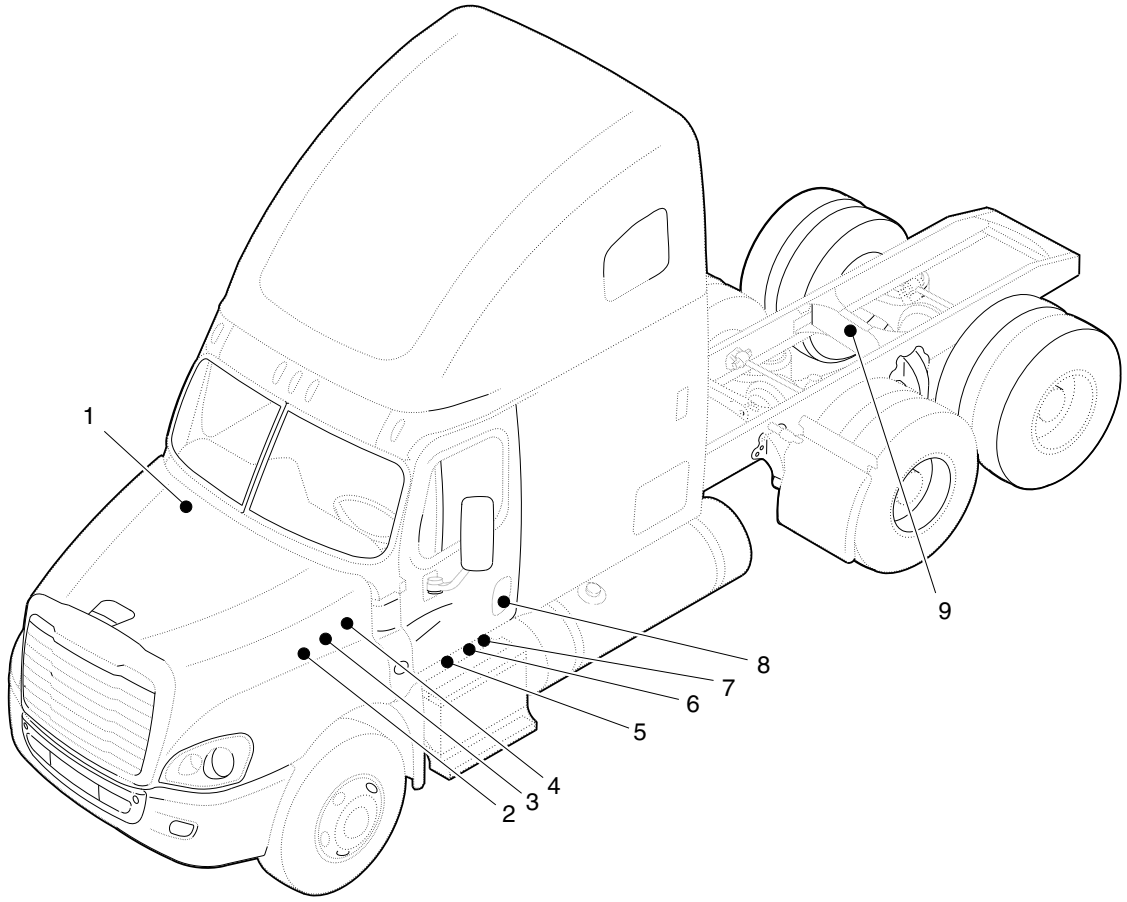


Fig. 1, PDM Diagram

600 — Component Locations



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1. SAM Cab
2. Powertrain PDM (PT-PDM)
3. Powernet Distribution Box (PNDB)
4. SAM Chassis
5. Main Ground Junction Block (MGJB)
6. MEGA Fuse Junction Block (MFJB)
7. Cab Load Disconnect Switch (optional location)
8. Cab Load Disconnect Switch (optional location)
9. Trailer PDM

Fig. 2, Component Locations

601 — Component Details

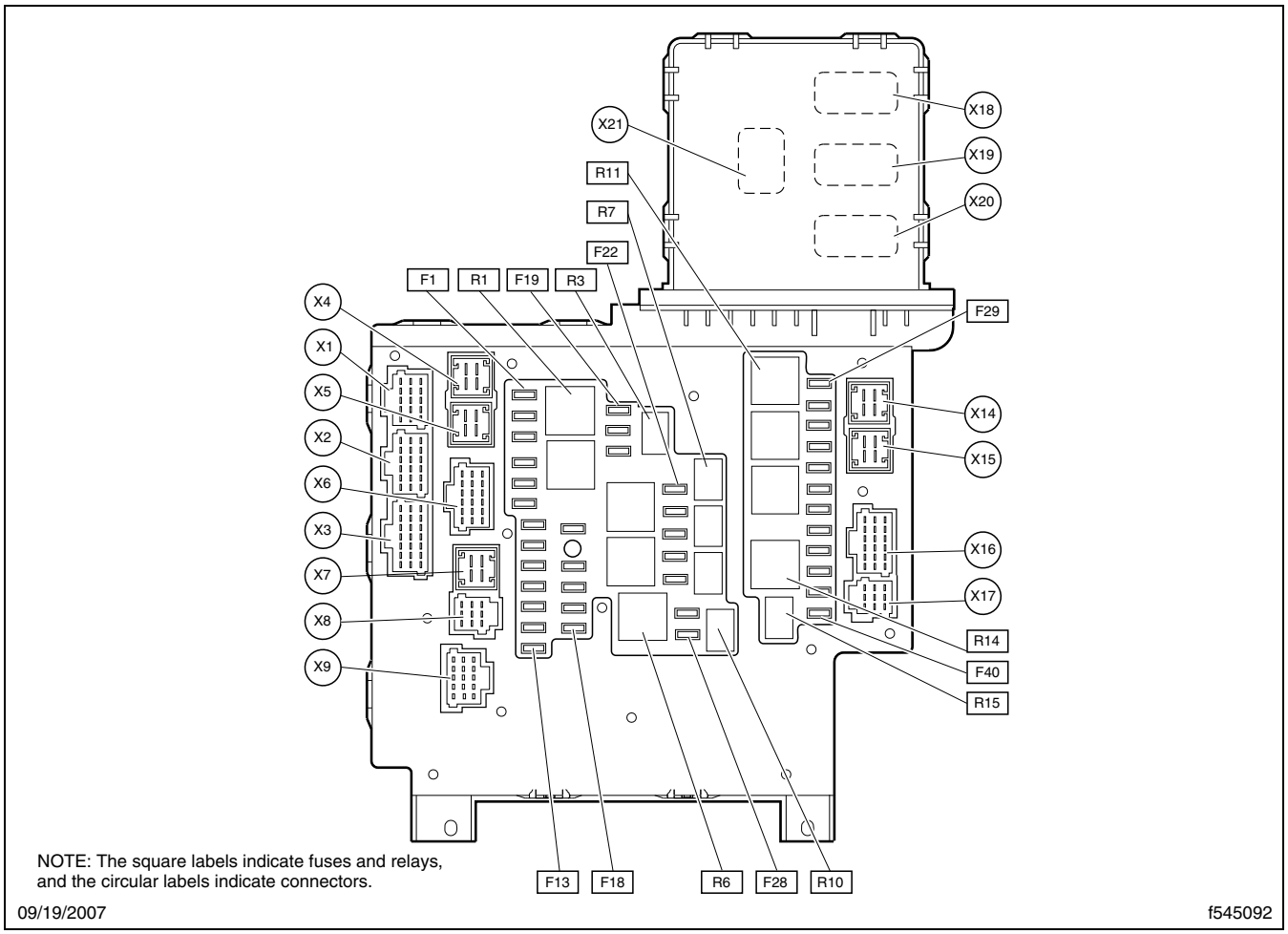


Fig. 3, SAM Cab Fuses and Relays (top)

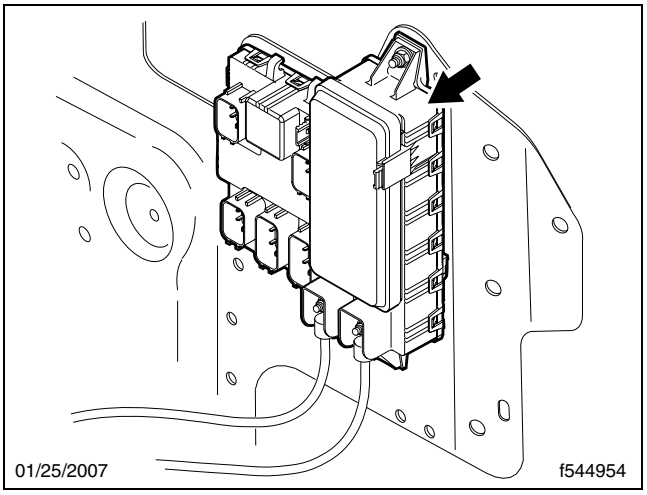


Fig. 4, SAM Chassis

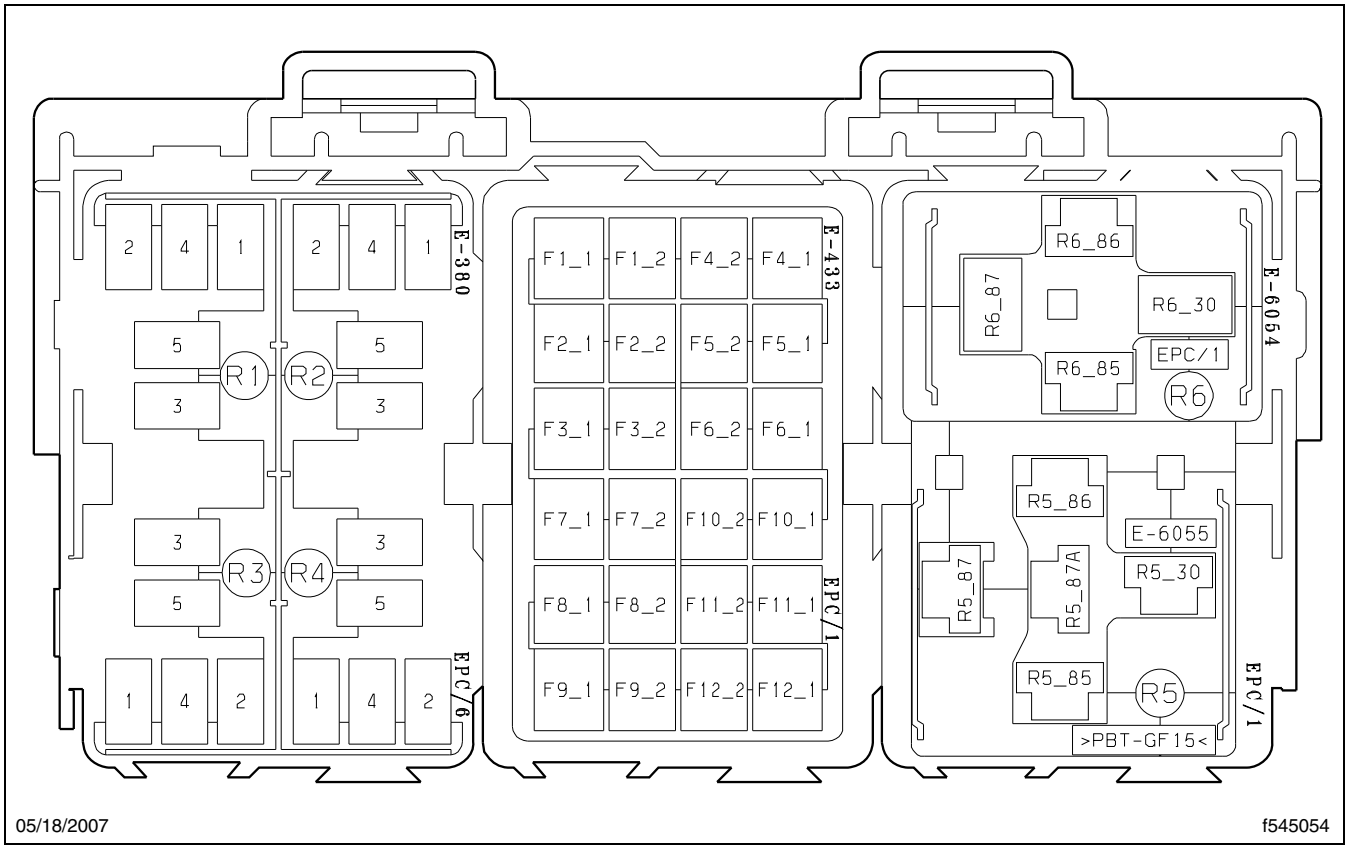
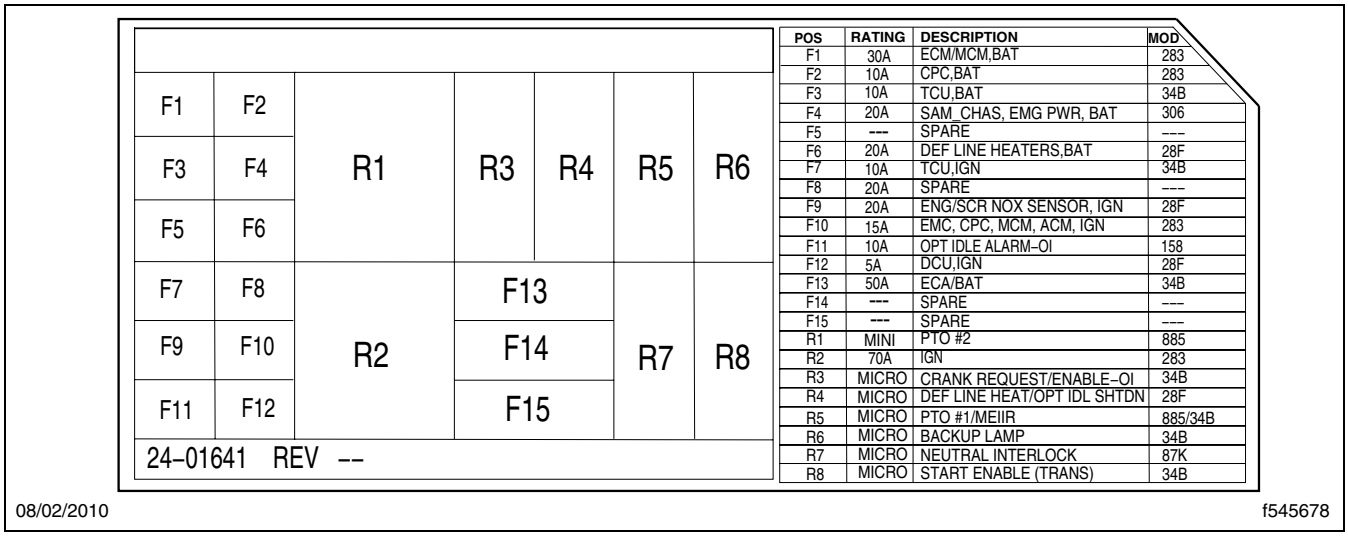


Fig. 5, Powertrain PDM (EPA07)



POS	RATING	DESCRIPTION	MOD
F1	30A	ECM/MCM,BAT	283
F2	10A	CPC,BAT	283
F3	10A	TCU,BAT	34B
F4	20A	SAM_CHAS, EMG PWR, BAT	306
F5	---	SPARE	----
F6	20A	DEF LINE HEATERS,BAT	28F
F7	10A	TCU,IGN	34B
F8	20A	SPARE	----
F9	20A	ENG/SCR NOX SENSOR, IGN	28F
F10	15A	EMC, CPC, MCM, ACM, IGN	283
F11	10A	OPT IDLE ALARM–OI	158
F12	5A	DCU,IGN	28F
F13	50A	ECA/BAT	34B
F14	---	SPARE	----
F15	---	SPARE	----
R1	MINI	PTO #2	885
R2	70A	IGN	283
R3	MICRO	CRANK REQUEST/ENABLE–OI	34B
R4	MICRO	DEF LINE HEAT/OPT IDL SHTDN	28F
R5	MICRO	PTO #1/MEIIR	885/34B
R6	MICRO	BACKUP LAMP	34B
R7	MICRO	NEUTRAL INTERLOCK	87K
R8	MICRO	START ENABLE (TRANS)	34B

Fig. 6, Powertrain PDM (EPA10)

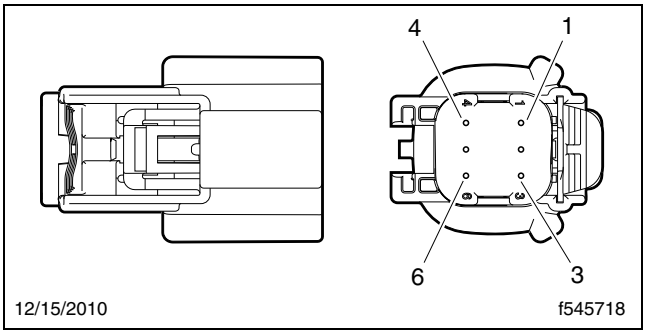


Fig. 7, Wire Insertion View of PNDB Connector X1

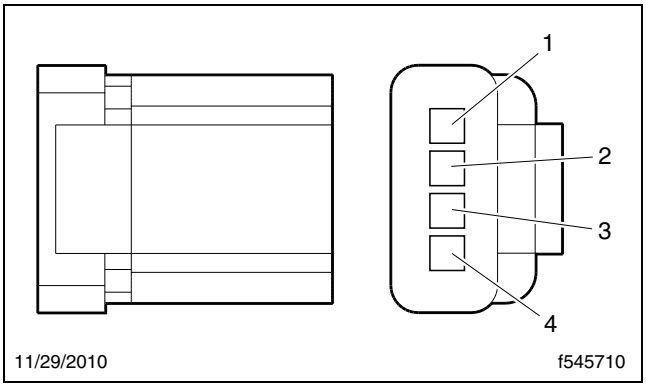


Fig. 8, Wire Insertion View of PNDB Connector X2

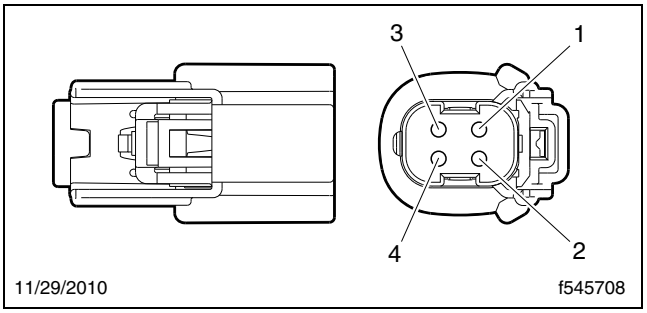


Fig. 9, Wire Insertion View of CLDS Connector X1

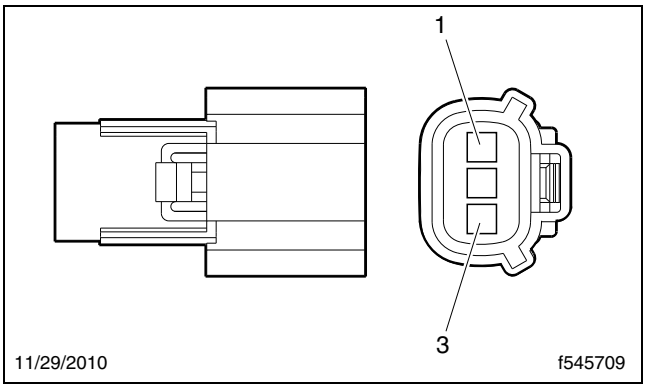


Fig. 10, Wire Insertion View of CLDS Connector X2

700 — Possible Causes

- Water Intrusion
- Voltage Spikes
- Short Circuits
- Missing Fuse/Relay
- Incorrect Fuse Rating

701 — Diagnostic Tools Required

- Digital Multimeter

702 — Diagnosis

Refer to the schematic in modules 280 and 285 for an overview of the vehicle power distribution system for troubleshooting. Use **Table 1**to cross reference the individual modules for each subsystem.

Power Distribution with Module Numbers				
Source	**Battery Node**	**Input/Output Device**	**Secondary Battery**	**Module**
Battery	Starter Bat Terminal	Starter Motor	—	155
	Alternator Bat Terminal	Alternator	—	125
	Grid Heater	Heater Element	—	12C
	Jump Start Post	—	—	295
	Emergency Power Supply	SAM Cab	—	32A
		SAM Chassis	—	32K
	Load Disconnect Switch	MFJB	Powertrain PDM	286
			SAM Cab	32A
			SAM Chassis	32K
			Trailer PDM	296
			Inverter	337

Table 1, Power Distribution with Module Numbers

703 — PNDB Troubleshooting

Each powernet distribution box (PNDB) on the vehicle provides up to 4 low amperage circuits (30 amp and less), and up to three high amperage circuits through midi fuses. The fuses are located behind a cover on the face of the PNDB. On vehicles equipped with a cab load disconnect switch (CLDS), the high amperage circuits are switched on and off with the CLDS. The low amperage circuits are always live. Vehicles may have one or two PNDBs and both are connected to the same CLDS.

When the CLDS is in the on position, an LED on the switch, and another on the PNDB, will be illuminated. When there is an error condition with the PNDB system, the LED on the PNDB and CLDS may flash. A flashing LED indicates an error. An LED that remains on when the switch is off, or no LED when the switch is on, also indicates an error condition.

To test for open fuses, use conventional troubleshooting methods. The LED's in the PNDB and switch are not affected by open fuses or the circuits they connect.

See **Fig. 7**, **Fig. 8**, **Fig. 9**, and **Fig. 10** for illustrations of the connectors with pin identification.

NOTE: See **Table 2** to troubleshoot a switched PNDB system.

NOTE: PNDB connector X2 is not part of the switching and control system. See **Table 3** for information on the function of PNDB connector X2.

See **Fig. 11** for a schematic of the dual PNDB system with the cab load disconnect switch option.

PNDB and CLDS Troubleshooting			
Step	**Test Procedure**	**Test Result**	**Action**
1	Check the power cables on the PNDB for proper torque. Open the cover and inspect the MIDI fuse fastener torque and for discoloration caused by excessive heat.	Loose fasteners or heat discoloration	Determine if the fasteners can be properly torqued or if the PNDB needs replacement. Repair or replace as required.
		All OK	Go to step 2.
2	Does the LED on the PNDB flash in a constant pattern when the CLDS is switched to the OFF or ON position or does the LED on the PNDB just randomly flicker?	Constant Repeating Flashing Pattern	Troubleshoot and repair any wiring faults on circuits 425D, 425F, or circuit 425G between the CLDS and the PNDB. If there is no wiring fault, replace the CLDS.
		Random flickering	Replace the PNDB.
		No	Go to step 3.
3	Measure for ground on PNDB connector 1, pins 1 and 6. If either of these pins are not populated with a wire disregard measuring the unpopulated pin. Is ground present in the wiring harness supplying these pins?	Yes	Measure the voltage on PNDB connector X1, pin 4. If pin 4 is at about 11 volts then troubleshoot and repair for a wiring fault in circuits 425D, 425F, 425G between the CLDS and the PNDB and for a open or short circuit in the CLDS. If there is no wiring or switch fault, replace the PNDB.
		No	Repair an open ground circuit to the PNDB.

Table 2, PNDB and CLDS Troubleshooting

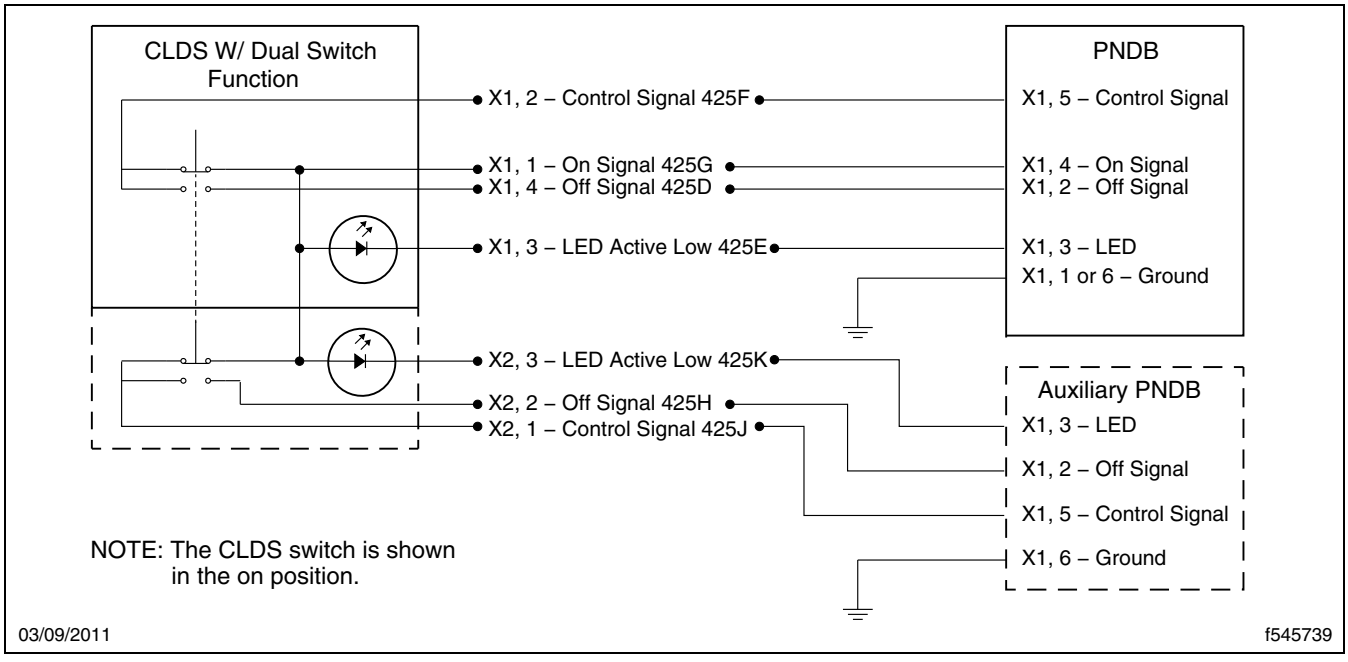


Fig. 11, Primary and Auxiliary PNDB with CLDS Option

Primary PNDB and CLDS Connector and Pin Functions			
Device	**Connector, Pin**	**Voltage**	**Function**
Primary PNDB	X1, 1	0	Ground
	X1, 2	0	Off Signal – Always at ground.
	X1, 3	0 – ON	LED Indicator – PNDB drives this low when the switch is on.
	X1, 4	11	On Signal – Approximately 11 volts.
	X1, 5	11 – ON 0 – OFF	Control Signal – Approximately 11 volts when CLDS is on. At ground when off.
	X1, 6	0	Not used, or ground circuit connecting to the auxiliary PNDB.
CLDS	X1, 1	11	On Signal – Approximately 11 volts.
	X1, 2	11 – ON 0 – OFF	Control Signal – Approximately 11 volts. when CLDS is on. At ground when off.
	X1, 3	0 – ON	LED Indicator – PNDB drives this low when switch is on.
	X1, 4	0	Off Signal – Always at ground.
	X2, 1	11 – ON 0 – OFF	Control Signal - Approximately 11 volts when CLDS is on. At ground when off.
	X2, 2	0	Off Signal – Always at ground.
	X2, 3	0 – ON	LED Indicator – PNDB drives this low when the switch is on.
Auxiliary PNDB	X1, 1	0	Ground
	X1, 2	0	Off Signal – Always at ground.
	X1, 3	0 – ON	LED Indicator – PNDB drives this low when the switch is on.
	X1, 4	X	Not used.
	X1, 5	11 – ON 0 – OFF	Control Signal – At approximately 11 volts when CLDS is on. At ground when off.
	X1, 6	0	Not used, or ground.

Table 3, PNDB and CLDS Connector and Pin Functions

704 — SAM Cab and SAM Chassis Automatic Resetting Circuit Protection

IMPORTANT: Do not change the self-resetting circuit breakers without using the special removal tool, located inside the cover of the SAM device. See **Fig. 13**. Failure to use the special tool could result in component damage.

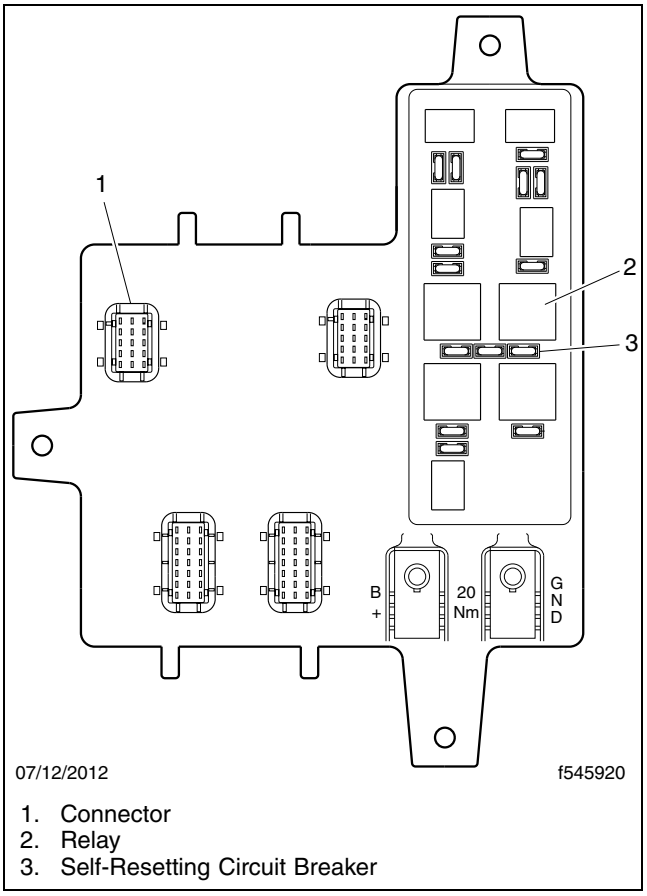
The SAM Chassis and SAM Cab may use self-resetting circuit protection instead of fuses for some circuits. See **Fig. 12**.

IMPORTANT: Disconnect the batteries before removing the SAM devices. These devices can be permanently damaged if they are removed when power is applied.

Never grip the self-resetting devices with pliers or other tools that squeeze the body of the device. Use the removal tool that is supplied with the SAM. See **Fig. 13**.

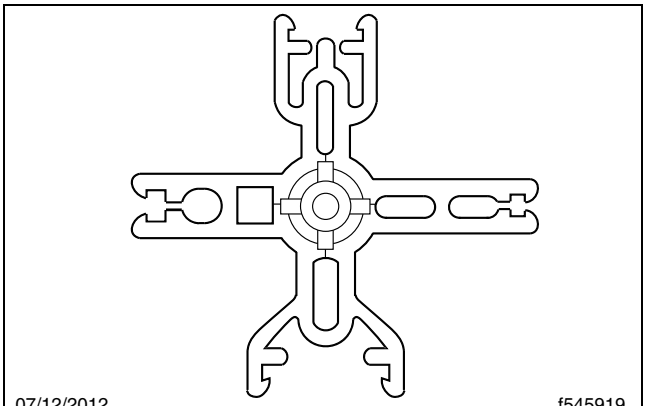
Never test the self-resetting devices with the voltmeter applied directly to the inspection holes. The device can be tested out of the circuit using an ohm meter on the terminals, or with a non-contact infrared thermometer. See

Fig. 14. When the temperature of the device is above 170°F (77°C), it is in the tripped state. When it cools off, the circuit will again be energized.



1. Connector
2. Relay
3. Self-Resetting Circuit Breaker

Fig. 12, SAM Chassis



NOTE: The removal tool is located inside the cover of the SAM Chassis.

Fig. 13, Removal Tool

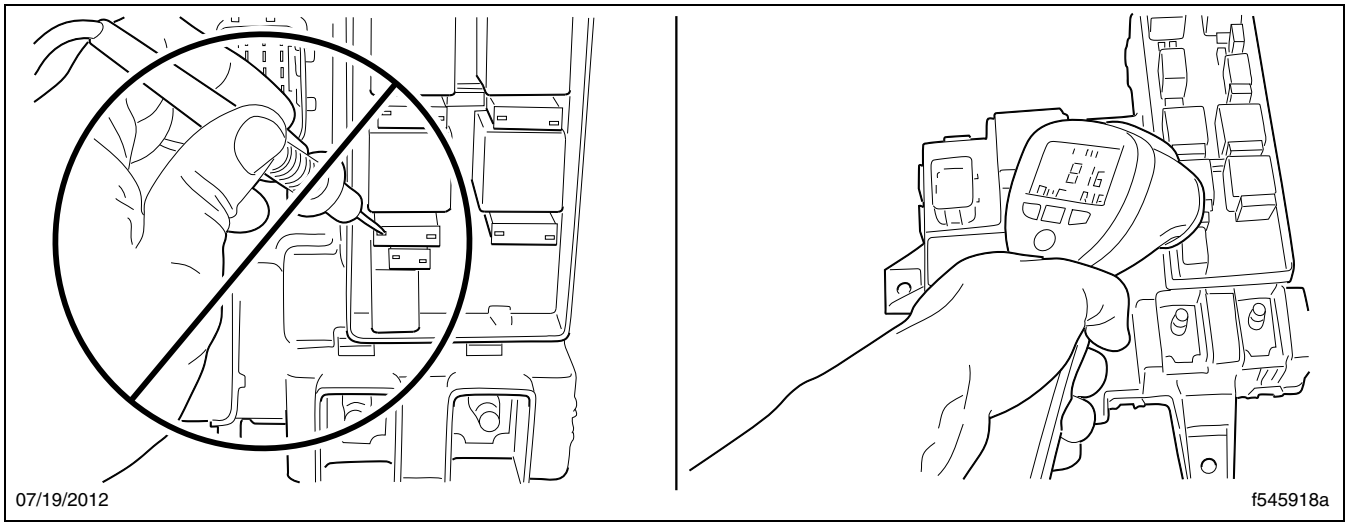


Fig. 14, Properly Testing the Self-Resetting Device

800 — SAM Chassis Fuses and Relays

SAM Chassis Relays	
Part	**Name**
R1	H2O SEP HEAT, IGN
R2	TRLR TRN L
R3	ABS/WIF/CAMERA, IGN
R4	TRLR TRN R
R5	TRLR MARKER
R6	TRLR ABS, IGN

SAM Chassis Relays	
Part	**Name**
R7	TRLR STOP LAMPS
R8	TRLR POWER
R9	TRLR TAIL LAMPS

Table 4, SAM Chassis Relays

SAM Chassis Fuses	
Part	**Name**
F1	EAPU (20A)
F2	H2O SEP HEAT (20A)
R3	ABS—BAT1 (20A)
F4	ABS—BAT2 (10A)
F5	TRLR TRN L (20A)
F6	ABS—IGN (15A)
F7	WIF/CAMERA (10A)
F8	TRLR TRN R (20A)
F9	TRLR MKR (30A)
F10	SAM RELAY COILS (5A)
F11	TRLR ABS—IGN (30A)
F12	TRLR STOP (30A)
F13	TRLR TAIL (20A)
F14	TRLR PWR (30A)

Table 5, SAM Chassis Fuses

801 — SAM Cab Fuses and Relays

SAM Cab Relays	
Part	**Name**
R1	PWR FD SPARE 1 and 3, BAT
R2	PWR FD SPARE 2 and 4, BAT
R3	HEATED SEAT, IGN
R4	DASH PWR RCPT 1 and 2, BAT
R5	FLT MGM SYS and CB, BAT
R6	PWR RCPT3 and STD HVAC, BAT
R7	DRV INFO/GAUGE, IGN
R8	ICU/VEHICLE SYS, IGN
R9	AMPLIFIER PWR, ACC

SAM Cab Relays	
Part	**Name**
R10	MIRROR HEAT
R11	PWR RCPT 6 / FRIG, BAT
R12	PWR RCPT 5, BAT
R13	CAB LIGHTING, BAT
R14	PWR RCPT4/CIR FAN/LAMP, BAT
R15	PWR WINDOW, ACC

Table 6, SAM Cab Relays

SAM Cab Fuses	
Part	**Name**
F1	PWR FD SPARE 1 and 3 (30A)
F2	CAB/SLPR HVAC CTRL/SHF PNL (15A)
F3	PWR FD SPARE 2 and 4 (30A)
F4	MSF (15A)
F5	OBD J1939—BAT (10A)
F6	DASH PWR RCPT 1 (15A)
F7	DASH PWR RCPT 2 (15A)
F8	PHONE/RADIO—BAT (15A)
F9	AMPLIFIER PWR (20A)
F10	CAB HVAC MTR (30A)
F11	SLPR HVAC MTR (30A)
F12	DR CTRL L (20A)
F13	DR LOCK/SM CRUISE (20A)
F14	FLT MGM SYS and CB (25A)
F15	SLPR PWR RCPT 3 (20A)
F16	STAND ALONE HVAC (7.5A)
F17	SLPR PWR RCPT 4 (20A)
F18	TELEMATICS/WARNING SYS (15A)
F19	HEATED SEAT (20A)
F20	CGW (2A)
F21	AREA LIGHT (15A)
F22	ICU—BAT (5A)
F23	DR INF /GAUGE (15A)
F24	ICU—IGN (10A)
F25	DASH SPLICE PACK (7.5A)
F26	SRS—AIRBAG (5A)

SAM Cab Fuses	
Part	**Name**
F27	MIRROR HEAT L (10A)
F28	MIRROR HEAT R (10A)
F29	SAM RELAY COILS (3A)
F30	PWR RCPT 6 / FRIG (20A)
F31	SLPR PWR RCPT 5 (20A)
F32	PWR FD SPARE 5 and 6 (25A)
F33	SPOT LIGHT (20A)
F34	BAGGAGE COMP LAMP (3A)
F35	DOMELAMP CAB (15A)
F36	AUX CIR FAN/RD LAMP (15A)
F37	CLK/DRV INFO/CD/KEYLESS (15A)
F38	DR CTRL R (20A)
F39	PWR WINDOW R (15A)
F40	PWR WINDOW L (15A)

Table 7, SAM Cab Fuses

802 — MFJB Fuses

MFJB Fuses	
Part	**Name**
1	Engine Harness (175A)
2	SAM Cab (175A)
3	SAM Chassis (125A)
4	Chassis-Mounted Trailer PDM (125A)
5	Inverter (200A)

Table 8, MFJB Fuses

803 — Powertrain PDM and Trailer PDM Fuses and Relays

Powertrain PDM Fuses and Relays	
Part	**Name**
F1	N/A
F2	TRANS ECU IGN FUSE
F3	FUEL HEATER FUSE
F4	FUEL HEATER FUSE
F5	ENGINE IGN

Powertrain PDM Fuses and Relays	
Part	**Name**
F6	SAM CHASS
F7	PLVD/REMOTE SENSE
F8	ENGINE ECU BATT FUSE
F9	CPC/ENG ECU BATT FUSE
F10	TRANS BATT FUSE
F11	TRANS BATT FUSE
F12	TRANS BATT FUSE
R1	TRANS BACKUP RELAY
R2	MEIIR RELAY
R3	NEUTRAL RELAY/START ENABLE
R4	SPARE RELAY/HEAT RELAY
R5	N/A
R6	70A IGN RELAY

Table 9, Powertrain PDM Fuses and Relays

804 — Primary PNDB Fuses and Functions

Primary PNDB Fuses and Functions		
Fuse	**Function**	**Amperage**
A	Aftertreatment Control Module	30
B	Emergency Power	20
C	Radio and Clock	5
D	Alternator Remote Sense	5
1	Powertrain PDM	175
2	SAM Chassis	125
3	SAM Cab	175

Table 10, Primary PNDB Fuses and Functions

Datalink Communication Structure G02.02

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500 — Terms and Abbreviations

Backbone—The main J1939 datalink wiring that lies between the two terminating resistors. It does not include the branch circuits to each ECU or to the diagnostic connector.

Baud Rate—The rate at which data is transmitted in bits per second.

Branch Circuit—The section of J1939 datalink between the backbone and each ECU that has J1939, and between the backbone and the diagnostic connector.

Cabin CAN—A proprietary datalink connecting certain ECUs on the vehicle, specifically the CGW, MSF, SAM Cab, and SAM Chassis.

CAN—Controller Area Network

CAN ID—The identifier for a specific message, which also contains the source address of the sending ECU communicating on the J1939 datalink.

CGW—Central Gateway

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Datalink Topology—The arrangement in which the nodes (ECUs) of a datalink are connected to each other.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

Diagnostic Connector—A 9-pin diagnostic connector is used for troubleshooting the electrical system.

ECU—Electronic Control Unit, typically connected to a datalink.

J1939 Terminating Resistors—The J1939 datalink has two 120-ohm terminating resistors, one at each end of the backbone. The total datalink parallel resistance is 60 ohms.

MID—Message Identifier

MSF—Modular Switch Field

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

SA—Source Address; indicates numeric assignment for a device that communicates on J1939.

SAM—Signal Detect and Actuation Module

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

501 — Multiplexing Overview

The term "multiplexing" describes the electrical system. Multiplexing is defined as sending multiple electronic messages simultaneously through the same signal path. All the wires used for sending electronic messages make up what is called the "datalink."

Multiplexing allows the electrical system to simultaneously perform tasks and to monitor components. A multiplexed system uses electronic control units (ECUs) to operate the various systems on the vehicle (lighting, braking, and wipers, for example). The electrical system components, such as switches and lamps, are con-

nected to the ECUs, which collect and control all information about the components by communicating on a datalink. See **Fig 1**.

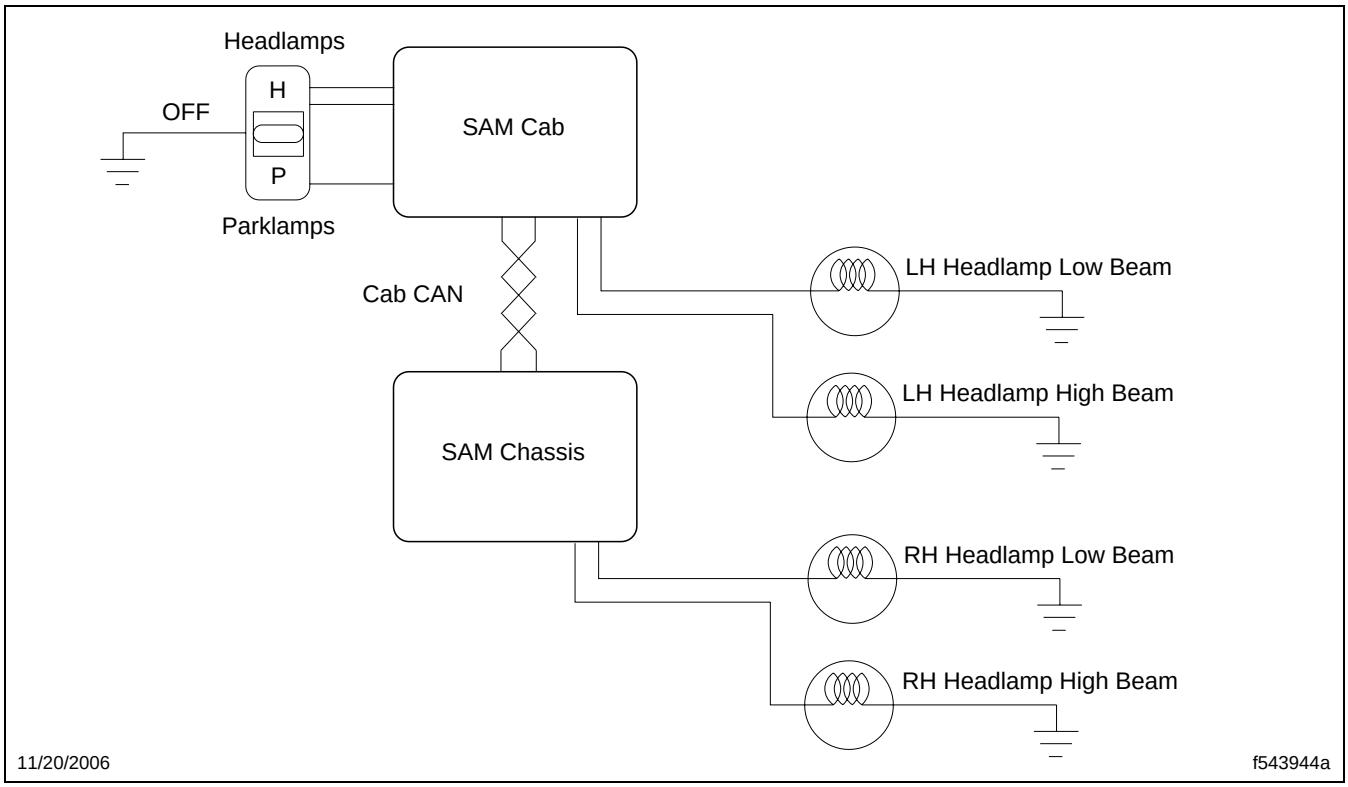


Fig. 1, Example of Multiplexed System with ECUs and Electrical Components

The multiplexed electrical system on this vehicle combines traditional power distribution module (PDM) devices, such as relays and circuit breakers, with electronic devices (ECUs) that communicate over a vehicle datalink. The electronic devices can control power distribution to the electrical loads on the vehicle. This is done by monitoring inputs (from devices such as sensors and switches) and supplying power to outputs (for devices such as lighting, displays, gauges, and indicators). This distributed approach to handling switch inputs and controlling electrical load outputs sharply reduces the number of wires on a vehicle by sharing wires.

502 — Vehicle Datalinks Overview

ECUs on the Cascadia electrical system communicate on four datalinks:

- J1587/J1708 datalink
- J1939 datalink
- Cabin CAN datalink
- Diagnostic CAN datalink (used strictly for off-board tool interaction with Cabin CAN ECUs)

Cabin CAN is the primary datalink for control messaging of most cab and chassis features (interior and exterior lighting, comfort features, and optional features, for example) and has some interaction with control messaging on the J1939 and J1587/J1708 datalinks.

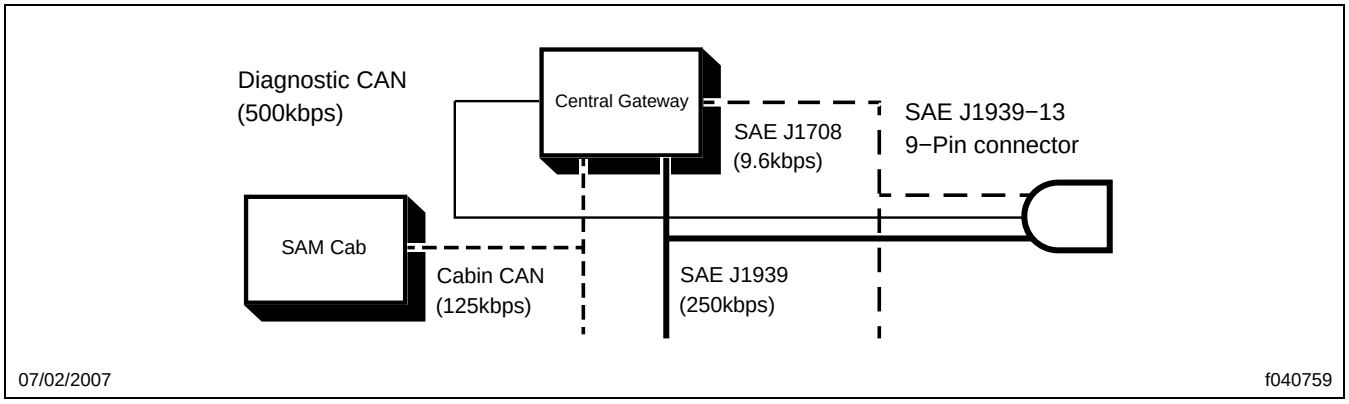


Fig. 2, Central Gateway, Diagnostic Connector, and Vehicle Datalinks

J1939 and J1587/J1708 remain the primary datalinks for powertrain control (engine, transmission, and ABS, for example).

503 — SAE J1587/J1708 Datalink

The J1587 datalink is a low-speed vehicle datalink that communicates information between the electronic control units on the vehicle. The J1587 datalink is also referred to as J1708 or "J1587/J1708."

J1708 refers to the SAE standard for the physical part of the datalink, such as the wiring and electronic components. J1587 refers to the SAE standard for the messaging protocol that communicates on the J1708 network. In the context of vehicle repair, the terms J1708 and J1587 are used interchangeably.

See **G03.01 — Datalink, J1587/J1708** for more information.

504 — SAE J1939 Datalink

The J1939 datalink is a high-speed vehicle datalink that communicates information between electronic control units on the vehicle.

Unlike the J1587 datalink, the J1939 datalink allows an ECU to broadcast requests as well as information. Examples of information that can be communicated on the J1939 datalink are:

- engine rotational speed;
- road speed;
- transmission tailshaft speed;
- engine retarder deactivation request;
- engine torque reduction request.

The "backbone" of the J1939 datalink is the section of the datalink that is between the two terminating resistors. Each ECU is connected to the backbone. The wiring between each ECU and the backbone is referred to as a branch.

See **G03.02 — Datalink, J1939** for more details.

505 — Cabin CAN Datalink

The Cabin CAN datalink does not have a direct connection to the diagnostic connector. Therefore, an off-board tool must connect to the Diagnostic CAN pins on the diagnostic connector to troubleshoot or configure Cabin CAN ECUs.

The Cabin CAN datalink has the following ECUs directly connected to it:

- SAM Cab
- SAM Chassis
- Modular Switch Field (MSF)
- Central Gateway Module (CGW)

See **G03.03 — Datalink, Cabin CAN** for more information.

506 — Diagnostic CAN

When an off-board tool is connected to the vehicle, it communicates with the Cabin CAN ECUs via the Diagnostics CAN datalink because there is no accessible service port to the Cabin CAN. The CGW translates messages between the Diagnostic CAN and Cabin CAN datalinks, due to the different speed of the two datalinks.

See **G03.04 — Datalink, Diagnostic CAN** for more information.

507 — ECU Troubleshooting Datalinks

An ECU's "troubleshooting datalink" is the datalink that an off-board tool uses to communicate and diagnose that ECU. See **Table 1**.

ECU Troubleshooting Datalinks				
ECU is on this Datalink	**Direct Connection to Diagnostic Connector?**	**ECU Troubleshooting Datalink**	**Direct Connection to Diagnostic Connector?**	**Diagnostic Communication Protocol**
J1708	Yes	J1587/J1708	Yes	J1587/J1708
J1939	Yes	J1939	Yes	J1939
Cabin CAN	No	Diagnostic CAN	Yes	CAN

Table 1, ECU Troubleshooting Datalinks

Fault codes are displayed on the instrument cluster (ICU) display for J1587/J1708 or J1939, depending on the type of ICU installed. Faults from all ECUs can be viewed on ServiceLink or DiagnosticLink.

508 — ECU Configuration

All ECUs connected to the Cabin CAN datalink can have their software updated using ServiceLink or DiagnosticLink.

All ECUs connected to the Cabin CAN datalink have parameters that can be configured, except for CGWs on vehicles built before 2010.

Some J1939 and J1587/J1708 ECUs may be programmed, or have parameters configured, using ServiceLink, DiagnosticLink, or the ECU manufacturer's proprietary off-board tool. For more information, refer to the applicable subjects in this manual, and the diagnostic tool's user documentation.

509 — Datalink Network Topology

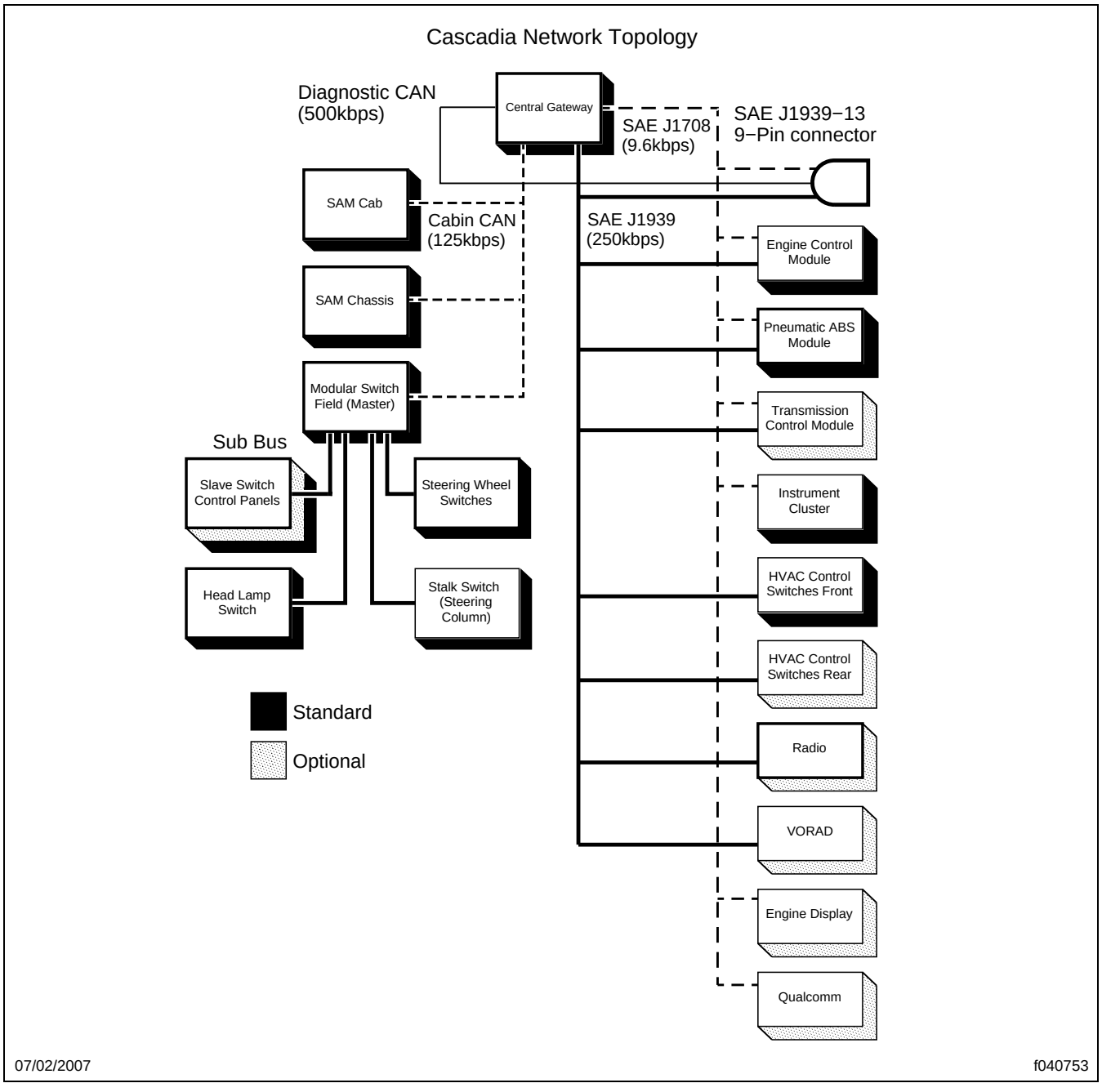
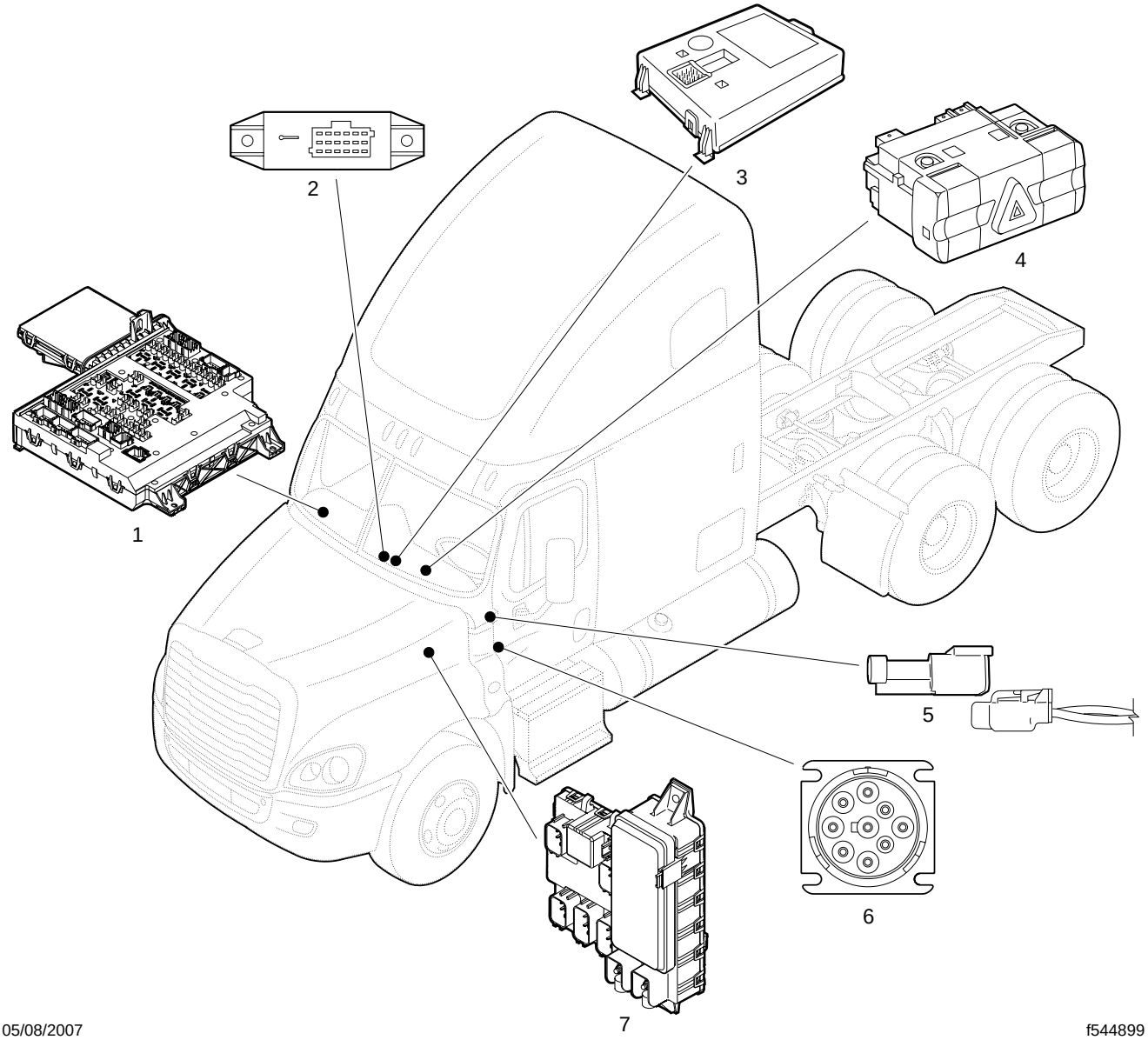


Fig. 3, Datalink Network Topology

510 — Related Subjects

- **G02.01 — Electrical System and Main PDM Overview**
- **G02.03 — Central Gateway**
- **G02.04 — SAM Cab**
- **G02.05 — SAM Chassis**
- **G02.06 — Modular Switch Field**
- **G03.01 — Datalink, J1587/J1708**
- **G03.02 — Datalink, J1939**
- **G03.03 — Datalink, Cabin CAN**
- **G03.04 — Datalink, Diagnostic CAN**

600 — Component Locations



1. SAM Cab
2. Starpoint Connector
3. Central Gateway
4. Modular Switch Field
5. J1939 Terminating Resistor
6. Diagnostic Connector
7. SAM Chassis

Fig. 4, Component Locations

601 — Component Details

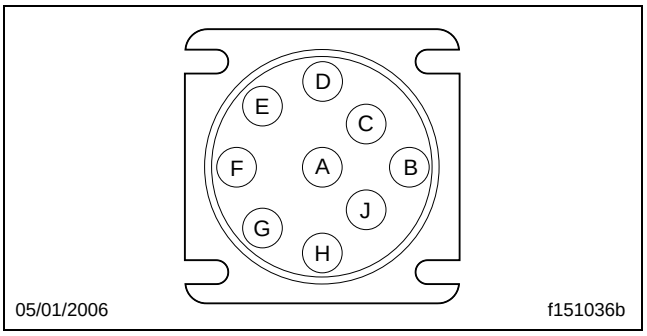


Fig. 5, Diagnostic Connector

Diagnostic Connector	
Pin	**Function**
A	Battery (–)
B	Battery (+)
C	J1939 CAN High (+)
D	J1939 CAN Low (–)
E	CAN Shield (ground)
F	J1708/J1587 (+)
G	J1708/J1587 (–)
H	Diagnostic CAN High (+)
J	Diagnostic CAN Low (–)

Table 2, Diagnostic Connector

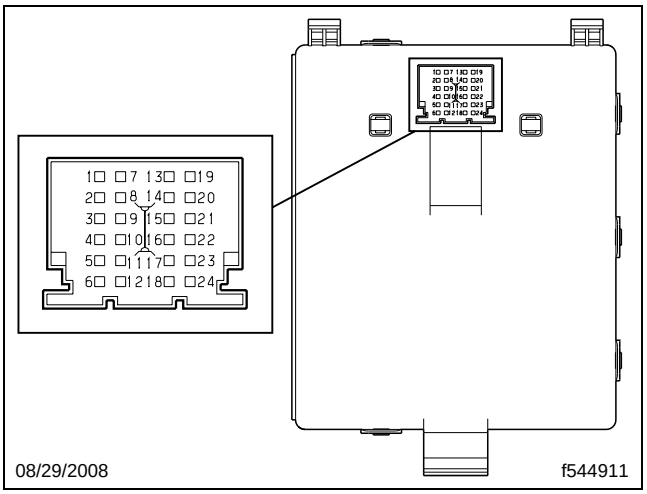


Fig. 6, Central Gateway Module, Cabin CAN Pins

CGW ECU (single connector)	
Pin	**Function**
1	Battery Power
2	J1708 (+)
3	Not used
4	Not used
5	Not used
6	Not used
7	Ground
8	J1708 (–)
9	Not used
10	Not used
11	Not used
12	Not used
13	Not used
14	Cabin CAN Low
15	Not used
16	J1939 CAN Low
17	Not used
18	Diagnostic CAN Low
19	Cabin CAN High
20	Not used
21	J1939 CAN High
22	Not used
23	Diagnostic CAN High
24	Not used

Table 3, CGW ECU (single connector)

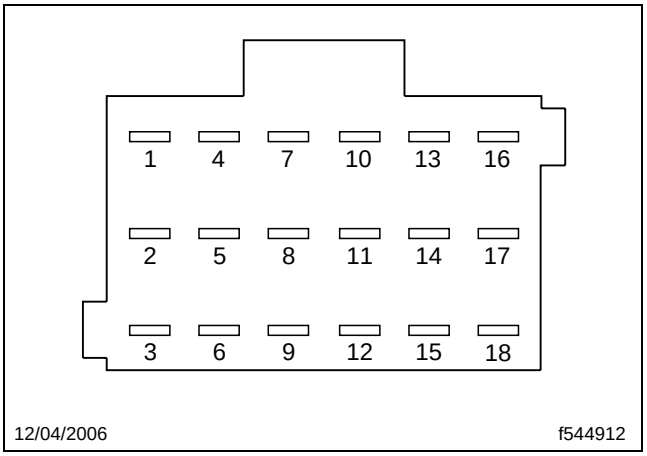


Fig. 7, Starpoint Connector

CGW ECU (single connector)	
Pin	**Function**
1	Cabin CAN High (to CGW)
2	Not connected
3	Cabin CAN Low (to CGW)
4	Cabin CAN High (to SAM Cab)
5	Not connected
6	Cabin CAN Low (to SAM Cab)
7	Cabin CAN High (to SAM Chassis)
8	Not connected
9	Cabin CAN Low (to SAM Chassis)
10	Cabin CAN High (to MSF)
11	Not connected
12	Cabin CAN Low (to MSF)
13	Not connected
14	Not connected
15	Not connected
16	Not connected
17	Ground
18	Not connected

Table 4, CGW ECU (single connector)

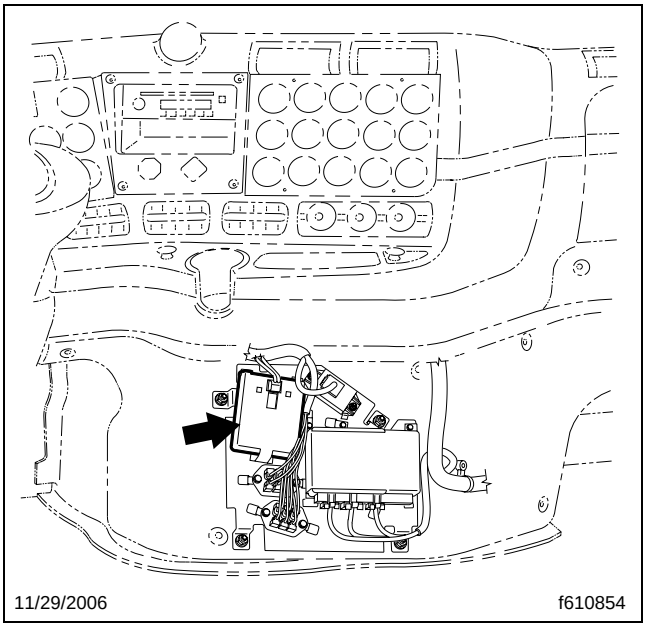
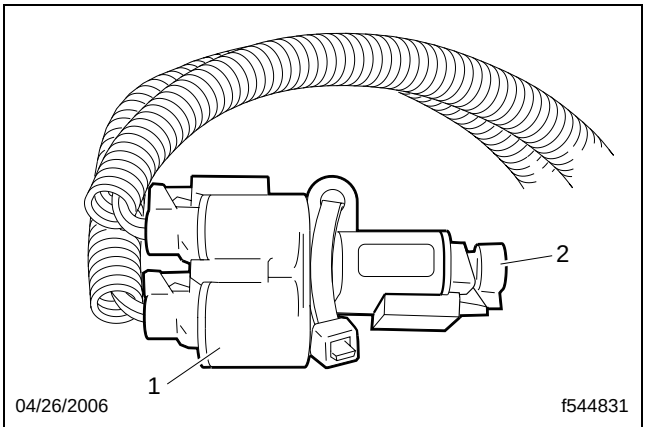


Fig. 8, Central Gateway



1. Connector Tee
2. Terminating Resistor

Fig. 9, Connector Tee

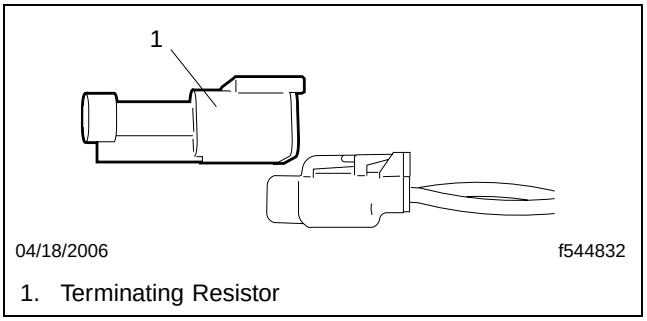


Fig. 10, Terminating Resistor

700 — General Troubleshooting Techniques

Follow the steps below to troubleshoot the datalinks.

1. Identify which datalink has a problem.
2. Perform general electrical troubleshooting for wiring continuity and connections.
3. Refer to individual datalink chapters for more info to troubleshoot the specific datalink.

701 — Diagnostic Tools Required

- ServiceLink or DiagnosticLink

702 — Fault Codes

Refer to **G03.01 — Datalink, J1587/J1708** to troubleshoot the J1587 and J1708 datalink.

Refer to **G03.02 — Datalink, J1939** to troubleshoot the J1939 datalink.

Refer to **G03.03 — Datalink, Cabin CAN** to troubleshoot the Cabin CAN datalink.

Refer to **G03.04 — Datalink, Diagnostic CAN** to troubleshoot the Diagnostic CAN datalink.

703 — References

Refer to **G01.04 — How to Locate a Schematic** for information on wiring.

704 — Possible Causes

Any Datalink:

- wiring
- any ECU connected to the problem datalink

J1939 Datalink:

- terminal resistor value on J1939 datalink

Cabin CAN Datalink:

- starpoint connector resistor value on Cabin CAN datalink

800 — Wiring

Wiring		
Datalink	Wire Color	
	High	Low
J1939	Yellow	Dark Green
J1587/J1708	Dark Green	Orange
Cabin CAN	Light Blue	White
Diagnostic CAN	Brown with Light Blue Stripe	Brown with White Stripe

Table 5, Wiring

801 — Datalink Communication Rates

Datalink Communication Rates	
Datalink	Kilobits Per Second
J1939	250
J1587/J1708	9600
Cabin CAN	125
Diagnostic CAN	500

Table 6, Datalink Communication Rates

802 — ECU Identification on Datalinks

ECU Identification on Datalinks			
ECU Description	J1587 MID*	J1939 SA†	CAN ID
Engine	128	0	—
Transmission	130	3	—
Antilock Brakes	136	11	—
Instrument Cluster	140	23	—
Vehicle Security Unit (VSU)	163	—	—
Data Logging Unit (DLU)	179	251	—
Collision Avoidance System (headway controller)	219	42	—
SAM Cab	—	—	33
SAM Chassis	—	—	71

ECU Identification on Datalinks			
ECU Description	**J1587 MID***	**J1939 SA†**	**CAN ID**
Modular Switch Field	—	—	49
Central Gateway	—	—	37

* Message Identifier
† Source Address

Table 7, ECU Identification on Datalinks

Table of Contents

500 — Terms and Abbreviations

Baud Rate—The rate at which data is transmitted in bits per second.

CAN—Controller Area Network

CGW—Central Gateway

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

ECU—Electronic Control Unit, typically connected to a datalink.

MSF—Modular Switch Field

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

Parameter—A parameter is a specific value that is assigned to a feature or function of the vehicle, and allows the customer to choose how that particular feature or function will work on the vehicle.

SA—Source Address; indicates numeric assignment for a device that communicates on J1939.

SAE—Society of Automotive Engineers

SAM—Signal Detect and Actuation Module

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

501 — General Information

The Central Gateway (CGW), translates data between four vehicle data busses:

- Diagnostic CAN
- Cabin CAN
- J1939
- J1708/1587

See **Fig. 1** for a diagram of CGW data translation.

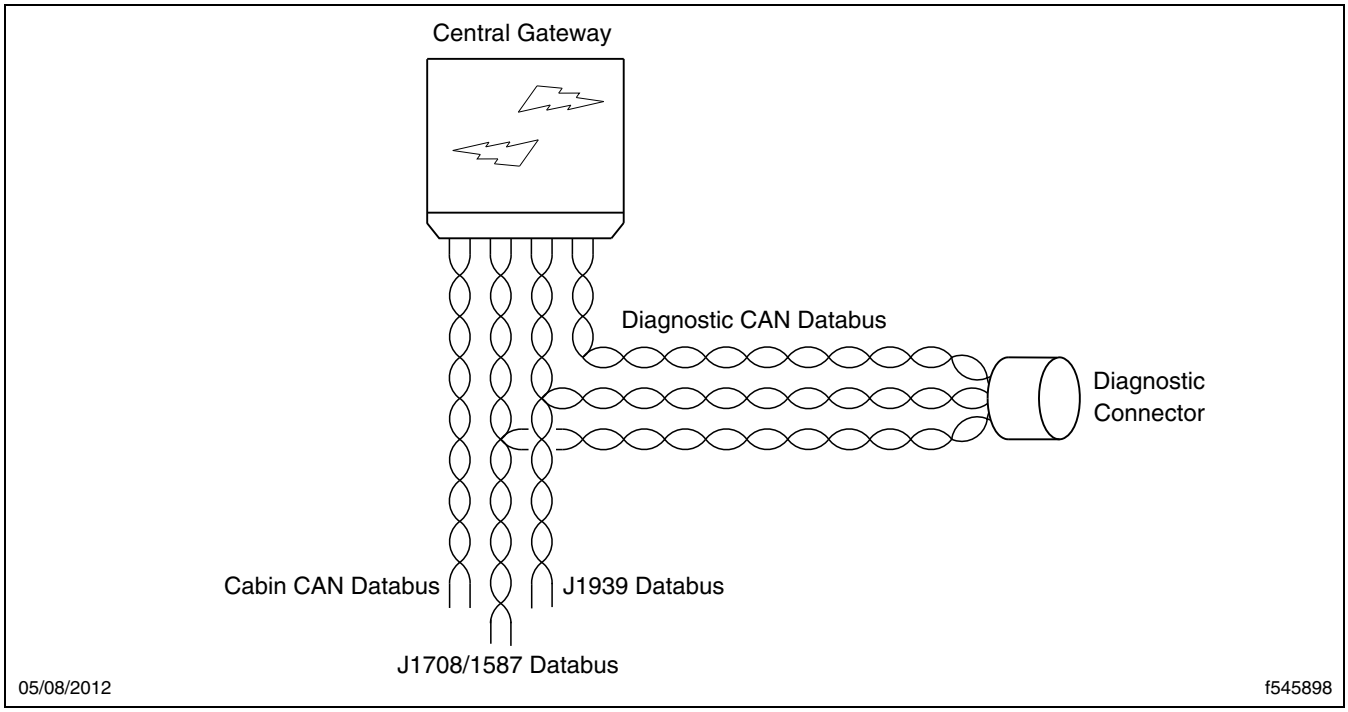


Fig. 1, Central Gateway Data Translation

The CGW receives battery power and ground from the SAM Cab; power comes through fuse F20 (2A) and out connector X3, pin 18 on the SAM Cab.

502 — Interface Between Off-Board Tools and Cabin CAN ECUs

The CGW is the interface between ECUs on the Cabin CAN and other data networks.

The CGW separates the Cabin CAN from off-board tools, which acts as a firewall and protects Freightliner's proprietary Cabin CAN datalink from "public" access.

503 — ECU Parameter Configuration

A CGW with software version 09.33.000, or later, has a parameter to configure. Refer to **800 — Parameters** for a description of this parameter. A CGW with earlier software (e.g. 08.42.001) does not have any parameters to configure. Refer to **702 — Configuring a Replacement Central Gateway** for the procedure to use when a new CGW is installed.

The Central Gateway can be flashed using ServiceLink, which flashes to its same version, or upgrade, if required for software compatibility.

The software flashing procedure should only be performed on the CGW in the following cases:

- **Fixing a problem with the existing software:** In case a new version of ECU software is needed to fix a problem with the existing ECU software, ServiceLink automatically makes available any necessary software upgrades.
- **Replacement of the Central Gateway:** Flashing allows the CGW to be configured for the vehicle.

For instructions on how to use ServiceLink to flash the software of a CAN ECU like the Central Gateway, refer to the *ServiceLink User Guide* or *ServiceLink Help* user documentation, available in ServiceLink's "Help" menu.

504 — Cascadia Data Networks

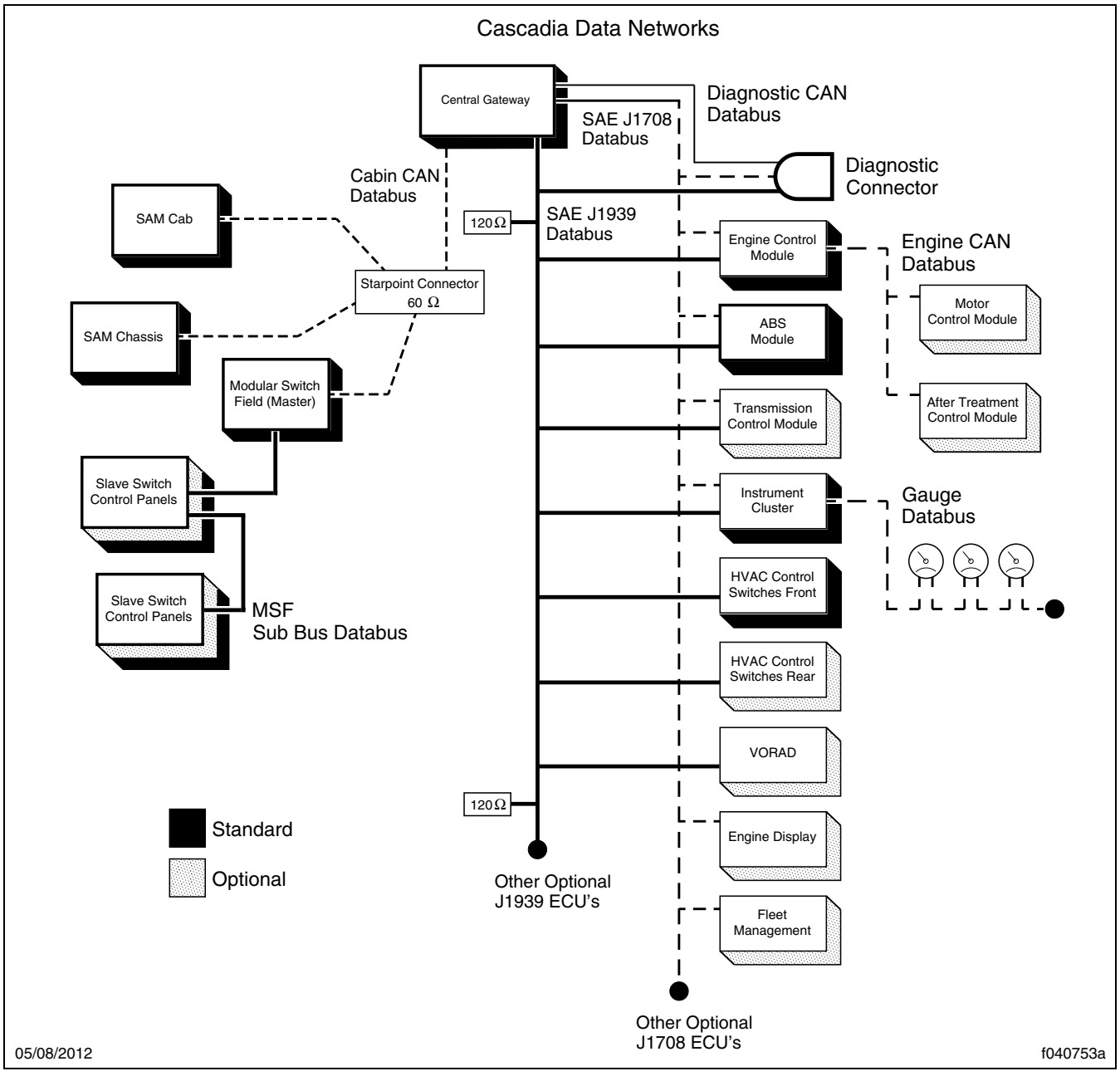


Fig. 2, Cascadia Data Networks

600 — Component Locations

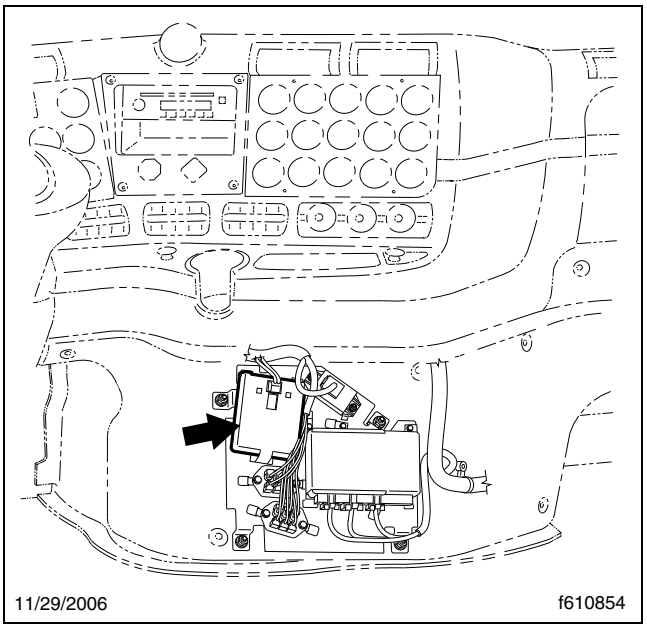


Fig. 3, Central Gateway

601 — Component Details

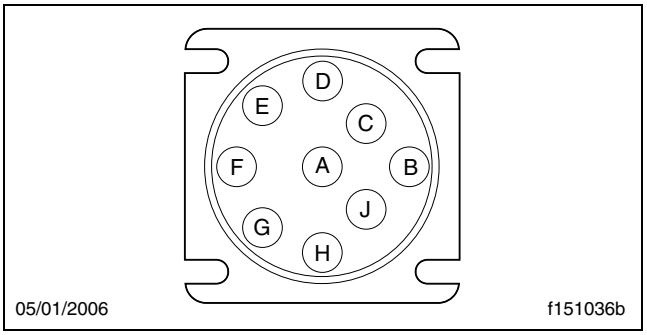


Fig. 4, Diagnostic Connector

Diagnostic Connector	
Pin	**Function**
A	Battery (–)
B	Battery (+)
C	J1939 CAN High
D	J1939 CAN Low
E	Reserved

Diagnostic Connector	
Pin	**Function**
F	J1708/J1587 (+)
G	J1708/J1587 (–)
H	Diagnostic CAN High
J	Diagnostic CAN Low

Table 1, Diagnostic Connector

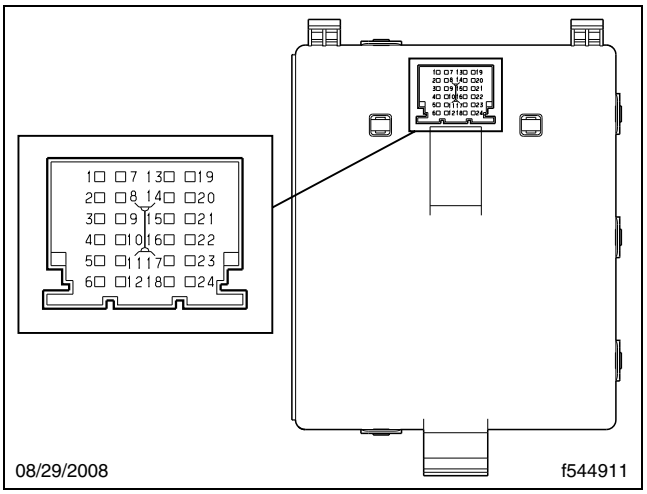


Fig. 5, Central Gateway Module Connector

CGW ECU (single connector)		
Pin	**Function**	**Color**
1	Battery Power	Red
2	J1708/J1587 (+)	Dark Green
7	Ground	Black
8	J1708/J1587 (–)	Orange
14	Cabin CAN Low (–)	White
16	J1939 Low (–)	Dark Green
18	Diagnostic CAN Low (–)	Brown/White
19	Cabin CAN High (+)	Light Blue
21	J1939 High (+)	Yellow
23	Diagnostic CAN High (+)	Brown/Light Blue

Table 2, CGW ECU (single connector)

700 — Required Tools

- ServiceLink
- Multimeter

701 — Fault Codes

NOTE: **Table 3** lists fault codes generated by the Central Gateway, source address 37.

NOTE: Unless otherwise specified, all voltage measurements reference system ground.

IMPORTANT: The batteries **must** be disconnected prior to any resistance tests being performed. Failure to do so may result in inconclusive resistance measurements.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
37	168	3	pin 1	SAM Cab F20	—	Voltage above normal, or shorted to high	The fault is active when voltage detected at the Central Gateway is higher than 16V for 15 seconds, or more. The fault becomes historic when voltage detected is less than 16V for 15 seconds, or more.
Action: Measure the voltage at pin 1 on the CGW connector. If the voltage detected is greater than BAT voltage, troubleshoot circuit 433 between the SAM Cab conn X3, pin 18 and the CGW, for a short to a high voltage source. Check fuse F20 (CGW BAT, 2 amps) on the SAM Cab.							
37	168	4	pin 1	SAM Cab F20	—	Voltage below normal, or shorted to ground	The fault is active when voltage detected at the CGW is less than 9V for 15 seconds, or more. The fault becomes historic when voltage detected is higher than 9V for 15 seconds, or more.
Action: Measure the voltage at pin 1 on the CGW connector. If the voltage detected is not BAT voltage, troubleshoot circuit 433 between the SAM Cab conn X3, pin 18, and the CGW, for a short to GND. Check fuse F20 (CGW BAT, 2 amps) on the SAM Cab.							
37	628	12	—	—	—	Program memory - Bad intelligent device or component	A problem has been detected in the CGW memory. **Vehicle Behavior**: Vehicle functions involving data communication may be impaired. It may not be possible to establish a ServiceLink connection with the CGW, or with any of the other CAN ECUs.
Action: Disconnect all batteries for 1 minute. Connect the batteries and wait for 6 minutes, then attempt to establish a ServiceLink connection. If a connection can be made, and the CAN protocol is functional, attempt to flash the CGW. If the fault remains active, replace the CGW.							
37	523510	31	pin 18 pin 23	—	—	Diagnostic CAN performance	Diagnostic CAN performance failure (communication is not possible). ServiceLink will not show any CAN connectivity, but J1939 and/or J1708 data connectivity may be possible.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
Action: Disconnect all batteries and measure the resistance between pins H and J at the diagnostic connector. If 60 ohms is not detected, troubleshoot the Diagnostic CAN datalink wiring between CGW pins 23 and 18, and the diagnostic connector pins H and J, for a wiring fault. If there is no wiring fault, replace and use the procedure in **702 — Configuring a Replacement Central Gateway** to program the CGW.							
37	523511	31	pin 14 pin 19	—	—	Cabin CAN performance	Cabin CAN performance failure (communication is not possible). ServiceLink will show problems with the SAM Cab, SAM Chassis, and MSF. All three data protocols should be present when ServiceLink is connected.
Action: Disconnect all batteries and measure the resistance of the Cabin CAN datalink at the starpoint connector. The resistance should be 60 ohms between any blue and white wire. The resistance measurement between ground and these circuits should be extremely high. Disconnect the connector from the starpoint block, and measure the resistance across each datalink wiring pair and each of these circuits to ground, to determine which circuit is causing the databus problem.							
37	523512	31	pin 16 pin 21	—	—	J1939 CAN performance.	J1939 performance. ServiceLink should show connectivity problems with J1939.
Action: Disconnect all batteries and measure the resistance between J1939+ and J1939– on pins C and D at the diagnostic connector. The resistance should be 60 ohms. Also measure the resistance of these pins to ground. There should be extremely high resistance to ground. Troubleshoot for a wiring fault with the J1939 databus if these tests indicate incorrect resistance. Refer to **G03.02 — Datalink, J1939** to troubleshoot the J1939 datalink.							
37	523513	31	pin 2 pin 8	—	—	J1708 performance	J1708 performance failure occurs when the bus load on the J1708 datalink is too high, or when the CGW has an extremely high processor load due to high traffic on any of the other data busses. A short or open circuit between J1708 (+) and J1708 (–) will NOT cause this fault to become active. The fault becomes historic once the CGW is able to successfully communicate on the J1708 datalink.
Action: Refer to troubleshooting provided in **G03.01 — Datalink, J1587/J1708**.							
37	524033	31	—	—	—	Lost communication with SAM Cab	The fault is active when the CGW misses 10 consecutive messages from the SAM Cab (on the Cabin CAN datalink). The fault becomes historic when the CGW receives at least one message from the SAM Cab. **Vehicle Behavior**: SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode for a SAM Cab failure. An indication for a SAM Cab failure is that the clearance lamps, marker lights, trailer tail lights, and rear stop lights are flashing when the ignition key is in the "run" position.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
Action: Measure the voltage on the SAM Cab battery studs. If the voltage is low, check the MEGA fuse on EPA07 vehicles, or the MIDI fuse in the PNDB on EPA10 vehicles. Verify that there is no fault with the Cabin CAN datalink between the SAM Cab and the starpoint connector. The Cabin CAN datalink is on connector X13, pins 2 and 3 on the SAM Cab. Refer to **G06.09 — Powernet Management** to troubleshoot the SAM Cab for Emergency Power Diagnostics.							
37	524049	31	—	—	—	Lost communication with MSF	The fault is active when the CGW misses 10 consecutive messages from the MSF (on the Cabin CAN datalink). The fault becomes historic when the CGW receives at least one message from the MSF. **Vehicle behavior**: The headlamps, marker lamps, and clearance lamps are on when the ignition key is in the "run" position.
Action: Check SAM Cab fuse F4 (MSF BAT). Continue to check circuit 14F for battery power at the MSF connector D, pins 2 (BATT) and 6 (GND). Repair any wiring fault found. Verify there is no fault with the Cabin CAN datalink between the MSF and the starpoint connector. The Cabin CAN datalink is on connector D, pins 3 and 5 on the MSF.							
37	524071	31	—	—	—	Lost communication with SAM Chassis	The fault is active when the CGW misses 10 consecutive messages from the SAM Chassis (on the Cabin CAN datalink). The fault becomes historic when the CGW receives at least one message from the SAM Chassis.
Action: Measure the voltage on the SAM Chassis battery studs. If the voltage is low, check the MEGA fuse on EPA07 vehicles, or the MIDI fuse in the PNDB on EPA10 vehicles. Repair any wiring fault found. Verify that there is no fault with the Cabin CAN datalink between the SAM Chassis and the starpoint connector. The Cabin CAN datalink is on connector X51, pins 1 and 2 on the SAM. Refer to **G06.09 — Powernet Management** to troubleshoot the SAM Chassis for emergency power diagnostics.							

Table 3, CAN Fault Codes

702 — Configuring a Replacement Central Gateway

1. Turn the key to the ON position without starting the engine, and connect ServiceLink.
2. When the dialog box appears asking which module to connect to, select "Other" and enter the full 17 digit VIN for the vehicle. The VIN is written to the CGW in the following procedure.
3. When the main ServiceLink screen appears identifying the ECUs, click on the Central Gateway icon.
4. When the CGW screen appears, click on the "Flashing" tab.
5. Select the latest software version when it appears on the flashing screen. Click the "Flash Now" box.
6. If the new module already has the latest version of software programmed, a box appears indicating the module software is current. Click OK to allow the parameterization, and the VIN flashing will complete.
7. Disconnect ServiceLink.
8. Turn the ignition off, then turn it to the ON position without starting the engine, then connect to ServiceLink. All the CAN ECUs and communication functions will be restored.

9. Select the faults tab in ServiceLink and clear fault history for all communication protocols.

800 — Parameters

Parameters				
Module	**Part Number**	**Description**	**Parameter**	**ECU**
835	050 447 00 27	Gateway configuration, Cascadia gateway. For use on Cascadia vehicles only. Applies to Gateway software version 09.33.000 or later.	PARM-CGW, CFG, CAS	Central Gateway
	050 447 01 27	Gateway configuration, simplified gateway. For use on non-Cascadia vehicles only. DO NOT use on Cascadia.	PARM-CGW, CFG, SG	

Table 4, Parameters

Table of Contents

500 — Terms and Abbreviations

Baud Rate—The rate at which data is transmitted in bits per second.

Cabin CAN—A proprietary datalink connecting certain ECUs on the vehicle, specificall the CGW, MSF, SAM Cab, and SAM Chassis.

CAN—Controller Area Network

CAN ID—The identifie for a specifi message, which also contains the source address of the sending ECU communicating on the J1939 datalink.

CGW—Central Gateway

CPC—Common Powertrain Controller (for M-B and DDC engines only).

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Datalink Topology—The arrangement in which the nodes (ECUs) of a datalink are connected to each other.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

Diagnostic Connector—A 9-pin diagnostic connector is used for troubleshooting the electrical system.

FMI—Failure Mode Indicator. The part of a J1587, J1939, and CAN fault code that identifie how part of a device, or item on a device, failed.

HVAC—Heating, Ventilation, and Air Conditioning

ICU—Instrumentation Control Unit

I/O Controls—Input/Output controls allow a technician to activate and deactivate an input or output pin for troubleshooting purposes. I/O controls appear on ServiceLink templates as buttons, typically labeled "ON" and "OFF."

ISS—Ignition Switch Status

MSF—Modular Switch Field

NO—Normally Open

NC—Normally Closed

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

OBD—Onboard Diagnostics

Parameter—A parameter is a specifi value that is assigned to a feature or function of the vehicle, and allows the customer to choose how that particular feature or function will work on the vehicle.

PDM—Power Distribution Module

PLVD—Progressive Low Voltage Disconnect

SA—Source Address; indicates numeric assignment for a device that communicates on J1939.

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

SPN—Suspect Parameter Number. The part of a J1939 or CAN fault code that identifie how part of a device, or item on a device, failed.

501 — General Information

The SAM Cab is an ECU (Electronic Control Unit). It is also referred to as the "SAM Cabin."

The SAM Cab works closely with the SAM Chassis to control much of the vehicle functionality. The SAM Cab controls most of the cab functions. The SAM Chassis controls most of the chassis functions.

This ECU uses inputs (such as switches, sensors, and datalink messages) and drives outputs (such as lights, motors, and solenoids). See **601 — Component Details** for complete pin information.

IMPORTANT: This subject describes the SAM Cab ECU in general terms. To understand a particular function or system that the SAM Cab is part of, see the appropriate subject in this manual on that function or system. Each subject contains details about the way a function should work, as well as crucial information such as inputs, outputs, interlocks, any related parameters for that particular function, and any other ECUs or components that are a part of that function.

502 — Fuses and Relays

The SAM Cab houses a number of fuses and relays.

See **601 — Component Details** for fuse and relay locations. See **602 — Pinout Mapping**, **603 — Fuse Mapping**, and **604 — Relay Mapping** for the functions associated with each pin, fuse, and relay.

For more information on the power distribution system, see **G02.01 — Electrical System and Main PDM Overview**.

503 — Datalink Connections

The SAM Cab is connected directly to the Cabin CAN datalink. Cabin CAN wires run from the SAM Cab to the starpoint connector, where it joins the rest of the Cabin CAN datalink.

See **G03.03 — Datalink, Cabin CAN** for details.

504 — Diagnostic CAN Datalink

When an off-board tool, such as ServiceLink, is connected to the vehicle, it communicates with the Cabin CAN ECUs via the Diagnostics CAN datalink; there is no accessible service port to the Cabin CAN. The CGW translates between the Diagnostics CAN and Cabin CAN datalink, due to the different speed and message formats of the two datalinks.

505 — Functional Messaging and ECU Troubleshooting

To communicate with the ECU, a different set of messages is used by the off-board tool during troubleshooting than the set of messages used during normal operation.

The set of messages used during normal operation is referred to as functional messages, which are sent cyclically on the Cabin CAN datalink. However, the set of messages (protocol) used during troubleshooting is referred to as Control Area Network (CAN), which operates on a request-and-response basis over the Diagnostic CAN datalink.

Any fault reported on the Cabin CAN is translated to Diagnostics CAN by the CGW, and can be displayed when requested by an off-board tool, such as ServiceLink. Similarly, an off-board tool is able to display input and output pin status information, software interlocks, and allows a user to control inputs or outputs for troubleshooting. This information is displayed in ServiceLink's Datalink Monitor (DLM) templates.

506 — ECU Configuration

The diagnostic protocol used for troubleshooting or configu ing the SAM Cab is the Control Area Network (CAN). For more information on CAN, see **G03.04 — Datalink, Diagnostic CAN**.

The SAM Cab has parameters that can be viewed or changed for vehicle configuration

The SAM Cab software can be flashe using ServiceLink, which will flas to its same version or upgrade, if required.

The software flashin procedure should only be performed on the SAM Cab in the following cases:

- **As a last resort:** Troubleshooting has narrowed the problem down to being at the SAM Cab itself and no other mechanical or electrical causes for the symptom have been identified As a last resort, flashin the SAM Cab software with the same version may help in the case it became corrupt during the course of normal vehicle operation.
- **For a feature upgrade:** Adding a new feature to a vehicle may require a newer version of ECU software. ServiceLink will automatically make available any necessary software upgrades.
- **Fixing a problem in the existing software:** In case a new version of ECU software is needed to fi a problem in the existing ECU software, ServiceLink will automatically make available any necessary software upgrades.
- **Replacing the SAM Cab:** Flashing ensures that the most recent software is on the installed ECU.

For instructions on how to use ServiceLink to flas the software of a CAN ECU like the SAM Cab, refer to the *ServiceLink User Guide* or *ServiceLink Help* user documentation, available in ServiceLink's "Help" menu.

507 — Datalink Network Topology

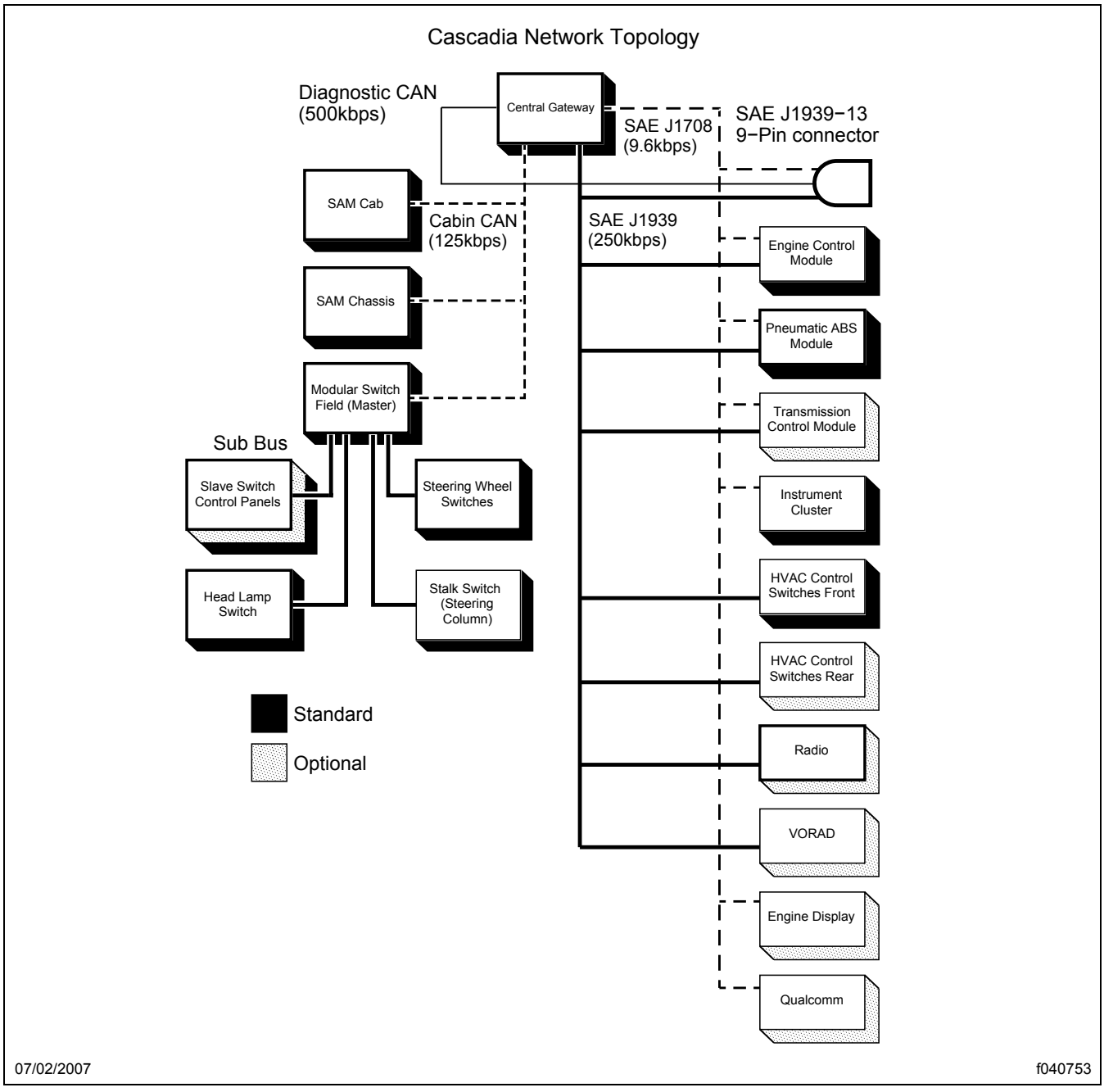
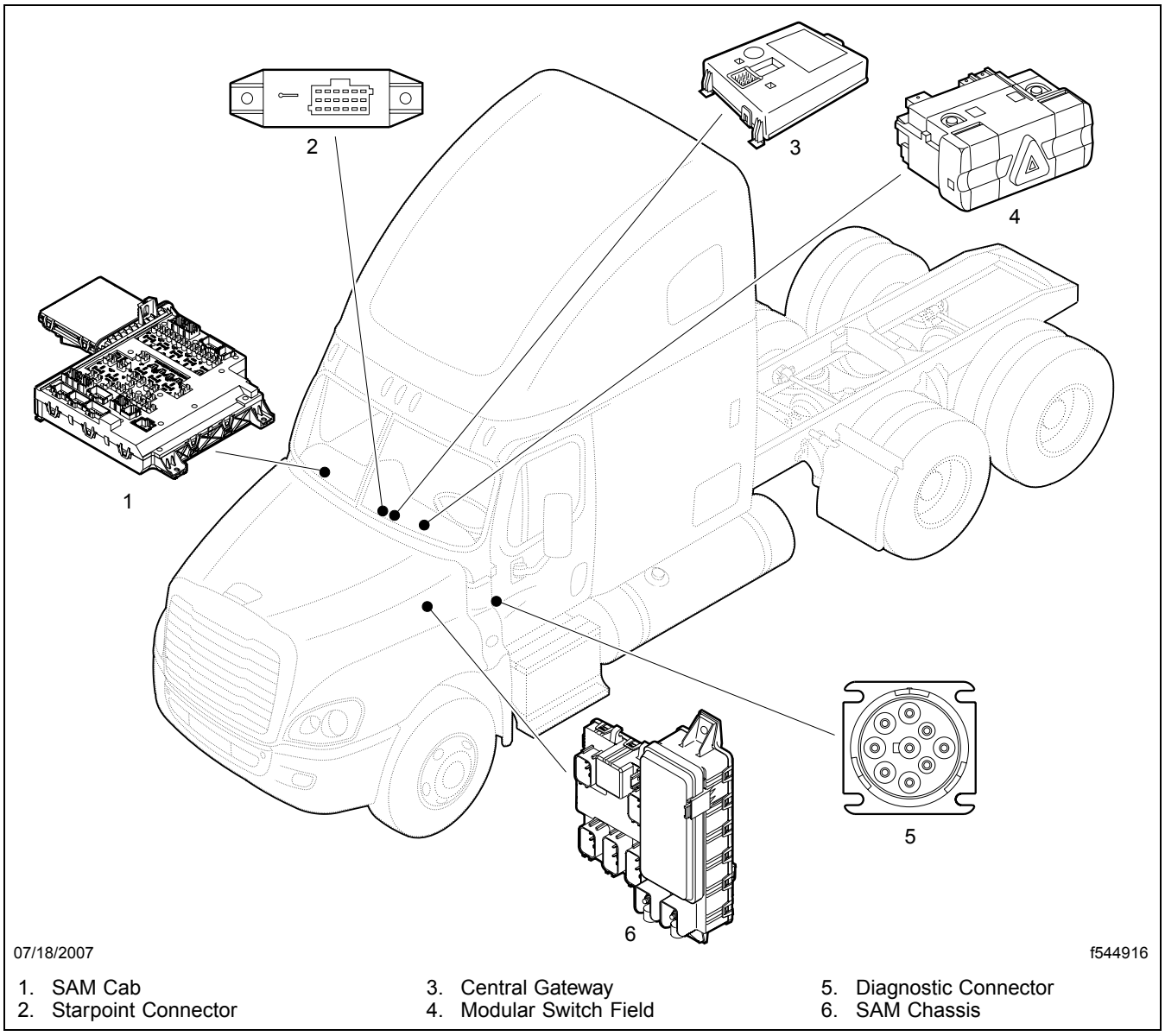


Fig. 1, Datalink Network Topology

600 — Component Locations



1. SAM Cab
2. Starpoint Connector
3. Central Gateway
4. Modular Switch Field
5. Diagnostic Connector
6. SAM Chassis

Fig. 2, Component Locations

NOTE: J1939 and J1708 ECUs in this diagram are not intended to represent actual vehicle configura tion.

601 — Component Details

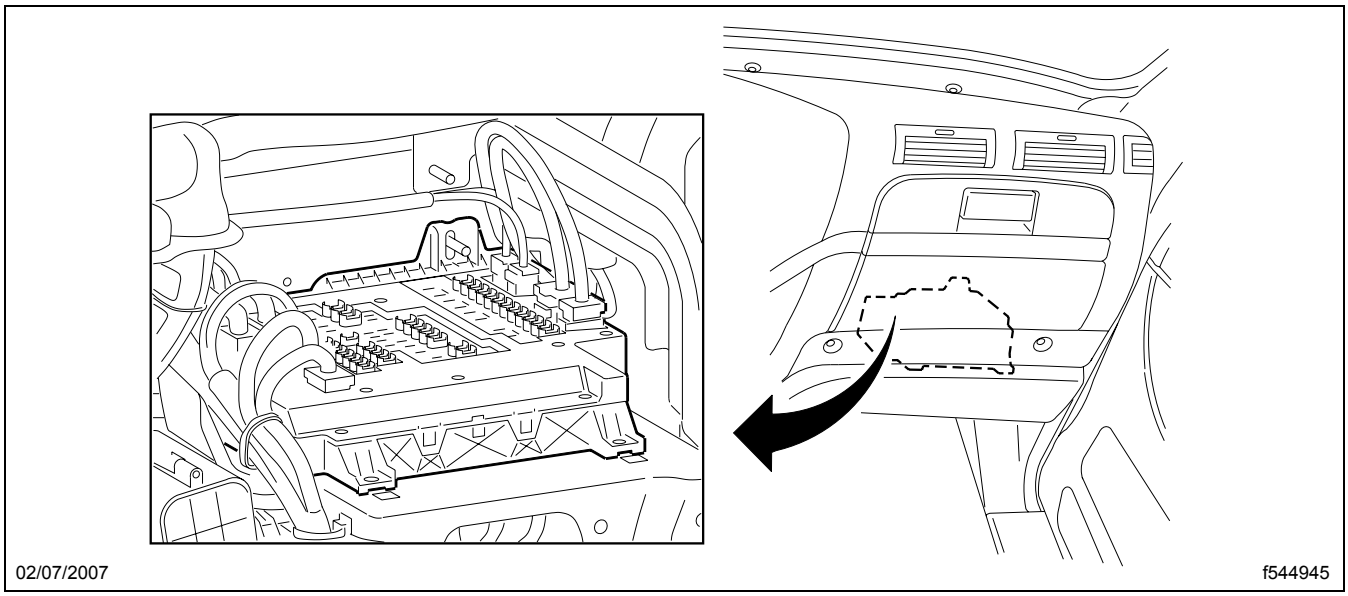


Fig. 3, SAM Cab

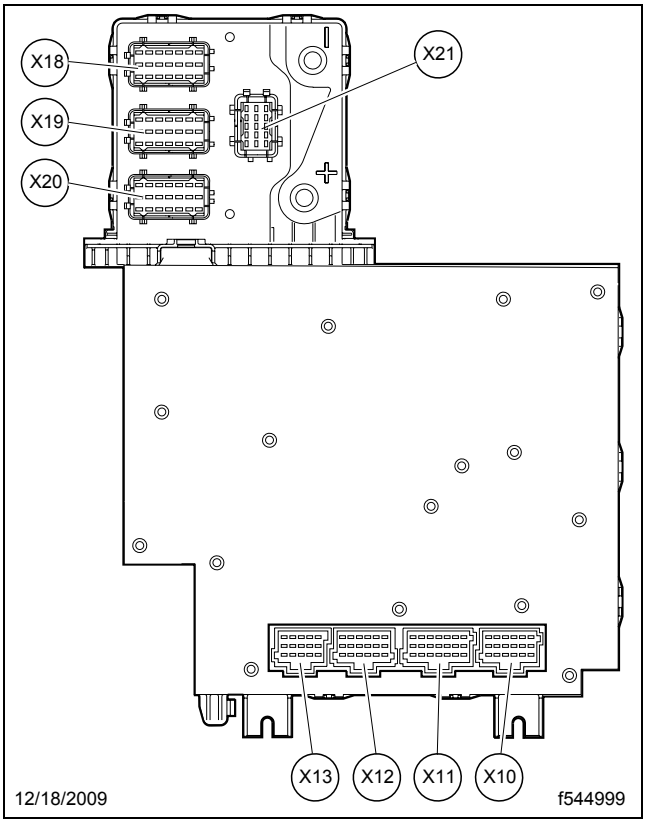


Fig. 4, SAM Cab Connectors (top view)

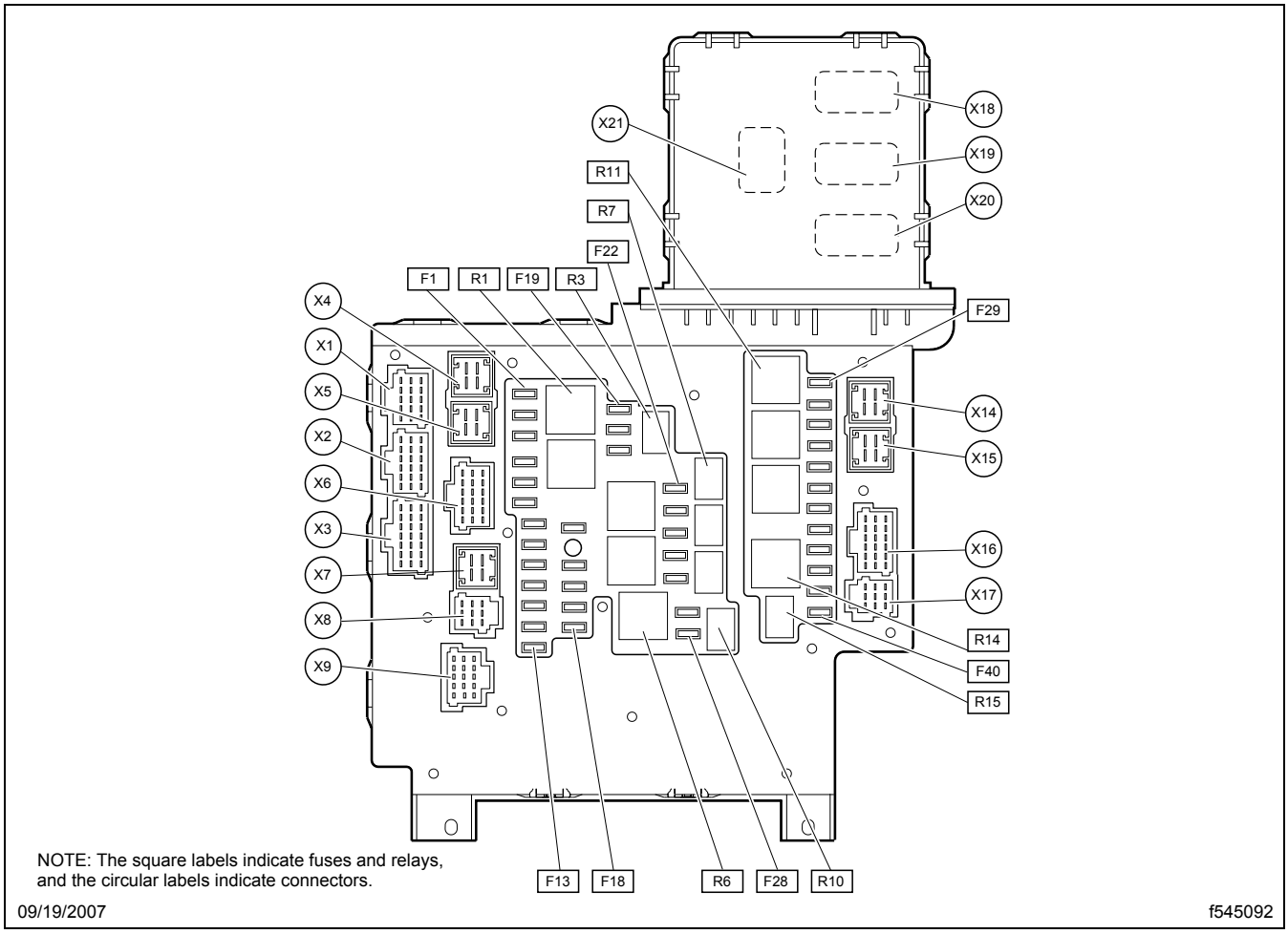


Fig. 5, SAM Cab Fuses and Relays (bottom view)

NOTE: Not all fuse and relay locations are labeled in this image. Locations for fuses and relays in the middle can be determined based on end labels of a row. For example, fuse F17 is one above F18, and R8 is one below R7 and two above R10. All connectors are labeled in this image.

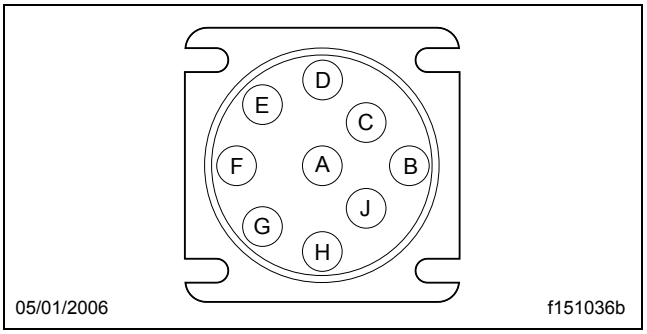


Fig. 6, Diagnostic Connector

Diagnostic Connector	
Pin	**Function**
A	Battery (–)
B	Battery (+)
C	J1939 CAN High (+)
D	J1939 CAN Low (–)
E	No Connection
F	J1708/J1587 (+)
G	J1708/J1587 (–)
H	Diagnostic CAN High (+)
J	Diagnostic CAN Low (–)

Table 1, Diagnostic Connector

602 — Pinout Mapping

NOTE: The housing of the SAM Cab contains raised lettering, labeling all connectors, fuses, and relays.

The SAM Cab is available in different hardware models: Highline, Midline, and Baseline. **Table 2** describes any differences in pin functionality between these hardware models

Pinout Mapping				
Connector	**Cavity Number**	**Function**		
		Highline	**Baseline**	**Midline**
X1	1	Transmission temperature gauge, Ignition	Transmission temperature gauge, Ignition	—
X1	2	Hands-Free Phone, Ground	Not Connected	—
X1	3	Cabin HVAC Controller, Battery	Cabin HVAC Controller, Battery	—
X1	4	Hands-Free Phone, Ignition	Not Connected	—
X1	5	Heated Seats, Ground	Not Connected	—
X1	6	Sleeper HVAC Controller, Battery	Sleeper HVAC Controller, Battery	—
X1	7	Hands-Free Phone, Battery	Not Connected	—
X1	8	Auxiliary Circulation Fan, Sleeper, Ground	Not Connected	—
X1	9	Transmission Shift Control Panel, Battery	Transmission Shift Control Panel, Battery	—
X1	10	Cabin HVAC Controller, Accessory	Cabin HVAC Controller, Accessory	—
X1	11	Sleeper HVAC Controller, Ground	Sleeper HVAC Controller, Ground	—
X1	12	Heated Seats, Ignition	Not Connected	—
X1	13	Auxiliary Circulation Fan, Sleeper, Battery	Not Connected	—

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X1	14	Cabin HVAC Controller, Ground	Cabin HVAC Controller, Ground	—
X1	15	Sleeper HVAC Controller, Accessory	Sleeper HVAC Controller, Accessory	—
X2	1	Auxiliary Heater (ESPAR), Power	Not Connected	—
X2	2	MSF, Ground	MSF, Ground	—
X2	3	OBD J1939, Battery	OBD J1939, Battery	—
X2	4	VCU/CPC, Ignition	VCU/CPC, Ignition	—
X2	5	Area Lighting (Lower Bunk Area and Sleeper Work Surface), Ground	Area Lighting (Lower Bunk Area and Sleeper Work Surface), Ground	—
X2	6	Reserved for future use	Reserved for future use	—
X2	7	Starter relay output from Engine Controller (Optimized Idle)	Starter relay output from Engine Controller (Optimized Idle)	—
X2	8	Diagnostic Connector, Ground 1 (GND1)	Diagnostic Connector, Ground 1 (GND1)	—
X2	9	Diagnostic Connector, Ignition	Diagnostic Connector, Ignition	—
X2	10	Hardwired ISS (Ignition Switch Status), Cab	Hardwired ISS (Ignition Switch Status), Cab	—
X2	11	Diagnostic Connector, Ground 2	Diagnostic Connector, Ground 2	—
X2	12	MSF, Battery	MSF, Battery	—
X2	13	Collision Avoidance System, Battery	Not Connected	—
X2	14	Collision Avoidance System, Ignition	Not Connected	—
X2	15	Area Lighting (Lower Bunk Area and Sleeper Work Surface), Battery	Area Lighting (Lower Bunk Area and Sleeper Work Surface), Battery	—
X2	16	Collision Avoidance System, Ground	Not Connected	—
X2	17	Auxiliary Heater (ESPAR), Ground	Not Connected	—
X2	18	Emergency Battery, Cab	Emergency Battery, Cab	—
X3	1	GPS (Global Positioning System), Battery	Not Connected	—
X3	2	Antitheft Warning System, Battery	Not Connected	—
X3	3	12V Power Receptacle 4 (Sleeper, Cigar), Battery	12V Power Receptacle 4 (Sleeper, Cigar), Battery	—
X3	4	Advertising Light, Accessory	Not Connected	—
X3	5	Standalone HVAC, Battery	Standalone HVAC, Battery	—
X3	6	SRS Airbag, Ignition	Not Connected	—
X3	7	Utility Light	Utility Light	—

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X3	8	Not Connected	Not Connected	—
X3	9	Amplifie Power, Accessory	Not Connected	—
X3	10	GPS (Global Positioning System), Ignition	Not Connected	—
X3	11	Radio, Battery	Radio, Battery	—
X3	12	Not Connected	Not Connected	—
X3	13	Standalone HVAC, Ground	Standalone HVAC, Ground	—
X3	14	SRS Airbag, Ground	Not Connected	—
X3	15	12V Power Receptacle 3 (Sleeper, Cigar), Battery	12V Power Receptacle 3 (Sleeper, Cigar), Battery	—
X3	16	CGW (Central Gateway ECU), Ground	CGW (Central Gateway ECU), Ground	—
X3	17	Amplifie Power, Ground	Not Connected	—
X3	18	CGW (Central Gateway ECU), Battery	CGW (Central Gateway ECU), Battery	—
X3	19	Radio, Ground	Radio, Ground	—
X3	20	Antitheft Warning System, Ground	Not Connected	—
X3	21	Utility Light, Ground	Utility Light, Ground	—
X4	1	Power Feed Spare Output I, Battery	Power Feed Spare Output I, Battery	—
X4	2	Power Feed Spare Output III, Battery	Not Connected	—
X4	3	Power Feed Spare Output I, Ground	Power Feed Spare Output I, Ground	—
X4	4	Power Feed Spare Output III, Ground	Not Connected	—
X5	1	Power Feed Spare Output II, Battery	Power Feed Spare Output II, Battery	—
X5	2	Power Feed Spare Output IV, Battery	Not Connected	—
X5	3	Power Feed Spare Output II, Ground	Power Feed Spare Output II, Ground	—
X5	4	Power Feed Spare Output IV, Ground	Not Connected	—
X6	1	CB Radio, Ground	CB Radio, Ground	—
X6	2	Fleet Management System, Battery	Fleet Management System, Battery	—
X6	3	CB Radio, Battery	CB Radio, Battery	—
X6	4	Instrument Cluster, Ground	Instrument Cluster, Ground	—
X6	5	Power Feed Driver Information System, Ignition	Not Connected	—

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X6	6	Fleet Management System, Ignition	Fleet Management System, Ignition	—
X6	7	Fleet Management System, Ground	Fleet Management System, Ground	—
X6	8	Power Feed Gauge Pyrometer, Ignition	Not Connected	—
X6	9	12V Power Receptacle 2 (Dash, Phone), Battery	12V Power Receptacle 2 (Dash, Phone), Battery	—
X6	10	Power Feed Gauge Axle Temperature, Ignition	Power Feed Gauge Axle Temperature, Ignition	—
X6	11	Power Feed Gauge Engine Oil Temperature, Ignition	Power Feed Gauge Engine Oil Temperature, Ignition	—
X6	12	Power Feed Clock Cab, Battery	Power Feed Clock Cab, Battery	—
X6	13	Power Feed Driver Information System, Battery	Not Connected	—
X6	14	Power Feed Clock Sleeper, Battery	Power Feed Clock Sleeper, Battery	—
X6	15	12V Power Receptacle 1 (Dash, Cigar), Battery	12V Power Receptacle 1 (Dash, Cigar), Battery	—
X6	16	Instrument Cluster, Ignition	Instrument Cluster, Ignition	—
X6	17	Not Connected	Not Connected	—
X6	18	Instrument Cluster, Battery	Instrument Cluster, Battery	—
X7	1	Sleeper HVAC Fan Motor, Ground	Sleeper HVAC Fan Motor, Ground	—
X7	2	Cabin HVAC Fan Motor, Ground	Cabin HVAC Fan Motor, Ground	—
X7	3	Sleeper HVAC Fan Motor, Battery	Sleeper HVAC Fan Motor, Battery	—
X7	4	Cabin HVAC Fan Motor, Battery	Cabin HVAC Fan Motor, Battery	—
X8	1	Door Open Driver Side Input Pull Down	Door Open Driver Side Input Pull Down	—
X8	2	Mirror Heating Driver, Ground	Mirror Heating Driver, Ground	—
X8	3	Door Control Driver, Ground	Door Control Driver, Ground	—
X8	4	Door Control Driver, Battery	Door Control Driver, Battery	—
X8	5	Door Open Status ICU Input	Door Open Status ICU Input	—
X8	6	Door Lock, Battery	Door Lock, Battery	—
X8	7	Power Window Driver Side, Accessory	Power Window Driver Side, Accessory	—
X8	8	Mirror Heating Driver	Mirror Heating Driver	—
X8	9	Door Sill Lamp Driver	Door Sill Lamp Driver	—
X9	1	Body Builder Connector: Revolution	Not Connected	—

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X9	2	Body Builder Connector: Vehicle Speed	Not Connected	—
X9	3	Function Pin 1	Function Pin 1	—
X9	4	Body Builder Connector: Park Brake	Not Connected	—
X9	5	Function Pin 2	Function Pin 2	—
X9	6	Function Pin 4	Function Pin 4	—
X9	7	Function Pin 3	Function Pin 3	—
X9	8	Body Builder Connector: Ground 1 (GND1)	Not Connected	—
X9	9	Body Builder Connector: Backup Lamp	Not Connected	—
X9	10	Body Builder Connector: Marker Lights	Not Connected	—
X9	11	Body Builder Connector: Ignition	Not Connected	—
X9	12	Body Builder Connector: Tail Lights	Not Connected	—
X9	13	Body Builder Connector: Right Turn	Not Connected	—
X9	14	Body Builder Connector: Left Turn	Not Connected	—
X9	15	Body Builder Connector: Stop Lights	Not Connected	—
X10	1	Tire Pressure Monitoring, Ignition	Not Connected	—
X10	2	Inside Temperature Sensor, Propeller Control, Accessory	Inside Temperature Sensor, Propeller Control, Accessory	—
X10	3	Belt Buckle Contact Signal	Not Connected	—
X10	4	Panel Lamps, Ground	Panel Lamps, Ground	—
X10	5	Tire Pressure Monitoring, Ground	Not Connected	—
X10	6	Vehicle Power Shut Down Signal (Optimized Idle)	Vehicle Power Shut Down Signal (Optimized Idle)	—
X10	7	Service Brake Pressure Switch, Supply	Service Brake Pressure Switch, Supply	—
X10	8	Power Feed Sleeper Thermostat (Optimized Idle), Ground	Power Feed Sleeper Thermostat (Optimized Idle), Ground	—
X10	9	Inside Temperature Sensor, Feedback	Inside Temperature Sensor, Feedback	—
X10	10	Power Feed Sleeper Thermostat (Optimized Idle), Ignition	Power Feed Sleeper Thermostat (Optimized Idle), Ignition	—
X10	11	Inside Temperature Sensor/ Propeller, Ground	Inside Temperature Sensor/Propeller, Ground	—
X10	12	Not Connected	Not Connected	—

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X10	13	Panel Lamps	Panel Lamps	—
X10	14	Inside Temperature Sensor, Ground	Inside Temperature Sensor, Ground	—
X10	15	Belt Buckle Contacts, Ground	Not Connected	—
X10	16	Tire Pressure Monitoring, Battery	Not Connected	—
X10	17	Instrument Cluster, HL Wake Up	Instrument Cluster, HL Wake Up	—
X10	18	Radio, Accessory	Radio, Accessory	—
X11	1	Differential Lock ICU Indicator, RA2	Not Connected	—
X11	2	Washer Level ICU Indicator	Washer Level ICU Indicator	—
X11	3	Electrical Global Fault Indicator (Future Use)	Electrical Global Fault Indicator (Future Use)	—
X11	4	Fuel Water Separator ICU Indicator	Not Connected	—
X11	5	Differential Lock ICU Indicator, RA1	Differential Lock ICU Indicator, RA1	—
X11	6	Low Air Pressure Switch ICU Indicator	Low Air Pressure Switch ICU Indicator	—
X11	7	Lights On Buzzer	Lights On Buzzer	—
X11	8	Air Filter Restriction ICU Indicator	Air Filter Restriction ICU Indicator	—
X11	9	High Beam ICU Indicator	High Beam ICU Indicator	—
X11	10	Rain / Light Sensor, Ground	Not Connected	—
X11	11	Turn Signal Left ICU Indicator	Turn Signal Left ICU Indicator	—
X11	12	Alternator No Charge ICU Indicator	Alternator No Charge ICU Indicator	—
X11	13	Turn Signal Right ICU Indicator	Turn Signal Right ICU Indicator	—
X11	14	Park Brake Switch ICU Indicator	Park Brake Switch ICU Indicator	—
X11	15	Rain / Light Sensor, LIN	Not Connected	—
X11	16	Clutch Switch Return, Ground	Clutch Switch Return, Ground	—
X11	17	Top of Clutch (Cruise Control Disable)	Top of Clutch (Cruise Control Disable)	—
X11	18	Auxiliary Telematic Unit, Ground	Not Connected	—
X11	19	Auxiliary Telematic Unit, Battery	Not Connected	—
X11	20	Bottom of Clutch (Starter Control)	Bottom of Clutch (Starter Control)	—
X11	21	Rain / Light Sensor, Battery	Not Connected	—
X12	1	Rear Baggage Compartment Light Switch Center	Rear Baggage Compartment Light Switch Center	—
X12	2	Rear Baggage Compartment Light Switch Left	Rear Baggage Compartment Light Switch Left	—
X12	3	Footwell Light	Footwell Light	—

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X12	4	Dome Lamps Sleeper, Ground	Dome Lamps Sleeper, Ground	—
X12	5	Rear Baggage Compartment Light Switch Right	Rear Baggage Compartment Light Switch Right	—
X12	6	Reading Lamp 1 (Dimmable / Theater)	Reading Lamp 1 (Dimmable / Theater)	—
X12	7	Not Connected	Not Connected	—
X12	8	Reading Lamps 1 & 2 (Dimmable / Theater), Ground	Reading Lamps 1 & 2 (Dimmable / Theater), Ground	—
X12	9	General Sleeper Lamp	General Sleeper Lamp	—
X12	10	Footwell Light, Ground	Footwell Light, Ground	—
X12	11	General Sleeper Lamp, Ground	General Sleeper Lamp, Ground	—
X12	12	Rear Baggage Compartment Lights	Rear Baggage Compartment Lights	—
X12	13	Not Connected	Not Connected	—
X12	14	Rear Baggage Compartment Lights, Ground	Rear Baggage Compartment Lights, Ground	—
X12	15	Turn Left Front Side	Turn Left Front Side	—
X12	16	Reading Lamp 2 (Dimmable / Theater)	Reading Lamp 2 (Dimmable / Theater)	—
X12	17	Dome Lamp, Rear	Dome Lamp, Rear	—
X12	18	Turn Right Front Side	Turn Right Front Side	—
X13	1	Not Connected	Not Connected	—
X13	2	SAM Cab, Cabin CAN Low (-)	SAM Cab, Cabin CAN Low (-)	—
X13	3	SAM Cab, Cabin CAN High (+)	SAM Cab, Cabin CAN High (+)	—
X13	4	Ignition Switch - Off	Not Connected	—
X13	5	Ignition Switch - Accessory	Ignition Switch - Accessory	—
X13	6	Ignition Switch - On (Ignition)	Ignition Switch - On (Ignition)	—
X13	7	Ignition Switch - Battery	Ignition Switch - Battery	—
X13	8	Park Brake Switch Feedback	Park Brake Switch Feedback	—
X13	9	Park Brake Switch Supply	Park Brake Switch Supply	—
X13	10	Low Air Pressure Switch Feedback	Low Air Pressure Switch Feedback	—
X13	11	Low Air Pressure Switch Supply	Low Air Pressure Switch Supply	—
X13	12	Service Brake Pressure Switch Feedback	Service Brake Pressure Switch Feedback	—
X13	13	Horn Switch uC (microcontroller) Bypass	Horn Switch uC (microcontroller) Bypass	—
X13	14	Start Enable - Crank Interlock	Not Connected	—
X13	15	Ignition Switch - Crank	Ignition Switch - Crank	—

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X14	1	12V Power Receptacle 5 (Sleeper, Cigar), Battery	12V Power Receptacle 5 (Sleeper, Cigar), Battery	—
X14	2	12V Power Receptacle 6 (Sleeper, Refrigerator), Battery	12V Power Receptacle 6 (Sleeper, Refrigerator), Battery	—
X14	3	12V Power Receptacles 3 & 4, Ground	12V Power Receptacles 3 & 4, Ground	—
X14	4	12V Power Receptacles 5 & 6, Ground	12V Power Receptacles 5 & 6, Ground	—
X15	1	Power Feed Spare Output V, Battery	Not Connected	—
X15	2	Power Feed Spare Output VI, Battery	Not Connected	—
X15	3	Power Feed Spare Output V, Ground	Not Connected	—
X15	4	12V Power Receptacles 1 & 2, Ground	12V Power Receptacles 1 & 2, Ground	—
X16	1	CD Player, Battery	Not Connected	—
X16	2	Lane Guidance, Ignition	Not Connected	—
X16	3	Lane Guidance, Ground	Not Connected	—
X16	4	Clearance Lamps Front II	Clearance Lamps Front II	—
X16	5	Auxiliary Circulation Fan - Windshield, Accessory	Not Connected	—
X16	6	CD Player, Ground	Not Connected	—
X16	7	Dome Lamp Cab, Battery	Dome Lamp Cab, Battery	—
X16	8	Clearance Lamps Front I	Clearance Lamps Front I	—
X16	9	Clearance Lamps Front, Ground	Clearance Lamps Front, Ground	—
X16	10	Not Connected	Not Connected	—
X16	11	Dome Lamp, Driver / Forward Overhead	Dome Lamp, Driver / Forward Overhead	—
X16	12	Reading Lamps 3 & 4, Ground	Reading Lamps 3 & 4, Ground	—
X16	13	Reading Lamp 4, Battery	Reading Lamp 4, Battery	—
X16	14	Dome Lamp, Passenger	Dome Lamp, Passenger	—
X16	15	Dome Lamps, Forward, Ground	Dome Lamps, Forward, Ground	—
X16	16	Spot Light	Spot Light	—
X16	17	Overhead Compartment Lights, Battery	Overhead Compartment Lights, Battery	—
X16	18	Auxiliary Circulation Fan - Windshield, Ground	Not Connected	—
X17	1	Power Window Passenger Side, Accessory	Power Window Passenger Side, Accessory	—
X17	2	Mirror Heating Passenger	Mirror Heating Passenger	—

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X17	3	Door Sill Lamp Passenger	Door Sill Lamp Passenger	—
X17	4	Door Control Passenger, Battery	Door Control Passenger, Battery	—
X17	5	Door Open Passenger Side, Input	Door Open Passenger Side, Input	—
X17	6	Keyless Go / Keyless Entry, Ground	Not Connected	—
X17	7	Keyless Go / Keyless Entry, Battery	Not Connected	—
X17	8	Mirror Heating Passenger, Ground	Mirror Heating Passenger, Ground	—
X17	9	Door Control Passenger, Ground	Door Control Passenger, Ground	—
X18	1	Marker Lamps, Front Left, Ground	Marker Lamps, Front Left, Ground	—
X18	2	Headlamp, Turn Lamp Corner Right, Ground	Headlamp, Turn Lamp Corner Right, Ground	—
X18	3	Horn (Electric), Ground	Horn (Electric), Ground	—
X18	4	Marker Lamps, Corner Front Right, Ground	Marker Lamps, Corner Front Right, Ground	—
X18	5	Low Beam, Left	Low Beam, Left	—
X18	6	High Beam, Left	High Beam, Left	—
X18	7	Headlamp, Turn Lamp Corner Left, Ground	Headlamp, Turn Lamp Corner Left, Ground	—
X18	8	Marker Lamps, Corner Front Right	Marker Lamps, Corner Front Right	—
X18	9	Turn Right Front Corner	Turn Right Front Corner	—
X18	10	Marker Lamps, Front Right, Ground	Marker Lights, Front Right, Ground	—
X18	11	Hood Tilt Switch Signal (Optimized Idle)	Hood Tilt Switch Signal (Optimized Idle)	—
X18	12	Marker Lamps, Front Right	Marker Lamps, Front Right	—
X18	13	Marker Lamps, Corner Front Left, Ground	Marker Lamps, Corner Front Left, Ground	—
X18	14	Marker Lamps, Front Left	Marker Lamps, Front Left	—
X18	15	DRL (Daytime Running Lights), Right	DRL (Daytime Running Lights), Right	—
X18	16	Marker Lamps, Corner Front Left	Marker Lamps, Corner Front Left	—
X18	17	High Beam, Right	High Beam, Right	—
X18	18	DRL (Daytime Running Lights), Left	DRL (Daytime Running Lights), Left	—
X18	19	Turn Left Front Corner	Turn Left Front Corner	—
X18	20	Low Beam, Right	Low Beam, Right	—

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X18	21	Horn (Electric), Control	Horn (Electric), Control	—
X19	1	Activate PTO Solenoid, Ground	Not Connected	—
X19	2	Starter Relay, Ground	Starter Relay, Ground	—
X19	3	Starter Relay	Starter Relay	—
X19	4	Not Connected	Not Connected	—
X19	5	Not Connected	Not Connected	—
X19	6	A/C Compressor Clutch	A/C Compressor Clutch	—
X19	7	Not Connected	Not Connected	—
X19	8	Not Connected	Not Connected	—
X19	9	Activate PTO Solenoid, Control	Not Connected	—
X19	10	HVAC Pressure Transducer, Feedback	HVAC Pressure Transducer, Feedback	—
X19	11	Air Intake Warmer / Grid Heater, Ignition	Not Connected	—
X19	12	HVAC Pressure Transducer, Return	HVAC Pressure Transducer, Return	—
X19	13	Air Filter Restriction Sensor, Ignition	Air Filter Restriction Sensor, Ignition	—
X19	14	Hood Tilt Switch Signal Supply	Hood Tilt Switch Signal Supply	—
X19	15	Air Filter Restriction Sensor, Signal	Air Filter Restriction Sensor, Signal	—
X19	16	Hood Tilt & Neutral & Park Brake (Optimized Idle)	Hood Tilt & Neutral & Park Brake (Optimized Idle)	—
X19	17	HVAC Pressure Transducer, Supply (+5V)	HVAC Pressure Transducer, Supply (+5V)	—
X19	18	Engine ECU, Ignition	Engine ECU, Ignition	—
X19	19	PTO Response (Feedback)	Not Connected	—
X19	20	Ether Start Power, Ignition	Ether Start Power, Ignition	—
X19	21	PTO Solenoid Activated	Not Connected	—
X20	1	Fog Lamp, Front Right, Ground	Fog Lamp, Front Right, Ground	—
X20	2	Distance Sensor (Adaptive Cruise Control), Ground	Not Connected	—
X20	3	Fog Lamp, Front Left, Ground	Fog Lamp, Front Left, Ground	—
X20	4	High / Low Beam Auxiliary Right, Ground	High / Low Beam Auxiliary Right, Ground	—
X20	5	High / Low Beam Auxiliary Left, Ground	High / Low Beam Auxiliary Left, Ground	—
X20	6	Not Connected	Not Connected	—
X20	7	Washer Pump, Ground	Washer Pump, Ground	—
X20	8	Fog Lamp, Front Left	Fog Lamp, Front Left	—

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X20	9	Not Connected	Not Connected	—
X20	10	High Beam Auxiliary, Left	Not Connected	—
X20	11	Low Beam Auxiliary, Left	Low Beam Auxiliary, Left	—
X20	12	High Beam Auxiliary, Right	Not Connected	—
X20	13	Temperature Sensor Outside Air Gauge, Ignition	Temperature Sensor Outside Air Gauge, Ignition	—
X20	14	Low Beam Auxiliary, Right	Low Beam Auxiliary, Right	—
X20	15	Turn Right Front Side	Turn Right Front Side	—
X20	16	Temperature Sensor Outside Air, Feedback	Temperature Sensor Outside Air, Feedback	—
X20	17	Fog Lamp, Front Right	Fog Lamp, Front Right	—
X20	18	Temperature Sensor Outside Air, Ground	Temperature Sensor Outside Air, Ground	—
X20	19	Distance Sensor (Adaptive Cruise Control), Battery	Not Connected	—
X20	20	Washer Pump, Control	Washer Pump, Control	—
X20	21	Washer Fluid Level, Feedback	Washer Fluid Level, Feedback	—
X21	1	Horn (Pneumatic), Ground	Not Connected	—
X21	2	Not Connected	Not Connected	—
X21	3	Wiper, Ground	Wiper, Ground	—
X21	4	Not Connected	Not Connected	—
X21	5	Utility Light, Ground	Utility Light, Ground	—
X21	6	LVD Sense, Ground	LVD Sense, Ground	—
X21	7	Not Connected	Not Connected	—
X21	8	Alternator Charging, Feedback	Alternator Charging, Feedback	—
X21	9	Wiper Parked	Wiper Parked	—
X21	10	Horn (Pneumatic), Control	Not Connected	—
X21	11	Turn Left Front Side	Turn Left Front Side	—
X21	12	Wiper Low	Wiper Low	—
X21	13	LVD Sense, Battery / Emergency Supply	LVD Sense, Battery / Emergency Supply	—
X21	14	Utility Light	Utility Light	—
X21	15	Wiper High	Wiper High	—

Table 2, Pinout Mapping

603 — Fuse Mapping

Fuse Mapping					
Fuse	**Fuse Name**	**Rating**	**Connection**	**Pin**	**Function**
F1	PWR FD SPARE 1&3	30	X4	1	Power Feed Spare Output I, BAT
			X4	2	Power Feed Spare Output III, BAT
F2	CAB/SLPR HVAC CTRL/SHF PNL	15	X1	3	Cabin HVAC controller, BAT
			X1	6	Sleeper HVAC controller, BAT
			X1	9	Transmission shift control panel, BAT
F3	PWR FD SPARE 2&4	30	X5	1	Power Feed Spare Output II, BAT
			X5	2	Power Feed Spare Output IV, BAT
F4	MODULAR SWITCH FIELD	15	X2	12	MSF, BAT
F5	OBD J1939-BAT	10	X2	3	OBD J1939, BAT
			X2	6	OBD DCDI, BAT
F6	DASH PWR RCPT 1	15	X6	15	12V Power Receptacle 1 BAT (Dash, Cigar)
F7	DASH PWR RCPT 2	15	X6	9	12V Power Receptacle 2 BAT (Dash, Phone)
F8	PHONE/RADIO-BAT	15	X1	7	Hands-free phone, BAT
			X3	11	Radio, BAT
F9	AMPLIFIER PWR	20	X3	9	Amplifie Power, ACC
F10	CAB HVAC MTR	30	X7	4	Cabin HVAC fan motor, BAT
F11	SLPR HVAC MTR	30	X7	3	Sleeper HVAC fan motor, BAT
F12	DR CTRL L	20	X8	4	Door control driver, BAT
F13	DR LOCK/SM CRUISE	20	X2	13	Collision avoidance system, BAT
			X8	6	Door lock, BAT
F14	FTL MGM SYS and CB	25	X6	2	Fleet Management System, BAT
			X6	3	CB Radio, BAT
F15	SLPR PWR RCPT 3	20	X3	15	12V Power Receptacle 3 BAT (Sleeper, Cigar)
F16	STAND ALONE HVAC	7.5	X3	5	Stand Alone HVAC, BAT
F17	SLPR PWR RCPT 4	20	X3	3	12V Power Receptacle 4 BAT (Sleeper, Cigar)
F18	TELEMATICS/ WARNING SYS	15	X3	1	GPS, BAT
			X3	2	Antitheft warning system, BAT
			X10	16	Tire Pressure Monitoring, BAT
			X11	19	Auxiliary Telematic Unit, BAT
F19	HEATED SEAT	20	X1	12	Heated Seats, IGN
F20	CENTRAL GATEWAY	2	X3	18	CGW, BAT

Fuse Mapping					
Fuse	**Fuse Name**	**Rating**	**Connection**	**Pin**	**Function**
F21	AREA LIGHT	15	X2	15	Area Lighting BAT (Lwr Bunk and Sleeper Work Surface)
F22	ICU-BAT	5	X6	18	Instrument Cluster / Horn switch supply, BAT
F23	DR INFO/GAUGE	15	X3	10	GPS, IGN
			X6	5	Power Feed Driver Information System, IGN
			X6	6	Fleet Management System, IGN
			X6	8	Power Feed Gauge Pyrometer, IGN
			X6	10	Power Feed Gauge Axle Temp, IGN
			X6	11	Power Feed Gauge Engine Oil Temp, IGN
F24	ICU-IGN	10	X2	9	Diagnostic Connector, IGN
			X6	16	Instrument Cluster, IGN
F25	DASH SPLICE PAK	7.5	X1	1	Trans Temp Gauge, IGN
			X1	4	Dash Splice, IGN
			X2	14	Collision Avoidance System, IGN
F26	SRS-AIRBACK	5	X3	6	SRS Airbag, IGN
F27	MIRROR HEAT L	10	X8	8	Mirror Heat, Driver
F28	MIRROR HEAT R	10	X17	2	Mirror Heat, Passenger
F29	SAM RELAY COILS	3	N/A	N/A	Internal Relay Coil Supply
F30	PWR RCPT 6/FRIG	20	X14	2	12V Pwr Recept 6 BAT (Sleeper, Refrigerator)
F31	SLPR PWR RCPT 5	20	X14	1	12V Power Receptacle 5 BAT (Sleeper, Cigar)
F32	PWR FD SPARE 5&6	25	X15	1	Power feed spare output V, BAT
			X15	2	Power feed spare output VI, BAT
F33	SPOT LIGHT	20	X16	16	Spot Light
F34	BAG COMP LIGHT	3	X16	17	Overhead Compartment Light, BAT
F35	DOMELAMP CAB	15	X16	7	Dome Lamp Cab, BAT
F36	AUX CIR FAN/RD LAMP	15	X1	13	Auxiliary Circulation Fan (Sleeper) BAT
			X16	13	Reading Lamp 4 BAT

Fuse Mapping					
Fuse	**Fuse Name**	**Rating**	**Connection**	**Pin**	**Function**
F37	CLK/DRV INFO/CD/ KEYLESS	15	X6	12	Power Feed Clock Cab, BAT
			X6	13	Power Feed Driver Information System, BAT
			X6	14	Power Feed Clock sleeper, BAT - X6/14
			X16	1	CD-Player, BAT
			X17	7	Keyless Go /Keyless Entry, BAT
F38	DR CTRL R	20	X17	4	Door control passenger, BAT
F39	PWR WINDOW R	15	X17	1	Power Window Passenger Side, ACC
F40	PWR WINDOW L	15	X8	7	Power Window Driver Side, ACC

Table 3, Fuse Mapping

604 — Relay Mapping

Relay Mapping									
Relay	**Relay Name**	**Relay Coil (low current side)**		**Relay (high current side)**			**Conn.**	**Pin**	**Circuits Supplied**
		Control (-) (86)	**Control (+) (85)**	**Common (30)**	**Type**	**Suppl. Pwr To**			
R1	PWR FD SPARE 1&3, BAT	SAM Micro	F29 (batt power)	Batt	NC	F1	X4	1	Power Feed Spare Output I - BAT
								2	Power Feed Spare Output III - BAT
R2	PWR FD SPARE 2&4, BAT	SAM Micro	F29 (batt power)	Batt	NC	F3	X5	1	Power Feed Spare Output II, BAT
								2	Power Feed Spare Output IV, BAT
R3	HEAT SEAT, IGN	SAM Micro	F29 (batt power)	Batt	NO	F19	X1	12	Heated Seats, IGN
R4	DASH PWR RCPT 1&2, BAT	SAM Micro	F29 (batt power)	Batt	NC	F6	X6	15	12V Power Receptacle 1 BAT (Dash, Cigar)
						F7		9	12V Power Receptacle 2 BAT (Dash, Phone)
R5	FLT MGM SYS & CB, BAT	SAM Micro	F29 (batt power)	Batt	NC	F14	X6	3	CB Radio BAT
								2	Fleet Management System BAT
R6	PWR RCPT 3 & STD HVAC, BAT	SAM Micro	F29 (batt power)	Batt	NC	F15	X3	15	12V Power Receptacle 3 BAT (Sleeper, Cigar)
						F16		5	Stand Alone HVAC

Relay Mapping									
Relay	Relay Name	Relay Coil (low current side)		Relay (high current side)			Conn.	Pin	Circuits Supplied
		Control (-) (86)	Control (+) (85)	Common (30)	Type	Suppl. Pwr To			
R7	DRV INFOGAUGE, IGN	SAM Micro	F29 (batt power)	Batt	NO	F23	X3	10	GPS, IGN
							X6	5	Power Feed Driver Information System, IGN
								6	Fleet Management System, IGN
								8	Power Feed Gauge Pyrometer, IGN
								10	Power Feed Gauge Axle Temp, IGN
								11	Power Feed Gauge Engine Oil Temp, IGN
R8	ICU/ VEHICLE SYS, IGN	SAM Micro	F29 (batt power)	Batt	NO	F24	X2	9	Diagnostics Connector, IGN
							X6	16	Instrument Cluster, IGN
						F25	X1	1	Transmission Temp Gauge, IGN
							X1	4	Dash Splice, IGN
							X2	14	Collision Avoidance System, IGN
						F26	X3	6	SRS Airbag, IGN
R9	AMPLIFIER PWR, ACC	SAM Micro	F29 (batt power)	Batt	NO	F9	X3	9	Amplifie Power, ACC
R10	MIRROR HEAT	SAM Micro	F29 (batt power)	Batt	NO	F27	X8	8	Mirror Heat, Driver
						F28	X17	2	Mirror Heat, Passenger
R11	PWR RCPT 6/FRIG, BAT	SAM Micro	F29 (batt power)	Batt	NC	F30	X14	2	12V Power Receptacle 6 BAT (Sleeper, Refrigerator)
R12	PWR RCPT 5, BAT	SAM Micro	F29 (batt power)	Batt	NC	F31	X14	1	12V Power Receptacle 5 BAT (Sleeper, Cigar)
R13	CAB LIGHTING, BAT	SAM Micro	F29 (batt power)	Batt	NC	F21	X2	15	Area Lighting BAT (Lower Bunk Area and Sleeper Work Surface)
						F34	X16	17	Overhead Compartment Light, BAT
						F35	X16	7	Dome Lamp Cab, BAT

Relay Mapping									
Relay	Relay Name	Relay Coil (low current side)		Relay (high current side)			Conn.	Pin	Circuits Supplied
		Control (-) (86)	Control (+) (85)	Common (30)	Type	Suppl. Pwr To			
R14	PWR RCPT4/ CIR FAN/ LAMP, BAT	SAM Micro	F29 (batt power)	Batt	NC	F17	X3	3	12V Power Receptacle 4 BAT (Sleeper, Cigar)
						F36	X1	13	Auxiliary Circulation Fan, Sleeper, BAT
							X16	13	Reading Lamp 4, BAT
R15	PWR WINDOW, ACC	SAM Micro	F29 (batt power)	Batt	NO	F39	X17	1	Power Window Passenger Side, ACC
						F40	X8	7	Power window Driver Side, ACC

Table 4, Relay Mapping

700 — Troubleshooting Overview

IMPORTANT: If the symptom is specifi to a function or system (left low beam headlight does not function, for example), refer to the applicable subject in this manual.

In ServiceLink, use the CAN protocol to troubleshoot or configur the SAM Cabin, via the Diagnostic CAN datalink. See **601 — Component Details** for the Diagnostic CAN pins in the diagnostic connector.

For more information on the Diagnostic CAN datalink or CAN, see **G03.04 — Datalink, Diagnostic CAN**.

701 — Required Tools

- ServiceLink

702 — Possible Causes

- Wiring (bad/loose connection, corrosion, miswiring, etc)
- SAM Cab relays
- SAM Cab fuses
- SAM Cab parameters
- SAM Cab ECU software
- Cabin CAN datalink
- Other ECUs on the Cabin CAN datalink
- Diagnostic CAN datalink

703 — Fault Codes

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	168	3	System voltage — higher than normal.	—	—	—	The SAM Cab is measuring system voltage that is higher than 16 volts. There may be a fault with the charging system. If this code is in history only, the vehicle could have been jump started with a 24-volt battery pack.
33	168	4	System voltage — lower than normal.	—	—	—	The SAM Cab is measuring system voltage that is lower than 9 volts. There may be a fault with the charging system. If this code is in history only, the batteries could have been discharged.
33	520201	4	Fuse 25 circuits — voltage below normal.	conn X12, pin 14 conn X1, pin 1 conn X1, pin 4	F25	R8	No voltage is present on fuse F25 circuits. An open fuse F25, relay R8 stuck in the OFF position, or a wiring or component fault on any of these circuits will set this fault. The SAM will not deactivate this output when the fault is active.
33	520203	4	Fuse 2 Circuits — voltage below normal.	conn X1, pin 3 conn X1, pin 6 conn X1, pin 9	F2	—	No voltage is present on fuse F2 circuits. An open fuse F2, or a wiring or component fault on any of these circuits will set this fault. The SAM will not deactivate this output when the fault is active.
33	520210	3	Front HVAC controller — power circuit shorted to high source.	conn X1, pin 10	—	—	Battery power is present on the front HVAC power supply circuit when it is not being powered by the SAM Cab.
33	520210	4	Front HVAC controller — power circuit shorted to ground.	conn X1, pin 10	—	—	The SAM Cab is attempting to supply power to the front HVAC control unit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	520215	3	Rear HVAC controller — power circuit shorted to high source.	conn X1, pin 15	—	—	Battery power is present on the rear HVAC power supply circuit when it is not being powered by the SAM Cab.
33	520215	4	Rear HVAC controller — power circuit shorted to ground.	conn X1, pin 15	—	—	The SAM Cab is attempting to supply power to the rear HVAC control unit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	520304	3	VCU/CPC — Ignition power circuit shorted to high source.	conn X2, pin 4	—	—	Battery power is present on the VCU/CPC ignition power supply circuit when it is not being powered by the SAM Cab.
33	520304	4	VCU/CPC — Ignition power circuit shorted to ground.	conn X2, pin 4	—	—	The SAM Cab is attempting to supply power to the CPC wake up circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	520403	31	Bistable relay BR25 — not switching to requested position.	conn X1, pin 13 conn X3, pin 3 conn X14, pin 1 conn X16, pin 13	F17 F31 F36	BR25	The SAM Cab attempted to switch bistable relay 25 from ON to OFF, but power is still present on the circuits that were attempted to be switched OFF. This fault will also set when the SAM Cab attempts to switch the relay from OFF to ON and power is not present on the output circuits. The fault will clear if the SAM Cab switches the relay to the other position, even though the problem has not been corrected.
33	520404	3	Advertising light circuit — shorted to high source.	conn X3, pin 4	—	—	Battery power is present on the advertising light circuit when it is not being powered by the SAM Cab.
33	520404	4	Advertising light circuit — shorted to ground.	conn X3, pin 4	—	—	The SAM Cab is attempting to supply power to the advertising lights but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	520406	4	SRS Airbag circuit — shorted to ground.	conn X3, pin 6	F26	R8	No voltage is present on the SRS/airbag circuit. An open fuse F26, relay R8 stuck in the OFF position, or a wiring or component fault on this circuit will set this fault. The SAM will not deactivate this output when the fault is active.
33	520407	3	Utility light circuit — shorted to high source.	conn X3, pin 7	—	—	Battery power is present on the utility light circuit when it is not being powered by the SAM Cab.
33	520407	4	Utility light circuit — shorted to ground.	conn X3, pin 7	—	—	The SAM Cab is attempting to supply power to the utility lights but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	520407	5	Utility light circuit — amperage below normal.	conn X3, pin 7	—	—	The utility light circuit is not using any amperage. A utility light bulb is out or there is a wiring fault.
33	520415	31	Bistable relay BR22 — not switching to commanded position.	conn X3, pin 15 conn X5, pin 1 conn X5, pin 2	F3 F15	BR22	The SAM Cab attempted to switch bistable relay 22 from ON to OFF, but power is still present on the circuits that were attempted to be switched OFF. This fault will also set when the SAM Cab attempts to switch the relay from OFF to ON and power is not present on the output circuits. The fault will clear if the SAM Cab switches the relay to the other position, even though the problem has not been corrected.
33	520702	4	Fuse 14 circuits — voltage below normal.	conn X6, pin 2 conn X6, pin 3	F14	BR23	No voltage is present on fuse F14 circuits. An open fuse F14, relay BR23 stuck in the OFF position, or a wiring or component fault on this circuit will set this fault. The SAM will not deactivate this output when the fault is active.
33	520709	31	Bistable relay BR23 — not switching to commanded position.	conn X6, pin 2 conn X6, pin 3 conn X6, pin 9	F7 F14	BR23	The SAM Cab attempted to switch bistable relay 23 from ON to OFF, but power is still present on the circuits that were attempted to be switched OFF. This fault will also set when the SAM Cab attempts to switch the relay from OFF to ON and power is not present on the output circuits. The fault will clear if the SAM Cab switches the relay to the other position, even though the problem has not been corrected.
33	520710	3	Fuse 23 circuits — shorted to high source.	conn X3, pin10 conn X6, pin 5 conn X6, pin 6 conn X6, pin 8 conn X6, pin 10 conn X6, pin 11	F23	R7	Battery voltage is present on fuse F23 circuits when the SAM Cab is controlling the relay OFF. Relay R7 stuck in the ON position, or a wiring or component fault on this circuit will set this fault. The SAM will not deactivate this output when the fault is active.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	520710	4	Fuse 23 circuits — shorted to ground.	conn X3, pin10 conn X6, pin 5 conn X6, pin 6 conn X6, pin 8 conn X6, pin 10 conn X6, pin 11	F23	R7	No voltage is present on fuse F23 circuits. An open fuse F23, relay R7 stuck in the OFF position, or a wiring or component fault on this circuit will set this fault. The SAM will not deactivate this output when the fault is active.
33	520715	31	Bistable relay BR21 — not switching to commanded position.	conn X4, pin 1 conn X4, pin 2 conn X6, pin 15	F1 F6	BR21	The SAM Cab attempted to switch bistable relay 21 from ON to OFF, but power is still present on the circuits that were attempted to be switched OFF. This fault will also set when the SAM Cab attempts to switch the relay from OFF to ON and power is not present on the output circuits. The fault will clear if the SAM Cab switches the relay to the other position, even though the problem has not been corrected.
33	520716	3	Relay 8 circuits — shorted to high source.	conn X1, pin 1 conn X1, pin 4 conn X2, pin 9 conn X2, pin 14 conn X3, pin 6 conn X6, pin 16	F24 F25 F26 (SAM 6.+)	R8	The SAM Cab attempted to switch relay R8 OFF, but power is still present on the circuits that were attempted to be switched OFF. Troubleshoot by removing these fuses and measuring for power still present on any of the output circuits and for a stuck relay.
33	520718	4	Instrument cluster power circuit — voltage below normal.	conn X6, pin 18	F22	—	No voltage is present on the fuse F22 circuit. An open fuse F22, or a wiring short to ground on this circuit will set this fault. The SAM will not deactivate this output when the fault is active.
33	520804	4	Front HVAC fan power circuit — voltage below normal.	conn X7, pin 4	F10	—	No voltage is present on the HVAC fan power circuit. Fuse F10 could be open or there could be a wiring fault on this circuit.
33	520905	3	Drivers side door dome lamp switch power supply circuit — shorted to high source.	conn X8, pin 5	—	—	Battery power is present on the drivers side door dome lamp switch power supply circuit when it is not being supplied by the SAM Cab.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	520905	4	Drivers side door dome lamp switch power supply circuit — shorted to ground.	conn X8, pin 5	—	—	The SAM Cab is attempting to supply power to the drivers side door dome lamp switch power supply circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	520908	3	Mirror heating circuits — shorted to high source.	conn X8, pin 8 conn X17, pin 2 conn X16, pin 10 (SAM 6.+)	F27 F28 F41 (SAM6.+)	R10	The SAM Cab attempted to switch relay R10 OFF, but power is still present on the circuits that were attempted to be switched OFF. Troubleshoot by removing these fuses and measuring for power still present on any of the output circuits and for a stuck relay.
33	520908	4	Mirror heating relay circuit — voltage below normal.	conn X8, pin 8	F27	R10	No voltage is present on the fuse F27 circuit. An open fuse F7, a stuck relay R10, or a wiring short to ground on this circuit will set this fault. The SAM will not deactivate this output when the fault is active.
33	520909	3	Door sill lamp circuit — shorted to high source.	conn X8, pin 9	—	—	Battery power is present on the door sill light light circuit when it is not being powered by the SAM Cab.
33	520909	4	Door sill lamp circuit — shorted to ground.	conn X 8, pin 9	—	—	The SAM Cab is attempting to supply power to the door sill lights but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521001	3	Body builder connector: RPM circuit — shorted to high source.	conn X9, pin 1	—	—	The RPM circuit is a variable voltage output. The SAM Cab is detecting a constant battery voltage on this circuit.
33	521001	4	Body builder connector: RPM circuit — shorted to ground.	conn X9, pin 1	—	—	The RPM circuit is a variable voltage output. The RPM is greater than 300 and the SAM Cab is detecting ground on this circuit. The output is deactivated for the remainder of the ignition cycle.
33	521002	3	Body builder connector: vehicle speed circuit — shorted to high source.	conn X9, pin 2	—	—	The vehicle speed circuit is a variable voltage output. The SAM Cab is detecting a constant battery voltage on this circuit.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521002	4	Body builder connector: vehicle speed circuit — shorted to ground.	conn X9, pin 2	—	—	The vehicle speed circuit is a variable voltage output. The speed is greater than 3 MPH and the SAM Cab is detecting ground on this circuit. The output is deactivated for the remainder of the ignition cycle.
33	521003	3	Configura le function 1 circuit — shorted to high source.	conn X9, pin 3	—	—	Battery power is present on the configura le function 1 circuit when it is not being powered by the SAM Cab.
33	521003	4	Configura le function 1 circuit — shorted to ground.	conn X9, pin 3	—	—	The SAM Cab is attempting to supply power to the configura le function 1 circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521004	3	Body builder connector: park brake circuit — shorted to high source.	conn X9, pin 4	—	—	Battery power is present on the body builder park brake circuit when it is not being powered by the SAM Cab.
33	521004	4	Body builder connector: park brake circuit — shorted to ground.	conn X9, pin 4	—	—	The SAM Cab is attempting to supply power to the body builder park brake circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521005	3	Configura le function 2 circuit — shorted to high source.	conn X9, pin 5	—	—	Battery power is present on the configura le function 2 circuit when it is not being powered by the SAM Cab.
33	521005	4	Configura le function 2 circuit — shorted to ground.	conn X9, pin 5	—	—	The SAM Cab is attempting to supply power to the configura le function 2 circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521006	3	Configura le function 4 circuit — shorted to high source.	conn X9, pin 6	—	—	Battery power is present on the configura le function 4 circuit when it is not being powered by the SAM Cab.
33	521006	4	Configura le function 4 circuit — shorted to ground.	conn X9, pin 6	—	—	The SAM Cab is attempting to supply power to the configura le function 4 circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521007	3	Configura le function 3 circuit — shorted to high source.	conn X9, pin 7	—	—	Battery power is present on the configura le function 3 circuit when it is not being powered by the SAM Cab.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521007	4	Configura le function 3 circuit — shorted to ground.	conn X9, pin 7	—	—	The SAM Cab is attempting to supply power to the configura le function 3 circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521009	3	Body builder connector — back up light circuit shorted to high source.	conn X9, pin 9	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521010	3	Body builder connector — marker light circuit shorted to high source.	conn X9, pin 10	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521011	3	Body builder connector — ignition power circuit shorted to high source.	conn X9, pin 11	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521012	3	Body builder connector — tail light circuit shorted to high source.	conn X9, pin 12	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521013	3	Body builder connector — right turn signal circuit shorted to high source.	conn X9, pin 13	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521014	3	Body builder connector — left turn signal circuit shorted to high source.	conn X9, pin 14	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521015	3	Body builder connector — stop lights circuit shorted to high source.	conn X9, pin 15	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521101	3	Tire pressure monitoring power supply circuit — shorted to high source.	conn X10, pin 1	—	—	Battery power is present on the tire pressure monitoring power supply circuit when it is not being powered by the SAM Cab.
33	521101	4	Tire pressure monitoring power supply circuit — shorted to ground.	conn X10, pin 1	—	—	The SAM Cab is attempting to supply power to the tire pressure monitoring circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521102	4	Mirror adjust switch power supply circuit — shorted to ground.	conn X10, pin 2	—	—	The SAM Cab is attempting to supply power to the mirror adjust switch power circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521107	3	Service brake pressure switch circuit — shorted to high source.	conn X10, pin 7 conn X13, pin 12	—	—	Pin 7 is the source of a square wave signal for the service brake switch signal input on pin 12. The SAM Cab is detecting that this circuit is at a constant battery voltage instead of the square wave signal.
33	521107	4	Service brake pressure switch circuit — shorted to ground.	conn X10, pin 7 conn X13, pin 12	—	—	Pin 7 is the source of a square wave signal for the service brake switch. The SAM Cab is detecting that this circuit is at ground instead of the square wave signal.
33	521110	3	Temperature sensor power feed circuits — shorted to high source.	conn X10, pin 10 conn X20, pin 13	—	—	Battery power is present on the temperature sensor power feed circuit when it is not being powered by the SAM Cab.
33	521110	4	Temperature sensor power feed circuits — shorted to ground.	conn X10, pin 10 conn X20, pin 13	—	—	The SAM Cab is attempting to supply power to these circuits but excessive amperage is detected. The outputs are deactivated for the remainder of the ignition cycle.
33	521113	3	Panel lamps backlighting circuit — shorted to high source.	conn X10, pin 13	—	—	Battery power is present on the panel lamps circuit when it is not being powered by the SAM Cab.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521113	4	Panel lamps backlighting circuit — shorted to ground.	conn X10, pin 13	—	—	The SAM Cab is attempting to supply power to the panel lamps backlighting circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521117	4	Instrument cluster wake up power circuit — shorted to ground.	conn X10, pin 17	—	—	The SAM Cab is attempting to supply power to the instrument cluster wake up power circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521118	3	Radio power supply circuit — shorted to high source.	conn X10, pin 18	—	—	Battery power is present on the radio power supply circuit when it is not being powered by the SAM Cab.
33	521118	4	Radio power supply circuit — shorted to ground.	conn X10, pin 18	—	—	The SAM Cab is attempting to supply power to the radio power circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521120	3	Windshield washer pump output circuit — shorted to high source.	conn X20, pin 20	—	—	Battery power is present on the washer pump circuit when it is not being powered by the SAM Cab. The washer pump will run constantly.
33	521120	4	Washer pump output circuit — shorted to ground.	conn X20, pin 20	—	—	The SAM Cab is attempting to supply power to the washer pump but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521120	5	Windshield washer pump output circuit — amperage below normal.	conn X20, pin 20	—	—	The washer pump circuit is not using any amperage. The pump motor is open or there is a wiring fault.
33	521202	3	Washer level ICU indicator circuit — shorted to high source.	conn X11, pin 2	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521204	3	Fuel water separator ICU indicator circuit — shorted to high source.	conn X11, pin 4	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521206	3	Low air pressure ICU indicator circuit — shorted to high source.	conn X11, pin 6	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521207	3	Low voltage disconnect ICU chime circuit — shorted to high source.	conn X11, pin 7	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521208	3	Engine brake ICU indicator circuit — shorted to high source.	conn X11, pin 8	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521209	4	High beam ICU indicator circuit — shorted to ground.	conn X11, pin 9	—	—	The SAM Cab is attempting to supply power to the high beam indicator in the ICU but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521211	3	Left turn ICU indicator circuit — shorted to high source.	conn X11, pin 11	—	—	Battery power is present on the left turn signal indicator circuit when it is not being powered by the SAM Cab. The indicator in the instrument cluster will remain on when the turn signal is off.
33	521211	4	Left turn ICU indicator circuit — shorted to ground.	conn X11, pin 11	—	—	The SAM Cab is attempting to supply power to the left turn indicator in the ICU but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521212	3	Alternator no charge ICU indicator circuit — shorted to high source.	conn X11, pin 12	—	—	This is a "Low Side Drive" circuit. The SAM Cab detects that it is always at battery power even when it is attempted to be turned ON (driven to ground). The circuit is deactivated for the remainder of the ignition cycle.
33	521213	3	Right turn ICU indicator circuit — shorted to high source.	conn X11, pin 13	—	—	Battery power is present on the right turn signal indicator circuit when it is not being powered by the SAM Cab. The indicator in the instrument cluster will remain on when the turn signal is off.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521213	4	Right turn ICU indicator circuit — shorted to ground.	conn X11, pin 13	—	—	The SAM Cab is attempting to supply power to the right turn indicator in the ICU but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521220	2	Clutch witches — top and bottom closed at the same time.	conn X11, pin 16 conn X11, pin 17 conn X11, pin 20	—	—	The bottom of clutch and top of clutch switches are both closed at the same time. Pin 20 is the source of a 5 HZ square wave signal for the bottom of clutch switch. Pin 17 is the source of a 5 HZ square wave signal for the top of clutch switch. When the clutch is at the top or bottom of travel, the respective switch closes and the circuit is grounded through pin 16.
33	521220	3	Clutch switch circuit — shorted to high source.	conn X11, pin 20	—	—	Pin 20 is the source of a 5 HZ square wave signal for the bottom of clutch switch. The SAM Cab is detecting that this circuit is at a constant battery voltage instead of the square wave signal or ground.
33	521303	3	Footwell lamp circuit — shorted to high source.	conn X12, pin 3	—	—	Battery power is present on the footwell lamp circuit when it is not being powered by the SAM Cab. The footwell lamps will remain on constantly.
33	521303	4	Footwell lamp circuit — shorted to ground.	conn X12, pin 3	—	—	The SAM Cab is attempting to supply power to the footwell lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521306	3	Reading lamp 1, zone 9 — shorted to high source.	conn X12, pin 6	—	—	Battery power is present on the reading lamp circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521306	4	Reading lamp 1, zone 9 — shorted to ground.	conn X12, pin 6	—	—	The SAM Cab is attempting to supply power to the reading lamp 1, zone 9 circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521307	3	Mid dome lamp circuit — shorted to high source.	conn X12, pin 7	—	—	Battery power is present on the mid dome lamp circuit when it is not being powered by the SAM Cab. The lamp will remain on constantly.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521307	4	Mid dome lamp circuit — shorted to ground.	conn X12, pin 7	—	—	The SAM Cab is attempting to supply power to the mid dome lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521309	3	Sleeper lamp, zone 4b — shorted to high source.	conn X12, pin 9	—	—	Battery power is present on the sleeper lamp circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521309	4	Sleeper lamp, zone 4b — shorted to ground.	conn X12, pin 9	—	—	The SAM Cab is attempting to supply power to the sleeper lamp, zone 4b circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521312	3	Rear baggage compartment lights circuit — shorted to high source.	conn X12, pin 12	—	—	Battery power is present on the rear baggage compartment lights circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521312	4	Rear baggage compartment lights circuit — shorted to ground.	conn X12, pin 12	—	—	The SAM Cab is attempting to supply power to the rear baggage compartment lights circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521313	3	Sleeper footwell lamp circuit — shorted to high source.	conn X12, pin 13	—	—	Battery power is present on the sleeper footwell lamp circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521313	4	Sleeper footwell lamp circuit — shorted to ground.	conn X12, pin 13	—	—	The SAM Cab is attempting to supply power to the sleeper footwell lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521315	3	Left turn, cab side circuit — shorted to high source.	conn X12, pin 15 conn X21, pin 11	—	—	Battery power is present on the left turn cab side lamp circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521315	4	Left turn, cab side circuit — shorted to ground.	conn X12, pin 15 conn X21, pin 11	—	—	The SAM Cab is attempting to supply power to the left turn cab side lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521315	5	Left turn, cab side — amperage below normal.	conn X12, pin 15 conn X21, pin 11	—	—	The left side turn lamp is not using any amperage. The bulb is open or there is a wiring fault. All left turn signals flas at double the normal rate when this fault is active. The fault can clear when the correct load is completing the circuit and the turn signal is ON.
33	521316	3	Reading lamp 2, zone 5 — shorted to high source.	conn X12, pin 16	—	—	Battery power is present on the reading lamp circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521316	4	Reading lamp 2, zone 5 — shorted to ground.	conn X12, pin 16	—	—	The SAM Cab is attempting to supply power to the reading lamp 2, zone 5 light circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521317	3	Rear dome lamp, zone 4c — shorted to high source.	conn X12, pin 17	—	—	Battery power is present on the rear dome lamp circuit when it is not being powered by the SAM Cab. The lamp will remain on constantly.
33	521317	4	Rear dome lamp, zone 4c — shorted to ground.	conn X12, pin 17	—	—	The SAM Cab is attempting to supply power to the rear dome lamp, zone 4C circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521318	3	Right turn, cab side — shorted to high source.	conn X12, pin 18 conn X20, pin 15	—	—	Battery power is present on the right turn cab side lamp circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521318	4	Right turn, cab side — shorted to ground.	conn X12, pin 18 conn X20, pin 15	—	—	The SAM Cab is attempting to supply power to the right turn cab side lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521318	5	Right turn, cab side — amperage below normal.	conn X12, pin 18 conn X20, pin 15	—	—	The right side turn lamp is not using any amperage. The bulb is open or there is a wiring fault. All right turn signals flas at double the normal rate when this fault is active. The fault can clear when the correct load is completing the circuit and the turn signal is ON.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521402	3	CAN low circuit — voltage shorted to high source.	conn X13, pin 2	—	—	The SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode. Check Cabin CAN harness from the starpoint connector to all ECUs on this datalink.
33	521402	4	CAN low circuit — voltage shorted to ground.	conn X13, pin 2	—	—	The SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode. Check Cabin CAN harness from the starpoint connector to all ECUs on this datalink.
33	521403	3	CAN high circuit — voltage shorted to high source.	conn X13, pin 3	—	—	The SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode. Check Cabin CAN harness from the starpoint connector to all ECUs on this datalink.
33	521403	4	CAN high circuit — voltage shorted to ground.	conn X13, pin 3	—	—	The SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode. Check Cabin CAN harness from the starpoint connector to all ECUs on this datalink.
33	521405	2	Ignition switch circuits — invalid combination of active circuits.	conn X13, pin 4 conn X13, pin 5 conn X13, pin 6 conn X13, pin 15	—	—	Troubleshoot for short and open circuits in the ignition switch and wiring between the SAM Cab and the switch. If the fault is keeping the SAM awake in the key off position, the batteries may become discharged.
33	521407	6	Ignition switch battery power feed circuit — amperage above normal.	conn X13, pin 7	—	—	The ignition switch power feed circuit is drawing more amperage that expected. Troubleshoot for a short to ground in this circuit.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521411	3	Sensor signal supply group 5 — shorted to high source.	conn X13 pin 8 conn X13, pin 9 conn X13, pin 10 conn X13, pin 11 conn X19, pin 13 conn X19, pin 14 conn X19, pin 15 (SAM6.+)	—	—	The square wave signal that supplies the low air pressure, air filte restriction, park brake, and hood tilt switches is a constant battery voltage. The ICU indicators for low air pressure and air filte restriction are ON. The park brake ICU indicator is OFF and optimized idle is disabled. CAN message Low Air Pressure Stat changes to "not available", CAN message Optimized Idle Crank request changes to "OFF", CAN message Air Filter Differential Pressure changes to "12.5 kPa".
33	521411	4	Sensor signal supply group 5 — shorted to ground.	conn X13, pin 9 conn X13, pin 11 conn X19, pin 13 conn X19, pin 14	—	—	The square wave signal that supplies the low air pressure, air filte restriction, park brake, and hood tilt switches is drawing excessive amperage. The signal to these circuits is disabled for the remainder of the ignition cycle. The ICU indicators for low air pressure and air filte restriction are ON. CAN message Low Air Pressure Stat changes to "not available", CAN message Optimized Idle Crank request changes to "OFF", CAN message Air Filter Differential Pressure changes to 12.5 kPa.
33	521502	4	12 V power receptacle 6 — voltage shorted to ground.	conn X14, pin 2	F30	BR24	No voltage is present on the fuse F30 circuits. An open fuse F30, relay BR24 stuck in the OFF position, or a wiring or component fault on this circuit will set this fault. The SAM will not deactivate this output when the fault is active.
33	521502	31	Bistable relay BR24 — not switching to requested position.	conn X2, pin 15 conn X14, pin 2 conn X16, pin 7 conn X16, pin 17	F21 F30 F34 F35	BR24	The SAM Cab attempted to switch bistable relay 24 from ON to OFF, but power is still present on the circuits that were attempted to be switched OFF. This fault will also set when the SAM Cab attempts to switch the relay from OFF to ON and power is not present on the output circuits. The fault will only clear when the relay is in the same state as it was when the fault set.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521702	3	Lane guidance power feed circuit — shorted to high source.	conn X16, pin 2	—	—	Battery power is present on the lane guidance power feed circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521702	4	Lane guidance power feed circuit — shorted to ground.	conn X16, pin 2	—	—	The SAM Cab is attempting to supply power to the lane guidance power feed circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521704	3	Clearance lamps II circuit — shorted to high source.	conn X16, pin 4	—	—	Battery power is present on the clearance lamps II circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521704	4	Clearance lamps II circuit — shorted to ground.	conn X16, pin 4	—	—	The SAM Cab is attempting to activate the clearance lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521704	5	Clearance lamps II — amperage below normal.	conn X16, pin 4	—	—	The clearance lamp circuit is not drawing any amperage. The lamps are open circuit or there is a wiring fault.
33	521705	3	Auxiliary circulation fan circuit — shorted to high source.	conn X16, pin 5	—	—	Battery power is present on the windshield auxiliary fan circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521705	4	Auxiliary circulation fan circuit — shorted to ground.	conn X16, pin 5	—	—	The SAM Cab is attempting to supply power to the auxiliary fan circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521708	3	Clearance lamps I circuit — shorted to high source.	conn X16, pin 8	—	—	Battery power is present on the clearance lamps I circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521708	4	Clearance lamps I circuit — shorted to ground.	conn X16, pin 8	—	—	The SAM Cab is attempting to activate the clearance lamps I circuit, but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521708	5	Clearance lamps I — amperage below normal.	conn X16, pin 8	—	—	The clearance lamp circuit is not drawing any amperage. The lamps are open circuit or there is a wiring fault.
33	521711	3	Dome lamps driver and passenger circuit — shorted to high source.	conn X16, pin 11 conn X16, pin 14	—	—	Battery power is present on the driver / passenger dome lamp circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521711	4	Dome lamps driver and passenger circuit — shorted to ground.	conn X16, pin 11 conn X16, pin 14	—	—	The SAM Cab is attempting to supply power to the dome lamps, driver and passenger circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521802	4	Mirror heat circuit, passenger side — shorted to ground.	conn X17, pin 2	F28	R10	The SAM Cab is attempting to supply power to the mirror heat circuit, passenger side, but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521803	3	Door sill lamp passenger side circuit — shorted to high source.	conn X17, pin 3	—	—	Battery power is present on the passenger side door sill lamp circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	521803	4	Door sill lamp passenger side circuit — shorted to ground.	conn X17, pin 3	—	—	The SAM Cab is attempting to supply power to the door sill lamp, passenger side circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521905	3	Left low beam circuit — shorted to high source.	conn X18, pin 5	—	—	Battery power is present on the left low beam head lamp circuit when it is not being powered by the SAM Cab. The lamp is illuminated constantly.
33	521905	4	Left low beam circuit — shorted to ground.	conn X18, pin 5	—	—	The SAM Cab is attempting to supply power to the left low beam head lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521905	5	Left low beam circuit — amperage below normal / open circuit.	conn X18, pin 5	—	—	The left low beam circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521906	3	Left high beam circuit — shorted to high source.	conn X18, pin 6	—	—	Battery power is present on the left high beam head lamp circuit when it is not being powered by the SAM Cab. The lamp is illuminated constantly.
33	521906	4	Left high beam circuit — shorted to ground.	conn X18, pin 6	—	—	The SAM Cab is attempting to supply power to the left high beam head lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521906	5	Left high beam circuit — amperage below normal/ open circuit.	conn X18, pin 6	—	—	The left high beam circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.
33	521908	3	Marker lamp front right corner circuit — shorted to high source.	conn X18, pin 8	—	—	Battery power is present on the right front corner marker lamp circuit when it is not being powered by the SAM Cab. The lamp is illuminated constantly.
33	521908	4	Marker lamp front right corner circuit — shorted to ground.	conn X18, pin 8	—	—	The SAM Cab is attempting to activate the front right marker lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521908	5	Marker lamp front right corner — amperage below normal/open circuit.	conn X18, pin 8	—	—	The front right marker lamp circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.
33	521909	3	Right turn lamp, front corner — shorted to high source.	conn X18, pin 9	—	—	Battery power is present on the right front corner turn lamp circuit when it is not being powered by the SAM Cab. The lamp is illuminated constantly.
33	521909	4	Right turn lamp, front corner — shorted to ground.	conn X18, pin 9	—	—	The SAM Cab is attempting to supply power to the right front corner turn lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521909	5	Right turn lamp, front corner — amperage below/open circuit.	conn X18, pin 9	—	—	The right front corner turn lamp circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.
33	521912	3	Marker lamp, front right cab side circuit — shorted to high source.	conn X18, pin 12	—	—	Battery power is present on the right front cab side marker lamp circuit when it is not being powered by the SAM Cab. The lamp is illuminated constantly.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521912	4	Marker lamp, front right cab side circuit — shorted to ground.	conn X18, pin 12	—	—	The SAM Cab is attempting to activate the front right cab side marker lamp circuit, but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521912	5	Marker lamp, front right cab side — amperage below normal.	conn X18, pin 12	—	—	The front right cab side marker lamp circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.
33	521914	3	Marker lamp, front left cab side circuit — shorted to high source.	conn X18, pin 14	—	—	Battery power is present on the left front cab side marker lamp circuit when it is not being powered by the SAM Cab. The lamp is illuminated constantly.
33	521914	4	Marker lamp, front left cab side circuit — shorted to ground.	conn X18, pin 14	—	—	The SAM Cab is attempting to activate the front left cab side marker lamp circuit, but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521914	5	Marker lamp, front left cab side — amperage below normal.	conn X18, pin 14	—	—	The front left cab side marker lamp circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.
33	521915	3	Right daytime running light right — shorted to high source.	conn X18, pin 15	—	—	Battery power is present on the right DRL circuit when it is not being powered by the SAM Cab. The lamp is ON constantly.
33	521915	4	Right daytime running light right circuit — shorted to ground.	conn X18, pin 15	—	—	The SAM Cab is attempting to activate the right DRL circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521915	5	Right daytime running light — amperage below normal.	conn X18, pin 15	—	—	The right daytime running lamp circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault. The DRL is the same bulb as the right front corner turn signal.
33	521916	3	Marker lamp front left corner circuit — voltage above normal or shorted to high source.	conn X18, pin 16	—	—	Battery power is present on the left front corner marker lamp circuit when it is not being powered by the SAM Cab. The lamp is illuminated constantly.
33	521916	4	Marker lamp front left corner circuit — shorted to ground.	conn X18, pin 16	—	—	The SAM Cab is attempting to activate the front left marker lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521916	5	Marker lamp front left corner — amperage below normal.	conn X18, pin 16	—	—	The front left marker lamp circuit is not drawing any amperage. The bulb is open or there is a wiring fault.
33	521917	3	Right high beam circuit — shorted to high source	conn X18, pin 17	—	—	Battery power is present on the right high beam head lamp circuit when it is not being powered by the SAM Cab. The lamp is illuminated constantly.
33	521917	4	Right high beam circuit — shorted to ground.	conn X18, pin 17	—	—	The SAM Cab is attempting to supply power to the right high beam head lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521917	5	Right high beam circuit — amperage below normal/ open circuit.	conn X18, pin 17	—	—	The right high beam circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.
33	521918	3	Left daytime running light right — shorted to high source.	conn X18, pin 18	—	—	Battery power is present on the left DRL circuit when it is not being powered by the SAM Cab. The lamp is ON constantly.
33	521918	4	Left daytime running light right circuit — shorted to ground.	conn X18, pin 18	—	—	The SAM Cab is attempting to activate the left DRL circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521918	5	Left daytime running light — amperage below normal.	conn X18, pin 18	—	—	The left daytime running lamp circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault. The DRL is the same bulb as the left front corner turn signal.
33	521919	3	Left turn lamp, front corner circuit — shorted to high source.	conn X18, pin 19	—	—	Battery power is present on the left front corner turn lamp circuit when it is not being powered by the SAM Cab. The lamp is illuminated constantly.
33	521919	4	Left turn lamp, front corner circuit — shorted to ground.	conn X18, pin 19	—	—	The SAM Cab is attempting to supply power to the left front corner turn lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521919	5	Left turn lamp, front corner circuit — amperage below/ open circuit.	conn X18, pin 19	—	—	The left front corner turn lamp circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	521920	3	Right low beam circuit — shorted to high source.	conn X18, pin 20	—	—	Battery power is present on the right low beam head lamp circuit when it is not being powered by the SAM Cab. The lamp is illuminated constantly.
33	521920	4	Right low beam circuit — shorted to ground.	conn X18, pin 20	—	—	The SAM Cab is attempting to supply power to the right low beam head lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	521920	5	Right low beam circuit — amperage below/open circuit.	conn X18, pin 20	—	—	The right low beam circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.
33	521921	3	Electric horn circuit — shorted to high source.	conn X18, pin 21	—	—	Battery power is present on the electric horn circuit when it is not being powered by the SAM Cab. The horn is active constantly.
33	521921	5	Electric horn circuit — amperage below/open circuit.	conn X18, pin 21	—	—	The electric horn circuit is not drawing any amperage. The horn is open circuit or there is a wiring fault.
33	521921	6	Electric horn circuit — amperage higher than normal.	conn X18, pin 21	—	—	The SAM Cab is attempting to supply power to the electric horn circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522003	3	Starter relay circuit — shorted to high source.	conn X19, pin 3	—	—	Battery power is present on the starter relay circuit when it is not being powered by the SAM Cab. The starter will be running constantly.
33	522003	4	Starter relay circuit — shorted to ground.	conn X19, pin 3	—	—	The SAM Cab is attempting to activate the starter relay output circuit, but excessive amperage is detected. Troubleshoot circuit 472S2 between the SAM Cab and the magnetic switch for a wiring fault and repair as appropriate. Use an ohmmeter to test for a short to ground in the over crank protection switch and circuit 12 between the mag switch and the over crank protection switch. This circuit runs through the powertrain PDM on vehicles with Eaton automatic transmissions.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	522006	3	Air conditioning compressor clutch circuit — shorted to high source.	conn X19, pin 6	—	—	Battery power is present on the air conditioning compressor clutch circuit when it is not being powered by the SAM Cab. The AC compressor will be running constantly.
33	522006	4	Air conditioning compressor clutch circuit — shorted to ground.	conn X19, pin 6	—	—	The SAM Cab is attempting to supply power to the air conditioning compressor clutch circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522006	5	Air conditioning compressor clutch circuit — amperage below normal/open circuit.	conn X19, pin 6	—	—	The AC compressor clutch circuit is not drawing any amperage. The compressor clutch is open circuit or there is a wiring fault.
33	522009	4	PTO activate solenoid circuit — shorted to ground.	conn X19, pin 9	—	—	The SAM Cab is attempting to activate the PTO activate solenoid circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522010	2	HVAC pressure sensor — voltage out of range.	conn X19, pin 10	—	—	The voltage on the HVAC pressure signal is out of range high or low. This fault will also become active when the voltage supply to the sensor is out of range high or low.
33	522018	3	Engine controller IGN circuit — shorted to high source.	conn X19, pin 18	—	—	Battery power is present on the engine controller ignition circuit when it is not being powered by the SAM Cab. The engine controller will not power down. The batteries may become discharged.
33	522018	4	Engine controller IGN circuit — shorted to ground.	conn X19, pin 18	—	—	The SAM Cab is attempting to activate the engine controller ignition power circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522020	3	Ether start circuit — shorted to high source.	conn X19, pin 20	—	—	Battery power is present on the ether start circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	522020	4	Ether start power circuit — shorted to ground.	conn X19, pin 20	—	—	The engine is being cranked and the SAM Cab is attempting to activate the ether start circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	522021	3	PTO hold solenoid — shorted to high source.	conn X19, pin 21	—	—	Battery power is present on the PTO hold solenoid circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	522021	4	PTO hold solenoid circuit — shorted to ground.	conn X19, pin 21	—	—	The SAM Cab is attempting to activate the PTO hold solenoid circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522108	3	Left fog lamp circuit — shorted to high source.	conn X20, pin 8	—	—	Battery power is present on the left fog lamp circuit when it is not being powered by the SAM Cab. The lamp will be illuminated constantly.
33	522108	4	Left fog lamp circuit — shorted to ground.	conn X20, pin 8	—	—	The SAM Cab is attempting to supply power to the left fog lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522108	5	Left fog lamp circuit — amperage below normal/ open circuit.	conn X20, pin 8	—	—	The left fog lamp circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.
33	522110	3	Left auxiliary high beam circuit — shorted to high source.	conn X20, pin 10	—	—	Battery power is present on the left auxiliary high beam circuit when it is not being powered by the SAM Cab. The lamp will be illuminated constantly.
33	522110	4	Left auxiliary high beam circuit — shorted to ground.	conn X20, pin 10	—	—	The SAM Cab is attempting to supply power to the left auxiliary high beam circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522111	3	Left auxiliary low beam circuit — shorted to high source.	conn X20, pin 11	—	—	Battery power is present on the left auxiliary low beam circuit when it is not being powered by the SAM Cab. The lamp will be illuminated constantly.
33	522111	4	Left auxiliary low beam circuit — shorted to ground.	conn X20, pin 11	—	—	The SAM Cab is attempting to supply power to the left auxiliary low beam circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	522112	3	Right auxiliary high beam circuit — shorted to high source.	conn X20, pin 12	—	—	Battery power is present on the right auxiliary high beam circuit when it is not being powered by the SAM Cab. The lamp will be illuminated constantly.
33	522112	4	Right auxiliary high beam circuit — shorted to ground.	conn X20, pin 12	—	—	The SAM Cab is attempting to supply power to the right auxiliary high beam circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522114	3	Right auxiliary low beam circuit — shorted to high source	conn X20, pin 14	—	—	Battery power is present on the right auxiliary low beam circuit when it is not being powered by the SAM Cab. The lamp will be illuminated constantly.
33	522114	4	Right auxiliary low beam circuit — shorted to ground.	conn X20, pin 14	—	—	The SAM Cab is attempting to supply power to the right auxiliary low beam circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522116	2	Outside air temperature sensor — voltage out of range.	conn X20, pin 16	—	—	The voltage on the outside air temperature circuit is indicating an outside temperature that is either colder than -40 deg, or hotter than 100 deg C (212 deg F). If the actual temperature is inside of this range, troubleshoot for a sensor or a wiring fault.
33	522117	3	Right fog lamp circuit — shorted to high source.	conn X20, pin 17	—	—	Battery power is present on the right fog lamp circuit when it is not being powered by the SAM Cab. The lamp will be illuminated constantly.
33	522117	4	Right fog lamp circuit — shorted to ground.	conn X20, pin 17	—	—	The SAM Cab is attempting to supply power to the right fog lamp circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522117	5	Right fog lamp circuit — amperage below normal/ open circuit.	conn X20, pin 17	—	—	The right fog lamp circuit is not drawing any amperage. The bulb is open circuit or there is a wiring fault.
33	522119	3	Ignition group 2, grid heater and forward radar unit circuit — shorted to high source.	conn X19, pin 11 conn X20, pin 19	—	—	Battery power is present on either of these circuits when they are not being powered by the SAM Cab. The circuits are powered constantly.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	522119	4	Ignition group 2, grid heater and forward radar unit circuit — shorted to ground.	conn X19, pin 11 conn X20, pin 19	—	—	The SAM Cab is attempting to power the grid heater and forward radar circuits but excessive amperage is detected. The outputs are deactivated for the remainder of the ignition cycle.
33	522121	3	Washer flui level sensor circuit — shorted to high source.	conn X20, pin 21	—	—	Connector X20, pin 21 is the source of a square wave signal for the washer flui level switch. The SAM Cab is detecting that this circuit is at a constant battery voltage instead of the square wave signal or ground.
33	522209	2	Windshield wiper park circuit — voltage out of range.	conn X21, pin 9	—	—	The wiper park switch circuit is either at ground for too long, or open too long while the wipers are active on low or high speed. The fault will not clear until the repair is completed and the wipers are ON.
33	522210	3	Air horn circuit — shorted to high source.	conn X21, pin 10	—	—	Battery power is present on the air horn circuit when it is not being powered by the SAM Cab. The circuit is powered constantly.
33	522210	4	Air horn circuit — shorted to ground.	conn X21, pin 10	—	—	The SAM Cab is attempting to activate the air horn circuit but excessive amperage is detected. The output is deactivated for the remainder of the ignition cycle.
33	522213	31	Emergency power supply circuit — voltage out of range.	conn X21, pin 13	—	—	The emergency power/LVD sense circuit is lower than battery voltage. On EPA07 vehicles this could be an open fuse F7 in the PTPDM. On EPA10 vehicles this could be an open fuse D in the PNDB. There could also be a wiring fault between the fuse and the SAM Cab connector X21, pin 13.
33	522215	3	Wiper motor circuit — shorted to high source.	conn X21, pin 12 conn X21, pin 15	—	—	Battery power is present on the wiper motor high or low speed circuit when they are not being powered by the SAM Cab. The wipers will be running constantly.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Description**	**Connector/Pin**	**Fuse**	**Relay**	**Diagnosis**
33	522215	6	Wiper motor circuit — amperage higher than normal.	conn X21, pin 12 conn X21, pin 15	—	—	The SAM Cab is attempting to supply power to the wiper motor high or low speed circuits but excessive amperage is detected. The output is deactivated until the repair is completed and the wipers are activated in the speed that created this fault.
33	524037	31	Lost communication with CGW.	—	—	—	The SAM Cab is not receiving data from the central gateway. The gateway could be entirely powered OFF or there could be a fault with the cabin can databus between the CGW and the starpoint connector.
33	524049	31	Lost communication with MSF.	—	—	—	The SAM Cab is not receiving data from the MSF. The MSF could be entirely powered OFF or there could be a fault with the cabin can databus between the MSF and the starpoint connector. The SAM cab will turn the headlights ON when this fault is active.
33	524071	31	Lost communication with the SAM Chassis.	—	—	—	The SAM Cab is not receiving data from the SAM chassis. The SAM chassis could be entirely powered OFF or there could be a fault with the cabin can databus between the SAM chassis and the starpoint connector. This fault condition typically defaults to the SAM cab and chassis operating in emergency lighting mode.

Table 5, CAN Fault, SAM Cab

704 — Grounded Pins and Inputs

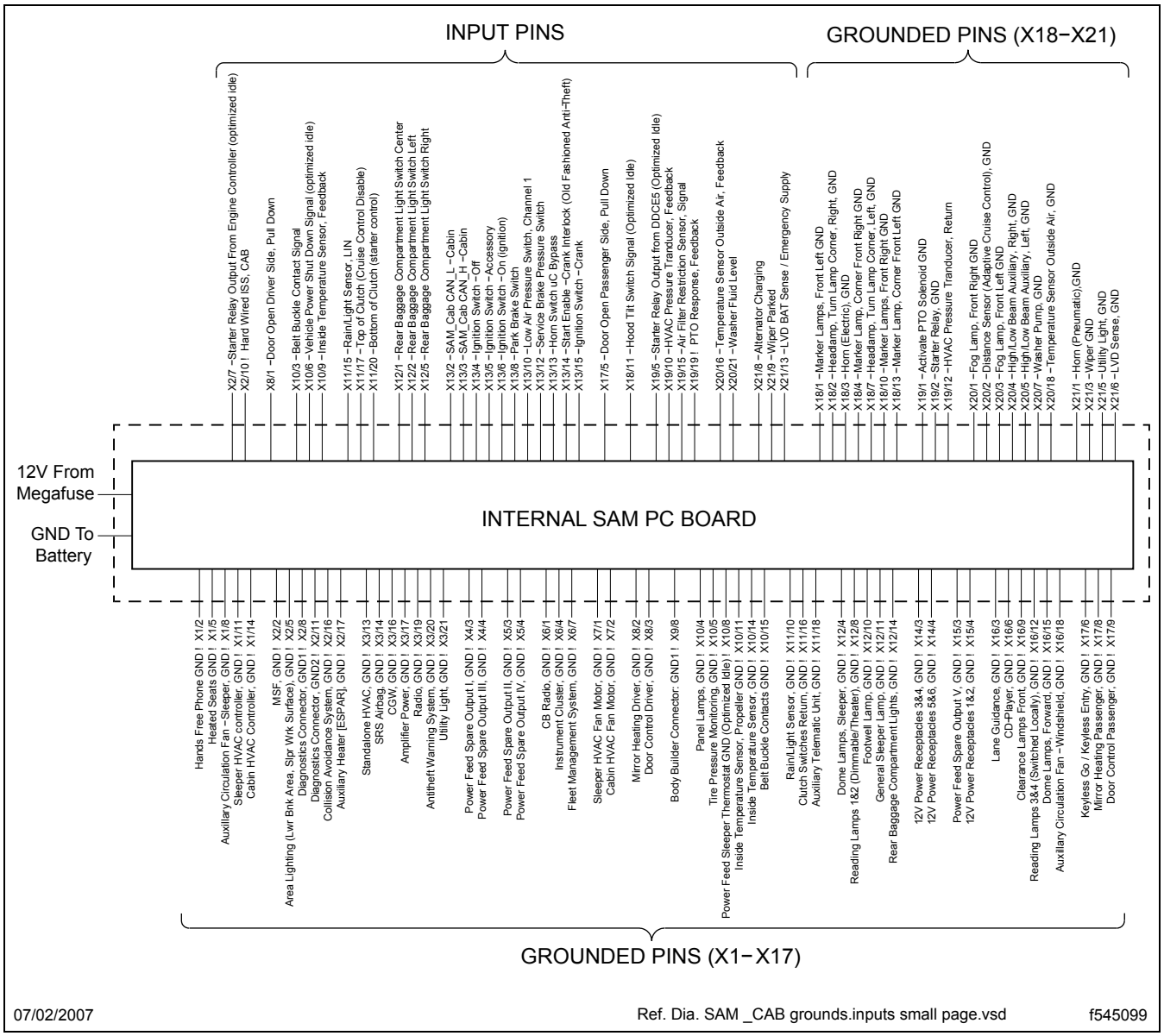


Fig. 7, Grounded Pins and Inputs

705 — Fused and FET Controlled Outputs

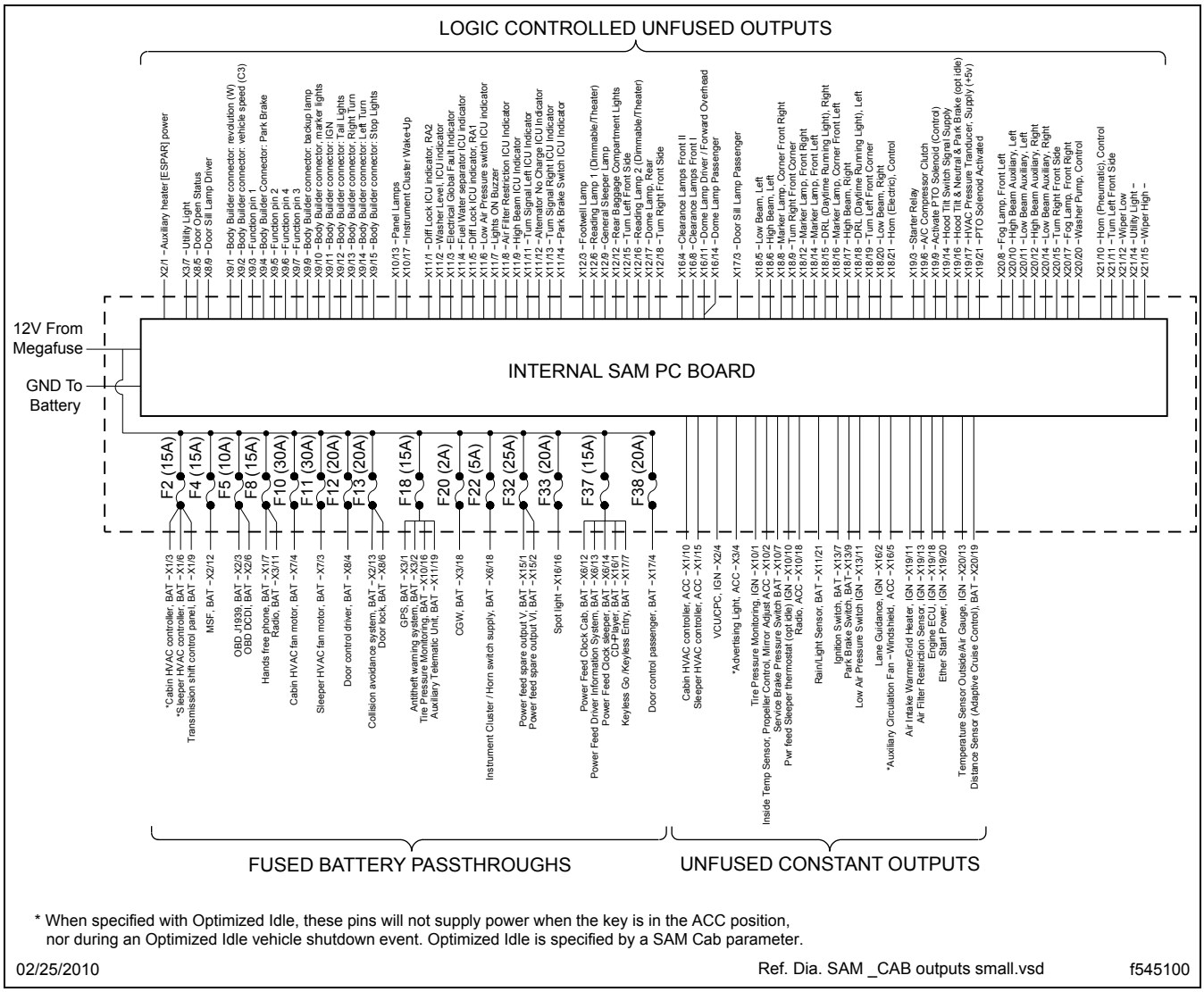


Fig. 8, Fused and FET Controlled Outputs

706 — Relayed Outputs

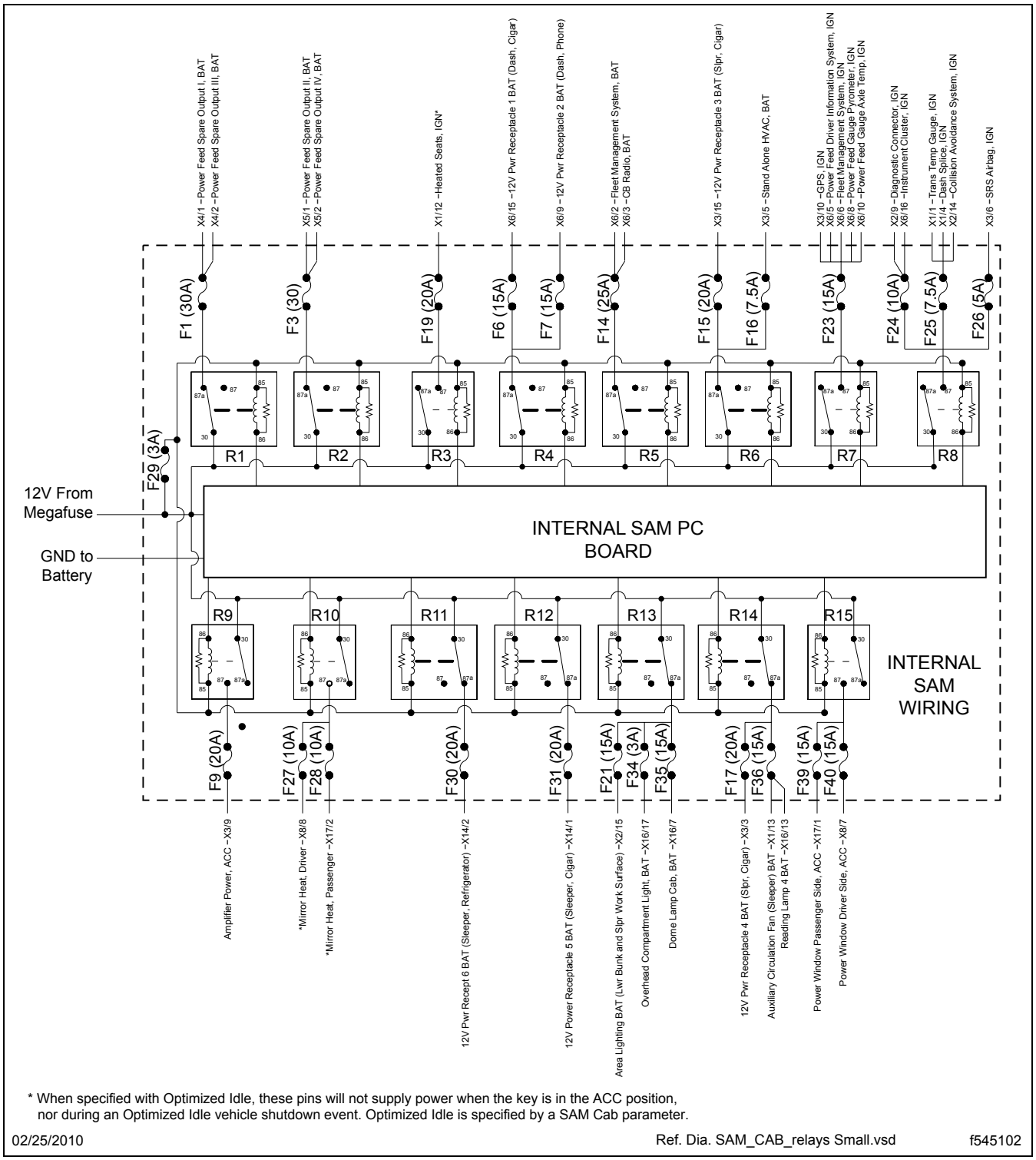


Fig. 9, Relayed Outputs

707 — Logic Controlled Unfused Outputs

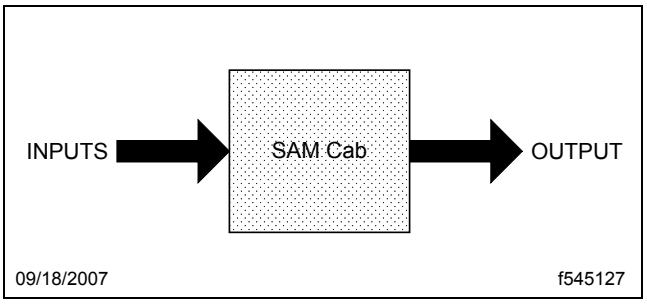


Fig. 10, SAM Unfused Inputs and Outputs

1. **Determine if the template has I/O controls available for the affected function.**

   Open the Datalink Monitor template for the function or output that is not functioning.

   Are I/O control buttons available for the affected function?

   YES → Go to test 2.

   NO → Go to test 5.

2. **Use the I/O control feature in Datalink Monitor to test the output circuit.**

   Does the function or output work when activated with Datalink Monitor?

   YES → Go to test 3.

   NO → Go to test 4.

3. **Use Datalink Monitor to determine if input conditions are met for the function or output to operate.**

   Are all of the input conditions met?

   YES → Check SAM Cab programming and parameters. For additional programming/parameter information specifi to this function, refer to the applicable subject in this manual. If programming/parameters are OK, replace the SAM Cab.

   NO → For additional input troubleshooting specifi to this function, refer to the applicable subject in this manual.

4. **Rule out the output by manually applying fused power and ground.**

   Does the function or output work when power and ground are applied manually?

   YES → Replace the SAM Cab.

   NO → The problem is in the output power or ground circuits, or the load itself. For additional output troubleshooting, refer to the applicable subject in this manual.

5. **Determine if input conditions are met for the function or output to operate using Datalink Monitor.**

   NOTE: To determine which Datalink Monitor template to use, refer to the applicable subject in this manual.

5.1 Refer to the function or output in this manual to identify what input conditions have to be met in order for the function or output to operate.

5.2 Open the Datalink Monitor template for the applicable function.

5.3 While monitoring the template inputs, attempt to activate the function or output using the normal method. Turn on the headlights, for example, if the rotary switch inputs are being tested.

Are all of the input conditions met?

YES → Go to test 6.

NO → For additional input troubleshooting specifi to this function, refer to the applicable subject in this manual.

6. **Check available voltage at the consumer.**

NOTE: Available voltage tests cannot be performed on every SAM Cab function. For example, checking voltage at a turn signal connector will not work. Refer to the applicable subject in this manual for more details about troubleshooting specifi outputs. If test 6 cannot be performed, proceed to test 7.

6.1 Disconnect the connector at the consumer.

6.2 Activate the function by normal means. Turn on the headlights, for example, if the rotary switch inputs are being tested.

6.3 Measure voltage between the positive and ground pins on the connector for the function being tested.

Is there battery voltage across the positive and ground terminals?

YES → Replace the consumer.

NO → Go to test 7.

7. **Rule out the output by manually applying fused power and ground.**

7.1 Disconnect the SAM connector(s) containing the circuits for the output (power) and ground for the function being tested.

7.2 Apply fused power to the output circuit using jumper wires, and apply ground to the ground circuit.

Does the function or output work when power and ground are applied manually?

YES → Check SAM Cab programming and parameters. For additional programming and parameter information, refer to the applicable subject in this manual. If the programming and parameters are OK, replace the SAM Cab.

NO → The problem is in the output power or ground circuits, or the load itself. For additional output troubleshooting, refer to the applicable subject in this manual.

708 — Logic Controlled Relayed Fused Outputs

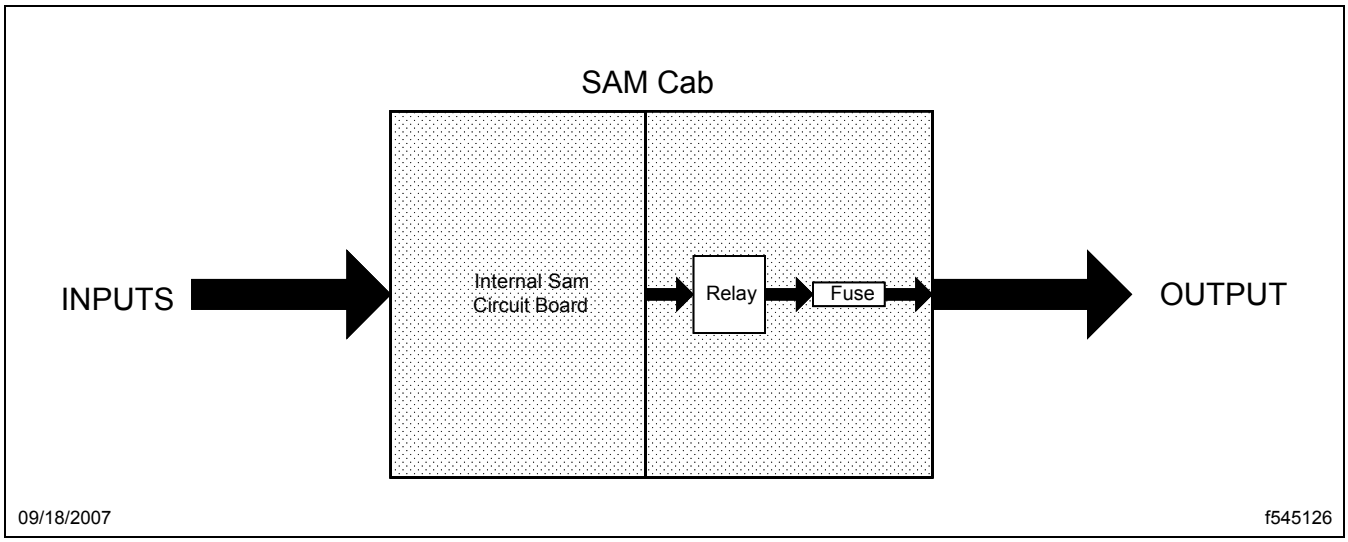


Fig. 11, SAM Fused Inputs and Outputs

1. **Determine if the template has I/O controls available for the affected function.**

   Open the Datalink Monitor template for the function or output that is not functioning.

   Are I/O control buttons available for the affected function?

   YES → Go to test 2.

   NO → Go to test 3.

2. **Use Datalink Monitor to determine if the output circuit can be eliminated as the problem.**

   NOTE: To determine which Datalink Monitor template to use, refer to the applicable subject in this manual.

   2.1 Open the Datalink Monitor template for the applicable function.

   2.2 Using the template, attempt to activate the function or output.

   Does the function or output work when activated manually in Datalink Monitor?

   NOTE: For normally closed relays, activating the SAM output will turn off the relay controls. For normally open relays, activating the SAM output will turn on the relay controls.

   YES → Go to test 3.

   NO → Go to test 4.

3. **Use Datalink Monitor to determine if input conditions are met for the function or output to operate.**

   NOTE: To determine which Datalink Monitor template to use, refer to the applicable subject in this manual.

3.1 Refer to the applicable function or output, and identify what input conditions have to be met for normal operation.

3.2 Open the applicable Datalink Monitor template.

3.3 While monitoring the template inputs, attempt to active the function or output using the normal method. For example, turn on the headlights if the rotary switch inputs are being tested.

Are all of the input conditions met?

YES → Go to test 4.

NO → For additional input troubleshooting specifi to this function, refer to the applicable subject in this manual.

4. **Check the available voltage at the consumer.**

NOTE: Available voltage tests cannot be performed on every SAM function. For example, checking voltage at a turn signal connector will not work. Refer to the applicable subject for more information about troubleshooting the specifi outputs. If test 4 cannot be performed, proceed to test 5.

4.1 Disconnect the connector at the consumer.

4.2 Activate the function by normal means. For example, turn on the headlights if the rotary switch inputs are being tested.

4.3 Measure voltage between the positive and ground pins.

Is there battery voltage across the positive and ground terminals?

YES → Replace the consumer.

NO → Go to test 5.

5. **Check for power at the relay coil (low current side).**

5.1 Remove the relay from the SAM for the function that is not working.

5.2 Check for voltage in the SAM relay cavity that corresponds to terminal 85 of the relay.

Is there voltage at relay cavity 85?

YES → Go to test 6.

NO → Check fuse F29 on the SAM Cab.

6. **Check for power at the relay common (high current side).**

Check for voltage in the SAM relay cavity that corresponds to terminal 30 of the relay.

Is there voltage at relay cavity 30?

YES → Go to test 7.

NO → Check main power to SAM from the MEGA fuse.

7. **Check the SAM fuse for the function.**

Check the fuse for the function or output.

Is the fuse good?

YES → Go to test 8.

NO → Check for a short to ground in the output circuit. Check the component that the output supplies power to for excessive current draw. Make repairs as necessary, and replace the fuse.

8. **Determine if the function works when power is manually applied.**

   Using a fused jumper, apply power to the SAM relay cavity that corresponds to 87 for normally open relay connections, or 87a for normally closed relays.

   Does the function work when power is manually applied at the relay?

   YES → Go to test 9.

   NO → The problem is in the output power or ground circuits, or the load itself. For additional output troubleshooting, refer to the applicable subject in this manual.

9. **Determine if the output works with a test relay that is operating properly.**

   Remove the relay from the SAM and install the known good relay.

   Does the function or output work with a known good relay?

   YES → Replace the relay.

   NO → Check SAM programming and parameters. For additional programming/parameter information, refer to the applicable subject in this manual. If programming and parameters are OK, replace the SAM.

709 — Unfused Constant Outputs

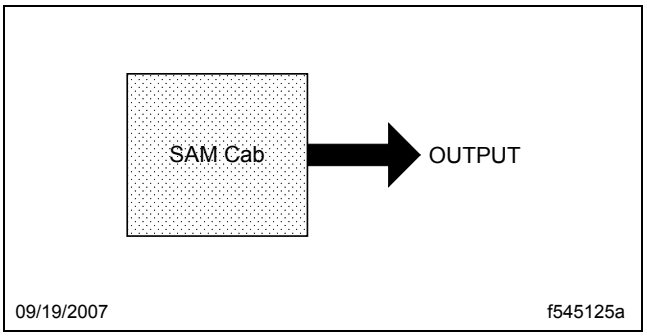


Fig. 12, SAM Unfused Constant Outputs

1. **Check available voltage at the consumer.**

   1.1 Disconnect the connector at the consumer.

   1.2 Measure the voltage between the positive and ground pins on the connector.

   Is there battery voltage across the positive and ground terminals?

   YES → Replace the consumer.

   NO → Go to test 2.

2. **Check the voltage at output pin.**

   2.1 Turn the ignition switch on.

2.2 Check for voltage at the unfused constant output pin.

Is there 12V at the unfused constant output pin?

YES → The problem is in the output power or ground circuits or the load itself. For additional output troubleshooting refer to the applicable subject in this manual.

NO → For IGN and ACC outputs, check for ignition switch function. For all types, check the main power and ground feeds to the SAM. If OK, replace the SAM.

710 — Fused Battery Pass-Through Outputs

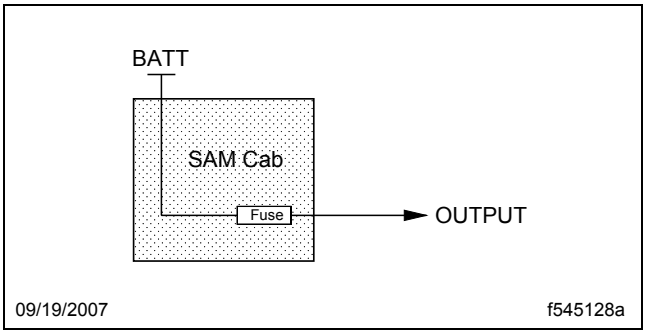


Fig. 13, Fused Battery Pass-Through Outputs

1. **Check the fuse in the SAM for the output.**

   Is the fuse OK?

   YES → Go to test 2.

   NO → Check for short to ground in the output circuit, repair as necessary, and then replace the fuse. For additional output troubleshooting, refer to the applicable subject in this manual.

2. **Check power and ground supply to the SAM.**

   Is power and ground supply to the SAM OK?

   YES → The problem is in the output power or ground circuits, or the load itself. For additional output troubleshooting, refer to the applicable subject in this manual.

   NO → Check the MEGA fuse, and the power and ground circuits to the SAM. Repair as necessary.

800 — Maximum Current Pin List

Legend:

NOTE: A dash indicates that information is not available at the time of publication.

- **Type**:
  - "o" Pin: A high-side-driven output (the function activates at higher or near-battery voltage).
  - "i" Pin: Input pin.
  - "comm" Pin: Used for communication.

- **Nominal Current (amps)**: The expected current under normal operating conditions.
- **Maximum Continuous Current (amps)**: The maximum current without shutting the pin off at 77°F (25°C).
- **Maximum Current (amps)**: When exceeded the pin will shut off at 185°F (85°C).

Maximum Current Pin List						
Connector	**Pin**	**Function**	**Type**	**Nominal Current (Amps)**	**Maximum Continuous Current (Amps)**	**Maximum Current (Amps)**
X1	1	Transmission oil temperature gauge, Ignition	o	0.5	0.675	7.5
X1	3	Cabin HVAC Controller, Battery	o	5	6.75	15
X1	4	Hands-Free Phone, Ignition	o	3	4.05	7.5
X1	6	Sleeper HVAC Controller, Battery	o	3	4.05	15
X1	7	Hands-Free Phone, Battery	o	3	4.05	15
X1	9	Transmission Shift Control Panel, Battery	o	1	1.35	15
X1	10	Cabin HVAC Controller, Accessory	o	0.7	0.945	1.9
X1	12	Heated Seats, Ignition	o	16	21.6	20
X1	13	Auxiliary Circulation Fan, Sleeper, Battery	o	5	6.75	25
X1	15	Sleeper HVAC Controller, Accessory	o	0.7	0.945	1.9
X2	3	OBD J1939, Battery	o	5	6.75	10
X2	6	Reserved for future use.	o	5	6.75	10
X2	7	Starter Relay Output from Engine-ECU (Optimized Idle)	i	0.02	0.027	—
X2	9	Diagnostic Connector, Ignition	o	5	6.75	10
X2	10	Hardwired ISS (Ignition Switch Status), Cab	o	0.02	0.027	—
X2	12	MSF (Modular Switch Field master ECU), Battery	o	10	13.5	15
X2	13	Collision Avoidance System, Battery	o	5	6.75	20
X2	14	Collision Avoidance System, Ignition	o	1.07	1.4445	7.5
X2	15	Area Lighting (lower bunk area and sleeper work surface), Battery	o	9.7	13.095	15
X2	18	Emergency Battery, Cab	o	20	27	—
X3	1	GPS (Global Positioning System), Battery	o	3.21	4.3335	15
X3	2	Antitheft Alarming System, Battery	o	2	2.7	15
X3	3	12V Power Receptacle 4 (sleeper, cigar), Battery	o	20	27	20
X3	4	Advertising Light, Accessory	o	4.8	6.48	9.35
X3	5	Stand Alone HVAC, Battery	o	5	6.75	7.5
X3	6	SRS (Safety Restraint System) Airbag, Ignition	o	3	4.05	5
X3	7	Utility Light	o	12.6	17.01	25
X3	9	Amplifie Power, Accessory	o	20	27	20
X3	10	GPS (Global Positioning System), Ignition	o	1.07	1.4445	15

Maximum Current Pin List						
Connector	**Pin**	**Function**	**Type**	**Nominal Current (Amps)**	**Maximum Continuous Current (Amps)**	**Maximum Current (Amps)**
X3	11	Radio, Battery	o	10	13.5	15
X3	18	CGW (Central Gateway ECU), Battery	o	0.38	0.513	2
X4	1	Power Feed Spare Output I, Battery	o	15	20.25	30
X4	2	Power Feed Spare Output III, Battery	o	15	20.25	30
X5	1	Power feed Spare Output II, Battery	o	15	20.25	30
X5	2	Power Feed Spare Output IV, Battery	o	15	20.25	30
X6	2	Fleet Management System, Battery	o	5	6.75	25
X6	3	CB Radio, Battery	o	20	27	25
X6	5	Power Feed, Driver Information System, Ignition	o	1.07	1.4445	15
X6	6	Fleet Management System, Ignition	o	5	6.75	15
X6	8	Power Feed, Gauge Pyrometer, Ignition	o	0.5	0.675	15
X6	9	12V Power Receptacle 2 (Dash, Phone), Battery	o	15	20.25	15
X6	10	Power Feed, Gauge Axle Temperature, Ignition	o	0.5	0.675	15
X6	11	Power Feed, Gauge Engine Oil Temp, Ignition	o	0.5	0.675	15
X6	12	Power Feed, Clock Cab, Battery	o	0.1	0.135	15
X6	13	Power Feed, Driver Information System, Battery	o	3	4.05	15
X6	14	Power Feed, Clock Sleeper, Battery	o	0.1	0.135	15
X6	15	12V Power Receptacle 1 (dash, cigar), Battery	o	15	20.25	15
X6	15	12V Power Receptacle 3 (sleeper, cigar), Battery	o	20	27	20
X6	16	Instrument Cluster, Ignition	o	4.6	6.21	10
X6	18	Instrument Cluster, Battery	o	3.78	5.103	5
X7	3	Sleeper HVAC Fan Motor, Battery	o	26	35.1	30
X7	4	Cabin HVAC Fan Motor, Battery	o	26	35.1	30
X8	1	Door Open, Driver side, Pull Down	i	0.04	0.054	—
X8	4	Door Control Driver, Battery	o	20	27	20
X8	5	Door Open Status	o	0.04	0.054	0.5
X8	6	Door Lock, Battery	o	12.4	16.74	20
X8	7	Power Window Driver Side, Accessory	o	10	13.5	15
X8	8	Mirror Heating Driver	o	10	13.5	10
X8	9	Door Sill Lamp Driver	o	0.7	0.945	1.9
X9	1	Body Builder Connector: Revolution	o	0.01	0.0135	1
X9	2	Body Builder Connector, Vehicle Speed	o	0.01	0.0135	1
X9	3	Function pin 1	o	0.2	0.27	2
X9	4	Body Builder Connector, Park Brake	o	0.04	0.054	2
X9	5	Function Pin 2	o	0.2	0.27	2

Maximum Current Pin List						
Connector	**Pin**	**Function**	**Type**	**Nominal Current (Amps)**	**Maximum Continuous Current (Amps)**	**Maximum Current (Amps)**
X9	6	Function Pin 4	o	0.2	0.27	2
X9	7	Function Pin 3	o	0.2	0.27	2
X9	9	Body Builder Connector, Backup Lamp	o	0.2	0.27	2
X9	10	Body Builder Connector, Marker Lights	o	0.2	0.27	2
X9	11	Body Builder Connector: Ignition	o	0.2	0.27	2
X9	12	Body Builder Connector: Tail Lights	o	0.2	0.27	2
X9	13	Body Builder Connector: Right Turn	o	0.2	0.27	2
X9	14	Body Builder Connector: Left Turn	o	0.2	0.27	2
X9	15	Body Builder Connector: Stop Lights	o	0.2	0.27	2
X10	1	Tire Pressure Monitoring, Ignition	o	0.1	0.135	2
X10	2	Inside Temperature Sensor, Propeller Control, Accessory	o	0.1	0.135	2
X10	3	Belt Buckle Contact Signal	i	0.04	0.054	—
X10	6	Vehicle Power Shut Down Signal (Optimized Idle)	i	0.02	0.027	—
X10	7	Service Brake Pressure Switch Supply (chopped)	o	0.05	0.0675	2
X10	9	Inside Temperature Sensor, Feedback	i	0.04	0.054	—
X10	10	Power Feed, Sleeper Thermostat (Optimized Idle), Ignition	o	0.04	0.054	1.7
X10	12	Not Connected	i	0.04	0.054	—
X10	13	Panel Lamps	o	4.2	5.67	9.35
X10	16	Tire Pressure Monitoring, Battery	o	2	2.7	15
X10	17	Wake-up, ICU (instrumentation control unit)	o	0.04	0.054	2
X10	18	Radio, Accessory	o	0.7	0.945	2
X11	1	Differential Lock ICU Indicator, RA2	o	0.13	0.1755	2
X11	2	Washer Level ICU Indicator	o	0.13	0.1755	2
X11	3	Electrical Global Fault Indicator (future use)	o	0.13	0.1755	2
X11	5	Differential Lock ICU Indicator, RA1	o	0.13	0.1755	2
X11	6	Low Air Pressure switch ICU Indicator	o	0.13	0.1755	2
X11	7	Lights ON Buzzer	o	0.03	0.0405	2
X11	8	Air Filter Restriction ICU Indicator	o	0.13	0.1755	2
X11	9	High Beam ICU Indicator	o	0.13	0.1755	2
X11	11	Turn Signal Left ICU Indicator	o	0.13	0.1755	2
X11	12	Alternator No Charge ICU Indicator	o	0.13	0.1755	2
X11	13	Turn Signal Right ICU Indicator	o	0.13	0.1755	2
X11	14	Park Brake Switch ICU Indicator	o	0.13	0.1755	2

Maximum Current Pin List						
Connector	**Pin**	**Function**	**Type**	**Nominal Current (Amps)**	**Maximum Continuous Current (Amps)**	**Maximum Current (Amps)**
X11	15	Rain/Light Sensor, LIN	comm	0.2	0.27	—
X11	17	Top of Clutch (cruise control disable)	i	0.02	0.027	—
X11	19	Auxiliary Telematic Unit, Battery	o	3.21	4.3335	20
X11	20	Bottom of Clutch (starter control)	i	0.02	0.027	—
X11	21	Rain/Light Sensor, Battery	o	1	1.35	3.2
X12	1	Rear Baggage Compartment Light Switch Center	i	0.02	0.027	—
X12	2	Rear Baggage Compartment Light Switch Left	i	0.02	0.027	—
X12	3	Footwell Light	o	1.1	1.485	2.8
X12	5	Rear Baggage Compartment Light Switch Right	i	0.02	0.027	—
X12	6	Reading Lamp 1 (dimmable/theater)	o	1.9	2.565	4.3
X12	9	General Sleeper Lamp	o	2.8	3.78	9.3
X12	12	Rear Baggage Compartment Lights	o	1.5	2.025	3.5
X12	15	Turn Left, Front Side	o	2.1	2.835	4.66
X12	16	Reading Lamp 2 (dimmable/theater)	o	1.5	2.025	3.5
X12	17	Dome Lamp, Rear	o	1.9	2.565	4.66
X12	18	Turn Right Front Side	o	2.1	2.835	3.5
X13	2	SAM Cab, Cabin CAN Low (–)	comm	0.2	0.27	0.2
X13	3	SAM Cab, Cabin CAN High (+)	comm	0.2	0.27	0.2
X13	4	Ignition Switch — Off	i	0.02	0.027	—
X13	5	Ignition Switch — Accessory	i	0.02	0.027	—
X13	6	Ignition Switch — On (ignition)	i	0.02	0.027	—
X13	7	Ignition Switch, Battery	o	0.1	0.135	0.2
X13	8	Park Brake Switch Feedback	i	0.05	0.0675	—
X13	9	Park Brake Switch Supply	o	0.05	0.0675	2
X13	10	Low Air Pressure Switch Feedback	i	0.05	0.0675	—
X13	11	Low Air Pressure Switch Supply (chopped)	o	0.05	0.0675	2
X13	12	Service Brake Pressure Switch Feedback	i	0.05	0.0675	—
X13	13	Horn Switch (microcontroller bypass)	i	0.02	0.027	—
X13	14	Start Enable — Crank Interlock	i	0.04	0.054	—
X14	1	12V Power Receptacle 5 (sleeper, cigar), Battery	o	20	27	20
X14	2	12V Power Receptacle 6 (sleeper, refrigerator), Battery	o	20	27	20
X15	1	Power Feed Spare Output V, Battery	o	10	13.5	25
X15	2	Power Feed Spare Output VI, Battery	o	10	13.5	25
X16	1	CD Player, Battery	o	2	2.7	15

Maximum Current Pin List						
Connector	**Pin**	**Function**	**Type**	**Nominal Current (Amps)**	**Maximum Continuous Current (Amps)**	**Maximum Current (Amps)**
X16	2	Lane Guidance, Ignition	o	5	6.75	9.35
X16	5	Auxiliary Circulation Fan — Windshield, Accessory	o	5	6.75	9.35
X16	7	Dome Lamp Cab, Battery	o	10	13.5	15
X16	8	Clearance Lamps front l	o	0.5	0.675	1.9
X16	11	Dome Lamp, Driver (forward overhead)	o	1.9	2.565	9.35
X16	13	Reading Lamp 4, Battery	o	3.5	4.725	15
X16	14	Dome Lamp, Passenger	o	1.9	2.565	9.35
X16	16	Spot Light	o	17	22.95	20
X16	17	Overhead Compartment Lights, Battery	o	1.94	2.619	3
X17	1	Power Window Passenger Side, Accessory	o	10	13.5	15
X17	2	Mirror heating Passenger	o	10	13.5	10
X17	3	Door Sill Lamp Passenger	o	0.7	0.945	1.9
X17	4	Door Control Passenger, Battery	o	20	27	20
X17	5	Door Open Passenger Side, Input	i	0.04	0.054	—
X17	7	Keyless Go/Keyless Entry, Battery	o	5	6.75	15
X18	5	Low Beam, Left	o	4.8	6.48	9.3
X18	6	High Beam, Left	o	4.8	6.48	10.3
X18	8	Marker Lamps, Corner Front Right	o	0.7	0.945	1.7
X18	9	Turn Right Front Corner	o	2.5	3.375	4.66
X18	11	Hood Tilt Switch Signal (Optimized Idle)	i	0.04	0.054	—
X18	12	Marker Lamps, Front Right	o	0.7	0.945	1.7
X18	14	Marker Lamps, Front Left	o	0.7	0.945	1.7
X18	15	DRL (daytime running light), Right	o	2.5	3.375	4.2
X18	16	Marker Lamps, Corner Front Left	o	0.7	0.945	1.7
X18	17	High Beam, Right	o	4.8	6.48	10.3
X18	18	DRL (daytime running light), Left	o	2.5	3.375	4.2
X18	19	Turn Left Front Corner	o	2.5	3.375	4.2
X18	20	Low Beam, Right	o	4.8	6.48	9.3
X18	21	Horn (electric), Ground	o	12.2	16.47	24.2
X19	3	Starter Relay	o	3	4.05	9.35
X19	6	A/C Compressor Clutch	o	5	6.75	9.35
X19	9	Activate PTO Solenoid, Control	o	2	2.7	4.66
X19	10	HVAC Pressure Transducer, Feedback	i	0.05	0.0675	—
X19	11	Air Intake Warmer/Grid Heater, Ignition	o	2.2	2.97	9.35

Maximum Current Pin List						
Connector	**Pin**	**Function**	**Type**	**Nominal Current (Amps)**	**Maximum Continuous Current (Amps)**	**Maximum Current (Amps)**
X19	13	Air Filter Restriction Sensor, Ignition	o	0.02	0.027	2
X19	14	Hood Tilt Switch Signal Supply (Optimized Idle, Chopped)	o	0.05	0.0675	2
X19	15	Air Filter Restriction Sensor, Signal	i	0.02	0.027	—
X19	16	Hood Tilt and Neutral and Park Brake (Optimized Idle)	o	0.04	0.054	2
X19	17	HVAC Pressure Transducer, Supply (+5V)	o	0.05	0.0675	0.1
X19	18	Engine ECU, Ignition	o	0.8	1.08	1.9
X19	19	PTO Response (Feedback)	i	0.02	0.027	—
X19	20	Ether Start Power, Ignition	o	1.5	2.025	4.66
X19	21	PTO Solenoid Activated	o	2	2.7	4.66
X20	8	Fog Lamp, Front Left	o	4.8	6.48	10.5
X20	10	High Beam Auxiliary, Left	o	4.8	6.48	10.5
X20	11	Low Beam Auxiliary, Left	o	4.8	6.48	10.5
X20	12	High Beam Auxiliary, Right	o	4.8	6.48	10.5
X20	13	Temperature Sensor Outside Air Gauge, Ignition	o	0.5	0.675	1.7
X20	14	Low Beam Auxiliary, Right	o	4.8	6.48	10.2
X20	15	Turn Right, Front Side	o	2.1	2.835	3.5
X20	16	Temperature Sensor Outside Air, Feedback	i	0.04	0.054	—
X20	17	Fog Lamp, Front Right	o	4.8	6.48	10.5
X20	19	Distance Sensor (Adaptive Cruise Control), Battery	o	1	1.35	20
X20	20	Washer Pump, Control	o	4.6	6.21	10.5
X20	21	Washer Fluid Level, Feedback	i	0.04	0.054	—
X21	8	Alternator Charging	i	0.04	0.054	—
X21	9	Wiper Parked	i	0.02	0.027	—
X21	10	Horn (pneumatic), Control	o	0.75	1.0125	1.5
X21	11	Turn Left Front Side	o	2.1	2.835	4.66
X21	12	Wiper Low	o	9	12.15	18.5
X21	13	LVD Sense, Battery/Emergency Supply	i	20	27	—
X21	14	Utility Light	o	12.6	17.01	25
X21	15	Wiper High	o	13	17.55	26.7

Table 6, SAM Cab Maximum Current Pin List

Table of Contents

500 — Terms and Abbreviations

Baud rate—The rate at which data is transmitted in bits per second.

Cabin CAN—A proprietary datalink connecting certain ECUs on the vehicle, specifically the CGW, MSF, SAM Cab, and SAM Chassis.

CAN—Controller Area Network

CAN ID—The identifier for a specific message, which also contains the source address of the sending ECU communicating on the J1939 datalink.

CGW—Central Gateway

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Datalink Topology—The arrangement in which the nodes (ECUs) of a datalink are connected to each other.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

Diagnostic Connector—A 9-pin diagnostic connector is used for troubleshooting the electrical system.

EAPU—Electric Air Processing Unit

FMI—Failure Mode Indicator. The part of a J1587, J1939, and CAN fault code that identifies how part of a device, or item on a device, failed.

I/O Controls—Input/Output controls allow a technician to activate and deactivate an input or output pin for troubleshooting purposes. I/O controls appear on ServiceLink templates as buttons, typically labeled "ON" and "OFF."

MSF—Modular Switch Field

NO—Normally Open

NC—Normally Closed

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

Parameter—A parameter is a specific value that is assigned to a feature or function of the vehicle, and allows the customer to choose how that particular feature or function will work on the vehicle.

PDM—Power Distribution Module

SA—Source Address; indicates numeric assignment for a device that communicates on J1939.

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality.

SPN—Suspect Parameter Number. The part of a J1939 or CAN fault code that identifies how part of a device, or item on a device, failed.

WIF—Water In Fuel

501 — General Information

The SAM Chassis is an ECU (Electronic Control Unit). "SAM" stands for "Signal Detect and Actuation Module."

The SAM Chassis works closely with the SAM Cab to control much of the vehicle functionality. The SAM Chassis controls most of the chassis functions, and the SAM Cab controls most of the cab functions.

This ECU uses inputs (such as switches, sensors, and datalink messages), and drives many outputs (such as lights, motors, and solenoids). See **601 — Component Details** for complete pin information.

To understand a particular function or system that the SAM Chassis controls, see the applicable subject in this manual. These subjects contain details about the way the function should work, as well as crucial information such as inputs, outputs, interlocks, any related parameters for that particular function, and any other ECUs or components that are a part of that function.

502 — Fuses and Relays

See **601 — Component Details** for fuse and relay information.

For more information on the power distribution system, see **G02.01 — Electrical System and Main PDM Overview**.

503 — Datalink Connections

The SAM Chassis is connected directly to the Cabin CAN datalink. Cabin CAN wires run from the SAM Chassis to the starpoint connector, where it joins the rest of the Cabin CAN datalink.

See **G03.03 — Datalink, Cabin CAN** for details.

504 — Diagnostic CAN Datalink

When an off-board tool, such as ServiceLink, is connected to the vehicle, it communicates with the Cabin CAN ECUs via the Diagnostics CAN datalink; there is no accessible service port to the Cabin CAN. The CGW translates between the Diagnostics CAN and Cabin CAN datalink, due to the different speed and message formats of the two datalinks.

505 — Functional Messaging and ECU Troubleshooting

To communicate with the ECU, a different set of messages is used by the off-board tool during troubleshooting than the set of messages used during normal operation.

The set of messages used during normal operation is referred to as functional messages, which are sent cyclically on the Cabin CAN datalink. However, the set of messages (protocol) used during troubleshooting is referred to as Control Area Network (CAN), which operates on a request-and-response basis over the Diagnostic CAN datalink.

Any fault reported on the Cabin CAN is translated to Diagnostics CAN by the CGW, and can be displayed when requested by an off-board tool, such as ServiceLink. Similarly, an off-board tool is able to display input and output pin status information, software interlocks, and allows a user to control inputs or outputs for troubleshooting. This information is displayed in ServiceLink's Datalink Monitor (DLM) templates.

506 — ECU Configuration

The diagnostic protocol used for troubleshooting or configuring the SAM Chassis is the Control Area Network (CAN). For more information on CAN, see **G03.04 — Datalink, Diagnostic CAN**.

The SAM Chassis has parameters that can be viewed or changed for vehicle configuration.

The SAM Chassis software can be flashed using ServiceLink, which will flash to its same version or upgrade, if required.

The software flashing procedure should only be performed on the SAM Chassis in the following cases:

- **As a last resort:** Troubleshooting has narrowed the problem down to being at the SAM Chassis itself and no other mechanical or electrical causes for the symptom have been identified. As a last resort, flashing the SAM Chassis software with the same version may help in the case it became corrupt during the course of normal vehicle operation.
- **For a feature upgrade:** Adding a new feature to a vehicle may require a newer version of ECU software. ServiceLink will automatically make available any necessary software upgrades.
- **Fixing a problem in the existing software:** In case a new version of ECU software is needed to fix a problem in the existing ECU software, ServiceLink will automatically make available any necessary software upgrades.
- **Replacing the SAM Chassis:** Flashing ensures that the most recent software is on the installed ECU.

For instructions on how to use ServiceLink to flash the software of a CAN ECU like the SAM Chassis, refer to the *ServiceLink User Guide* or *ServiceLink Help* user documentation, available in ServiceLink's "Help" menu.

507 — Datalink Network Topology

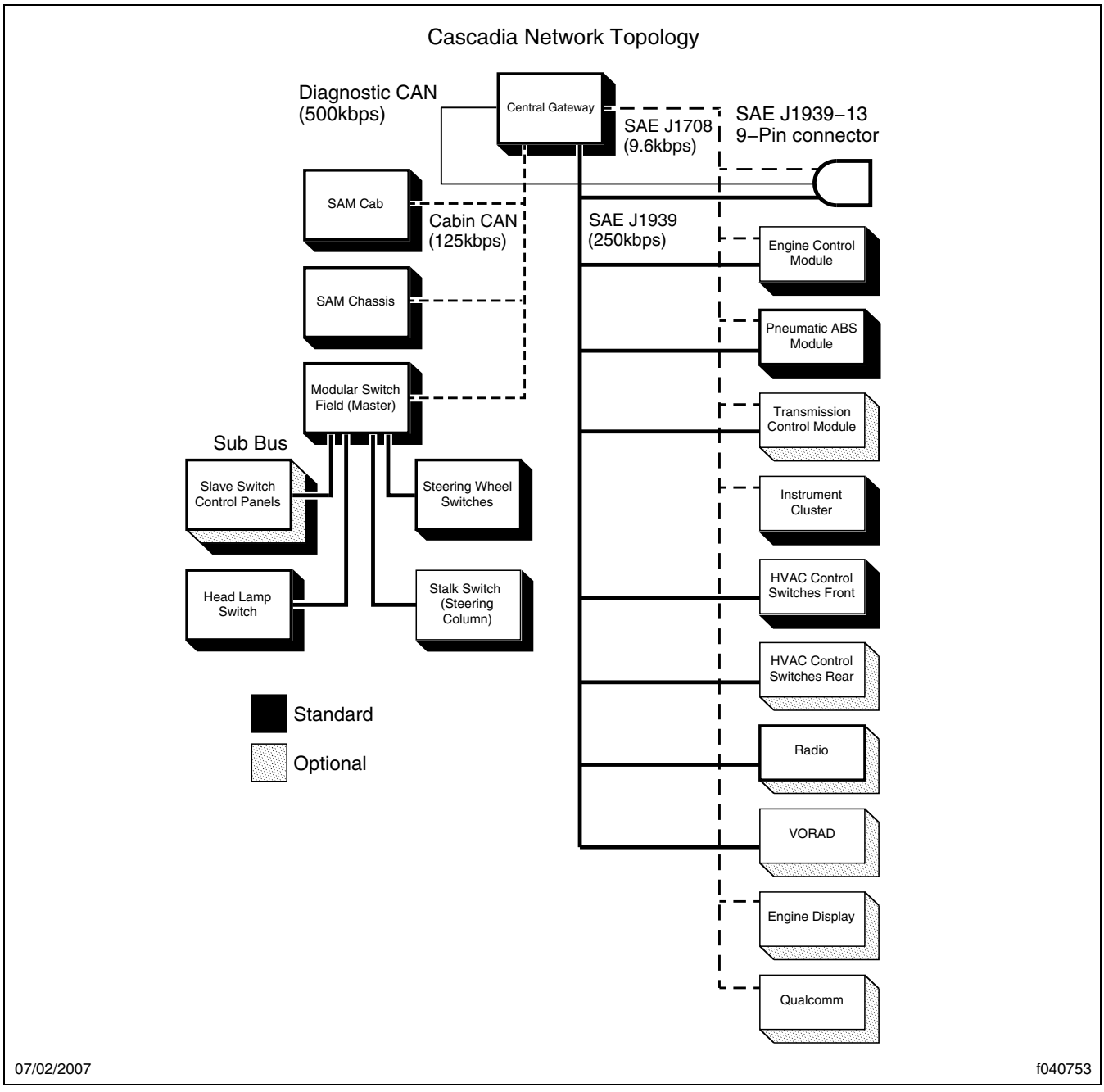
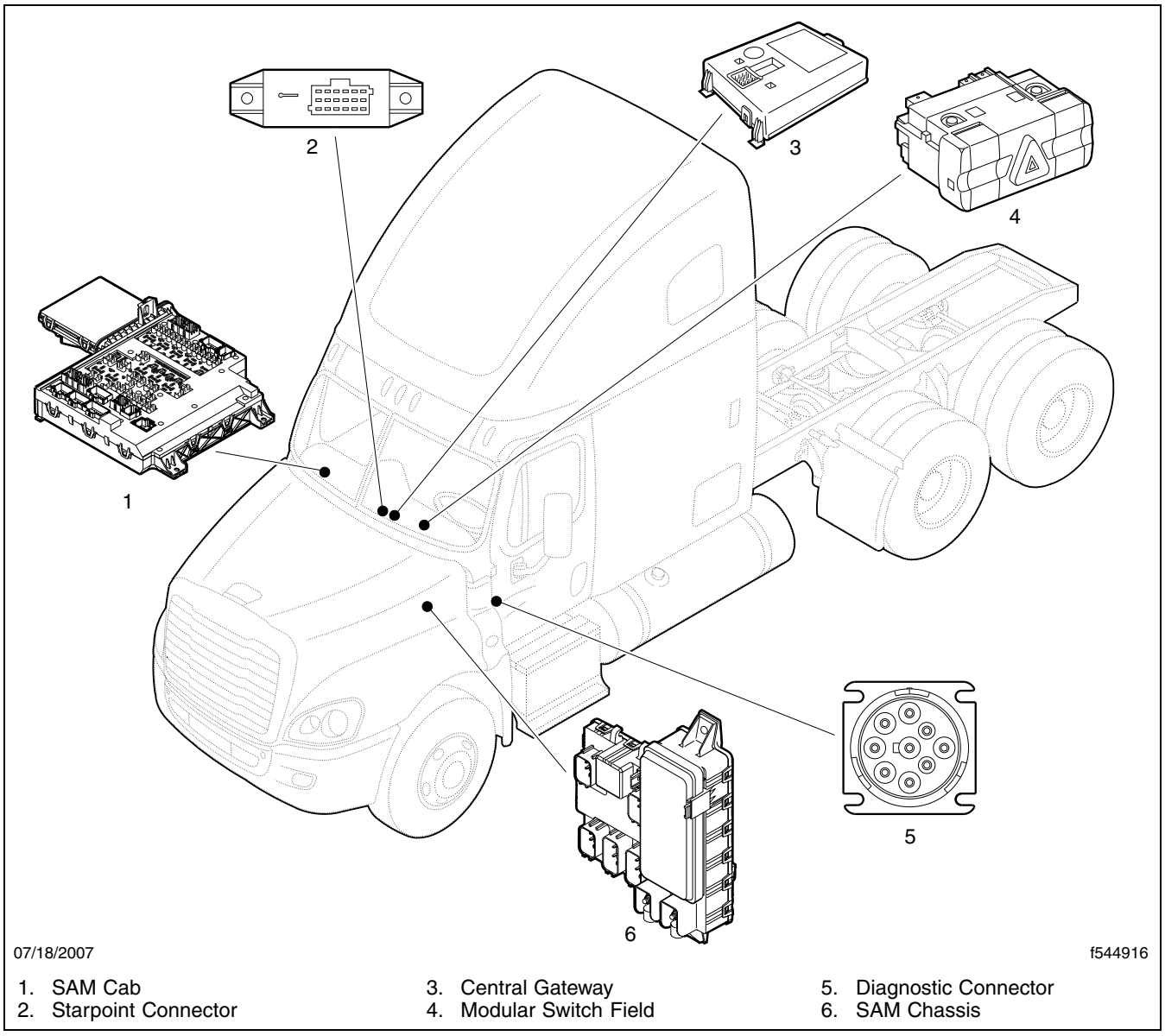


Fig. 1, Datalink Network Topology

600 — Component Locations



1. SAM Cab
2. Starpoint Connector
3. Central Gateway
4. Modular Switch Field
5. Diagnostic Connector
6. SAM Chassis

Fig. 2, Component Locations

601 — Component Details

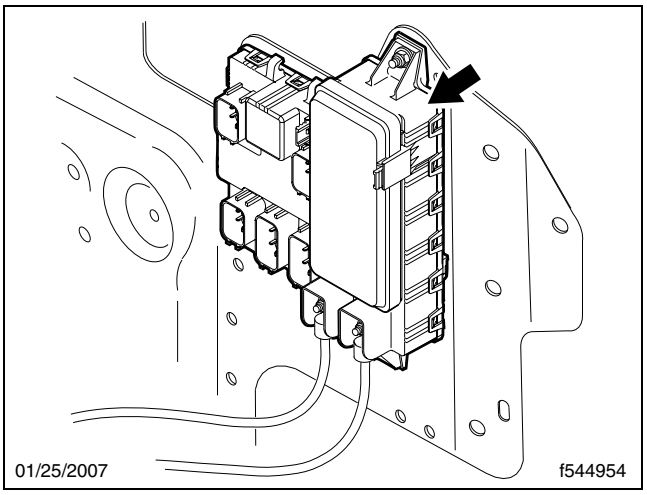


Fig. 3, View of the SAM Chassis on the Frontwall

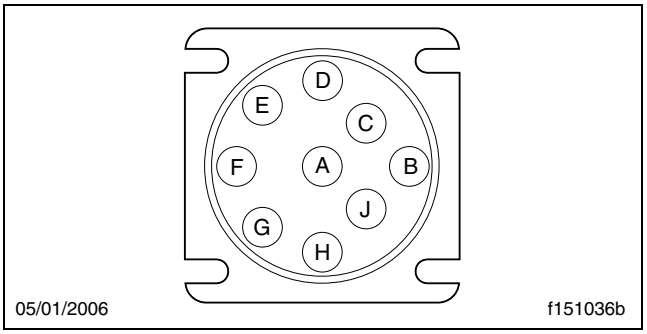


Fig. 4, Diagnostic Connector

Diagnostic Connector	
Pin	**Function**
A	Battery (–)
B	Battery (+)
C	J1939 CAN High (+)
D	J1939 CAN Low (–)
E	CAN Shield (ground)
F	J1708/J1587 (+)
G	J1708/J1587 (–)
H	Diagnostic CAN High (+)
J	Diagnostic CAN Low (–)

Table 1, Diagnostic Connector

602 — Pinout Mapping

NOTE: The housing of the SAM Cab contains raised lettering, labeling all connectors, fuses, and relays.

The SAM Chassis is available in different hardware models: Highline, Midline, and Baseline. **Table 2** describes any differences in pin functionality between these hardware models

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X51	1	SAM Chassis, Cabin CAN Low (-)	SAM Chassis, Cabin CAN Low (-)	SAM Chassis, Cabin CAN Low (-)
X51	2	SAM Chassis, Cabin CAN High (+)	SAM Chassis, Cabin CAN High (+)	SAM Chassis, Cabin CAN High (+)
X51	3	Hardwired ISS (Ignition Switch Status), SAM Chassis	Hardwired ISS (Ignition Switch Status), SAM Chassis	Hardwired ISS (Ignition Switch Status), SAM Chassis
X51	4	Not connected	Not connected	Not connected
X51	5	Emergency Battery, SAM Chassis	Emergency Battery, SAM Chassis	Emergency Battery, SAM Chassis
X51	6	Not connected	Not connected	Not connected
X52	1	Marker Lamp, Side Right	Marker Lamp, Side Right	Marker Lamp, Side Right
X52	2	Marker Lamp, Side Right, Ground	Marker Lamp, Side Right, Ground	Marker Lamp, Side Right, Ground
X52	3	Marker Lamp, Corner Rear Right	Marker Lamp, Corner Rear Right	Marker Lamp, Corner Rear Right
X52	4	Power Feed 2, ABS/BS, Battery	Power Feed 2, ABS/BS, Battery	Power Feed 2, ABS/BS, Battery
X52	5	Marker Lamp, Corner Rear Right, Ground	Marker Lamp, Corner Rear Right, Ground	Marker Lamp, Corner Rear Right, Ground
X52	6	Power Feed, ABS/BS, Ignition	Power Feed, ABS/BS, Ignition	Power Feed, ABS/BS, Ignition
X52	7	Power Feed 1, ABS/BS, Battery	Power Feed 1, ABS/BS, Battery	Power Feed 1, ABS/BS, Battery
X52	8	Power Feed 1, ABS/BS, Ground	Power Feed 1, ABS/BS, Ground	Power Feed 1, ABS/BS, Ground
X52	9	Power Feed 2, ABS/BS, Ground	Power Feed 2, ABS/BS, Ground	Power Feed 2, ABS/BS, Ground
X53	1	Marker Lamp, Side Left	Marker Lamp, Side Left	Marker Lamp, Side Left
X53	2	Marker Lamp, Corner Rear Left	Marker Lamp, Corner Rear Left	Marker Lamp, Corner Rear Left
X53	3	Rear View Camera, Ignition	Not connected	Rear View Camera, Ignition
X53	4	Marker Lamp, Corner Rear Left, Ground	Marker Lamp, Corner Rear Left, Ground	Marker Lamp, Corner Rear Left, Ground
X53	5	Trailer ABS Connector (7), ABS Detection	Trailer ABS Connector (7), ABS Detection	Trailer ABS Connector (7), ABS Detection
X53	6	Rear View Camera, Ground	Not connected	Rear View Camera, Ground

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X53	7	Trailer Turn Lamp Right	Trailer Turn Lamp Right	Trailer Turn Lamp Right
X53	8	Marker Lamp, Side Left, Ground	Marker Lamp, Side Left, Ground	Marker Lamp, Side Left, Ground
X53	9	Trailer Turn Lamp Left	Trailer Turn Lamp Left	Trailer Turn Lamp Left
X54	1	Trailer ABS Connector (7), Ignition	Trailer ABS Connector (7), Ignition	Trailer ABS Connector (7), Ignition
X54	2	Not connected	Not connected	Not connected
X54	3	Trailer ABS Connector (7), Ground 1 (GND1)	Trailer ABS Connector (7), Ground 1 (GND1)	Trailer ABS Connector (7), Ground 1 (GND1)
X54	4	Not connected	Not connected	Not connected
X55	1	Trailer Power, Battery or Ignition	Trailer Power, Battery or Ignition	Trailer Power, Battery or Ignition
X55	2	Trailer Marker Lamps	Trailer Marker Lamps	Trailer Marker Lamps
X55	3	Trailer Tail Lamps	Trailer Tail Lamps	Trailer Tail Lamps
X55	4	Trailer Stop Lamps	Trailer Stop Lamps	Trailer Stop Lamps
X56	1	Trailer, Ground 2 (GND2)	Not connected	Not connected
X56	2	End of Frame Primary Trailer Power	Not connected	Not connected
X56	3	Not connected	Not connected	Not connected
X56	4	Differential Lock Solenoid Return, FA1 and FA2	Not connected	Not connected
X56	5	Differential Lock Feedback Switch Return, FA1	Not connected	Not connected
X56	6	Differential Lock Feedback Switch Return, FA2	Not connected	Not connected
X56	7	End of Frame Primary Trailer Turn Lamps Right	Not connected	Not connected
X56	8	Differential Lock Feedback Switch Supply (Chopped), FA2	Not connected	Not connected
X56	9	Not connected	Not connected	Not connected
X56	10	End of Frame Primary Trailer Turn Lamps Left	Not connected	Not connected
X56	11	Differential Lock Feedback Switch Supply (Chopped), FA1	Not connected	Not connected
X56	12	Differential Lock Solenoid Driver, FA1 and FA2	Not connected	Not connected
X56	13	End of Frame Primary Trailer Tail Lamps	Not connected	Not connected
X56	14	End of Frame Primary Trailer Stop Lamps	Not connected	Not connected

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X56	15	End of Frame Primary Trailer Marker Lamps	Not connected	Not connected
X57	1	Power Feed EAPU / WIF Module, Ignition	Not connected	Power Feed EAPU / WIF Module, Ignition
X57	2	Power Feed EAPU (Air Processing Unit), Ground	Not connected	Power Feed EAPU (Air Processing Unit), Ground
X57	3	Air Dryer (Pneumatic, Electrically Heated), Ground	Air Dryer (Pneumatic, Electrically Heated), Ground	Air Dryer (Pneumatic, Electrically Heated), Ground
X57	4	Air Dryer (Pneumatic, Electrically Heated), Accessory	Air Dryer (Pneumatic, Electrically Heated), Accessory	Air Dryer (Pneumatic, Electrically Heated), Accessory
X57	5	Fuel Water Separator Heater Element, Ground	Fuel Water Separator Heater Element, Ground	Fuel Water Separator Heater Element, Ground
X57	6	Not connected	Not connected	Not connected
X57	7	Not connected	Not connected	Not connected
X57	8	Not connected	Not connected	Not connected
X57	9	Not connected	Not connected	Not connected
X57	10	Not connected	Not connected	Not connected
X57	11	Not connected	Not connected	Not connected
X57	12	Not connected	Not connected	Not connected
X57	13	Power Feed EAPU (Air Processing Unit), Battery	Not connected	Power Feed EAPU (Air Processing Unit), Battery
X57	14	Not connected	Not connected	Not connected
X57	15	Fuel Water Separator Heater Element, Ignition	Fuel Water Separator Heater Element, Ignition	Fuel Water Separator Heater Element, Ignition
X58	1	Turn Right Rear Lower	Turn Right Rear Lower	Turn Right Rear Lower
X58	2	Not connected	Not connected	Not connected
X58	3	Tail Lamp Right	Tail Lamp Right	Tail Lamp Right
X58	4	Marker Lamp, Side Left, Ground	Marker Lamp, Side Left, Ground	Marker Lamp, Side Left, Ground
X58	5	Tail Lamps Right, Ground	Tail Lamps Right, Ground	Tail Lamps Right, Ground
X58	6	Not connected	Not connected	Not connected
X58	7	Fuel Level Sensor, Feedback	Fuel Level Sensor, Feedback	Fuel Level Sensor, Feedback
X58	8	Tail Lamps Left, Ground	Tail Lamps Left, Ground	Tail Lamps Left, Ground
X58	9	Not connected	Not connected	Not connected
X58	10	Turn Left Rear Lower	Turn Left Rear Lower	Turn Left Rear Lower
X58	11	Not connected	Not connected	Not connected
X58	12	License Plate Lamp (First)	License Plate Lamp (First)	License Plate Lamp (First)

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X58	13	Marker Lamp Side Right	Marker Lamp Side Right	Marker Lamp Side Right
X58	14	Marker Lamp Side Right, Ground	Marker Lamp Side Right, Ground	Marker Lamp Side Right, Ground
X58	15	Fuel Level Sensor, Ground	Fuel Level Sensor, Ground	Fuel Level Sensor, Ground
X58	16	Marker Lamp, Side Left	Marker Lamp, Side Left	Marker Lamp, Side Left
X58	17	Not connected	Not connected	Not connected
X58	18	Tail Lamp Left	Tail Lamp Left	Tail Lamp Left
X58	19	Backup Lamp 1	Backup Lamp 1	Backup Lamp 1
X58	20	Stop Lamp, Rear Right Lower	Stop Lamp, Rear Right Lower	Stop Lamp, Rear Right Lower
X58	21	Stop Lamp, Rear Left Lower	Stop Lamp, Rear Left Lower	Stop Lamp, Rear Left Lower
X59	1	Backup Switch, Supply	Backup Switch, Supply	Backup Switch, Supply
X59	2	Transmission Neutral Switch, Supply	Transmission Neutral Switch, Supply	Transmission Neutral Switch, Supply
X59	3	Backup Switch, Return	Backup Switch, Return	Backup Switch, Return
X59	4	Not connected	Not connected	Not connected
X59	5	Not connected	Not connected	Not connected
X59	6	Not connected	Not connected	Not connected
X59	7	Not connected	Not connected	Not connected
X59	8	Not connected	Not connected	Not connected
X59	9	Fuel Water Separator Sensor, Feedback	Not connected	Fuel Water Separator Sensor, Feedback
X59	10	Temperature Sensor Rear Axle 1, Feedback	Temperature Sensor Rear Axle 1, Feedback	Temperature Sensor Rear Axle 1, Feedback
X59	11	Differential Lock Solenoid Driver, RA1 and RA2	Differential Lock Solenoid Driver, RA1 and RA2	Differential Lock Solenoid Driver, RA1 and RA2
X59	12	Not connected	Not connected	Not connected
X59	13	Temperature Sensor Rear Axle 2, Feedback	Temperature Sensor Rear Axle 2, Feedback	Temperature Sensor Rear Axle 2, Feedback
X59	14	Temperature Sensor Rear Axle 2, Ground	Temperature Sensor Rear Axle 2, Ground	Temperature Sensor Rear Axle 2, Ground
X59	15	Differential Lock Feedback Switch Return, RA1	Differential Lock Feedback Switch Return, RA1	Differential Lock Feedback Switch Return, RA1
X59	16	Differential Lock Solenoid Return, RA1 and RA2	Differential Lock Solenoid Return, RA1 and RA2	Differential Lock Solenoid Return, RA1 and RA2
X59	17	Temperature Sensor Rear Axle 1, Ground	Temperature Sensor Rear Axle 1, Ground	Temperature Sensor Rear Axle 1, Ground
X59	18	Transmission Neutral Switch, Return	Transmission Neutral Switch, Return	Transmission Neutral Switch, Return

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X59	19	Differential Lock Feedback Switch Supply (Chopped), RA1	Differential Lock Feedback Switch Supply (Chopped), RA1	Differential Lock Feedback Switch Supply (Chopped), RA1
X59	20	Differential Lock Feedback Switch Supply (Chopped), RA2	Differential Lock Feedback Switch Supply (Chopped), RA2	Differential Lock Feedback Switch Supply (Chopped), RA2
X59	21	Differential Lock Feedback Switch Return, RA2	Differential Lock Feedback Switch Return, RA2	Differential Lock Feedback Switch Return, RA2

Table 2, Pinout Mapping

603 — Fuse Mapping

Fuse Mapping					
Fuse	Fuse Name	Rating	Connection	Pin	Function
F1	EAPU	20	X57	13	Power Feed Air Processing Unit, BAT
F2	H2O SEP HEAT	20	X57	15	Fuel Water Heater, IGN
F3	ABS-BAT1	20	X52	7	Power Feed 1 ABS, BAT
F4	ABS-BAT2	10	X52	4	Power Feed 2 ABS, BAT
F5	TRLR TRN L	20	X53	9	Trailer Turn Lamp Left
F6	ABS-IGN	15	X52	6	Power Feed ABS, IGN
F7	WIF/CAMERA	10	X53	3	Rear View Camera
			X57	1	Power Feed EAPU, IGN
F8	TRLR TRN R	20	X53	7	Trailer Turn Lamp Right
F9	TRLR MKR	30	X55	2	Trailer Marker Lamps
F10	SAM RELAY COILS	5	N/A	N/A	Battery Feed for Relay Coils
F11	TRLR ABS-IGN	30	X54	1	Trailer ABS, IGN
F12	TRLR STOP	30	X55	4	Trailer Stop Lamps
F13	TRLR TAIL	20	X55	3	Trailer Tail Lamps
F14	TRLR PWR	30	X55	1	Trailer Power, BAT or IGN

Table 3, Fuse Mapping

604 — Relay Mapping

Relay Mapping									
Relay	Relay Name	Relay Coil (low current side)		Relay (high current side)			Conn.	Pin	Circuits Supplied
		Control (-) (86)	Control (+) (85)	Common (30)	Type	Suppl. Pwr To			
R1	H2O SEP HEAT, IGN	SAM Micro	F10 (batt power)	Batt	NO	F2	X57	15	Fuel Water Heater, IGN
R2	TRLR TRN L	SAM Micro	F10 (batt power)	Batt	NO	F5	X53	9	Trailer Turn Lamp Left
R3	ABS/WIF/ CAMERA, IGN	SAM Micro	F10 (batt power)	Batt	NO	F6	X52	6	Power Feed ABS, IGN
						F7	X53	3	Rear View Camera
							X57	1	Power Feed EAPU, IGN
R4	TRLR TRN R	SAM Micro	F10 (batt power)	Batt	NO	F8	C53	7	Trailer Turn Lamp Right
R5	TRLR MARKER	SAM Micro	F10 (batt power)	Batt	NO	F9	X55	2	Trailer Marker Lamps
R6	TRLR ABS-IGN	SAM Micro	F10 (batt power)	Batt	NO	F11	X54	1	Trailer ABS, IGN
R7	TRLR STOP LAMPS	SAM Micro	F10 (batt power)	Batt	NO	F12	X55	4	Trailer Stop Lamps
R8	TRLR POWER	SAM Micro	F10 (batt power)	Batt	NO*	F14	X55	3	Trailer Power, BAT or IGN
R9	TRLR TAIL LAMPS	SAM Micro	F10 (batt power)	Batt	NO	F13	X55	1	Trailer Tail Lamps

* R8 is a single throw relay, it will only have 4 prongs. Either pin 87 or pin 87a will be missing, depending on the intended functionality of the circuit. If prong 87a is missing the circuit will be normally open, the trailer power circuit is enabled only if the key is in IGN position or enabled through a switch (depending on SAM parameterization). If prong 87 is missing, the circuit is normally closed (BAT). If a 5 prong relay is used, the trailer power will be always on.

Table 4, Relay Mapping

700 — Troubleshooting Overview

If the symptom is function- or system-specific (stop lights do not function, for example), refer to the applicable subject in this manual.

In ServiceLink, use the CAN protocol to troubleshoot or configure the SAM Chassis, via the Diagnostic CAN datalink. See **601 — Component Details** for the Diagnostic CAN pins in the diagnostic connector.

For more information on the Diagnostic CAN datalink, see **G03.04 — Datalink, Diagnostic CAN**.

701 — Required Tools

- ServiceLink

702 — Possible Causes

- Wiring (bad/loose connection, corrosion, miswiring, etc.)
- SAM Chassis relays

- SAM Chassis fuses
- SAM Chassis parameters
- SAM Chassis ECU software
- Cabin CAN datalink
- Other ECUs on the Cabin CAN datalink
- Diagnostic CAN datalink

703 — Fault Codes

CAN Fault, SAM Chassis				
SA	**SPN**	**FMI**	**Fault Description**	**Fault Trigger**
71	168	3	Electrical Potential (Voltage) – voltage above normal, or shorted to high	**Trigger:** SAM Chassis battery voltage sensed to be above normal, or shorted to high. Reflects battery voltage datalink value from the SAM Cab ECU. **Action:** Check power feed wiring to the SAM Cab and the SAM Chassis. Check alternator charging wiring.
71	168	4	Electrical Potential (Voltage) – voltage below normal, or shorted to low	**Trigger:** SAM Chassis battery voltage sensed to be below normal, or shorted to low. Reflects battery voltage datalink value from the SAM Cab ECU. **Action:** Check power feed wiring to the SAM Cab and the SAM Chassis. Check alternator charging wiring.
71	520201	3	CAN low – voltage above normal, or shorted to high source	**Trigger:** The Cabin CAN Low (–) pin is shorted to battery, or high source. **Vehicle Behavior:** In the case of a serious error with the Cabin CAN datalink, SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode. **Action:** Check the Cabin CAN harness, especially in connection to the SAM Chassis. Verify proper connection of the Cabin CAN harness to the SAM Chassis.
71	520201	4	CAN low – voltage below normal, or shorted to low source	**Trigger:** The Cabin CAN Low (–) pin shorted to ground, or low source. **Vehicle Behavior:** In case of a serious error with the Cabin CAN datalink, SAM Cab, and SAM Chassis outputs may be behaving according to Emergency Power Mode. **Action:** Check the Cabin CAN harness, especially in connection to the SAM Chassis. Verify proper connection of the Cabin CAN harness to the SAM Chassis.

CAN Fault, SAM Chassis				
SA	**SPN**	**FMI**	**Fault Description**	**Fault Trigger**
71	520202	3	CAN high – voltage above normal, or shorted to high source	**Trigger:** The Cabin CAN High (+) pin shorted to battery, or high source. In the case of a serious error with the Cabin CAN datalink, SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode. **Action:** Check the Cabin CAN harness, especially in connection to the SAM Chassis. Verify proper connection of the Cabin CAN harness to the SAM Chassis.
71	520202	4	CAN high – voltage below normal, or shorted to low source	**Trigger:** The Cabin CAN High (+) pin shorted to ground, or low source. In the case of a serious error with the Cabin CAN datalink, SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode. **Action:** Check Cabin CAN harness, especially in connection to the SAM Chassis. Verify proper connection of the Cabin CAN harness to the SAM Chassis.
71	523511	31	Cabin CAN bus performance condition exists	**Trigger:** A problem is detected with Cabin CAN performance. In the case of a serious problem with the Cabin CAN datalink, the SAM Cab and/or SAM Chassis may be running in Emergency Power Mode. **Action:** Check Cabin CAN wiring.
71	524033	31	Lost communication with the SAM Cab	**Trigger:** The SAM Chassis did not receive heartbeat messages from the SAM Cab. **Vehicle Behavior:** SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode for a SAM Cab failure. An indication of a SAM Cab failure is that all gauges in the instrumentation control unit (ICU) drop to zero because power to the ICU is lost. **Action:** Check Cabin CAN wiring, especially connections to the SAM Cab and SAM Chassis. Check SAM Cab power supply cables.
71	524037	31	Lost communication with the CGW	**Trigger:** The SAM Chassis did not receive heartbeat messages from the CGW. **Action:** Check Cabin CAN wiring, especially connections to the CGW and the SAM Chassis. Check CGW power supply fuse and wiring.
71	524049	31	Lost communication with the MSF	**Trigger:** The SAM Chassis did not receive heartbeat messages from the MSF. **Vehicle Behavior:** Headlights automatically turn on for safety. All functions where input switches are controlled by the MSF do not function, such as turn and hazard functions, rotary switch (headlamp) functions, and wiper. **Action:** Check Cabin CAN wiring, especially connections to the MSF and the SAM Chassis.

Table 5, CAN Fault, SAM Chassis

704 — Fused and Relayed Outputs

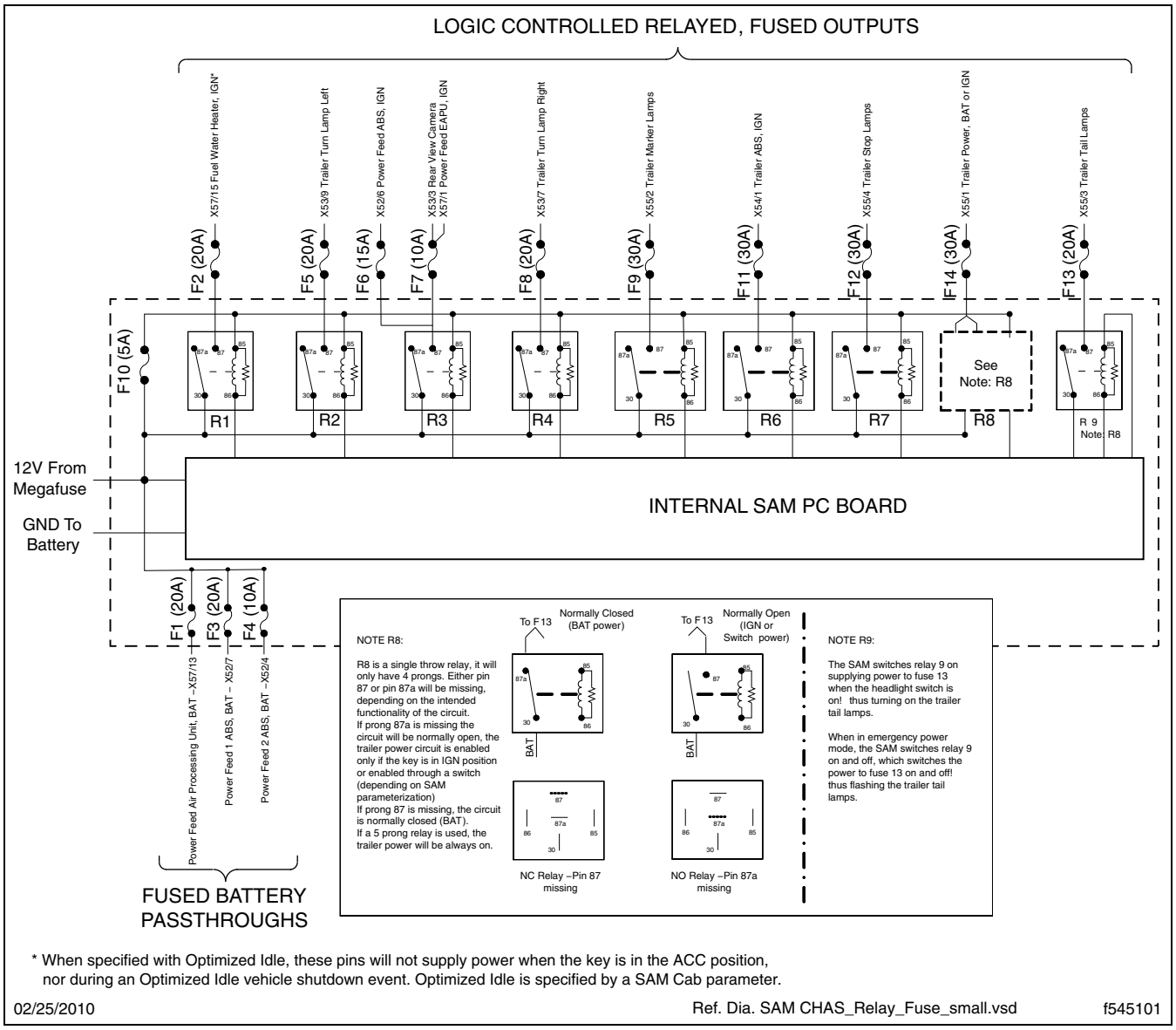


Fig. 5, Fused and Relayed Outputs

705 — Unfused Outputs, Grounded Pins, and Inputs

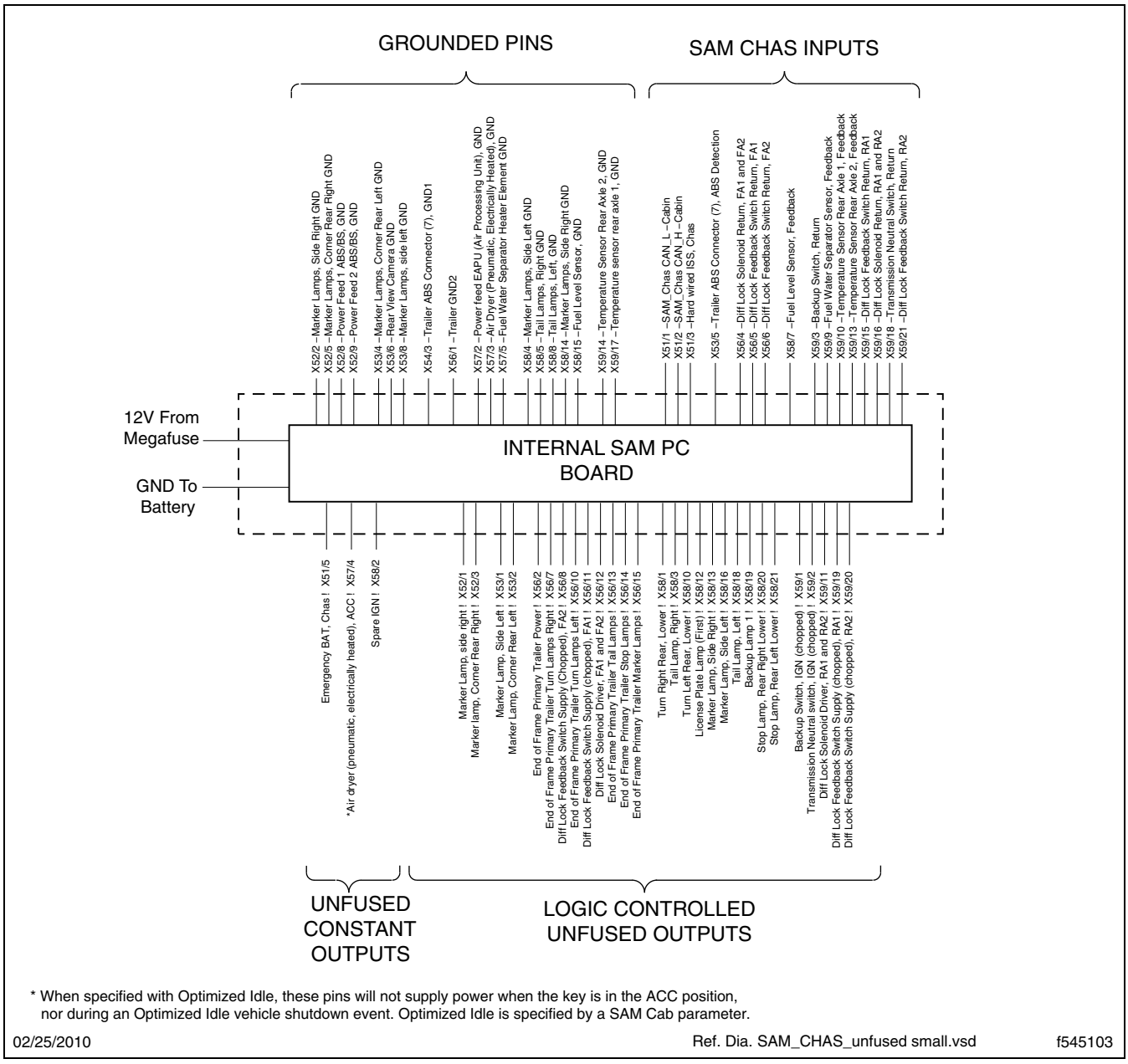


Fig. 6, Unfused Outputs, Grounded Pins, and Inputs

706 — Logic Controlled Unfused Outputs

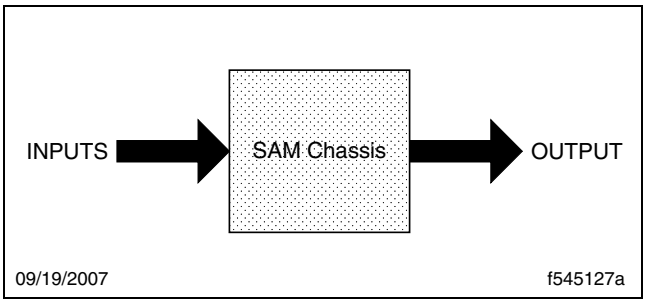


Fig. 7, SAM Unfused Inputs and Outputs

1. **Determine if the template has I/O controls available for the affected function.**

   Open the Datalink Monitor template for the function or output that is not functioning.

   Are I/O control buttons available for the affected function?

   YES →Go to test 2.

   NO →Go to test 5.

2. **Use the I/O control feature in Datalink Monitor to test the output circuit.**

   Does the function or output work when activated with Datalink Monitor?

   YES →Go to test 3.

   NO →Go to test 4.

3. **Use Datalink Monitor to determine if input conditions are met for the function or output to operate.**

   Are all of the input conditions met?

   YES →Check SAM Chassis programming and parameters. For additional programming/parameter information specific to this function, refer to the applicable subject in this manual. If programming/parameters are OK, replace the SAM Chassis.

   NO →For additional input troubleshooting specific to this function, refer to the applicable subject in this manual.

4. **Rule out the output by manually applying fused power and ground.**

   Does the function or output work when power and ground are applied manually?

   YES →Replace the SAM Chassis.

   NO →The problem is in the output power or ground circuits, or the load itself. For additional output troubleshooting specific to this function, refer to the applicable subject in this manual.

5. **Determine if input conditions are met for the function or output to operate using Datalink Monitor.**

   NOTE: To determine which Datalink Monitor template to use, refer to the applicable subject in this manual.

5.1 Refer to the function or output in this manual to identify what input conditions have to be met in order for the function or output to operate.

5.2 Open the Datalink Monitor template for the applicable function.

5.3 While monitoring the template inputs, attempt to activate the function or output using the normal method. For example, turn on the headlights if the rotary switch inputs are being tested.

Are all of the input conditions met?

YES →Go to test 6.

NO →For additional input troubleshooting specific to this function, refer to the applicable subject in this manual.

6. **Check available voltage at the consumer.**

NOTE: Available voltage tests cannot be performed on every SAM Chassis function. For example, checking voltage at a turn signal connector will not work. Refer to the applicable subject in this manual for more details about troubleshooting specific outputs. If test 6 cannot be performed, proceed to test 7.

6.1 Disconnect the connector at the consumer.

6.2 Activate the function by normal means. Turn on the headlights, for example, if the rotary switch inputs are being tested.

6.3 Measure voltage between the positive and ground pins on the connector.

Is there battery voltage across the positive and ground terminals?

YES →Replace the consumer.

NO →Go to test 7.

7. **Rule out the output by manually applying fused power and ground.**

7.1 Disconnect the SAM connector(s) containing the circuits for the output (power) and ground for the function being tested.

7.2 Apply fused power to the output circuit using jumper wires, and apply ground to the ground circuit.

Does the function or output work when power and ground are applied manually?

YES →Check SAM programming and parameters. For additional programming and parameter information, refer to the applicable subject in this manual. If the programming and parameters are OK, replace the SAM Chassis.

NO →The problem is in the output power or ground circuits, or the load itself. For additional output troubleshooting, refer to the applicable subject in this manual.

707 — Logic Controlled Relayed Fused Outputs

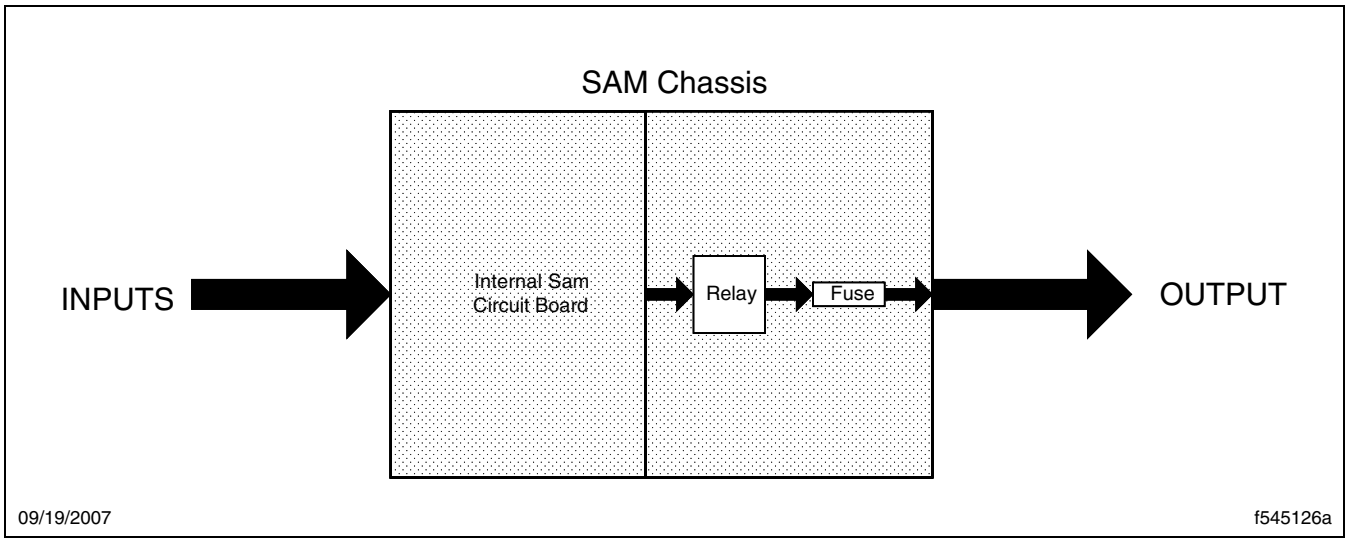


Fig. 8, SAM Fused Inputs and Outputs

1. **Determine if the template has I/O controls available for the affected function.**

   Open the Datalink Monitor template for the function or output that is not functioning.

   Are I/O control buttons available for the affected function?

   YES →Go to test 2.

   NO →Go to test 3.

2. **On SAM Chassis with I/O control, use Datalink Monitor to determine if the output circuit can be eliminated as the problem.**

   NOTE: To determine which Datalink Monitor template to use, refer to the applicable subject in this manual.

   2.1 Open the Datalink Monitor template for the applicable function.

   2.2 Using the template, attempt to activate the function or output.

   Does the function or output work when activated manually in Datalink Monitor?

   NOTE: For normally closed relays, activating the SAM output will turn off the function the relay controls. For normally open relays, activating the SAM output will turn on the function the relay controls.

   YES →Go to test 3.

   NO →Go to test 4.

3. **Use Datalink Monitor to determine if input conditions are met for function or output to operate.**

   NOTE: To determine which Datalink Monitor template to use, refer to the applicable subject in this manual.

3.1 Refer to the applicable function or output, and identify what input conditions have to be met for normal operation.

3.2 Open the applicable Datalink Monitor template.

3.3 While monitoring the template inputs, attempt to active the function or output using the normal method. Turn on the headlights, for example, if the rotary switch inputs are being tested.

Are all of the input conditions met?

YES →Go to test 4.

NO →For additional input troubleshooting specific to this function, refer to the applicable subject in this manual.

4. **Check the available voltage at the consumer.**

NOTE: Available voltage tests cannot be performed on every SAM function. For example, checking voltage at a turn signal connector will not work. Refer to the applicable subject for more information about troubleshooting the specific outputs. If test 4 cannot be performed, proceed to test 5.

4.1 Disconnect the connector at the consumer.

4.2 Activate the function by normal means. Turn on the headlights, for example, if the rotary switch inputs are being tested.

4.3 Measure voltage between the positive and ground pins.

Is there battery voltage across the positive and ground terminals?

YES →Replace the consumer.

NO →Go to test 5.

5. **Check for power at the relay coil (low current side).**

5.1 Remove the relay from the SAM for the function that is not working.

5.2 Check for voltage in the SAM relay cavity that corresponds to terminal 85 of the relay.

Is there voltage at relay cavity 85?

YES →Go to test 6.

NO →Check fuse F29 on the SAM Chassis.

6. **Check for power at the relay common (high current side).**

Check for voltage in the SAM relay cavity that corresponds to terminal 30 of the relay.

Is there voltage at relay cavity 30?

YES →Go to test 7.

NO →Check main power to SAM from the MEGA fuse.

7. **Check the SAM fuse for the function.**

Check the fuse for the function or output.

Is the fuse good?

YES →Go to test 8.

NO →Check for a short to ground in the output circuit. Check the component that the output supplies power to for excessive current draw. Make repairs as necessary, and replace the fuse.

8. **Determine if the function works when power is manually applied.**

   Using a fused jumper, apply power to the SAM relay cavity that corresponds to 87 for normally open relay connections, or 87a for normally closed relays.

   Does the function work when power is manually applied at the relay?

   YES →Go to test 9.

   NO →The problem is in the output power or ground circuits, or the load itself. For additional output troubleshooting, refer to the applicable subject in this manual.

9. **Determine if the output works with a test relay that is operating properly.**

   Remove the relay from the SAM and install the known good relay.

   Does the function or output work with a known good relay?

   YES →Replace the relay.

   NO →Check SAM programming and parameters. For additional programming/parameter information, refer to the applicable subject in this manual. If programming and parameters are OK, replace the SAM.

708 — Unfused Constant Outputs

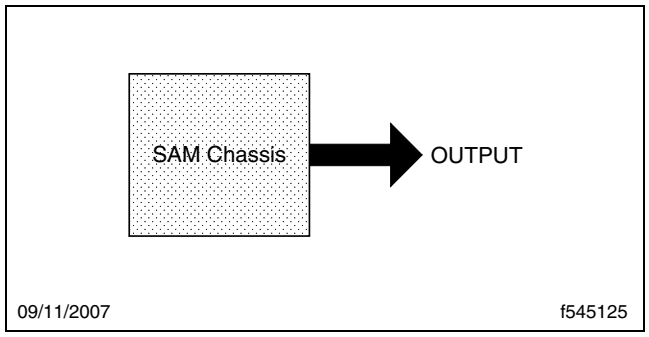


Fig. 9, SAM Unfused Constant Outputs

1. **Check available voltage at the consumer.**

   1.1 Disconnect the connector at the consumer.

   1.2 Measure the voltage between the positive and ground pins on the connector.

   Is there battery voltage across the positive and ground terminals?

   YES →Replace the consumer.

   NO →Go to test 2.

2. **Check the voltage at output pin.**

   2.1 Turn the ignition switch on.

2.2 Check for voltage at the unfused constant output pin.

Is there 12V at the unfused constant output pin?

YES →The problem is in the output power or ground circuits or the load itself. For additional output troubleshooting refer to the applicable subject in this manual.

NO →For IGN and ACC outputs, check for ignition switch function. For all types, check the main power and ground feeds to the SAM. If OK, replace the SAM.

709 — Fused Battery Pass-Through Outputs

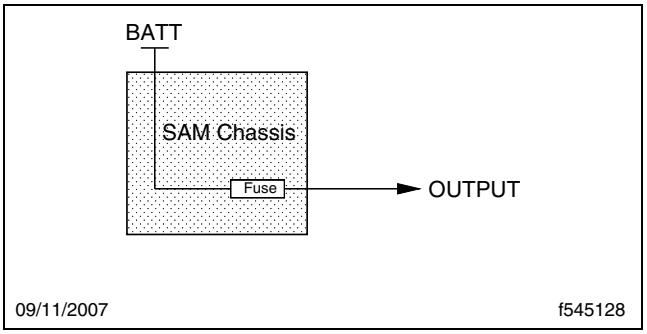


Fig. 10, Fused Battery Pass-Through Outputs

1. **Check the fuse in the SAM for the output.**

   Is the fuse OK?

   YES →Go to test 2.

   NO →Check for short to ground in the output circuit, repair as necessary, and then replace the fuse. For additional output troubleshooting, refer to the applicable subject in this manual.

2. **Check power and ground supply to the SAM.**

   Is power and ground supply to the SAM OK?

   YES →The problem is in the output power or ground circuits, or the load itself. For additional output troubleshooting, refer to the applicable subject in this manual.

   NO →Check the MEGA fuse, and the power and ground circuits to the SAM. Repair as necessary.

Table of Contents

500 — Terms and Abbreviations

Cabin CAN—A proprietary datalink connecting certain ECUs on the vehicle, specifically the CGW, MSF, SAM Cab, and SAM Chassis.

CAN—Controller Area Network

CAN ID—The identifier of an ECU communicating on CAN.

CGW—Central Gateway

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Datalink Topology—The arrangement in which the nodes (ECUs) of a datalink are connected to each other.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

Diagnostic Connector—A 9-pin diagnostic connector is used for troubleshooting the electrical system.

FMI—Failure Mode Indicator. The part of a J1587, J1939, and CAN fault code that identifies how part of a device, or item on a device, failed.

MSF—Modular Switch Field

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

Parameter—A parameter is a specific value that is assigned to a feature or function of the vehicle, and allows the customer to choose how that particular feature or function will work on the vehicle.

PDM—Power Distribution Module

PWM—Pulse-Width Modulation

SA—Source Address; represents the node address of any device that communicates on CAN.

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

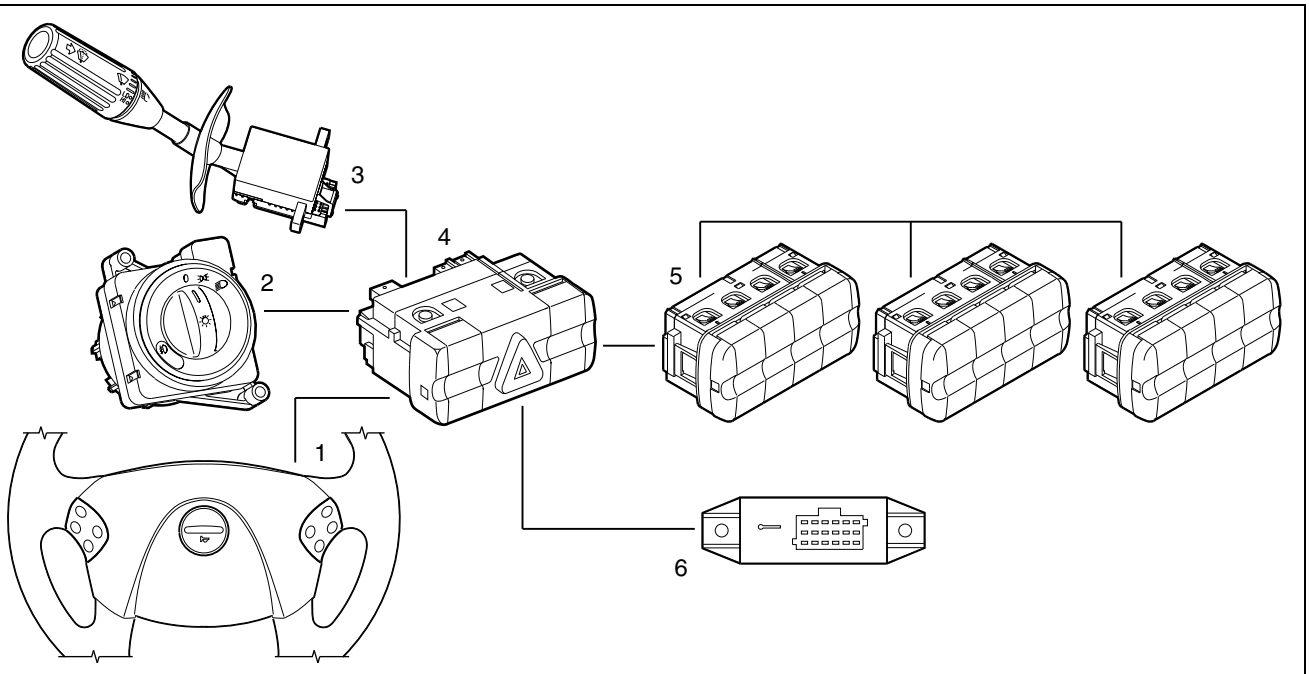
SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

SPN—Suspect Parameter Number. The part of a J1939 or CAN fault code that identifies how part of a device, or item on a device, failed.

501 — General Information

The Modular Switch Field (MSF) is a system that includes the MSF Master ECU, 4 switch-slave modules, the headlight switch, the steering wheel switches, and the turn signal/stalk switch. The MSF Master converts the positions of all these switches into data signals and broadcasts them over the cabin CAN databus.

NOTE: Additional troubleshooting is provided in the applicable subject for specific MSF switch functions.



1. Steering Wheel Switches
2. Headlight Switch
3. Stalk Switch
4. MSF Master ECU
5. MSF Slave Switch Modules
6. Starpoint Connector

Fig. 1, Modular Switch Field

NOTE: The Starpoint Connector is part of the Cabin CAN Datalink. It is included in this illustration because the MSF Master connects to the starpoint connector.

502 — MSF Master ECU

The MSF master ECU contains the hazard flasher push-button switch. It is the only component in the modular switch field that is connected to the Cabin CAN datalink. All other components of the switch field are connected to the MSF Master.

The MSF Master receives battery power and ground from the SAM Cab; power comes through fuse F4, (15A) on conn X2, pin 12.

503 — MSF Switches

There are two types of switches in the Modular Switch Field:

- Sub Bus Switches
- Other MSF Switches:
  - – hazard switch
  - – rotary switch (headlamps)

– stalk switch

– steering wheel switches

Parameters programmed into the MSF Master determine which sub bus switches belong on the vehicle. For more information on ECU parameters for Cabin CAN ECUs, refer to **G03.04 — Datalink, Diagnostic CAN**.

504 — Sub Bus Switches

MSF slave switches physically connect switches to the MSF Master via a three-wire "sub bus." This sub bus consists of one wire that provides power to all connected switches, one wire that provides ground to all connected switches, and one wire that carries a data signal. Off-board tools, such as ServiceLink, do not access this sub bus.

All sub bus switches have a unique ID number that the MSF Master monitors on the sub bus.

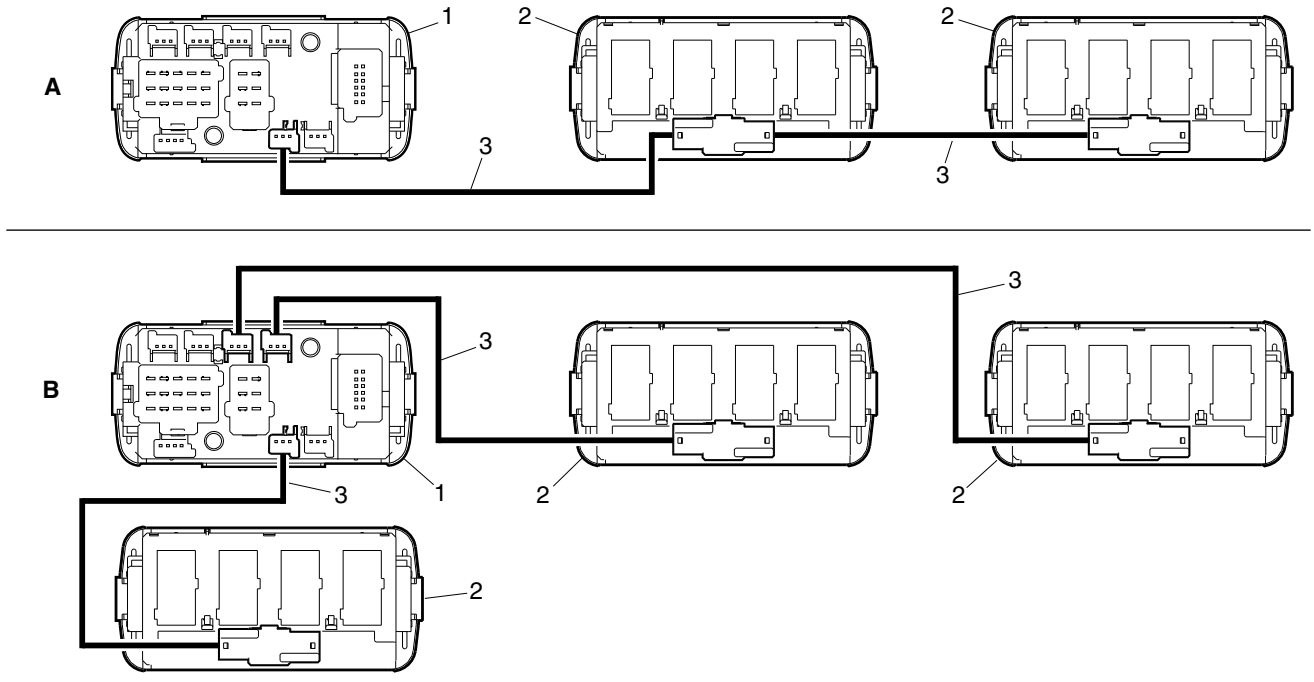
Backlighting for all sub bus switches is powered by the sub bus wiring and is controlled by the MSF Master.

There are two types of sub bus switches:

- **Signal-Only (multiplexed):** The MSF Master ECU monitors the sub bus for the presence of a signal switch, as well as its switch position. The switch position is then provided to other ECUs on the Cabin CAN datalink, that use the switch as an input.
- **Hardwired (load-interrupting)**: The MSF Master monitors the sub bus for the presence of a hardwired switch only; it does not monitor the switch position of a hardwired switch. Hardwired switches are hardwired to the load for which they are an input. They are also called "load-interrupting," because they often physically interrupt the load for which they are an input. This differs from signal switches, which do not connect to anything except for the sub bus.

There is the direct connection and the daisy chain connection method for the MSF sub bus switches. Both connection methods may be used at the same time and there is no functional difference between either of these two connection methods. The maximum total length of the sub bus is 40 meters.

See **Fig. 2** for examples of both connection methods.



A. Daisy-Chain Connection
B. Direct Connection to MSF Master

1. MSF Master
2. MSF Slave-Switch Module
3. 3-Wire Sub Bus

Fig. 2, MSF Slave Switch Connection Methods

The MSF Master provides faults for missing or extra sub bus switches. Missing and extra sub bus switch information can be viewed in the following ServiceLink screens:

- **ECU List icon**: "Faults" screen (CAN protocol)
- **MSF icon**: "Faults" screen (CAN protocol)
- **MSF icon**: "Switches" screen (CAN protocol)

Refer to **702 — Diagnostic Tests for Verifying Sub Bus Switch Type** for faults related to missing or extra sub bus switches, as well as diagnostic tests to determine if a sub bus switch is hardwired or signal.

505 — Other MSF Switches

Switches in the MSF include:

- headlight switch
- turn signal/stalk switch
- steering wheel switches

All of these switches are physically connected to the MSF Master via wiring, not via the sub bus. For troubleshooting information about a specific switch function, refer to that function's subject in this manual.

Headlight Switch: The headlight switch is the input for marker, clearance, tail, and license plate lamps, low- and high-beam headlamps, and when equipped, fog lamps.

Turn Signal/Stalk Switch: The stalk switch is used for left and right turn signals, high-beam activation, performing a flash-to-pass, and activating the wipers and windshield washer. It is wired to the MSF. The stalk switch has three fore/aft positions:

- Pushed: high-beam headlights are activated if the low-beam headlights are on (position 2).
- Neutral: no action.
- Pulled: the flash-to-pass function is performed, regardless of the position of the headlight switch.

The stalk switch has three vertical positions:

- **Down**: Left turn signal activated
- **Neutral**: no action
- **Up**: Right turn signal activated

The stalk switch is also rotated to activate the windshield wipers and pushed inward to activate the windshield washer pump.

Steering Wheel Switches: The steering wheel switches are the switch pads on the left and right sides of the steering wheel. They control the following, depending on vehicle options:

- cruise control (on/off, set/resume, accelerate/decelerate, cancel)
- engine brake
- marker interrupt
- menu scroll buttons (+/–) for the driver information center in the instrument cluster

Steering wheel switch inputs to the MSF master are a pulsed signal on two wires, S1 and S2. Each of the steering wheel switch buttons sets a different resistance across these circuits. To monitor the status of these switches, use the template "MSF Switches: Hazard, Rotary, Stalk, Steering wheel" in ServiceLink.

MSF Master: The MSF Master reports various faults for these switches, such as short-circuits to power or ground. Fault codes are identified in **701 — Fault Codes**, **Table 16**.

506 — Cascadia Data Networks

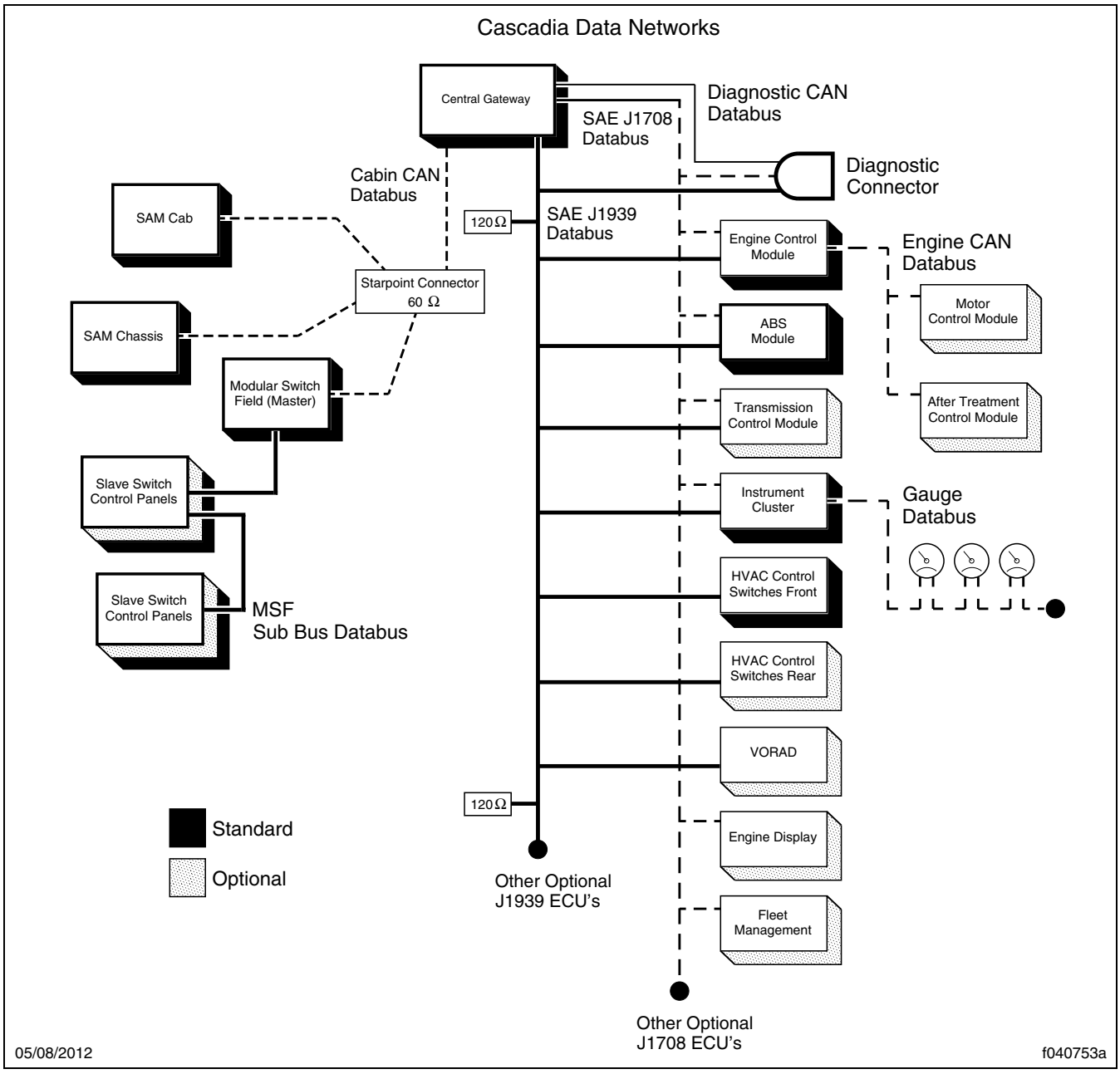


Fig. 3, Cascadia Data Networks

507 — ECU Parameter Configuration

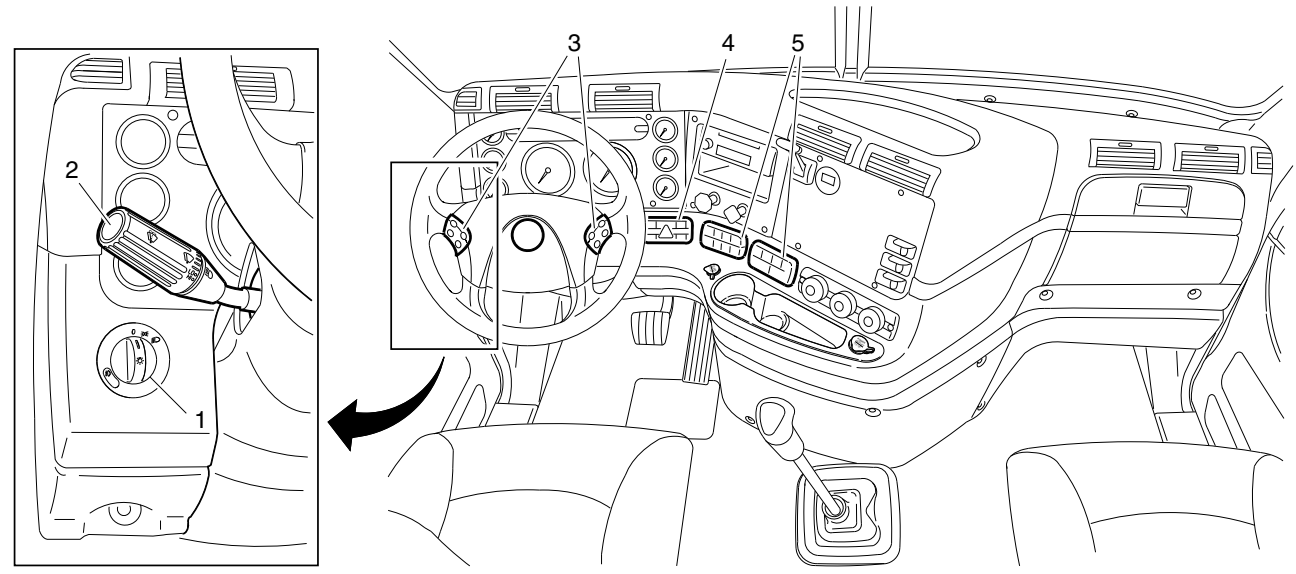
The MSF Master has parameters that can be viewed or changed for vehicle configuration. The MSF parameters can be flashed using ServiceLink.

The software flashing procedure should only be performed on the MSF in the following cases:

- **For a feature upgrade:** Adding a new feature to a vehicle may require a newer version of ECU software. ServiceLink will automatically make available any necessary software upgrades.
- **Fixing a problem in the existing software:** In case a new version of ECU software is needed to fix a problem in the existing ECU software, ServiceLink will automatically make available any necessary software upgrades.
- **Replacing the MSF:** Flashing configures the MSF with the most recent software and programs the correct vehicle parameters.

For instructions on how to use ServiceLink to flash the software of a CAN ECU like the MSF, refer to the *ServiceLink User Guide* or *ServiceLink Help* user documentation, available in ServiceLink's "Help" menu.

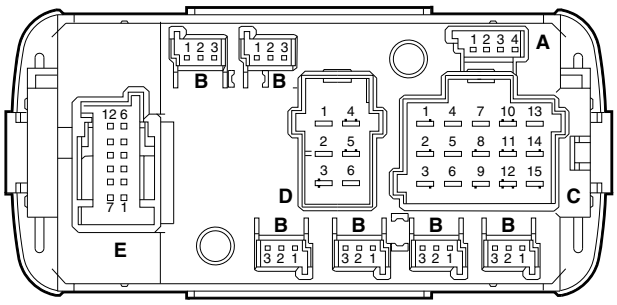
600 — Component Locations



1. Headlight Switch
2. Turn Signal/Stalk Switch
3. Steering Wheel Switches
4. MSF Master ECU
5. MSF Slave Switch Modules

Fig. 4, Component Locations (cab)

601 — MSF Master Connectors



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A. Steering Wheel Switch Connector
B. MSF Slave Sub Bus Connector
C. Stalk Switch Connector
D. Battery and Cabin CAN Connector
E. Headlight Switch Connector

Fig. 5, MSF Master Connection Locations

MSF Connector A Pinout, Steering Wheel Switches		
Pin	**Function**	**Circuit**
1	Steering Wheel, Switch Signal (S2)	474BA1
2	Backlighting PWM Signal	474BA2
3	Steering Wheel, Switch Signal (S1)	474BA3
4	Ground	474BA4

Table 1, MSF Connector A Pinout, Steering Wheel Switches

Connector B Pinout: MSF Slave Sub Bus Connector		
Pin	**Function**	**Circuit**
1	Battery Power Supply from MSF Master	14F
2	Sub Bus Data	507A
3	Ground from MSF Master	GND

Table 2, Connector B Pinout: MSF Slave Sub Bus Connector

MSF Connector C Pinout: Stalk Switch		
Pin	**Function**	**Circuit**
1	Turn Signal Switch Supply Power	38A
2	Left Turn Signal Power	38C
3	Right Turn Signal Power	38D
4	High-Beam Flash Signal	465A

MSF Connector C Pinout: Stalk Switch		
Pin	**Function**	**Circuit**
5	High-Beam Signal	465A
6	Low-Beam Signal	465A
7	Headlight low/high maintain 2.5 volts	465
8	Wiper Code Input A	473C
9	Wiper Code Input B	473C
10	No Connection	—
11	No Connection	—
12	Washer Signal	473B
13	No Connection	
14	Wiper Code Input C	473C
15	Wiper Switches Supply Power	433A

Table 3, MSF Connector C Pinout: Stalk Switch

MSF Connector D Battery and Cabin CAN Pinout		
Pin	**Function**	**Circuit**
1	Not connected	—
2	Battery Power	14F
3	Cabin CAN Low	508C
4	Not Connected	—
5	Cabin CAN High	508A
6	Ground	GND

Table 4, MSF Connector D Battery and Cabin CAN Pinout

MSF Connector E Pinout: Headlight Switch		
Pin	**Function**	**Circuit**
1	Headlight Switch Supply Power	20
2	Switch Position Code Input 1 (BC1)	474B01
3	Switch Position Code Input 2 (BC2)	474B05
4	Fog Lamp Version	474B03
5	Switch Position Code Redundant Circuit	474B02
6	Fog Lamp Signal	27A
7	Backlighting PWM	29A
8	No Connection	—
9	No Connection	
10	No Connection	

MSF Connector E Pinout: Headlight Switch		
Pin	**Function**	**Circuit**
11	No Connection	
12	Ground	GND

Table 5, MSF Connector E Pinout: Headlight Switch

MSF Slave Switch Sub Bus Connectors		
Pin	**Function**	**Circuit**
1	Battery Power from MSF Master	14F
2	Sub Bus Data	507A
3	Ground	GND

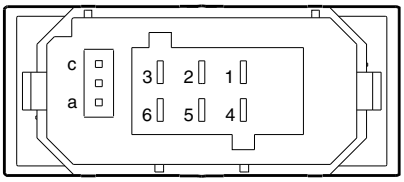
Table 6, MSF Slave Switch Sub Bus Connectors

602 — Sub Bus Switches

Each of the slave switch modules are capable of housing a maximum of 4 sub bus switches. These switches may directly control a device or only communicate switch position to the MSF master over the sub bus.

Only the switches that are hardwired directly to their device use pins 1 through 6. All the sub bus switches use connections a, b, and c for backlighting control. The slave switch module captures the sub bus connections but pins 1 through 6 are exposed out the back of the module.

Sub Bus Switches



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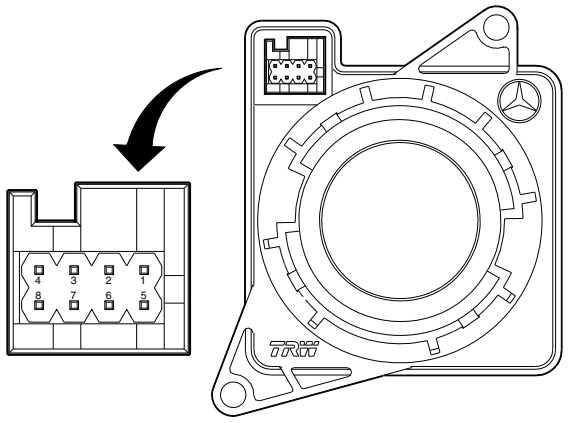
Pin	Function
A	Battery Power
B	Sub Bus Signal
C	Ground
1	For sub bus switch functionality, refer to the MSF hardwired sub bus switch drawing A06–53783. Pin function will vary, based on the individual switch.
2	
3	
4	
5	
6	

Table 7, Sub Bus Switches

603 — Headlight Switch

Headlight Switch



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Pin	Function
1	Switch Position Code 1
2	Switch Position Code Redundant Circuit
3	Fog Lamp Version*
4	Fog Lamp Signal
5	Switch Position Code 2
6	Backlighting PWM
7	Ground
8	Battery Power from MSF

* With the headlight switch disconnected the resistance between pins 3 and 7 will be approximately 10K ohm when the switch has fog lamp capability.

Table 8, Headlight Switch

Headlight Switch Position Codes			
Headlight Switch Position	**Voltage**		
	Position Code 1	**Position Code 2**	**Redundant Circuit**
OFF	0	0	12
Marker Lamps	12	0	12
Marker and Headlamps	12	12	0

Table 9, Headlight Switch Position Codes

604 — Turn Signal/Stalk Switch

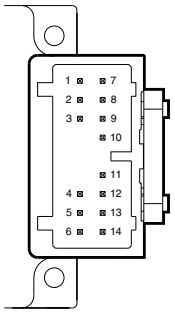
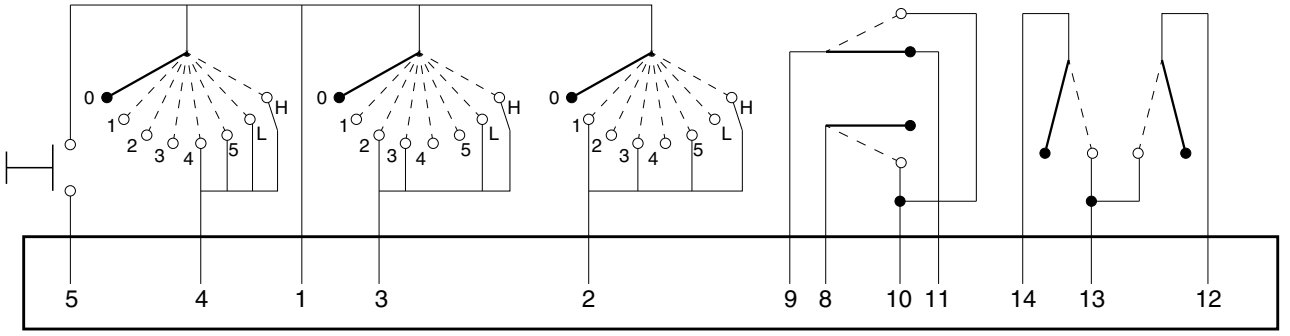
Turn Signal/Stalk Switch Connector Pinout	
 05/25/2012 f545038	
Pin	**Function**
1	Ignition Power Feed for Wiper Functions
2	Wiper Code A
3	Wiper Code B
4	Wiper Code C
5	Washer Signal
6	Backlighting
7	Ground
8	Headlamp Low/High Maintain Circuit
9	Headlamp High-Beam Flash Signal
10	Headlamp High Beam signal
11	Headlamp Low-Beam Signal
12	Left Turn Signal
13	Turn Signal Switch, Ignition Power Feed
14	Right Turn Signal

Table 10, Turn Signal/Stalk Switch Connector Pinout



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1. Ignition Power Feed for Wiper Functions
2. Wiper Code A
3. Wiper Code B
4. Wiper Code C
5. Washer Signal
6. Backlighting
7. Ground
8. Headlamp Low/High Maintain Circuit
9. Headlamp High-Beam Flash Signal
10. Headlamp High-Beam Signal
11. Headlamp Low-Beam Signal
12. Left Turn Signal
13. Turn Signal Switch, Ignition Power Feed
14. Right Turn Signal

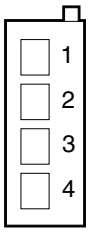
Fig. 6, Stalk Switch Internal Schematic

Wiper Switch Position Codes			
Wiper Switch Position	**Voltage**		
	C (pin 4)	**B (pin 3)**	**A (pin 2)**
OFF	0	0	0
Intermittent 1	0	0	12
Intermittent 2	0	12	0
Intermittent 3	0	12	12
Intermittent 4	12	0	0
Intermittent 5	12	0	12
LOW	12	12	0
HIGH	12	12	12

Table 11, Wiper Switch Position Codes

605 — Steering Wheel Switches

Steering Wheel Switches



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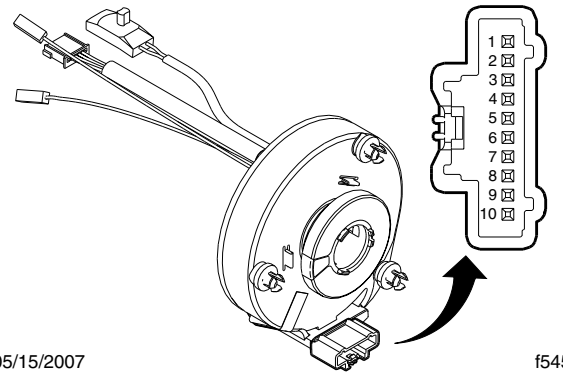
Pin	Function
1	Steering wheel, Switch Signal (S2)
2	Backlighting PWM
3	Steering Wheel, Switch Signal (S1)
4	Ground

Table 12, Steering Wheel Switches

606 — Clock Spring Connector

Clock Spring Connector



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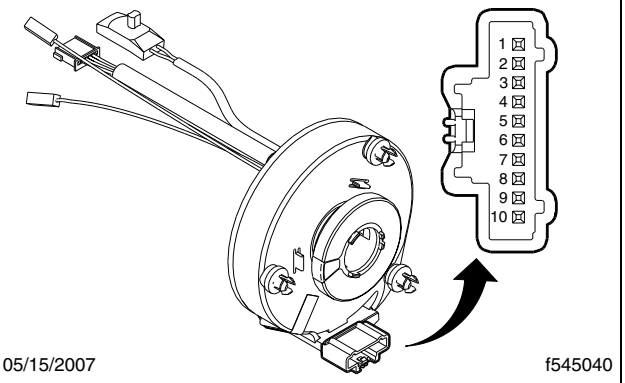
Pin	Function
1	Air bag (+), if used
2	Air bag (–), if used
3	No Connection
4	Backlighting Ground
5	Steering Wheel, Switch Signal (S1)
6	Backlighting PWM
7	Steering Wheel, Switch Signal (S2)

Clock Spring Connector

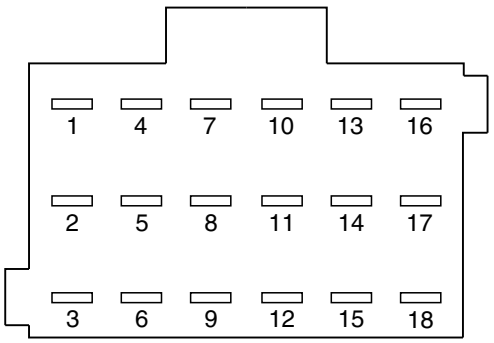


Pin	Function
8	No Connection
9	Horn Signal
10	Horn Switch Battery Power Feed

Table 13, Clock Spring Connector

607 — Starpoint Connector

Starpoint Connector



Pin	Function
10	MSF Cabin CAN High
12	MSF Cabin CAN Low
17	MSF Ground

Table 14, Starpoint Connector

700 — Troubleshooting Details

Most of the MSF switches report their position over serial data that is visible in ServiceLink templates. Use **Table 15** to determine which of the MSF switches are visible in ServiceLink.

MSF Switch Visibility in ServiceLink	
Switch	**Description**
Horn button	The horn switch receives battery power from the SAM Cab and switches it back to the SAM Cab to activate the horn. ServiceLink will display horn button status.
Steering wheel switches	The 8 steering wheel pushbutton switches are multiplexed together and operate using a pulsed square wave signal. There is a combination of resistors and diodes in the switches that prevent an ohm meter from giving any usable measurement. ServiceLink will display the status of these switches.
Hazard flashers and switches in the MSF master	ServiceLink will display the status of these switches.
Switches in the slave modules	Some switches directly operate circuits and some are sub bus data only. ServiceLink will display the position status of the switches that are sub bus data, but cannot display the position status of the switches that are hardwired.
Headlight/foglight switch	ServiceLink will display the status of these switches.
High/low beam	ServiceLink will display the status of these switches.
Wiper and washer	ServiceLink will display the status of these switches.
Turn signals	ServiceLink will display the status of these switches.

Table 15, MSF Switch Visibility in ServiceLink

Backlighting to the switches connected to the MSF is sourced from circuit 29A from the SAM Cab. The MSF outputs this PWM signal to the switches it reads.

701 — Fault Codes

NOTE: Unless otherwise specified, all voltage measurements reference system ground.

IMPORTANT: The batteries **must** be disconnected prior to any resistance tests being performed. Failure to do so may result in inconclusive resistance measurements.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
49	168	3	conn D, pin 2	—	—	Voltage above normal, or shorted to high source	Voltage detected at MSF conn D pin 2 (BAT) is greater than expected (16V). While fault is active, MSF may not be responsive (headlamps stay on). There may also be active faults from other CAN ECUs for "Lost communication with MSF." The fault is historic when voltage is detected to be below 15.5V for at least 15 seconds.
Action: Measure system voltage at the batteries and at the SAM Cab main power input studs with the engine off and also with it running. This fault indicates the system voltage is excessively high. If the alternator is overcharging with a voltage above 16 volts, this fault will become active. Use the instructions in the alternator troubleshooting manual to determine if there is a fault with the remote sense circuit or with the alternator.							
49	168	4	conn D, pin 2	—	—	Voltage below normal, or shorted to ground	Voltage detected at MSF conn D pin 2 (BAT) is less than expected (9V). While the fault is active, the MSF may not be responsive (headlamps stay on). There may also be active faults from other CAN ECUs for "Lost communication with MSF." The fault is historic when voltage is detected to be above 10.5V for at least 15 seconds.
Action: With the key on, measure the voltage at the batteries and at the MSF master conn D pin 2. If battery voltage is low, troubleshoot the charging system using the instructions in the alternator troubleshooting manual. If the voltage is lower than 9V on the MSF supply voltage circuit, troubleshoot circuit 14F (mod 860) from MSF master conn D pin 2 to SAM Cab conn 2 pin 12 for a short to GND. Check SAM Cab fuse F4 (15A) for MSF power. Repair as required.							
49	520201	3	conn A, pin 1 conn A, pin 3	—	—	Steering wheel switch circuit S1 or S2, voltage above normal or open circuit	The voltage present at the MSF is higher voltage than expected. Either circuit could be open or shorted to a high source.
Action: Use the ServiceLink "Steering Wheel Switches" template to monitor for any activity on the steering wheel switches. Connect an oscilloscope, scope meter, or use the Midtronics 1000 HD in scope mode to observe this signal. The MSF produces a square wave signal on this circuit. When any of the steering wheel switches are pressed, the peak voltage of this signal is reduced. Each of the four switches reduce it by a different level. Continue to check the signal through the clockspring in the steering wheel up to the switches to locate the open circuit. This circuit continues as the white wire in the steering wheel switches.							
49	520201	4	conn A, pin 3	—	—	Steering wheel switch circuit S1, voltage below normal or shorted to ground	The signal received at the MSF is lower voltage than expected. This circuit could be shorted to ground.
Action: Connect an oscilloscope, scope meter, or use the Midtronics 1000 HD in scope mode to observe this signal. The MSF produces a square wave signal on this circuit. The signal detected at the MSF is too low of peak voltage to be valid. Disconnect connector A and test for a short to ground or a short between pins 3 and 1. Continue to check the signal through the clockspring in the steering wheel up to the switches to locate the short circuit. This circuit continues as the white wire in the steering wheel switches.							
49	520203	3	conn A, pin 1 conn A, pin 3	—	—	Steering wheel switch circuit S2 or S1, voltage above normal or open circuit	The voltage present at the MSF is higher voltage than expected. This circuit could be open or shorted to a high source.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
Action: Use the ServiceLink "Steering Wheel Switches" template to monitor for any activity on the steering wheel switches. Connect an oscilloscope, scope meter, or use the Midtronics 1000 HD in scope mode to observe this signal. The MSF produces a square wave signal on this circuit. When any of the steering wheel switches are pressed, the peak voltage of this signal is reduced. Each of the four switches reduce it by a different level. Continue to check the signal through the clockspring in the steering wheel up to the switches to locate the open circuit. This circuit continues as the blue wire in the steering wheel switches.							
49	520203	4	conn A, pin 1	—	—	Steering wheel switch circuit S2, voltage below normal or shorted to ground	The signal received at the MSF is lower voltage than expected. This circuit could be shorted to ground.
Action: Connect an oscilloscope, scope meter, or use the Midtronics 1000 HD in scope mode to observe this signal. The MSF produces a square wave signal on this circuit. The signal detected at the MSF is too low of peak voltage to be valid. Disconnect connector A and test for a short to ground or a short between pins 1 and 3. Continue to check the signal through the clockspring in the steering wheel up to the switches to locate the short circuit. This circuit continues as the blue wire in the steering wheel switches.							
49	520302	2	conn B, pin 1	—	—	Sub bus supply voltage shorted low	Any of the connector B, pin 1 circuits have lower voltage than expected. The switch sub bus data will be erratic or completely not available.
Action: The MSF master has multiple sub bus connectors (conn B). With the key ON, disconnect each of the sub bus connectors one at a time and measure voltage on pin 1 of each sub bus connector on the MSF to determine if this one is shorted low. With all the sub bus connectors disconnected, disconnect the batteries and the fault should go to history, after reconnecting battery power to the vehicle. If it remains active, the MSF master is defective. NOTE: The sub bus can connect the MSF master to multiple MSF switches. The sub bus is routed into the sleeper compartment and is used for the switches on the bunk panel.							
49	520302	3	conn B, pin 2	—	—	Sub bus signal — Voltage above normal or shorted to high source	MSF sub bus data circuit voltage is high. When fault is active, none of the functions work for the data-only sub bus switches (A06-53782). The hardwired sub bus switches (A06-53783) may still work. Use ServiceLink's MSF "Switches" screen to see which sub bus switches on the vehicle are hardwired.
Action: The MSF master has multiple sub bus connectors (conn B). With the key ON, disconnect each of the sub bus connectors one at a time and measure voltage on pin 2 of each sub bus connector to determine which one is shorted high. With all the sub bus connectors disconnected, disconnect the batteries and the fault should go to history, after reconnecting power to the vehicle. If it remains active, the MSF master is defective. NOTE: The sub bus can connect the MSF master to multiple MSF switches. The sub bus is routed into the sleeper compartment and is used for the switches on the bunk panel.							
49	520302	4	conn B, pin 2	—	—	Sub bus signal — Voltage below normal or shorted to ground	The MSF sub bus data circuit voltage is low. When fault is active, none of the functions work for the data-only sub bus switches (A06-53782). The hardwired sub bus switches (A06-53783) may still work. Use ServiceLink's MSF "Switches" screen to see which switches on the vehicle are hardwired.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
Action: The MSF master has multiple sub bus connectors (conn B). With the key OFF and MSF connector D disconnected, disconnect each of the sub bus connectors and measure resistance to ground on pin 2 of each of the sub bus circuits to determine which one is shorted. With all the sub bus connectors disconnected, disconnect the batteries and the fault should go to history, after reconnecting power to the vehicle. If it remains active, the MSF master is defective NOTE: The sub bus can connect the MSF master to multiple MSF switches. The sub bus is routed into the sleeper compartment and is used for the switches on the bunk panel.							
49	520401	4	conn C, pin 12	—	—	Washer switch supply voltage shorted low	The circuit that supplies power to the washer switch on the turn signal lever is shorted to ground.
Action: Troubleshoot for a wiring fault on circuit 473B between the MSF and the stalk switch.							
49	520404	3	conn C, pin 5	—	—	Stalk switch hi beam circuit — shorted to high source	Active when the stalk switch is in the low beam position and MSF connector C pin 5 is at battery voltage.
Action: Open the ServiceLink Headlights template to observe the hi/low/flash switch position status. Measure the voltage at MSF conn C pin 5. With the ignition ON, and all wiring connected, troubleshoot for a short to battery power on this circuit between the MSF and the stalk switch. Repair as required.							
49	520404	4	conn B, pin 5 conn B, pin 7	—	—	Stalk switch high beam circuit — voltage out of range low	Active when the headlight switch is in the low beam position and ground is measured on pin 5.
Action: Open the ServiceLink Headlights template to observe the hi / low / flash switch position status. Before replacing the stalk switch, check the wiring as follows. With the ignition in the ON position and all wiring connected, measure the voltage on MSF connector C, pins 5 and 7. Pin 7 is typically around 2.5 volts. Move the stalk switch through all 3 headlight positions while making these measurements. Troubleshoot for a short to ground in the circuit that remains at ground during the switch cycling.							
49	520404	5	conn C, pin 8 conn C, pin 9 conn C, pin 14	—	—	Wiper Position Code Circuits — Current below normal, or open circuit	Active when any of the wiper position code circuits are 10% less than battery voltage.
Action: With the ignition ON, measure the voltage on all the terminals of MSF connector C. Use the schematic in figure 6 to place the stalk switch in a position so the wiper-switch signals will be in an active (switch closed) position. Locate the circuit with a partial short to ground that is pulling the voltage low. Repair as required.							
49	520405	3	conn C, pin 4 conn C, pin 6 conn C, pin 7	—	—	Stalk switch low-beam circuit — shorted to high source	Active when the stalk switch is in the low beam position and MSF connector C pin 6 is at battery voltage.
Action: Open the ServiceLink Headlights template to observe the hi / low / flash switch position status. Check the wiring as follows. With the ignition in the ON position and all wiring connected, measure the voltage on MSF connector C, pins 4, 6, and 7. Pin 7 is typically around 2.5 volts. Move the stalk switch through all 3 headlight positions while making these measurements. Troubleshoot for a short to battery voltage in the circuit that remains high during the switch cycling. Repair as required.							
49	520405	4	conn B, pin 5 conn B, pin 7	—	—	Stalk switch low beam circuit — Voltage out of range low	Active when the headlight switch is in the low beam position and ground is measured on pin 6.
Action: Open the ServiceLink Headlights template to observe the hi / low / flash switch position status. Before replacing the stalk switch, check the wiring as follows. With the ignition in the ON position and all wiring connected, measure the voltage on MSF connector C, pins 4 and 6. Move the stalk switch through all 3 headlight positions while making these measurements. Troubleshoot for a short to ground in the circuit that remains at ground during the switch cycling. Repair as required.							

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
49	520409	3	conn C, pin 3	—	—	Stalk switch right turn circuit — shorted to high source	Active when the turn signal switch is in the center position and battery voltage is detected on MSF connector C, pin 3.
Action: Open the ServiceLink Stop / Turn / Hazard Lamps template to observe the turn signal switch position status. Check the wiring as follows. With the ignition in the ON position and all wiring connected, measure the voltage on MSF connector C, pin 3. Move the stalk switch through all 3 turn signal positions while making these measurements. Troubleshoot for a short to battery voltage in circuit 38D. Repair as required.							
49	520411	3	conn C, pin 2	—	—	Stalk switch left turn circuit — shorted to high source	Active when the turn signal switch is in the center position and battery voltage is detected on MSF connector C, pin 2.
Action: Open the ServiceLink Stop/Turn/Hazard Lamps template and observe the turn signal switch position status. Check the wiring as follows. With the ignition in the ON position and all wiring connected, measure the voltage on MSF connector C, pin 2. Move the stalk switch through all 3 turn signal positions while making these measurements. Troubleshoot for a short to battery voltage in circuit 38C. Repair as required.							
49	520415	4	conn C, pin 15	—	—	Stalk switch wiper power feed — voltage out of range low	Active when the wiper switch ignition voltage power feed MSF connector C, pin 15 is at ground.
Action: Troubleshoot for a short in circuit 433A, 433B, and all three 433C circuits between the MSF and the stalk switch. Also use the ServiceLink wiper template to determine if the wiper switch is correctly indicating its position							
49	520601	4	conn E, pin 1	—	—	Headlamp switch +12V power supply circuit — Voltage below normal or shorted to ground	Active when voltage at MSF conn E pin 1 is less than 9V. When fault is active, headlamp switch functions will not work (headlamps, marker lamps, backlighting or fog lamps if equipped). Fault is historic when voltage is detected to be above 10.5V for at least 5 seconds.
Action: Troubleshoot circuit 20 and the 474B circuits between the MSF and the headlight switch for a wiring short to ground. Repair as required.							
49	520606	3	conn E, pin 6	—	—	Fog lamp switch circuit — shorted to high source	Active when battery voltage is detected on MSF connector E, pin 6.
Action: Open the ServiceLink Headlights template to observe the fog lamp switch position status. Check the wiring as follows. With the ignition in the ON position and all wiring connected, measure the voltage on MSF connector E, pin 6. Move the headlight and fog light switch through all positions while making these measurements. Troubleshoot for a short to battery voltage in circuit 27A. Repair as required.							
49	520607	4	conn A, pin 2 conn E, pin 7	—	—	Backlighting — Voltage below normal or shorted to ground	The backlighting PWM circuit is at ground.
Action: Troubleshoot circuit 29A between MSF connector E pin 7 and headlight switch pin 6 and also circuit 474BA2 between MSF connector A pin 2 and the steering wheel switches for a short to GND. Repair as required.							
49	523530	31	—	—	—	Sub bus switch missing	Active when the MSF Master does not sense one or more switches on the sub bus that it expects due to MSF parameter settings.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
Action: With the key ON, connect the vehicle to ServiceLink. Go to the MSF "Switches" screen, and note which switches are marked as missing. For each missing switch, determine whether or not the vehicle should have that switch installed. If it should be installed, install the switch. If it should not be installed, set the appropriate MSF parameter (based on switch ID) to make that switch "not available". If the switch is already installed, the fault indicates the MSF Master is not sensing the switch on the sub bus. Check the connections between the switch, MSF slave switch module and sub bus wiring. If there is no fault with the wiring, replace the switch.							
49	523531	31	—	—	—	Extra Sub bus switch	Active when one or more sub bus switches are plugged in that do not have a corresponding MSF parameter.
Action: With the key ON, connect to the vehicle with ServiceLink. Go to the MSF "Switches" screen and note which switches are marked as extra. For each extra switch, determine whether or not the vehicle should have that switch installed. If it should be installed, set the appropriate MSF parameter (based on switch ID) to make that switch "available." If it should not be installed, find the switch on the vehicle and remove it.							
49	523543	2	conn E, pin 2 conn E, pin 3 conn E, pin 4 conn E, pin 5	—	—	Headlamp switch inputs — Data erratic, intermittent, or incorrect	Active when the MSF master detects invalid signals from the headlamp switch on conn E, pins 2, 3 and 5. The fault is caused by a short to GND, short to BAT, or an open circuit. The fault is historic upon detecting a valid signal from the headlamp/rotary switch.
Action: Connect ServiceLink and use the headlights template to determine what position the headlight switch is reporting. Troubleshoot for a wiring fault in all of the 474B circuits between the MSF and the headlight switch before replacing the headlight switch. Repair as appropriate.							
49	523544	31	conn C, pin 4 conn C, pin 5 conn C, pin 6	—	—	Stalk Switch Interrupt	The MSF is not reading a voltage within the normal range for all 3 headlight switch circuits.
Action: Troubleshoot for a disconnected stalk switch. Repair as appropriate.							
49	524033	31	—	—	—	Lost communication with the SAM Cab	Refer to **G03.03 — Datalink, Cabin CAN** for troubleshooting details on this fault. The MSF will set backlighting to the headlight switch and the steering wheel switches at 100% because it is not able to read backlighting percentage data over the cabin CAN bus.
49	524037	31	—	—	—	Lost communication with CGW	Refer to **G03.03 — Datalink, Cabin CAN** for troubleshooting details on this fault.
49	524071	31	—	—	—	Lost communication with SAM Chassis	Refer to **G03.03 — Datalink, Cabin CAN** for troubleshooting details on this fault.

Table 16, CAN Fault Codes

702 — Diagnostic Tests for Verifying Sub Bus Switch Type

There are two methods for verifying if a sub bus switch is "hardwired" or "signal":

- Look at the "MSF Switches" screen in ServiceLink.

- Look at the back of the switch.

Determining the Type of Sub Bus Switch (Method 1)

1. **Look for the switch on the "MSF Switches" screen in ServiceLink.**

   1.1 Connect ServiceLink to the vehicle.

   1.2 Navigate to the MSF icon's "Switches" screen.

   1.3 Look at the "Switch" column and identify the switch in question.

   1.4 Look at the "Switch ID" column value for that switch.

   Is the switch ID between 1 and 150?

   YES → It is a sub bus signal switch.

   NO → It is a hardwired switch. Additionally, the word "Hardwired" will be displayed in this screen's "Position" column for all hardwired switches.

2. If the switch does not appear at all, or if it is marked as "missing" within this screen, the switch may not be connected securely, or may be broken. Repair the problem, then repeat the test.

Determining the Type of Sub Bus Switch (Method 2)

1. **Verify whether or not the switch has external circuits attached to it.**

   1.1 Remove the switch from its MSF Slave or Master housing.

   1.2 Look at the back of the switch.

   Does the switch have external circuits (harness) connected to it?

   YES → The switch is a Hardwired Switch.

   NO → Go to test 2.

2. **Check if the switch has terminals for connecting external circuits.**

   Does it have any terminals that are NOT connected to anything?

   YES → It is a Hardwired Switch, but is unused. This is an unlikely but possible scenario, which could mean someone installed a hardwired switch instead of a signal switch, or the harness for that switch is not connected. Check against the vehicle specifications, and make repair if necessary.

   NO → It is a sub bus signal switch.

800 — Sub Bus Switch Specifications

Sub Bus Switch Specifications	
Item	**Value**
Maximum number switches on the sub bus	38
Maximum sub bus length (in meters)	40

Sub Bus Switch Specifications	
Item	**Value**
Maximum number of MSF Slave switch modules on a vehicle	9
Maximum current capacity for Hardwired switch (external circuits)	18A

Table 17, Sub Bus Switch Specifications

Table of Contents

500 — Terms and Abbreviations

Cabin CAN—A proprietary datalink connecting certain ECUs on the vehicle, specifically the CGW, MSF, SAM Cab, and SAM Chassis.

CAN—Controller Area Network

CGW—Central Gateway

CPC—Common Powertrain Controller

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

DDDL—Detroit Diesel Diagnostic Link

ECU—Electronic Control Unit, typically connected to a datalink.

MCM—Motor Control Module

MSF—Modular Switch Field

Parameter—A parameter is a specific value that is assigned to a feature or function of the vehicle, and allows the customer to choose how that particular feature or function will work on the vehicle.

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

501 — General Information

The Common Powertrain Controller (CPC) is an ECU used with Detroit Diesel and Mercedes-Benz engines. The CPC is the interface between the Motor Control Module (MCM) and the vehicle electronics system, acting as a gateway.

All J1939 and J1587/J1708 datalink communication from the engine to the vehicle electronics occurs with the CPC. The CPC then communicates with the MCM via a proprietary communication protocol (not related to the Cabin CAN).

The CPC has three 18-pin connectors and one 21-pin connector, and is located behind the dash, to the right of the auxiliary panel.

600 — Component Locations

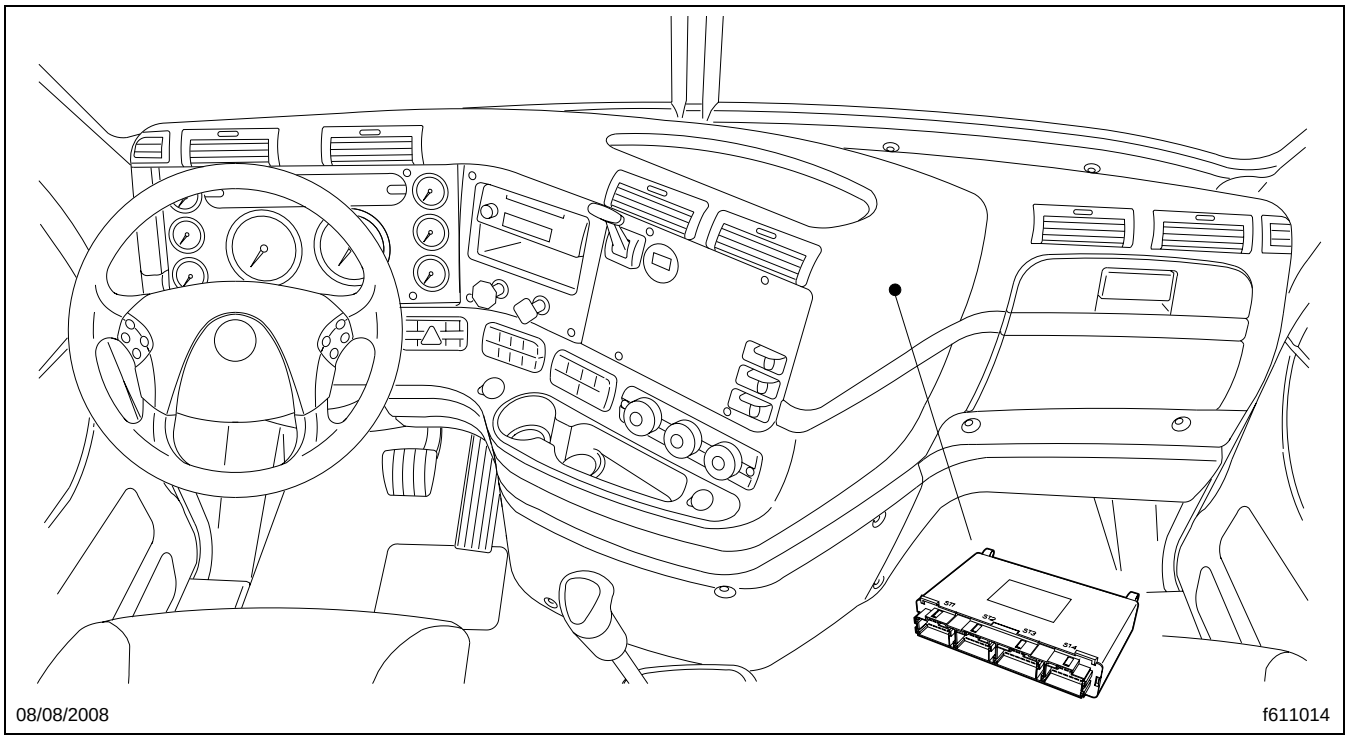
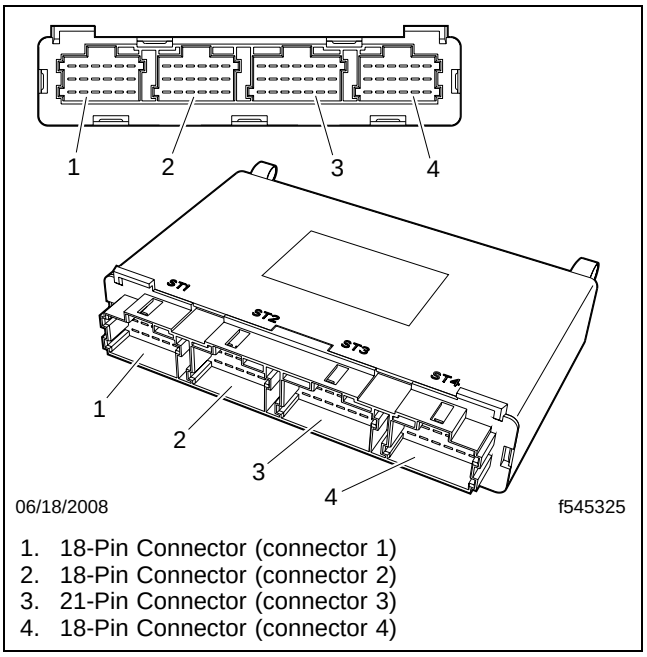


Fig. 1, Common Powertrain Controller

601 — Component Details



1. 18-Pin Connector (connector 1)
2. 18-Pin Connector (connector 2)
3. 21-Pin Connector (connector 3)
4. 18-Pin Connector (connector 4)

Fig. 2, CPC Connectors

700 — Diagnostic Tools Required

- Detroit Diesel Diagnostic Link (DDDL)

701 — Possible Causes

- Failed programming attempt
- Incorrect parameters
- Faulty wiring
- Low voltage
- Datalink problems
- Powertrain PDM fuses F9 (CPC) or F8 (MCM)

702 — Diagnostic Tests

Refer to Detroit Diesel Power Service Literature for troubleshooting and fault code information. Wiring information for the CPC can be found in PartsPro, under module 283.

800 — Specifications

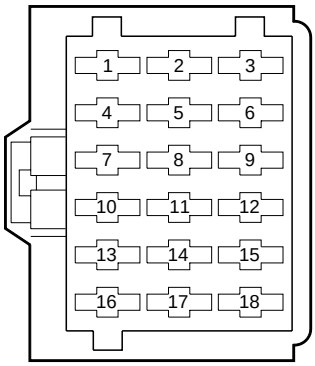
Connector 1, 18-Pin			
Pin	**Signal Type**	**Function**	**Connector**
1/1	Digital Input_FLEX_01	Dual-Speed Axle	 08/15/2008 f545337
1/2	Digital Input_FLEX_02	Park Brake Interlock	
1/3	Digital Input_SFP_05	Idle Validation Switch 2 (throttle active)	
1/4	Digital Output_LP_LS_02	Throttle Position Sensor Ground	
1/5	Digital Output_LP_LS_01	DPF Regeneration Lamp	
1/6	Digital Input _SFP_06	Idle Validation Switch 1 (idle active)	
1/7	SFP_08	Throttle Position Sensor	
1/8	SFP_07	Throttle Position Sensor Supply	
1/9	PWM_FPO_02	Tachometer	
1/10	Digital Input_FLEX_20	Stop Engine/Aux Shutdown #1	
1/11	Digital Input_FLEX_08	Limiter 0	
1/12	Digital Input_FLEX_03	Set/Coast Enable	
1/13	Digital Output_LP_FLEX_01	MIL Lamp	
1/14	Digital Input_FLEX_14	Cruise Control Enable	
1/15	Digital Input_FLEX_15	Stop Engine Override	
1/16	Digital Input_FLEX_16	Resume/Accel Enable	
1/17	Digital Input_FLEX_17	Not Used	
1/18	SFP_01	Run Start	

Table 1, Connector 1, 18-Pin

Connector 2, 18-Pin			
Pin	**Signal Type**	**Function**	**Connector**
2/1	Battery (+) PSU (KL_30)	Main Battery +12V	
2/2	Battery (–) PSU (KL_31)	Main Battery Ground	
2/3	Battery (+) Switched PSU	Ignition	
2/4	K_DIAG_C	K-line	
2/5	J1708_A_C	J1587 (+)	
2/6	J1708_B_C	J1587 (–)	
2/7	Digital Input_FLEX_15	Service Brake Released Switch	
2/8	Digital Input_FLEX_16	Remote Throttle Select Switch	
2/9	Digital Input_FLEX_09	Remote PTO Switch	
2/10	Digital Output_LP_FLEX_03	Amber Warning Lamp	
2/11	Digital Input_FLEX_10	Limiter 1	
2/12	Digital Input_FLEX_11	A/C Status	
2/13	Digital Input_FLEX_12	Fan Override	
2/14	Digital Input_FLEX_13	Engine Brake Low	
2/15	Digital Input_FLEX_14	Engine Brake Medium	
2/16	VCAN_L_C	J1939 (–)	
2/17	VCAN_GND_C	J1939 Shield	
2/18	VCAN_H_C	J1939 (+)	

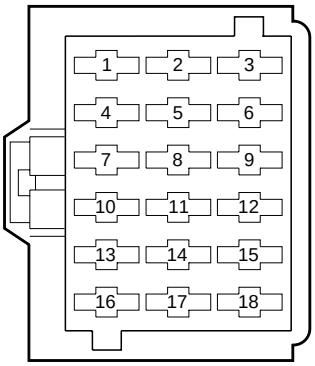


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Table 2, Connector 2, 18-Pin

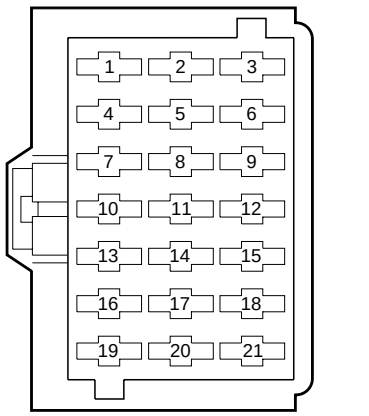
Connector 3, 21-Pin			
Pin	**Signal Type**	**Function**	**Connector**
3/1	Analog_In_01	OI Thermostat	 08/15/2008 f545339
3/2	Analog_GND	Sensor Return	
3/3	Analog_SUP_5V	Sensor Supply	
3/4	Analog_In_02	PTO	
3/5	Analog_Out_01	Not Used	
3/6	Analog_Out_02	Not Used	
3/7	Digital Output_HP_HS_01	Top2 Lockout Solenoid/AGS2 PTO Valve	
3/8	Digital Output_HP_HS_02	Top2 Shift Solenoid/AGS2 PTO Lamp	
3/9	Digital Output_HP_LS_01	AGS2 Backup Lamp/WIF Lamp (DD15)	
3/10	Digital Output_LP_FLEX_02	AGS2 Trans. Temp. Lamp	
3/11	SFP_14	Low Coolant Level Sensor	
3/12	Digital Output_LP_FLEX_04	AGS2 Check Trans. Lamp	
3/13	SFP_09	Vehicle Speed (+)	
3/14	SF_VGND	Vehicle Speed (–)	
3/15	Analog_In_SFP_13	Ambient Air Temp. Sensor	
3/16	Digital Output_LP_FLEX_05	Red Stop Lamp	
3/17	Digital Output_HP_FLEX_02	OI Alarm	
3/18	Digital Input_SFP_02	ABS Active (AGS2 Transmission)	
3/19	Not Used	Not Populated	
3/20	Not Used	Not Populated	
3/21	Not Used	Not Populated	

Table 3, Connector 3, 21-Pin

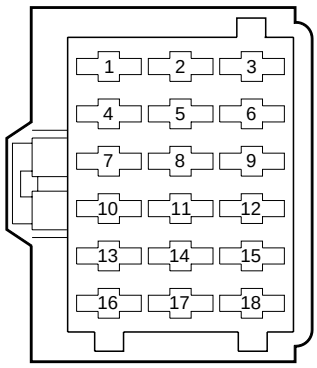
Connector 4, 18-Pin			
Pin	**Signal Type**	**Function**	**Connector**
4/1	C_ECAN_L	Engine CAN (–)	 08/15/2008 f545340
4/2	C_ECAN_GND	Engine CAN Shield	
4/3	C_ECAN_H	Engine CAN (+)	
4/4	Digital Input_SFP_11	Not Populated	
4/5	Digital Input_SFP_12	Not Populated	
4/6	Digital Output_LP_FLEX_06	Wait to Start Lamp (Grid Heater)	
4/7	Digital Output_HP_LS_02	High Exhaust Sys. Temp. Lamp	
4/8	Digital Input_FLEX_E1	Clutch Released/PTO Request for AGS2	
4/9	Digital Output_HP_Flex_01	OI Active Lamp/WIF Lamp (MBE 900)	
4/10	Digital Output_HP_HS_04	Vehicle Power Shutdown	
4/11	Frequency_SFP_10	Not Used	
4/12	PWM_FPO_01	Vehicle Speed Output	
4/13	Digital Input_FLEX_16	DPF Inhibit Switch	
4/14	Digital Input_SFP_03	Not Populated	
4/15	Digital Input_SFP_04	Not Populated	
4/16	Digital Input_FLEX_17	Trans. Neutral Switch	
4/17	Digital Input_FLEX_21	DPF Regeneration Switch	
4/18	Digital Input_FLEX_18	Hood Tilt Switch/AGS2 PTO Feedback	

Table 4, Connector 4, 18-Pin

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500 — Terms and Abbreviations

Cabin CAN—A proprietary datalink connecting certain ECUs on the vehicle, specifically the CGW, MSF, SAM Cab, and SAM Chassis.

CGW—Central Gateway

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Diagnostic Connector—A 9-pin diagnostic connector used for troubleshooting the electrical system.

MSF—Modular Switch Field

Multiplexing—Sending multiple electronic messages through the same signal path at the same time—in this case, through the CAN buses.

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

PDM—Power Distribution Module

SAE—Society of Automotive Engineers

SAM—Signal Detect and Actuation Module

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

501 — Introduction to Multiplexing

The Cascadia electrical and electronic system is a multiplexing system that replaces traditional power distribution devices with ECUs that communicate over the vehicle datalink. The electronic control units control power distribution to the vehicle electrical loads by monitoring inputs—such as sensors and switches—and supplying power to outputs, such as lighting, displays, gauges, and indicators. Multiplexing reduces the number of interconnecting wires and allows for more precise control of the electrical system by allowing multiple control or diagnostic commands to communicate on a two-wire datalink or network. See **Fig. 1** for a schematic of the multiplexing system.

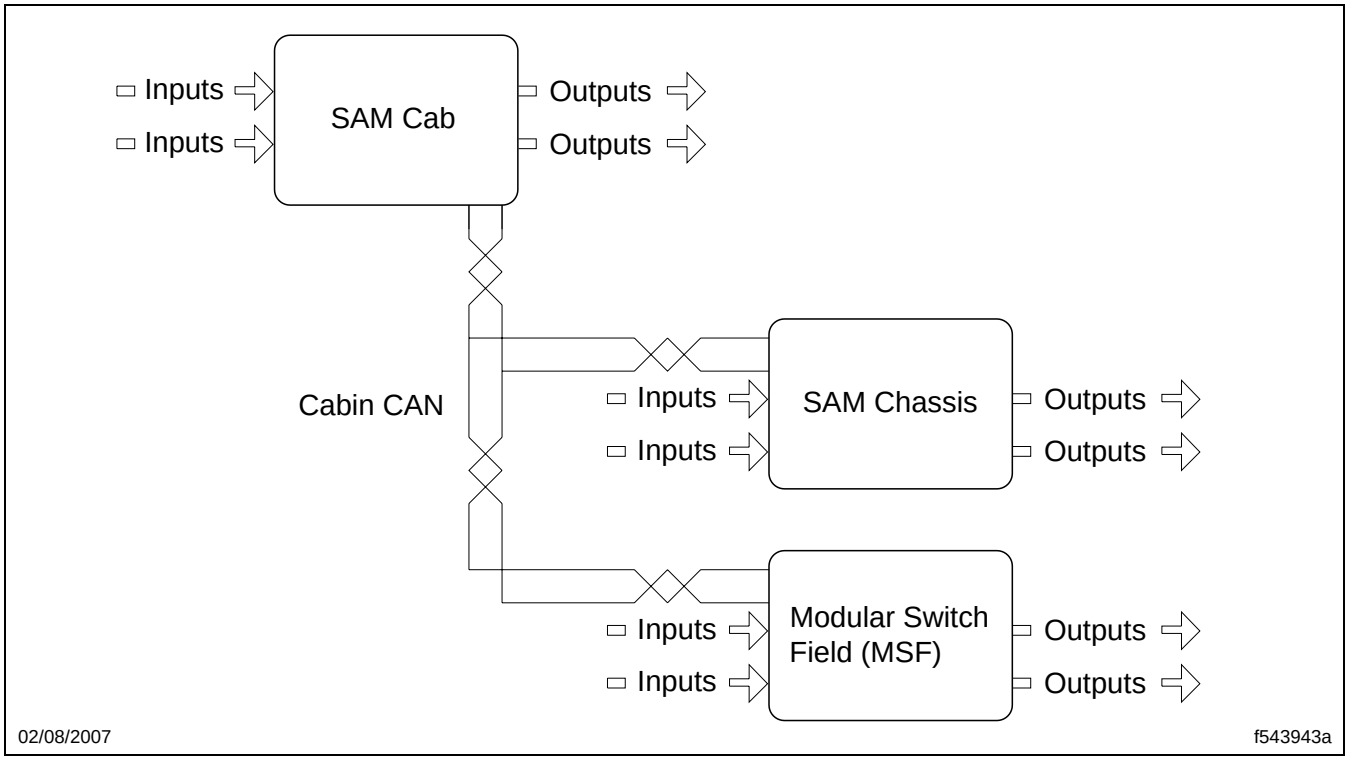


Fig. 1, Multiplexing System Controllers

The multiplexing system serves three main functions:

- Transmits multiple electronic messages through the same wire at the same time;
- Performs tasks and monitors components simultaneously;
- Uses electronic control units (ECU) to operate the system, such as interpreting different messages being transmitted on the same wire.

502 — Vehicle Datalinks

The Cascadia uses the following four datalinks:

- SAE J1587/J1708 datalink
- SAE J1939 datalink
- Cabin CAN datalink
- Diagnostic CAN datalink (mainly used for off-board tool interaction with Cabin CAN ECUs)

On this vehicle, Cabin CAN is the primary datalink for communicating control signals for most cab and chassis features such as interior and exterior lighting, comfort features, and optional features. Some of the Cabin CAN signals are routed to the J1939 and J1587/J1708 datalinks via the central gateway.

J1939 and J1587/J1708 remain the primary datalinks for chassis and powertrain control.

503 — SAE J1587/J1708 Datalink

The J1587 datalink is a low-speed vehicle datalink that communicates information between the electronic control units (ECU) on the vehicle. The J1587 datalink is also referred to as J1708.

J1708 refers to the SAE standard for the physical part of the datalink, such as the wiring and electronic components. J1587 refers to the SAE standard for the messaging protocol that communicates on the J1708 network. In the context of vehicle repair, the terms J1708 and J1587 are used interchangeably.

The J1587 datalink uses a twisted pair of wires to reduce interference from the digital messages being sent on the wires. Wire colors for the J1587 datalink are:

- orange J1587–
- dark green J1587+

504 — Datalink Network Topology

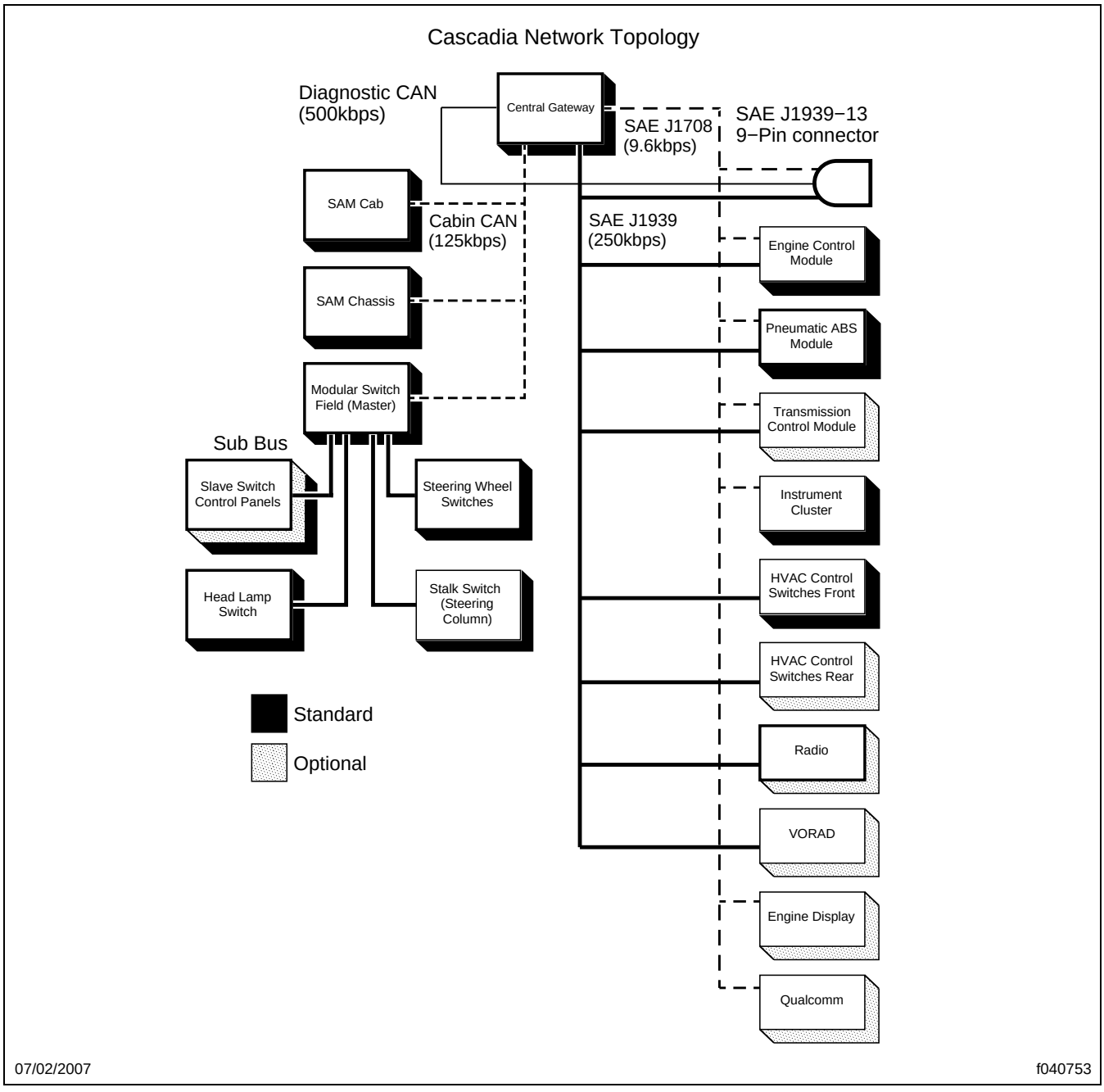
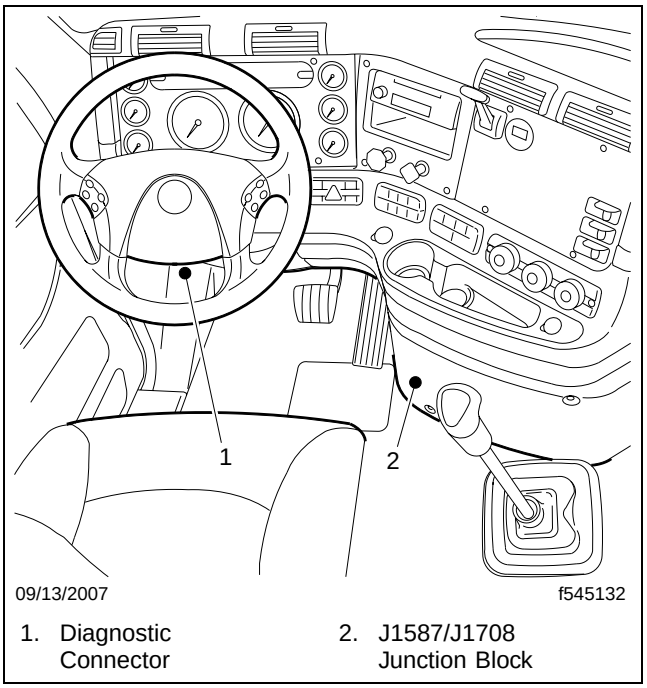


Fig. 2, Datalink Network Topology

600 — Component Locations



1. Diagnostic Connector
2. J1587/J1708 Junction Block

Fig. 3, Component Locations

601 — Component Details

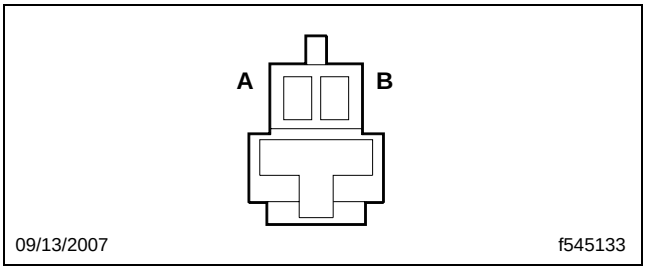


Fig. 4, J1587 Junction Block Connector

J1587 Connector		
Pin	**Color**	**Function**
A	Dark Green	J1587 (+)
B	Orange	J1587 (–)

Table 1, J1587 Connector

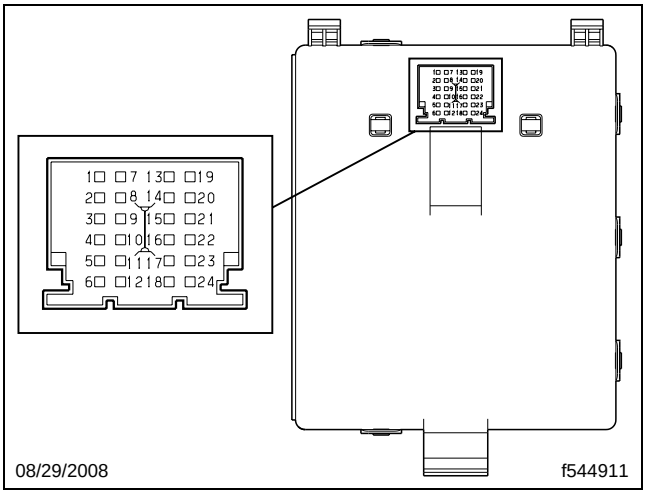


Fig. 5, Central Gateway Module, Cabin CAN Pins

CGW ECU (single connector)	
Pin	**Function**
1	Battery Power
2	J1708/J1587 (+)
7	Ground
8	J1708/J1587 (–)
14	Cabin CAN Low (–)
16	J1939 Low (–)
18	Diagnostic CAN Low (–)
19	Cabin CAN High (+)
21	J1939 High (+)
23	Diagnostic CAN High (+)

Table 2, CGW ECU (single connector)

700 — Symptoms of a Malfunctioning J1587 Datalink

Symptoms of a malfunctioning J1587 datalink may include the following conditions:

- Gauges are not working.
- ICU displays no J1587, no EnG, or no AbS.
- Warning lamps, such as ABS and CHECK ENGINE, are on.
- Cannot retrieve fault codes from an ECU.
- ServiceLink does not connect to the vehicle.
- One or more ECUs do not show up on the ServiceLink J1587 ECU list.

701 — Diagnosing the J1587/J1708 Datalink

NOTE: Before diagnosing the J1587/J1708 datalink, check the fuses and the battery voltage, and confirm that the ECU connectors are secure on the datalink.

1. **Make sure ServiceLink connects to the J1587 Datalink.**

    1.1 Connect ServiceLink to the vehicle.

    1.2 On the ECU list General Info screen, navigate to the J1708 protocol. Review the ECU list and verify that all ECUs expected on the J1708 datalink are communicating.

    1.3 Review the Problem ECU list on the bottom of the ECU List General Info Screen.

Does ServiceLink connect to the J1587/J1708 datalink?

YES → Go to test 2.

NO → Check the cables between the computer and vehicle. Check the vehicle interface adapter, and check the PC settings. Repair as necessary, then repeat test 1.

NOTE: ECUs on other protocols may appear as a result of CGW message routing behavior. Routed ECUs are displayed in grey on the ECU list. For more information on CGW message routing behavior, refer to **G02.03 — Central Gateway**.

2. **Diagnose the problem ECU.**

    2.1 Check the connector on the problem ECU to verify that it is not loose.

    2.2 With the key in the OFF position, remove the connector for the problem ECU.

    2.3 Turn the key to the ON position.

    2.4 Measure the voltage between the positive (J1587+) and the negative (J1587–) terminals on the connector.

    2.5 Measure the voltage between the positive post on the battery and the J1587+ terminal.

    2.6 Measure the voltage between the positive post on the battery and J1587– terminal.

    2.7 Compare the results to **Table 3**.

J1587 Datalink Voltage Test		
Meter (+) Probe	**Meter (–) Probe**	**Acceptable Voltage Reading**
ECU Datalink (+) Terminal	ECU Datalink (–) Terminal	3 to 4 VDC (1 to 3 VAC)
Battery Positive Post	ECU Datalink (+) Terminal	6 to 11 VDC
Battery Positive Post	ECU Datalink (–) Terminal	9 to 13.5 VDC

Table 3, J1587 Datalink Voltage Test

If the voltage is not within the acceptable range, go to test 3.

3. **Perform a resistance test.**

    3.1 Turn the key to the OFF position.

    3.2 Remove the connector from the problem ECU.

3.3 Measure the resistance between the J1587+ and J1587– terminals.

3.4 Measure the resistance between the J1587+ terminal and the vehicle ground.

3.5 Measure the resistance between the J1587– terminal and the vehicle ground.

3.6 Compare the values to **Table 4**.

J1587 Datalink Resistance Test		
Meter (+) Probe	**Meter (–) Probe**	**Acceptable Resistance Reading**
J1587/J1708 (+)	J1587/J1708 (–)	3k-18k
J1587/J1708 (+)	Vehicle Ground	More than 1k
J1587/J1708 (–)	Vehicle Ground	More than 1k

Table 4, J1587 Datalink Resistance Test

If the resistance is not in the acceptable range, go to test 4.

4. **Test the J1587 junction block.**

4.1 Remove the center dash lower trim panel.

4.2 Locate the J1587 junction block connector for the ECU.

4.3 Connect to the vehicle using ServiceLink.

4.4 Navigate to the J1708 tab on the ECU list General Info screen.

4.5 Disconnect a J1708 junction block connector. As a connector is removed, its ECU will drop off of the ECU list. If all ECUs drop off from the list, it means that the J1708 connection to the diagnostic connector is lost. If the CGW is disconnected from the junction block, the routed ECUs from other protocols (shared in the grey text) will drop off from the ECU list. When the connector with the datalink interruption is removed, no ECUs will drop off from the General Info screen.

4.6 Perform a continuity test to locate the wiring fault.

4.7 Repair the affected harness.

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500 — Terms and Abbreviations

Backbone—The main J1939 datalink wiring that lies between the two terminating resistors. It does not include the branch circuits to each ECU or to the diagnostic connector.

Branch Circuit—The section of J1939 datalink between the backbone and each ECU that has J1939, and between the backbone and the diagnostic connector.

Cabin CAN—A proprietary datalink connecting certain ECUs on the vehicle, specifically the CGW, MSF, SAM Cab, and SAM Chassis.

CAN—Controller Area Network

CGW—Central Gateway

Diagnostic Connector—A 9-pin diagnostic connector is used for troubleshooting the electrical system.

ECU—Electronic Control Unit, typically connected to a datalink.

J1939 Terminating Resistors—The J1939 datalink has two 120-ohm terminating resistors, one at each end of the backbone. The total datalink parallel resistance is 60-ohms.

Multiplexing—Sending multiple electronic messages through the same signal path at the same time—in this case, through the CAN buses.

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

Terminating Resistors—The J1939 datalink has two 120-ohm terminating resistors; one at each end of the backbone. The total datalink parallel resistance is 60-ohms.

501 — Introduction to Multiplexing

The Cascadia electrical and electronic system is a multiplexing system that replaces traditional power distribution devices with ECUs that communicate over the vehicle datalink. The electronic control units control power distribution to the vehicle electrical loads by monitoring inputs–such as sensors and switches–and supplying power to outputs, such as lighting, displays, gauges, and indicators. Multiplexing reduces the number of interconnecting wires, and allows for more precise control of the electrical system by allowing multiple control or diagnostic commands to communicate on a two-wire datalink or network. See **Fig. 1** for a schematic of the multiplexing system.

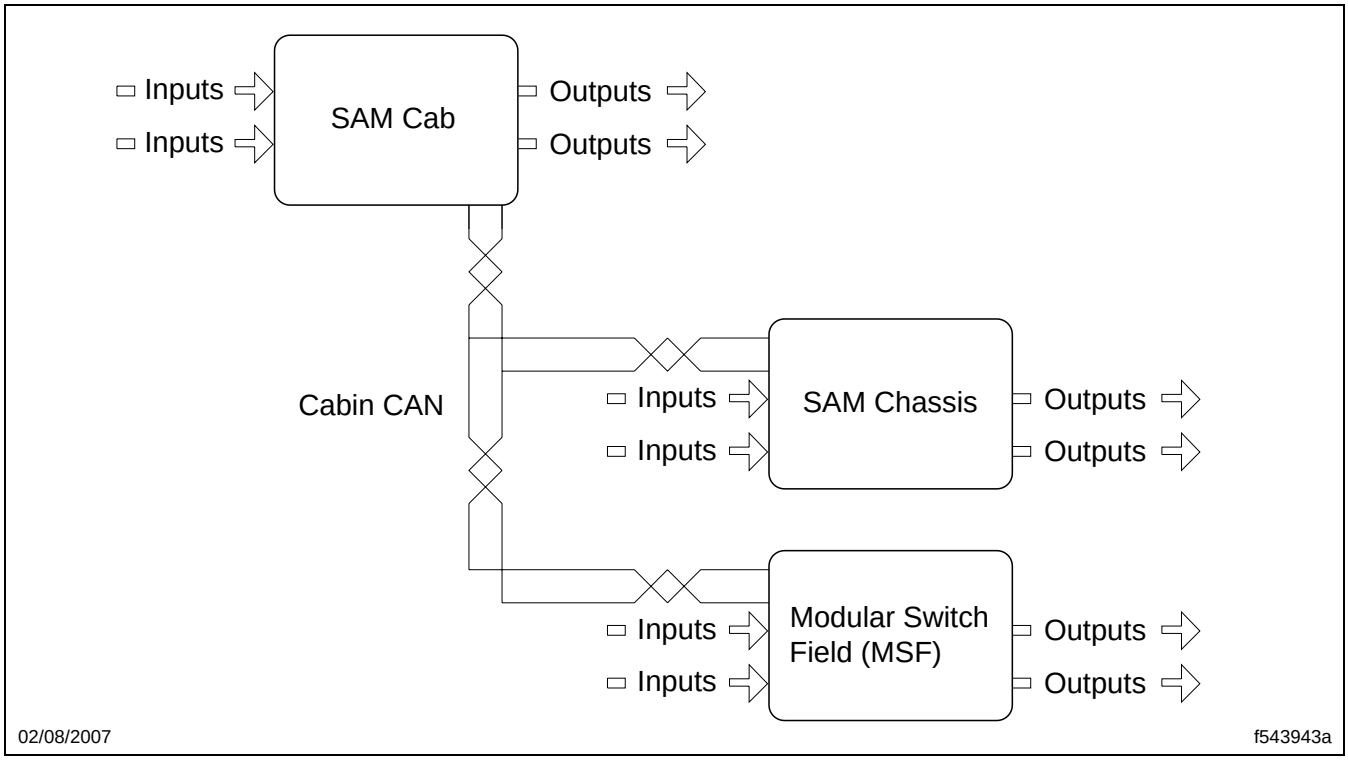


Fig. 1, Multiplexing System Controllers

The multiplexing system serves three main functions:

- Transmits multiple electronic messages through the same wire at the same time;
- Performs tasks and monitors components simultaneously;
- Uses electronic control units (ECU) to operate the system, such as interpreting different messages being transmitted on the same wire.

502 — Vehicle Datalinks

The Cascadia uses the following four datalinks:

- SAE J1708/J1587 datalink
- SAE J1939 datalink
- Cabin CAN datalink
- Diagnostic CAN datalink (used for off-board tool interaction with Cabin CAN ECUs)

Cabin CAN is the primary datalink for communicating control signals for most cab and chassis features such as interior and exterior lighting, comfort features, and optional features. Some of the Cabin CAN signals are routed to the J1939 and J1587/J1708 datalinks via the central gateway.

J1939 and J1587/J1708 remain the primary datalinks for chassis and powertrain control.

503 — SAE J1939 Datalink

The J1939 datalink is a high-speed datalink that communicates information between electronic control units (ECU) on the vehicle. The J1939 communicates at 250,000 bits per second.

Like the J1587 datalink, the J1939 datalink allows an ECU to broadcast requests as well as information. Information that can be communicated on the J1939 datalink includes the following:

- engine rotational speed
- road speed
- transmission tailshaft speed
- engine retarder deactivation request
- engine torque reduction request

The Backbone of the J1939 datalink is the section of the datalink that is between two terminating resistors. Each ECU is connected to the backbone. The wiring between each ECU and the backbone is referred to as a branch.

504 — Terminating Resistors

The J1939 datalink consists of twisted yellow and green wires. The yellow wire is J1939+, and the green wire is J1939–. The J1939 datalink has two terminating resistors, one at each end of the backbone.

The purpose of the terminating resistors is to minimize the reflection of data on the datalink. Collision of reflected data can cause J1939 messages to become partially or completely lost. Data collision can also cause the data to be erratic. Terminating resistors prevent this from occurring. Although the J1939 datalink may function with a missing or failed terminating resistor, data collision can occur and cause problems.

Each terminating resistor is 120 ohms, because the resistors are in parallel with one another, their total resistance equals 60 ohms. If a terminating resistor is removed, the circuit resistance should be 120 ohms. With both resistors installed in the circuit, there should be 60 ohms measured at any two points between J1939+ and J1939– in the circuit, such as between pins C and D of the diagnostic connector.

IMPORTANT: It is essential that two terminating resistors are installed in the J1939 datalink. Numerous J1939 problems are attributed to missing terminating resistors.

One of the terminating resistors is located in the driver side lower A pillar panel cover (near the diagnostic connector). The location of the second terminating resistor is behind the center dash lower trim panel near the ABS module.

505 — Datalink Network Topology

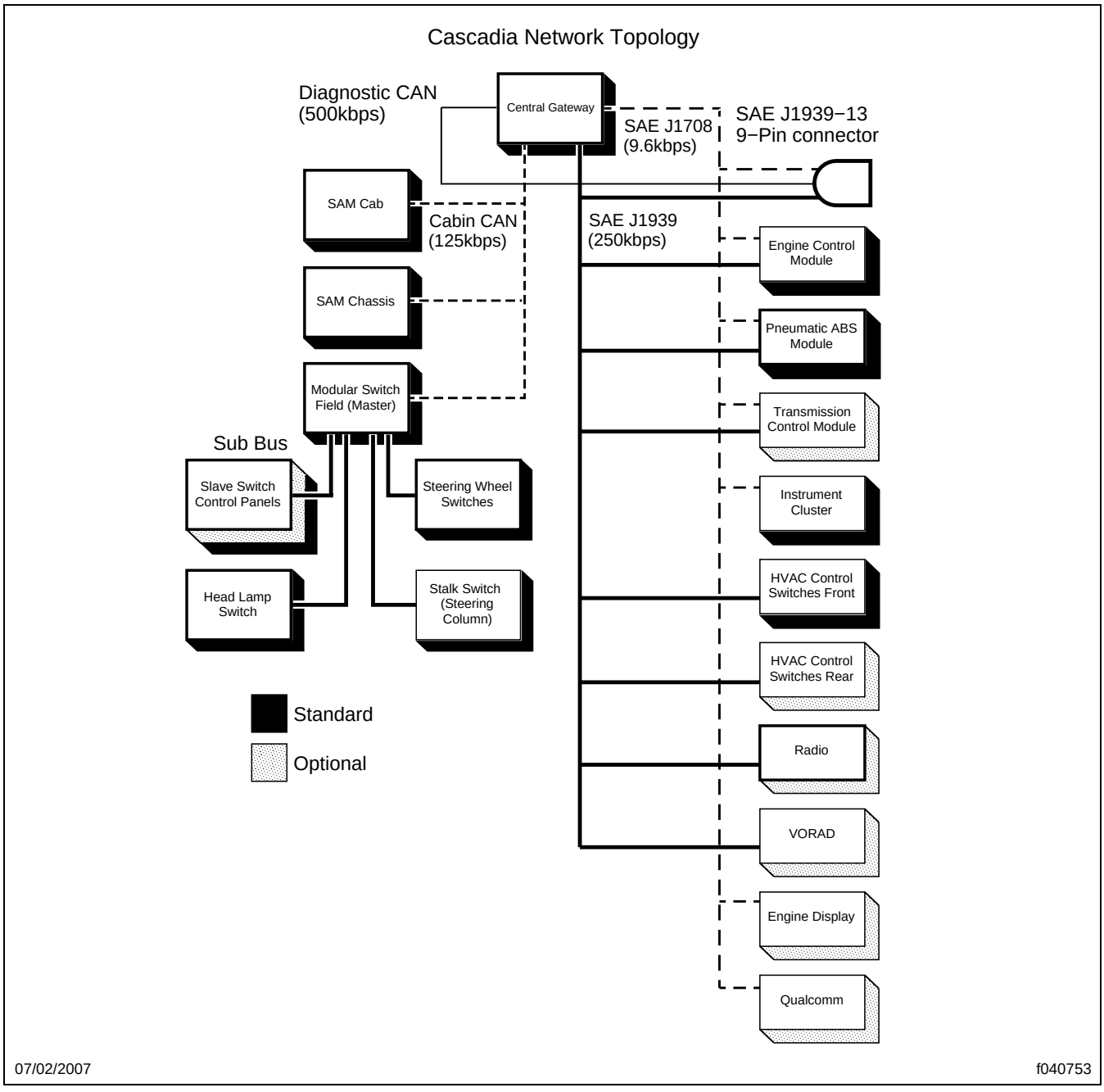
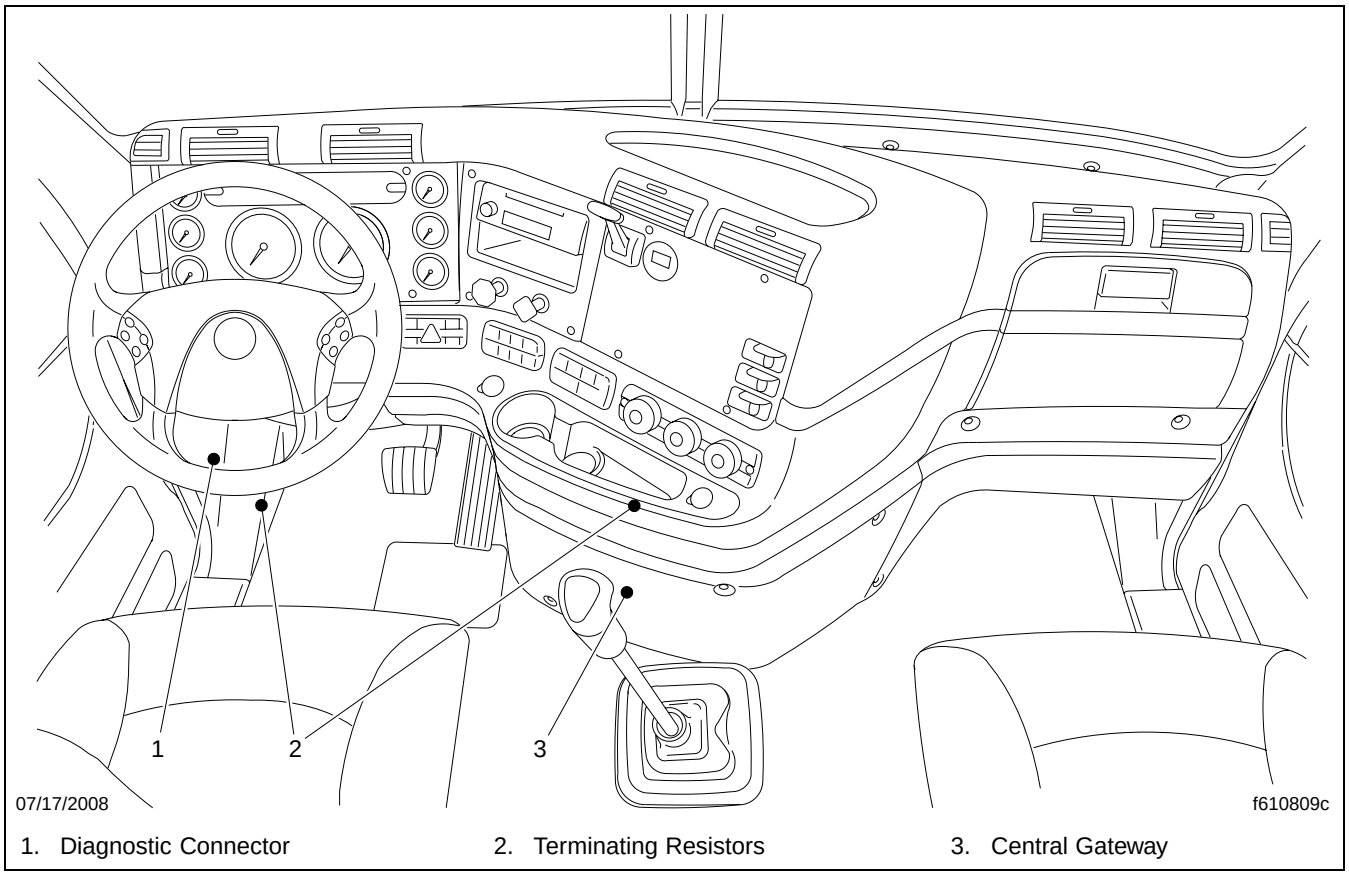


Fig. 2, Datalink Network Topology

600 — Component Locations



1. Diagnostic Connector
2. Terminating Resistors
3. Central Gateway

Fig. 3, Component Locations

601 — Component Details

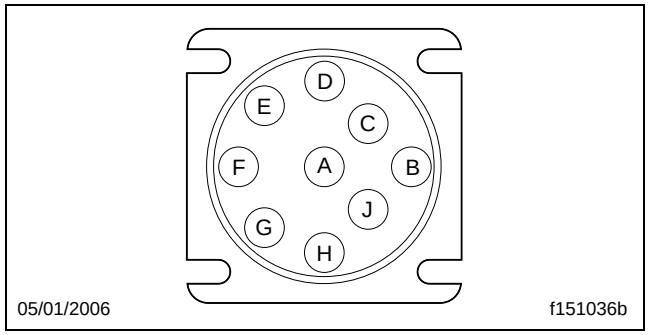


Fig. 4, Diagnostic Connector

Diagnostic Connector	
Pin	**Function**
A	Battery (–)
B	Battery (+)
C	J1939 CAN High (+)
D	J1939 CAN Low (–)
E	Reserved
F	J1708/J1587 (+)
G	J1708/J1587 (–)
H	Diagnostic CAN High (+)
J	Diagnostic CAN Low (–)

Table 1, Diagnostic Connector

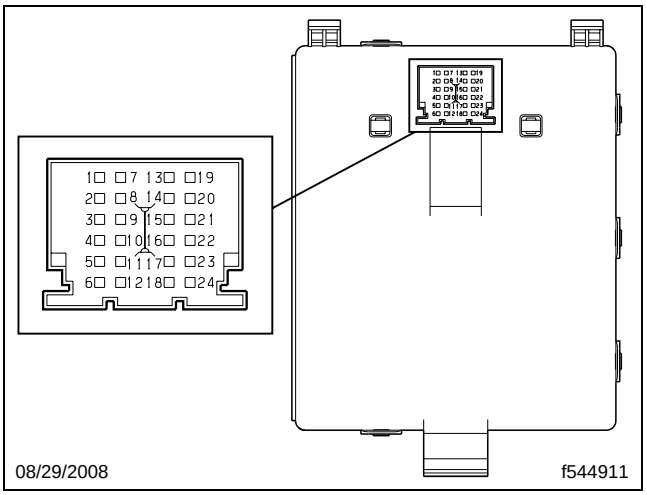


Fig. 5, Central Gateway Module, Cabin CAN Pins

CGW ECU (single connector)	
Pin	**Function**
1	Battery Power
2	J1708/J1587 (+)
7	Ground
8	J1708/J1587 (–)
14	Cabin CAN Low (–)
16	J1939 Low (–)
18	Diagnostic CAN Low (–)
19	Cabin CAN High (+)

CGW ECU (single connector)	
Pin	**Function**
21	J1939 High (+)
23	Diagnostic CAN High (+)

Table 2, CGW ECU (single connector)

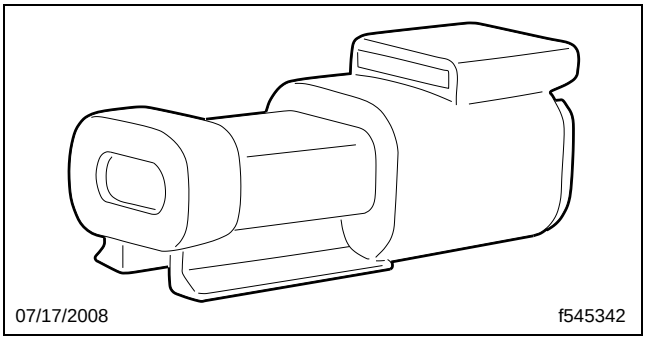


Fig. 6, Terminating Resistor

700 — Diagnostic Tools Required

- ServiceLink
- Datalink Monitor
- Digital Multimeter

701 — Diagnosing the J1939 Datalink

NOTE: Before diagnosing the J1939 datalink, check the fuses and the battery voltage, and confirm that the ECU connectors are secure on the Datalink.

1. **Make sure ServiceLink connects to the J1939 Datalink.**

   1.1 Connect ServiceLink to the vehicle.

   1.2 On the ECU list General Info screen, navigate to the J1939 protocol. Review the ECU list and verify that all ECUs expected on J1939 are communicating.

   1.3 Review the Problem ECU list on the bottom of the ECU List General Info screen.

   1.4 Load the Datalink Monitor Template "Cascadia J1939 Test." Review the gauges to verify ECUs communicating on J1939.

   1.5 Check the cables between the computer and vehicle. Check the vehicle interface adapter and the computer settings. Repair as necessary.

NOTE: ECUs on other protocols may appear as a result of CGW message routing behavior. Routed ECUs are displayed in grey on the ECU list. For more information on CGW message routing behavior, refer to **G02.03 — Central Gateway**.

2. **Verify J1939 backbone terminating resistance.**

2.1 Test the J1939 backbone terminating resistance to verify that terminating resistors are installed and a complete circuit from the diagnostic connector through the J1939 backbone is established. This does not guarantee that branch circuits to each ECU are OK.

2.2 Turn the key to the OFF position.

2.3 With the multimeter set to the resistance (Ω) scale, measure the resistance at the diagnostic connector across pin C (J1939+) and pin D (J1939–).

Compare the resistance values:

- **60 ± 6 Ω**: The J1939 wiring is intact and both terminating resistors are installed.
- **120 ± 12 Ω**: There is a terminating resistor missing, or a short present. Check the resistance across the terminating resistors.
- **40 ± 4 Ω**: There is a third terminating resistor installed on the datalink. One terminating resistor must be removed. There should be one terminating resistor on each end of the backbone for a total of two.
- **0-5 Ω**: There is a short between J1939+ and J1939– somewhere on the datalink.
- **Resistance is greater than 1000 Ω**: There is an open circuit between the diagnostic connector and the J1939 backbone, or both terminating resistors are missing or open.

3. **Test the terminating resistors.**

3.1 Remove the terminating resistor.

3.2 With the multimeter set to the resistance (Ω) scale, measure the resistance across both terminals on the terminating resistor. The acceptable reading value is 110 to 130 ohms. Replace the terminating resistor if it is not within the acceptable range.

4. **Verify resistance on the J1939 branch.**

4.1 If the backbone and terminating resistors on the J1939 datalink have been verified, proceed to testing the J1939 branch wiring at the problem ECU to verify connectivity.

4.2 Turn the key to the OFF position.

4.3 Remove the connector for the problem ECU.

4.4 With the multimeter on the resistance setting, measure the resistance between the J1939+ and J1939– terminals.

Compare the resistance values:

- **The resistance is 60 ± 6 Ω**: The J1939 wiring is intact. Inspect the connector for a loose connection or corrosion. Verify power and ground to the ECU.
- **The resistance is not 60 Ω**: There is a problem with J1939 wiring between the ECU connector and the J1939 backbone.

5. **Test the J1939 wiring for short to power and ground.**

5.1 Turn the key to the ON position.

5.2 Set the multimeter to read voltage (DC).

5.3 Attach the positive probe of the multimeter to the positive terminal of the battery.

5.4 With the negative probe, measure the voltage at the J1939+ and J1939– terminals.

Compare the voltage values:

- **0 VDC**: The J1939+ or J1939– wiring is shorted to Power.
- **12 VDC**: The J1939+ or J1939– wiring is shorted to Ground.

6. **If the previous tests do not isolate the problem, install a test ECU.**
   - 6.1 Remove the problem ECU and install a known good ECU.
   - 6.2 Connect to ServiceLink and navigate to the ECU list General Info screen.
   - 6.3 Verify ECU communication on the J1939 tab.
   - 6.4 If the test ECU operates normally, then replace the problem ECU.

Table of Contents

500 — Terms and Abbreviations

Baud Rate—The rate at which data is transmitted in bits per second.

Cabin CAN—A proprietary datalink connecting certain ECUs on the vehicle, specifically the CGW, MSF, SAM Cab, and SAM Chassis.

CAN—Controller Area Network

CAN ID—The identifier for a specific message, which also contains the source address of the sending ECU communicating on the J1939 datalink.

CGW—Central Gateway

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Datalink Topology—The arrangement in which the nodes (ECUs) of a datalink are connected to each other.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

Diagnostic Connector—A 9-pin diagnostic connector is used for troubleshooting the electrical system.

FMI—Failure Mode Indicator. The part of a J1587, J1939, and CAN fault code that identifies how part of a device, or item on a device, failed.

MID—Indicates numeric assignment for a device that communicates on J1587.

MSF—Modular Switch Field

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

Parameter—A parameter is a specific value that is assigned to a feature or function of the vehicle, and allows the customer to choose how that particular feature or function will work on the vehicle.

SA—Source Address; indicates numeric assignment for a device that communicates on J1939 or CAN.

SAM—Signal Detect and Actuation Module

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

SPN—Suspect Parameter Number. The part of a J1939 or CAN fault code that identifies how part of a device, or item on a device, failed.

501 — General Information

This vehicle has a multiplexed electrical system that uses a mix of traditional power distribution components and electronic control units (ECUs). See **G02.01 — Electrical System and Main PDM Overview** for more details.

502 — Vehicle Datalinks

The Cabin CAN is the primary datalink for control messaging of most cab and chassis features (interior and exterior lighting, comfort features, and optional features, for example), and has some interaction with messaging on the J1939 and J1587/J1708 datalinks.

J1939 and J1587/J1708 remain the primary datalinks for chassis and powertrain control (engine, transmission, and ABS, for example).

ECUs on the Cascadia electrical system communicate on four datalinks:

- SAE J1708/J1587 Datalink
- SAE J1939 Datalink
- Cabin CAN Datalink
- Diagnostic CAN Datalink (used strictly for off-board tool interaction with Cabin CAN ECUs)

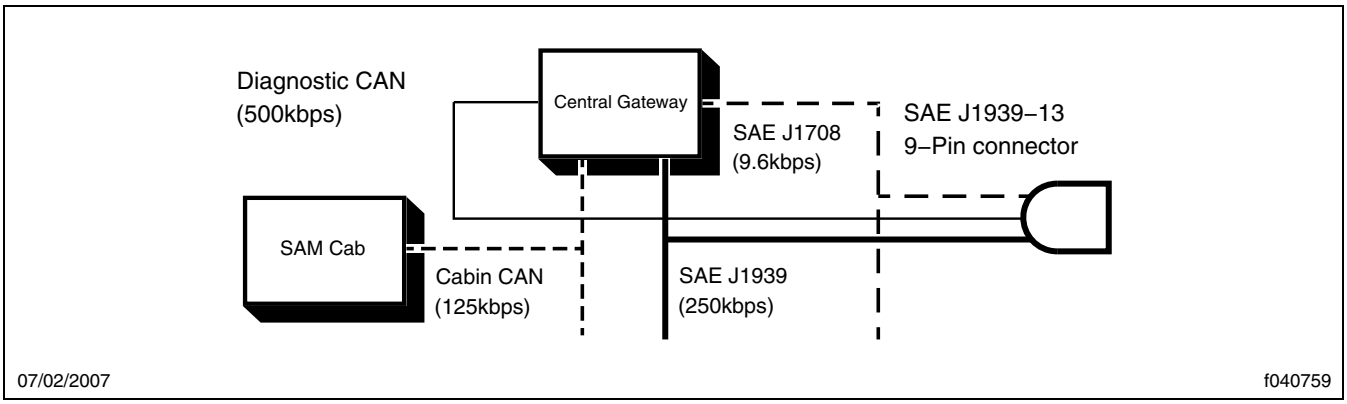


Fig. 1, Vehicle Datalinks, Central Gateway Module and Diagnostic Connector

503 —Cabin CAN Datalink

The Cabin CAN datalink has the following ECUs directly connected to it:

- SAM Cab
- SAM Chassis
- Modular Switch Field (MSF)
- Central Gateway

504 — Cabin CAN Network Topology

The Cabin CAN datalink uses a "star" network topology. The piece of hardware that connects the different components of the Cabin CAN datalink is called the "starpoint connector." Each leg of the Cabin CAN extends from the starpoint connector to an ECU, such as the SAM Cab, and a "star" is formed when multiple legs are connected. This is different from the J1939 datalink networks, which uses a “bus” network topology See **G03.01 — Datalink, J1587/J1708** and **G03.02 — Datalink, J1939** for more information.

The starpoint connector maintains an internal resistance value of 60 ohms for each leg of the network, similar to the terminating resistors on J1939. See **Fig. 4** and **Fig. 5**.

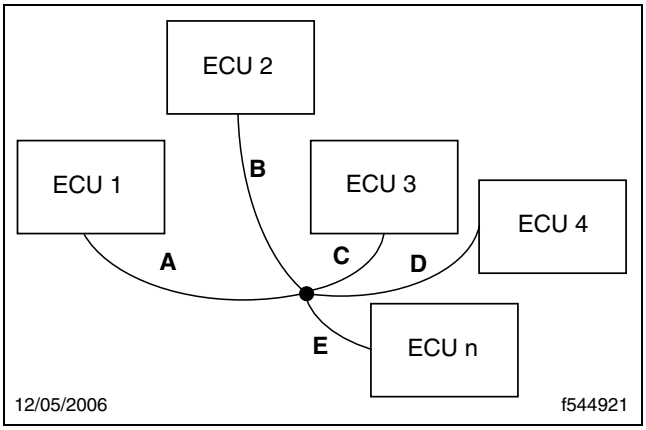


Fig. 2, Generic "Star" Network Topology

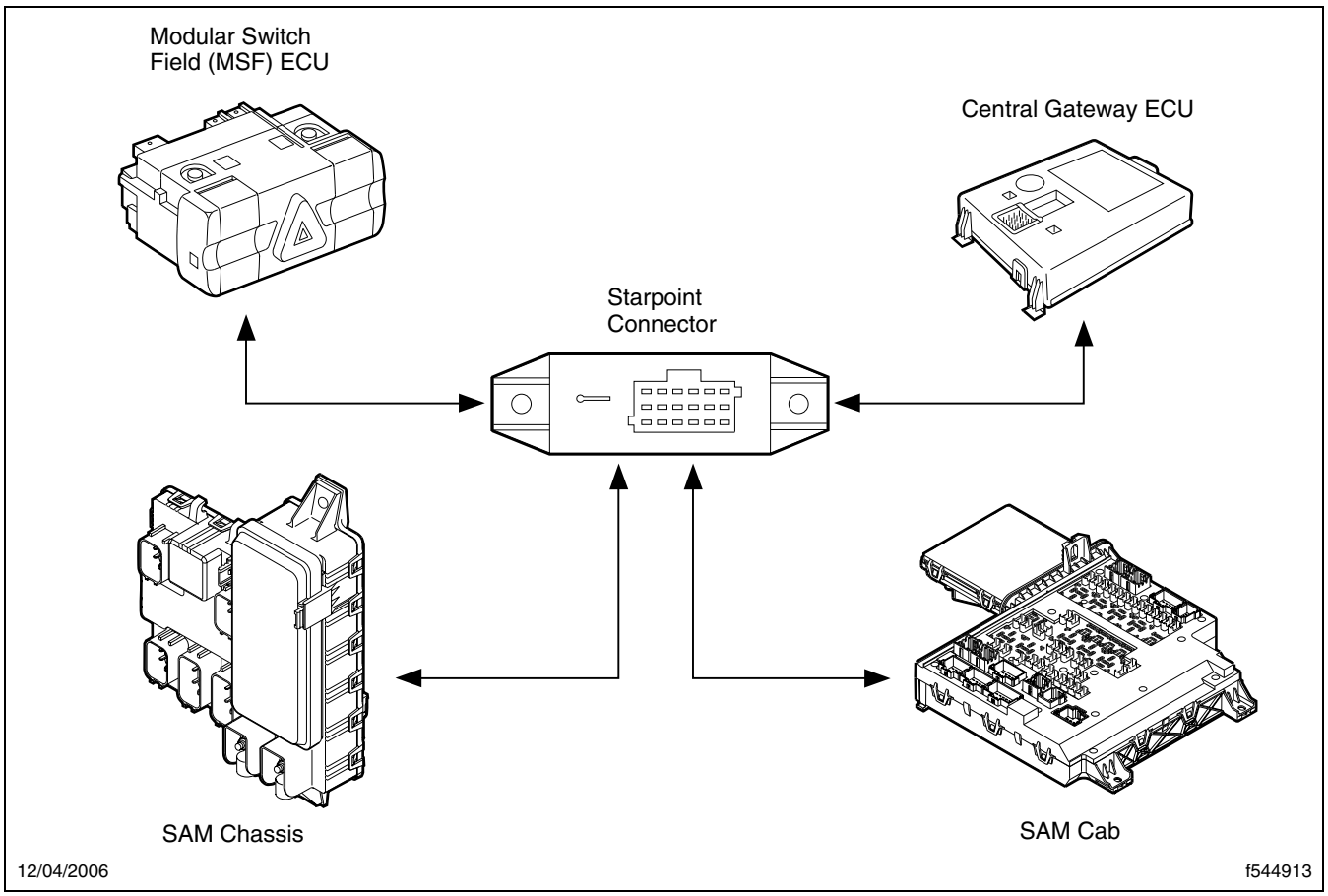


Fig. 3, Cabin CAN Network

For specifications on the starpoint connector, see **800 — Starpoint Connector**.

505 — Message Routing by the Central Gateway

Cabin CAN ECUs need information from the J1939 and J1708 datalinks. Information sent by J1939 or J1708 ECUs is obtained by the Central Gateway (CGW), which passes it to the appropriate Cabin CAN ECU. Similarly, the reverse happens when a J1939 or J1708 ECU needs information from a Cabin CAN ECU.

See **G02.03 — Central Gateway** for more information.

506 — Diagnostic CAN

The Cabin CAN datalink does not have a direct connection to the diagnostic connector. In order to troubleshoot or configure Cabin CAN ECUs, an off-board tool (such as ServiceLink) must use the Diagnostic CAN datalink.

The Diagnostic CAN datalink runs from the diagnostic connector to the CGW. Its sole purpose is to connect an off-board tool to the CGW, which routes messages between the tool and the other Cabin CAN ECUs. In this way, an off-board tool communicates with the Cabin CAN ECUs.

See **G03.04 — Datalink, Diagnostic CAN** for more information.

507 — Control Messaging and ECU Troubleshooting

Control messaging includes any datalink message required for vehicle functionality (such as for control of lighting, wipers or optional features).

Cabin CAN ECUs use the Cabin CAN datalink for control messaging, with the CGW sometimes routing information to or from the J1939 and J1708 datalinks.

ECU troubleshooting requires datalink messages that contain information such as fault codes, input or output pin controls, or data that is available specifically for troubleshooting the ECU.

An off-board tool (such as ServiceLink) uses the Diagnostic CAN datalink to access the messages needed for troubleshooting Cabin CAN ECUs.

Refer to **Table 1** for Cabin CAN ECU datalinks for control messaging and troubleshooting.

ECU Control Messaging and Troubleshooting Datalinks				
ECU is on this Datalink	**Direct Connection to Diagnostic Connector?**	**Troubleshooting Datalink**	**Direct Connection to Diagnostic Connector?**	**Diagnostic Communication Protocol**
Cabin CAN	No	Diagnostic CAN	Yes	CAN

Table 1, ECU Control Messaging and Troubleshooting Datalinks

508 — Controller Area Network

ServiceLink uses a communication protocol called the Controller Area Network (CAN) to communicate with ECUs on the Cabin CAN datalink.

509 — Vehicle Configuration

All Cabin CAN ECUs support flash reprogramming via ServiceLink, which updates the application software running on the ECU. All Cabin CAN ECUs, except for the CGW, have configurable parameters.

For more information on when and how to perform these functions in ServiceLink, see **G03.04 — Datalink, Diagnostic CAN**, the related subjects for the individual Cabin CAN ECUs, and ServiceLink user documentation.

510 — Datalink Network Topology

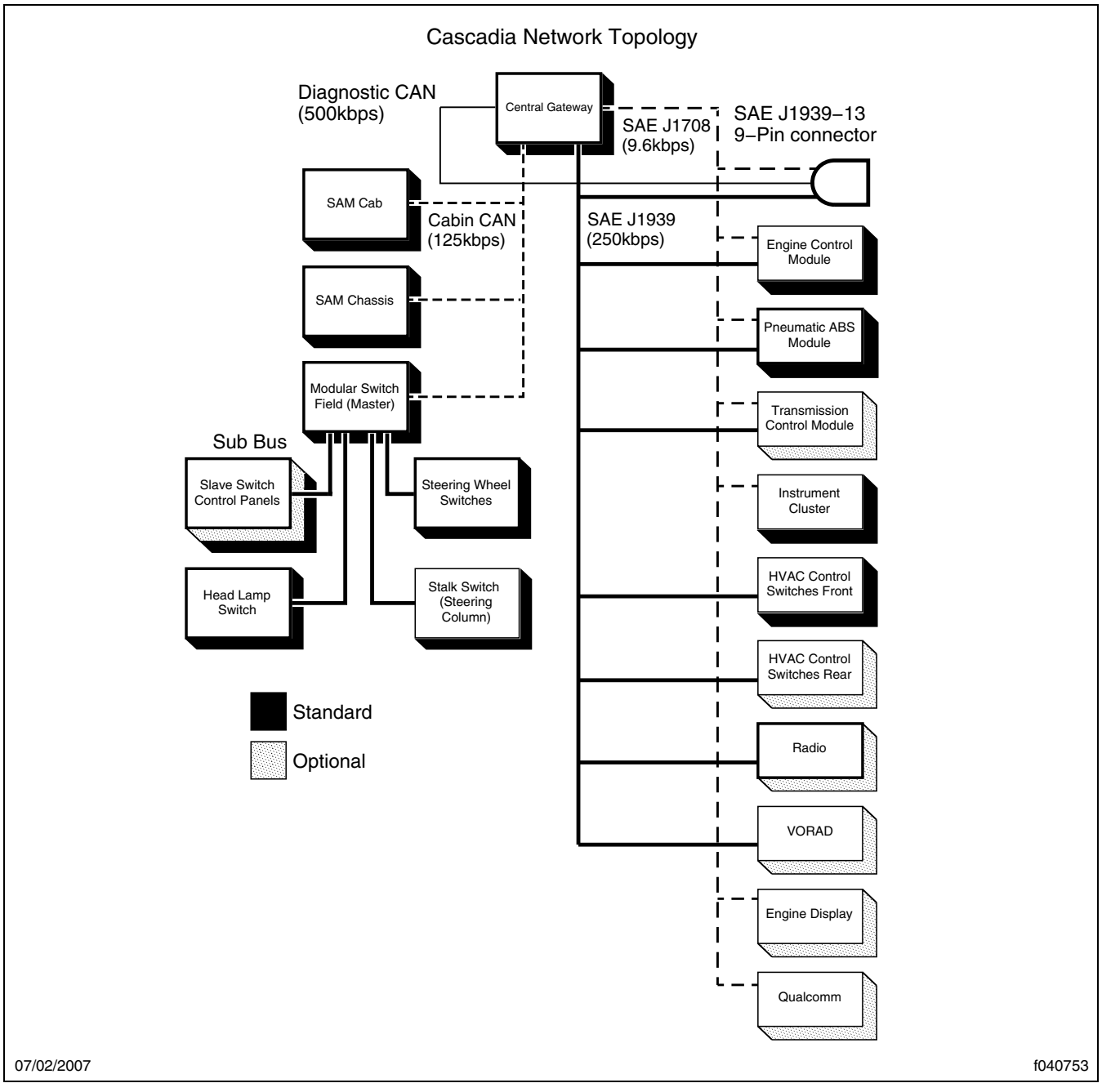
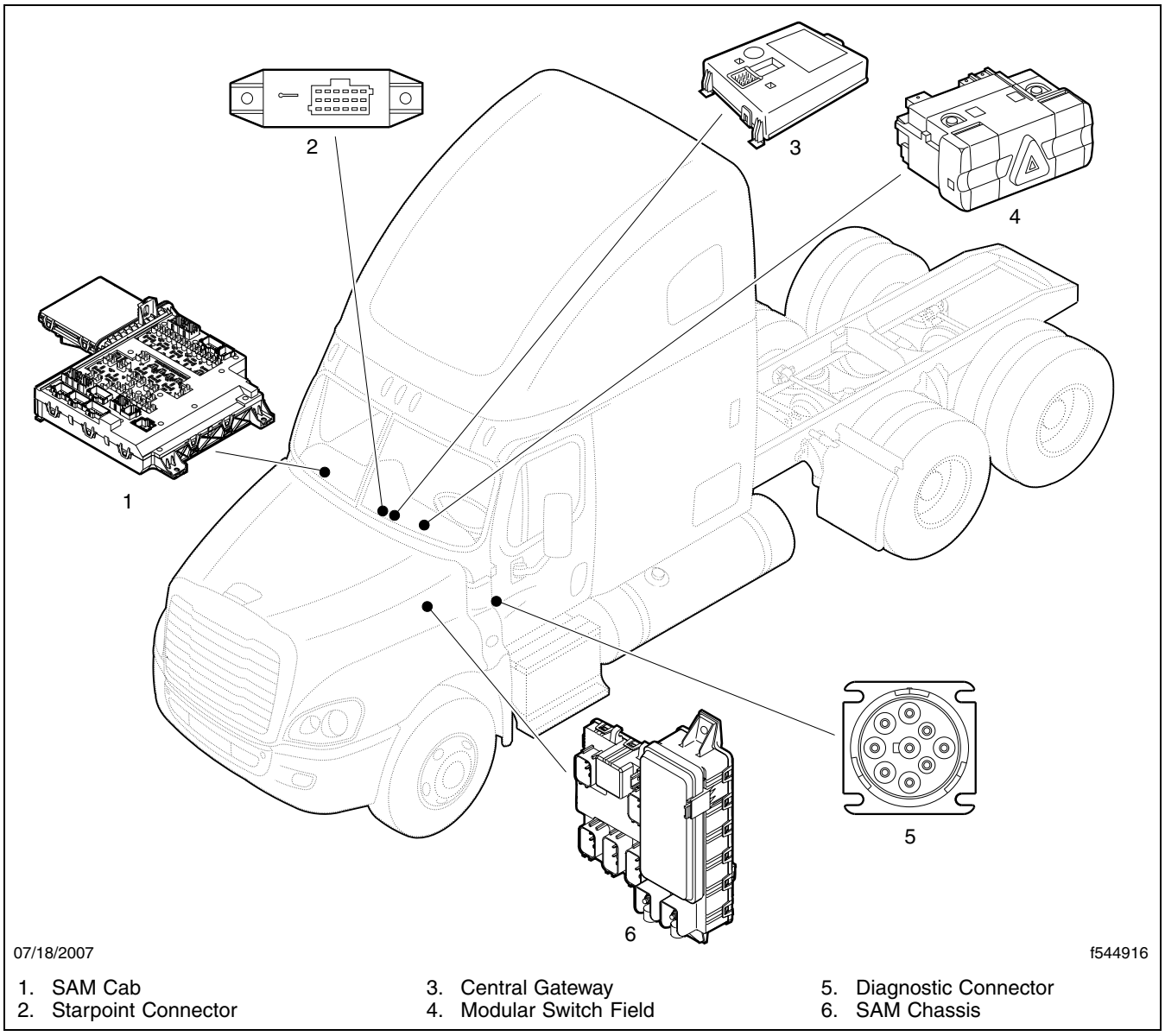


Fig. 4, Datalink Network Topology

511 — Related Subjects

- **G02.01 — Electrical System and Main PDM Overview**
- **G02.02 — Datalink Communication Structure**
- **G02.03 — Central Gateway**
- **G02.04 — SAM Cab**
- **G02.05 — SAM Chassis**
- **G02.06 — Modular Switch Field**
- **G04.03 — CAN Fault Codes**

600 — Component Locations



1. SAM Cab
2. Starpoint Connector
3. Central Gateway
4. Modular Switch Field
5. Diagnostic Connector
6. SAM Chassis

Fig. 5, Component Locations

601 — Component Details

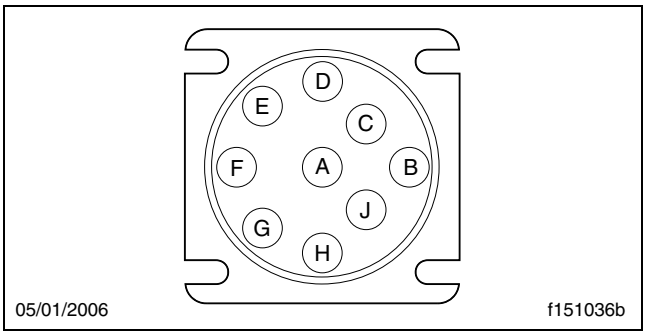


Fig. 6, Diagnostic Connector

Diagnostic Connector	
Pin	**Function**
A	Battery (–)
B	Battery (+)
C	J1939 CAN High (+)
D	J1939 CAN Low (–)
E	CAN Shield (ground)
F	J1708/J1587 (+)
G	J1708/J1587 (–)
H	Diagnostic CAN High (+)
J	Diagnostic CAN Low (–)

Table 2, Diagnostic Connector

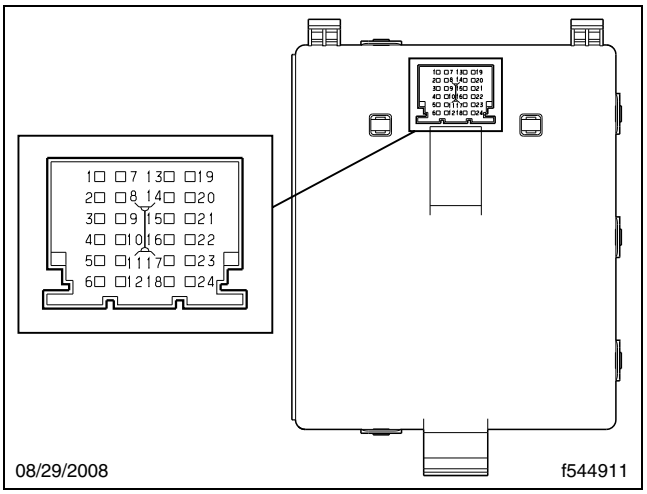
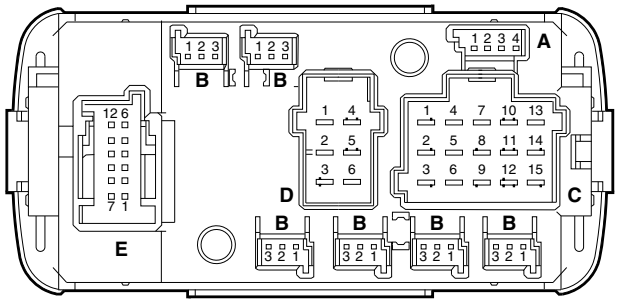


Fig. 7, Central Gateway Module, Cabin CAN Pins

CGW ECU (single connector)	
Pin	**Function**
1	Battery Power
7	Ground
14	Cabin CAN Low
18	Diagnostic CAN Low
19	Cabin CAN High
23	Diagnostic CAN High

Table 3, CGW ECU (single connector)



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A. Switch and Backlighting Pinout
B. MSF Slave Sub Bus Pinouts
C. Stalk Switch Pinout
D. Battery and Cabin CAN Pinout
E. Rotary Switch Pinout

Fig. 8, Modular Switch Field ECU

Modular Switch Field ECU, Cabin CAN pins, Connector D	
Pin	**Function**
3	Cabin CAN Low
5	Cabin CAN High

Table 4, Modular Switch Field ECU, Connector D

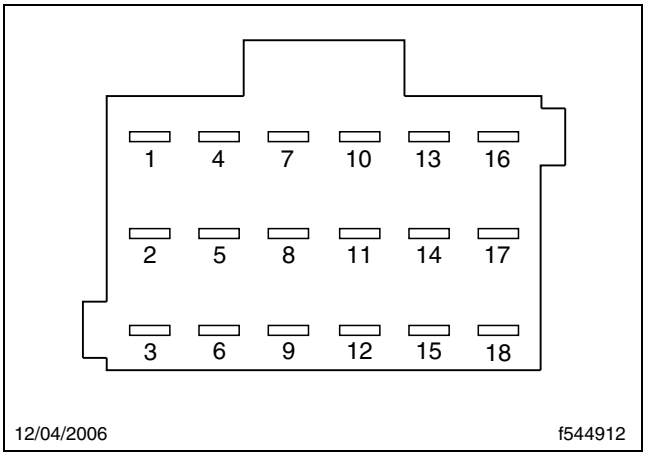


Fig. 9, Starpoint Connector

Starpoint Connector Pin Allocation	
Pin	**Function**
1	Cabin CAN High (to Central Gateway)
2	Not connected
3	Cabin CAN Low (to Central Gateway)
4	Cabin CAN High (to SAM Cab)
5	Not connected
6	Cabin CAN Low (to SAM Cab)
7	Cabin CAN High (to SAM Chassis)
8	Not connected
9	Cabin CAN Low (to SAM Chassis)
10	Cabin CAN High (to MSF)
11	Not connected
12	Cabin CAN Low (to MSF)
13	Not connected
14	Not connected
15	Not connected
16	Not connected
17	Ground
18	Not connected

Table 5, Starpoint Connector Pin Allocation

700 — Troubleshooting Tips

- Perform general electrical troubleshooting tests first, like checking for wiring continuity and connections.
- Refer to any fault codes reported on CAN in ServiceLink.

701 — Required Tools

- ServiceLink
- Digital Multimeter

702 — Possible Causes

Any Datalink

- Wiring
- Any ECU connected to the problem datalink

Cabin CAN datalink:

- Wiring
- Starpoint Connector resistor value on Cabin CAN datalink connections
- Any Cabin CAN ECU:
  - SAM Cab
  - SAM Chassis
  - Central Gateway
  - Modular Switch Field Master ECU

703 — CAN Fault Codes

NOTE: **Table 6** lists faults for the following ECUs:

- 33 – SAM Cab
- 37 – Central Gateway (CGW)
- 49 – Modular Switch Field (MSF)
- 71 – SAM Chassis

NOTE: Unless otherwise specified, all voltage measurements reference system ground.

IMPORTANT: The batteries **must** be disconnected prior to any resistance tests being performed. Failure to do so may result in inconclusive resistance measurements.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
33	521402	3	conn X13 pin 2	—	—	CAN low – Voltage above normal, or shorted to high source.	The Cabin CAN Low (–) pin is shorted to BAT, or high source. **Vehicle behavior**: SAM Cab and SAM Chassis outputs are behaving according to Emergency Power Mode for a Cabin CAN datalink failure. Indication of such a failure is that the headlamps are active, clearance and marker lamps are flashing, and turn signal ICU indicators are alternating when the ignition key is in the "run" position.
Action: Disconnect the batteries and measure the voltage at conn X13 pin 2. If the voltage detected is greater than 4.8V, troubleshoot the Cabin CAN Low datalink wiring on the SAM Cab and the other Cabin CAN ECUs for a short to BAT. Refer to **G06.09 — Powernet Management** for Emergency Power Diagnostics.							
33	521403	4	conn X13 pin 3	—	—	CAN high – Voltage below normal, or shorted to low source.	The Cabin CAN High (+) pin is shorted to GND, or low source. **Vehicle behavior**: SAM Cab and SAM Chassis outputs are behaving according to Emergency Power Mode for a Cabin CAN datalink failure. Indication of such a failure is that the headlamps are active, clearance and marker lamps are flashing, and turn signal ICU indicators are alternating when the ignition key is in the "run" position.
Action: Disconnect the batteries and measure the voltage at conn X13 pin 3. If the voltage detected is 0V, troubleshoot the Cabin CAN High datalink wiring on the SAM Cab and the other Cabin CAN ECUs for a short to GND. Refer to **G06.09 — Powernet Management** for Emergency Power Diagnostics.							
33	524037	31	—	—	—	Lost communication with CGW.	The fault becomes active when the SAM Cab misses 10 consecutive messages from the CGW. The fault becomes historic when the SAM Cab receives at least one message from the CGW.
Action: Verify the connection between the Cabin CAN datalink and the CGW. Disconnect the batteries and measure the resistance at pin 14 and 19 at the CGW. If 60 ohms is not detected, troubleshoot the Cabin CAN connection to the CGW. Measure the voltage on CGW pin 1. If battery voltage is not detected, troubleshoot circuit 443 between CGW pin 1 and SAM Cab conn X3 pin 18. Troubleshoot the GND circuit between CGW pin 7 and SAM Cab conn X3 pin 16. Check fuse F20 (CGW BAT) on the SAM Cab for continuity.							
33	524049	31	—	—	—	Lost communication with MSF.	The fault becomes active when the SAM Cab misses 10 consecutive messages from the MSF. The fault becomes historic when the SAM Cab receives at least one message from the MSF. **Vehicle behavior**: The headlamps, marker lamps, and clearance lamps will be on when the ignition key is in the "run" position.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
Action: Verify the connection between the Cabin CAN datalink and the MSF. Disconnect the batteries and measure the resistance at connector D, pins 3 and 5 on the MSF. If 60 ohms is not detected, troubleshoot the Cabin CAN datalink connection to the MSF. Measure the voltage at conn D pin 2 on the MSF for battery voltage. If battery voltage is not detected, troubleshoot circuit 14F between MSF conn D pin 2 and SAM Cab conn X2 pin 12. Troubleshoot the GND circuit between MSF conn D pin 6 and SAM Cab conn X2 pin 2. Check fuse F4 (MSF BAT) on the SAM Cab for continuity.							
33	524071	31	—	—	—	Lost communication with the SAM Chassis.	The fault becomes active when the SAM Cab misses ten consecutive messages from the SAM Chassis. **Vehicle Behavior**: SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode for a SAM Chassis failure. An indication of a SAM Chassis failure is that the ICU turn signal indicators flash alternately when the ignition key is in the "run" position.
Action: Verify the connection between the Cabin CAN datalink and the SAM Chassis. Disconnect the batteries and measure the resistance at conn X51 pin 1 and conn X51 pin 2 at the SAM Chassis. If 60 ohms is not detected, troubleshoot the Cabin CAN datalink connection to the SAM Chassis. Measure the battery stud on the SAM Chassis for battery voltage. Check the MEGA fuse and battery cables that supply the SAM Chassis. Refer to **G06.09 — Powernet Management** to troubleshoot the SAM Chassis for Emergency Power Diagnostics.							
37	523510	31	pin 18 pin 23	—	—	Diagnostic CAN performance.	Diagnostic CAN performance failure (communication is not possible) occurs when the Diagnostic CAN High is shorted to GND, the Diagnostic CAN Low is shorted to BAT, or the Diagnostic CAN Low is shorted to Diagnostic CAN High.
Action: Disconnect the batteries and measure the resistance between pins H and J at the diagnostic connector. If 60 ohms is not detected, troubleshoot the Diagnostic CAN datalink wiring for a short to BAT and GND. An open circuit and high shorted to low is also a cause. Troubleshoot the Diagnostic CAN high wiring between diagnostic connector pin H and CGW pin 23. Troubleshoot the Diagnostic CAN low wiring between diagnostic connector pin J and CGW pin 18.							
37	523511	31	pin 14 pin 19	—	—	Cabin CAN performance.	Cabin CAN performance failure (communication is not possible) occurs when the Cabin CAN High is shorted to GND, the Cabin CAN Low is shorted to BAT, or the Cabin CAN Low is shorted to Cabin CAN High.
Action: Disconnect the batteries and measure the resistance of the Cabin CAN datalink. If 60 ohms is not detected, troubleshoot the Cabin CAN low datalink for a short to Cabin CAN high. Measure the voltage at Cabin CAN high and Cabin CAN low. If BAT voltage is detected, troubleshoot for a short to GND. If 0V is detected, troubleshoot for a short to BAT. Check the following connector pairs: • SAM Cab conn X13 pin 2 and conn X13 pin 3 • SAM Chassis conn X51 pin 1 and conn X51 pin 2 • MSF conn D, pins 3 and 5							

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
37	523512	31	pin 16 pin 21	—	—	J1939 CAN performance.	J1939 performance failure occurs when the J1939 High is shorted to GND, the J1939 Low is shorted to BAT, the J1939 resistance is not equal to 60 ohms, or the J1939 Low is shorted to J1939 High.
Action: Disconnect the batteries and measure the resistance between J1939+ and J1939–. If the resistance is not 60 ohms, refer to **G03.02 — Datalink, J1939** to troubleshoot the J1939 datalink. With the key ON, measure the voltage at J1939+ and J1939–. Troubleshoot the J1939 datalink for a short to BAT or short to GND.							
37	523513	31	pin 2 pin 8	—	—	J1708 performance.	J1708 performance failure occurs when the bus load on the J1708 datalink is too high, or when the CGW has an extremely high processor load due to high traffic on Cabin CAN, J1939, or Diagnostic CAN. A short or open circuit between J1708 (+) and J1708 (–) will NOT cause this fault to become active. Fault will become historic once the CGW is able to successfully communicate on the J1708 datalink.
Action: Refer to troubleshooting provided in **G03.01 — Datalink, J1587/J1708**.							
37	524033	31	—	—	—	Lost communication with SAM Cab.	The fault is active when the CGW misses 10 consecutive messages from the SAM Cab (on the Cabin CAN datalink). The fault becomes historic when the CGW receives at least one message from the SAM Cab. **Vehicle Behavior**: SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode for a SAM Cab failure. An indication for a SAM Cab failure is the clearance lamps, marker lights, trailer tail lights, and rear stop lights are flashing when the ignition key is in the "run" position.
Action: Verify the connection between the Cabin CAN datalink and the SAM Cab. Disconnect the batteries and measure the resistance at SAM Cab conn X13 pin 2 and conn X13 pin 3. If 60 ohms is not detected, troubleshoot the Cabin CAN datalink connection to the SAM Cab. Measure the battery studs for the SAM cab for battery voltage. Check the MEGA fuse and battery cables that supply the SAM Cab. Refer to **G06.09 — Powernet Management** to troubleshoot the SAM Cab for Emergency Power Diagnostics.							

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
37	524049	31	—	—	—	Lost communication with MSF.	The fault is active when the CGW misses 10 consecutive messages from the MSF (on the Cabin CAN datalink). The fault becomes historic when the CGW receives at least one message from the MSF. **Vehicle behavior**: The headlamps, marker lamps, and clearance lamps will be on when the ignition key is in the "run" position.
Action: Verify the connection between the Cabin CAN datalink and the MSF. Disconnect the batteries and measure the resistance at conn D pins 3 and 5 on the MSF. If 60 ohms is not detected, troubleshoot the Cabin CAN datalink connection to the MSF. Measure the voltage at conn D pin 2 on the MSF for battery voltage. If battery voltage is not detected, troubleshoot circuit 14F between MSF conn D pin 2 and SAM Cab conn X2 pin 12. Troubleshoot the GND circuit between MSF conn D pin 6 and SAM Cab conn X2 pin 2. Check fuse F4 (MSF BAT) on the SAM Cab for continuity.							
37	524071	31	—	—	—	Lost communication with the SAM Chassis.	The fault is active when the CGW misses 10 consecutive messages from the SAM Chassis (on the Cabin CAN datalink). The fault becomes historic when the CGW receives at least one message from the SAM Chassis.
Action: Verify the connection between the Cabin CAN datalink and the SAM Chassis. Disconnect the batteries and measure the resistance at conn X51 pin 1 and conn X51 pin 2 at the SAM Chassis. If 60 ohms is not detected, troubleshoot the Cabin CAN datalink connection to the SAM Chassis. Measure the battery stud for the SAM Chassis for battery voltage. Check the MEGA fuse and battery cables that supply the SAM Chassis. Refer to **G06.09 — Powernet Management** to troubleshoot the SAM Chassis for Emergency Power Diagnostics.							
49	524033	31	—	—	—	Lost communication with the SAM Cab.	The fault is active when the MSF misses 10 consecutive messages from the SAM Cab (on the Cabin CAN datalink). The fault becomes historic when the MSF receives at least one message from the SAM Cab. **Vehicle behavior**: MSF backlighting defaults to 100%. SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode for a SAM Cab failure. An indication for a SAM Cab failure is the clearance lamps, marker lights, trailer tail lights, and rear stop lights are flashing when the ignition key is in the "run" position.
Action: Verify the connection between the Cabin CAN datalink and the SAM Cab. Disconnect the batteries and measure the resistance at SAM Cab conn X13 pin 2 and conn X13 pin 3. If 60 ohms is not detected, troubleshoot the Cabin CAN datalink connection to the SAM Cab. Measure the battery stud of the SAM Cab for battery voltage. Check the MEGA fuse and battery cables that supply the SAM Cab. Refer to **G06.09 — Power Management** to troubleshoot the SAM Cab for Emergency Power Diagnostics.							

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
49	524037	31	—	—	—	Lost communication with CGW.	The fault is active when the MSF misses 10 consecutive messages from the CGW. The fault becomes historic when the MSF receives at least one message from the CGW.
Action: Verify the connection between the Cabin CAN datalink and the CGW. Disconnect the batteries and measure the resistance at pins 14 and 19 at the CGW. If 60 ohms is not detected, troubleshoot the CGW. Measure the voltage on CGW pins 1 and 7. If battery voltage is not detected, troubleshoot circuit 443 between CGW pin 1 and SAM Cab conn 3 pin 18. Troubleshoot GND circuit between CGW pin 7 and SAM Cab conn 3 pin 16. Check fuse F20 (CGW BAT) on the SAM Cab for continuity.							
49	524071	31	—	—	—	Lost communication with SAM Chassis.	The fault is active when the MSF misses 10 consecutive messages from the SAM Chassis (on the Cabin CAN datalink). The fault becomes historic when the MSF receives at least one message from the SAM Chassis. **Vehicle behavior**: Indicator light on the Trailer Power sub bus switch is off. The SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode for a SAM Chassis failure. Indication of such a failure is that the turn signal ICU indicators are flashing alternately, rear turn signal lights are flashing, and the stop lights are off when the ignition key is in the "run" position.
Action: Verify the connection between the Cabin CAN datalink and the SAM Chassis. Disconnect the batteries and measure the resistance at conn 51 pin 1 and conn 51 pin 2 at the SAM Chassis. If 60 ohms is not detected, troubleshoot the Cabin CAN datalink connection to the SAM Chassis. Measure the battery stud on the SAM Chassis for battery voltage. Check the MEGA fuse and battery cables that supply the SAM Chassis. Refer to **G06.09 — Powernet Management** to troubleshoot the SAM Chassis for Emergency Power Diagnostics.							
71	520201	3	conn 51 pin 1	—	—	CAN low – Voltage above normal, or shorted to high source.	Cabin CAN Low (–) pin is shorted to BAT, or high source. **Vehicle behavior**: SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode for a for a Cabin CAN datalink failure. Indication of such a failure is that the headlamps are active, clearance and marker lamps are flashing, and turn signal ICU indicators are alternating when the ignition key is in the "run" position.
Action: Disconnect the batteries and measure the voltage at conn X51 pin 1. If the voltage detected is greater than 4.8V, troubleshoot the Cabin CAN Low datalink wiring on the SAM Chassis and the other Cabin CAN ECUs for a short to BAT. Refer to **G06.09 — Powernet Management** for Emergency Power Diagnostics							

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
71	520202	4	conn 51 pin 2	—	—	CAN high – Voltage below normal, or shorted to low source.	The Cabin CAN High (+) pin is shorted to GND, or low source. **Vehicle behavior**: SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode for a Cabin CAN datalink failure. Indication of such a failure is that the headlamps are active, clearance and marker lamps are flashing, and the turn signal ICU indicators are alternating when the ignition key is in the "run" position.
Action: Disconnect the batteries and measure the voltage at conn X51 pin 2. If the voltage detected is 0V, troubleshoot the Cabin CAN High datalink wiring on the SAM Chassis and the other Cabin CAN ECUs for a short to GND. Refer to **G06.09 — Powernet Management** for Emergency Power Diagnostics.							
71	524033	31	—	—	—	Lost communication with SAM Cab.	The fault is active when the SAM Chassis misses 10 consecutive messages from the SAM Cab. **Vehicle behavior**: SAM Cab and SAM Chassis outputs may be behaving according to Emergency Power Mode for a SAM Cab failure. An indication for a SAM Cab failure is the clearance lamps, marker lights, trailer tail lights, and rear stop lights are flashing when the ignition key is in the "run" position.
Action: Verify the connection between the Cabin CAN datalink and the SAM Cab. Disconnect the batteries and measure the resistance at SAM Cab conn X13 pin 2 and conn X13 pin 3. If 60 ohms is not detected, troubleshoot the Cabin CAN datalink connection to the SAM Cab. Measure the battery stud on the SAM cab for battery voltage. Check the MEGA fuse and battery cables that supply the SAM Cab. Refer to **G06.09 — Power Management** to troubleshoot the SAM Cab for Emergency Power Diagnostics.							
71	524037	31	—	—	—	Lost communication with the CGW.	The fault is active when the SAM Chassis misses 10 consecutive messages from the CGW. The fault becomes historic when the SAM Chassis receives at least one message from the CGW.
Action: Verify the connection between the Cabin CAN datalink and the CGW. Disconnect the batteries and measure the resistance at pins 14 and 19 at the CGW. If 60 ohms is not detected, troubleshoot the Cabin CAN connection to the CGW. Measure the voltage on CGW pins 1 and 7. If battery voltage is not detected, troubleshoot circuit 443 between CGW pin 1 and SAM Cab conn X3 pin 18 and GND circuit between CGW pin 7 and SAM Cab conn X3 pin 16. Check fuse F20 (CGW BAT) on the SAM Cab for continuity.							

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
71	524049	31	—	—	—	Lost communication with the MSF.	The fault becomes active when the SAM Chassis misses 10 consecutive messages from the MSF. The fault becomes historic when the SAM Chassis receives at least one message from the MSF. **Vehicle behavior**: Functions for MSF headlamp/rotary, stalk or steering wheel switches cannot be activated or deactivated (headlamps, wipers, and turn signals) when the ignition key is in the "run" position. Headlights stay on.
Action: Verify the connection between the Cabin CAN datalink and the MSF. Disconnect the batteries and measure the resistance at connector D, pins 3 and 5 on the MSF. If 60 ohms is not detected, troubleshoot the Cabin CAN datalink connection to the MSF. Measure the voltages at connector D, pins 2 and 6 on the MSF for battery voltage. If battery voltage is not detected, troubleshoot circuit 14F between MSF conn D pin 2 and SAM Cab conn X2 pin 12. Troubleshoot the GND circuit between MSF conn D pin 6 and SAM Cab conn X2 pin 2. Check fuse F4 (MSF BAT) on the SAM Cab for continuity.							

Table 6, CAN Fault Codes

800 — Starpoint Connector

- The starpoint connector provides 60-ohms of terminating resistance to the Cabin CAN connection of each leg.
- The starpoint connector has capacity to connect up to 6 components.
- All starpoint ground connections are directly connected. A screw connection ties this ground to the chassis ground.

801 — Wiring

Datalink Wire Colors		
Datalink	**Wire Color**	
	High	**Low**
Cabin CAN	Light Blue	White
Diagnostic CAN	Brown with Light Blue Stripe	Brown with White Stripe

Table 7, Datalink Wire Colors

802 — Datalink Communication Rates

Datalink Communication Rates	
Datalink	**Kilobits Per Second**
Cabin CAN	125
Diagnostic CAN	500

Table 8, Datalink Communication Rates

803 — ECU Identification on Datalinks

NOTE: Parenthesis indicate ECU may appear under these identifiers in the given protocol based on message routing behavior by the CGW.

ECU Identification on Datalinks			
ECU	**J1587 MID**	**J1939 SA**	**CAN SA**
SAM Cab	(249)	(33)	33
SAM Chassis	(216)	(71)	71
Modular Switch Field	(164)	(49)	49
Central Gateway	(206)	(37)	37

Table 9, ECU Identification on Datalinks

Table of Contents

500 — Terms and Abbreviations

Baud Rate—The rate at which data is transmitted in bits per second.

Cabin CAN—A proprietary datalink connecting certain ECUs on the vehicle, specifically the CGW, MSF, SAM Cab, and SAM Chassis.

CAN—Controller Area Network

CAN ID—The identifier for a specific message, which also contains the source address of the sending ECU communicating on the J1939 datalink.

CGW—Central Gateway

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Datalink Topology—The arrangement in which the nodes (ECUs) of a datalink are connected to each other.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

Diagnostic Connector—A 9-pin diagnostic connector is used for troubleshooting the electrical system.

FMI—Failure Mode Indicator. The part of a J1587, J1939, and CAN fault code that identifies how part of a device, or item on a device, failed.

MSF—Modular Switch Field

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

Parameter—A parameter is a specific value that is assigned to a feature or function of the vehicle, and allows the customer to choose how that particular feature or function will work on the vehicle.

SA—Source Address; indicates any device that communicates on J1939.

SAM—Signal Detect and Actuation Module

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

SPN—Suspect Parameter Number. The part of a J1939 or CAN fault code that identifies how part of a device, or item on a device, failed.

501 — General Information

This vehicle has a multiplexed electrical system that uses a mix of traditional power distribution components and electronic control units (ECUs). See **G02.01 — Electrical System and Main PDM Overview** for more information.

502 — Vehicle Datalinks

The system communicates on four datalinks:

- SAE J1708/J1587 datalink

- SAE J1939 datalink
- Cabin CAN datalink
- Diagnostic CAN datalink (strictly used for off-board tool interaction with Cabin CAN ECUs)

The Cabin CAN is the primary datalink used for control messaging (interior and exterior lighting, brakes, and optional features, for example) and has some interaction with control messaging on the J1939 and J1587/J1708 datalinks.

J1939 and J1587/J1708 remain the primary datalinks for chassis and powertrain control (engine, transmission, and ABS, for example).

503 — Diagnostic CAN

The Cabin CAN datalink does not have a direct connection to the diagnostic connector. Therefore, in order to troubleshoot or configure Cabin CAN ECUs, an off-board tool must connect to the Diagnostic CAN datalink in the diagnostic connector. In this way, the off-board tool can communicate with the Cabin CAN ECUs via the CGW.

The Diagnostic CAN datalink runs from the diagnostic connector to the CGW. Its sole purpose is to connect an off-board tool like ServiceLink to the CGW, in order to diagnose or configure ECUs connected to the Diagnostic CAN or the Cabin CAN datalinks.

The CGW separates the Cabin CAN from off-board tools because:

- the CGW acts as a firewall, where Freightliner's proprietary Cabin CAN datalink is protected from "public" access;
- the CGW provides for better protection from electrical damage and better control of electrical capabilities, which leads to more reliable ECUs.

Voltage activity will be seen on the diagnostic connector's Diagnostic CAN datalink pins only while an off-board tool is communicating with the Cabin CAN ECUs. When no off-board tool is communicating, there is no voltage activity on the Diagnostic CAN datalink pins in the diagnostic connector.

504 — Diagnostic CAN Network Topology

The Diagnostic CAN Datalink uses a "point-to-point" network topology where two nodes are connected directly.

This is different from the Cabin CAN, which uses a "star" network topology, and the J1939 datalink network, which uses a "bus" network topology.

The CGW contains an internal resistance of 60 ohms required to terminate the Diagnostic CAN network.

505 — Control Messaging and ECU Troubleshooting

An ECUs "control messaging" refers to the messages it sends to other ECUs to control the vehicle. This takes place over its connected datalink. However, an ECUs "troubleshooting datalink" refers to the datalink that an off-board tool like ServiceLink uses to troubleshoot that ECU.

Cabin CAN is the primary datalink for control messaging of most cab and chassis features, including interior and exterior lighting, comfort features, optional features, and some interaction with control messaging on the J1939 and J1587/J1708 datalinks.

The Cabin CAN datalink does not have a direct connection to the diagnostic connector. Troubleshooting ECUs on the Cabin CAN datalink requires an off-board tool (such as ServiceLink), which connects to the Diagnostic

CAN datalink wires in the diagnostic connector. An off-board tool can communicate with the Cabin CAN ECUs via the CGW. See **Table 1** for a Cabin CAN ECU's datalinks for control messaging and troubleshooting.

ECU Control Messaging and Troubleshooting Datalinks					
ECU is on this Datalink	**Control Messaging Datalink**	**Direct Connection to Diagnostic Connector?**	**Troubleshooting Datalink**	**Direct Connection to Diagnostic Connector?**	**Diagnostic Communication Protocol**
Cabin CAN	Cabin CAN	No	Diagnostic CAN	Yes	CAN

Table 1, ECU Control Messaging and Troubleshooting Datalinks

506 — Controller Area Network (CAN)

In general, "CAN" refers to a specific protocol definition of a network's physical layer. By this definition, the J1939, Cabin CAN and Diagnostic CAN datalinks are all CAN networks at the physical layer.

In terms of ServiceLink, "CAN" refers specifically to the device and protocol option used to diagnose and configure ECUs connected to the Diagnostic CAN and Cabin CAN datalinks, including the CGW, SAM Cab, SAM Chassis and MSF. See **Fig. 1**. Cabin CAN ECUs can be viewed in ServiceLink via the CAN protocol. Active and historic faults can be viewed, and historic faults can be cleared. ECU information is available, as is access to Datalink Monitor templates. In addition, ECU configuration functions can be performed, such as flashing ECU software and changing ECU parameters.

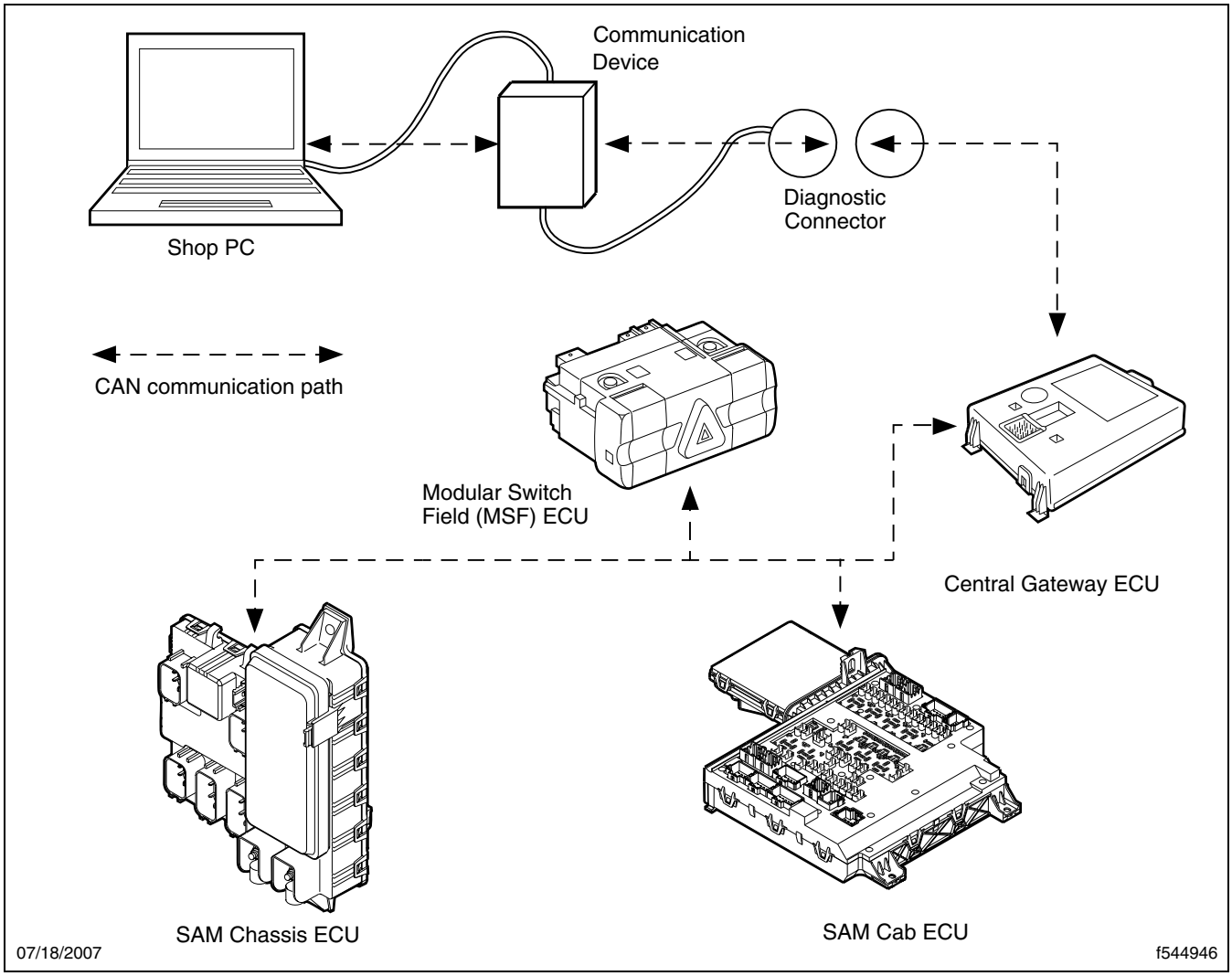


Fig. 1, Diagram of the Cabin CAN ECU Troubleshooting Path

507 — ECU Parameter and Software Configuration

All of the ECUs connected to the Cabin CAN datalink have parameters that can be configured. The only Cabin CAN ECU without parameters is the CGW on EPA07 vehicles. Parameters tell the ECU how to control the vehicle. All Cabin CAN ECUs with parameters have the same parameter structure and behavior described in this subject.

There are two levels of parameters. The higher level is called a "function parameter" in ServiceLink. For each function parameter, there may be one or more detailed parameters describing what the function does. These are called "parameters" in ServiceLink, and include the following:

- hardware or software interlocks
- cut-off speeds
- maximum and minimum limits

In a CAN ECUs "Parameters" screen in ServiceLink, parameters will be either view-only or changeable.

All changeable parameters have a part number associated with them, just like a hardware part. When adding, removing, or changing a feature, the parameters are provided in the form of a part number in the bill of material (BOM).

Viewing, changing, or re-applying parameters may be necessary in the following scenarios:

- Adding an optional feature (daytime running lights, for example).
- Removing an optional feature.
- Changing the functionality of an existing feature, for example, changing the vehicle's daytime running light feature to activate both the marker lights and the low beams, instead of activating only the low beams.

Flashing (or reprogramming) the software is separate from programming the parameters, just as it is in an engine controller.

NOTE: As part of the flashing process in ServiceLink, any parameters that the ECU may have will automatically be reapplied.

For instructions on how to use ServiceLink to change the parameters of a CAN ECU, see the *ServiceLink User Guide* or *ServiceLink Help*.

508 — ECU Configuration

All of the ECUs connected to the Cabin CAN datalink can have their software "flashed" using ServiceLink. This means the ECU's software can be flashed to its same version or upgraded, if required.

The flashing procedure should be performed on an ECU in the following cases only:

- **For a feature upgrade:** Adding a new feature to a vehicle may require a newer version of ECU software. ServiceLink will automatically make available any necessary software upgrades.
- **To fix a problem in the existing software:** In case a new version of ECU software is needed to fix a problem in the existing ECU software, ServiceLink automatically makes available any necessary software upgrades.
- **When replacing the ECU on a vehicle:** Flashing ensures the correct software is on the newly installed ECU.
- **As a last resort:** Troubleshooting has narrowed the problem down to being at the ECU itself and no other mechanical or electrical causes for the symptom have been identified. As a last resort, flashing the ECU's software with the same version may help in the case it became corrupt during the course of normal vehicle operation.

For more information on when and how to perform these processes in ServiceLink, see the ServiceLink user documentation (available via the "Help" drop-down menu in ServiceLink).

509 — Datalink Network Topology

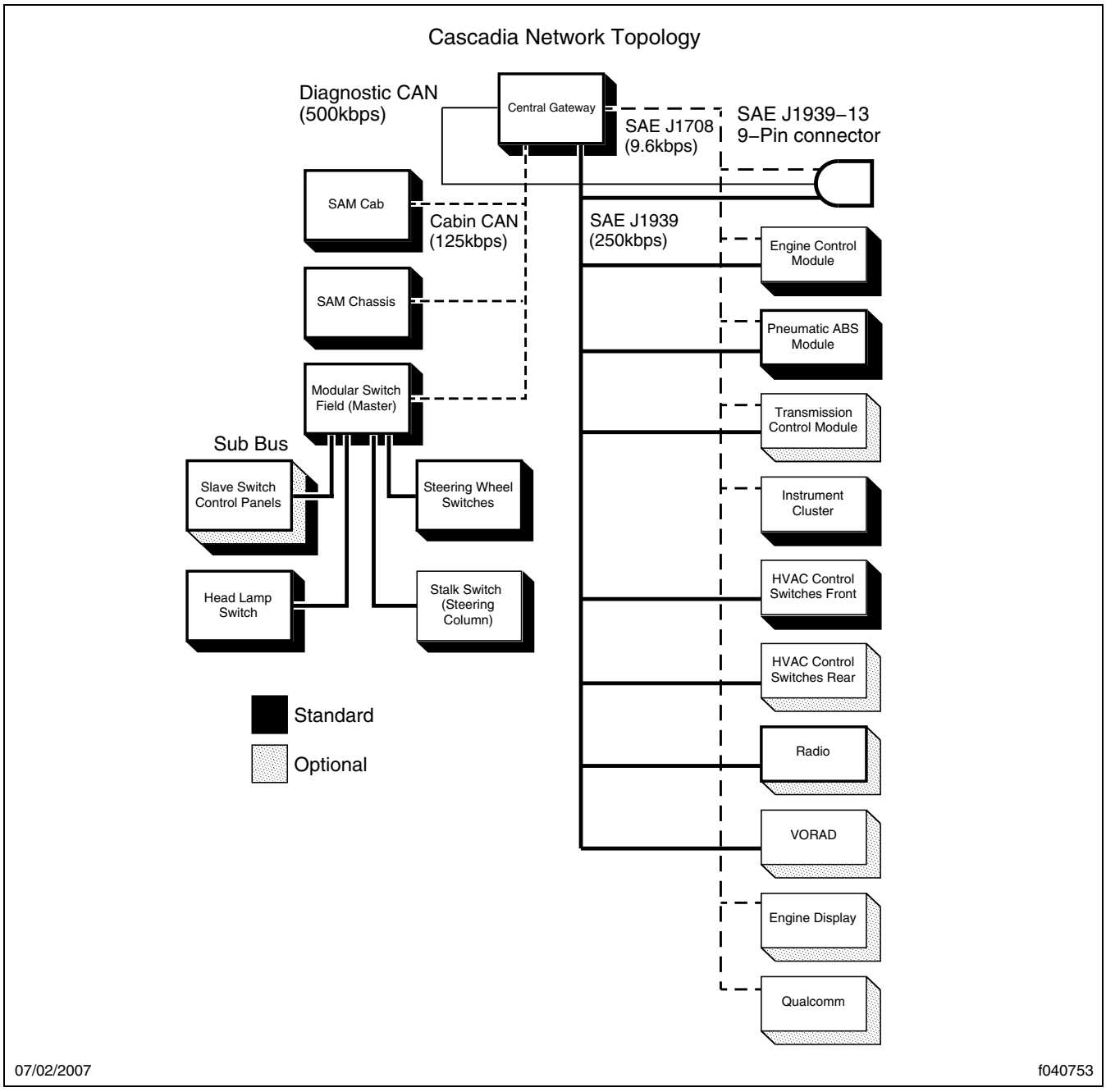
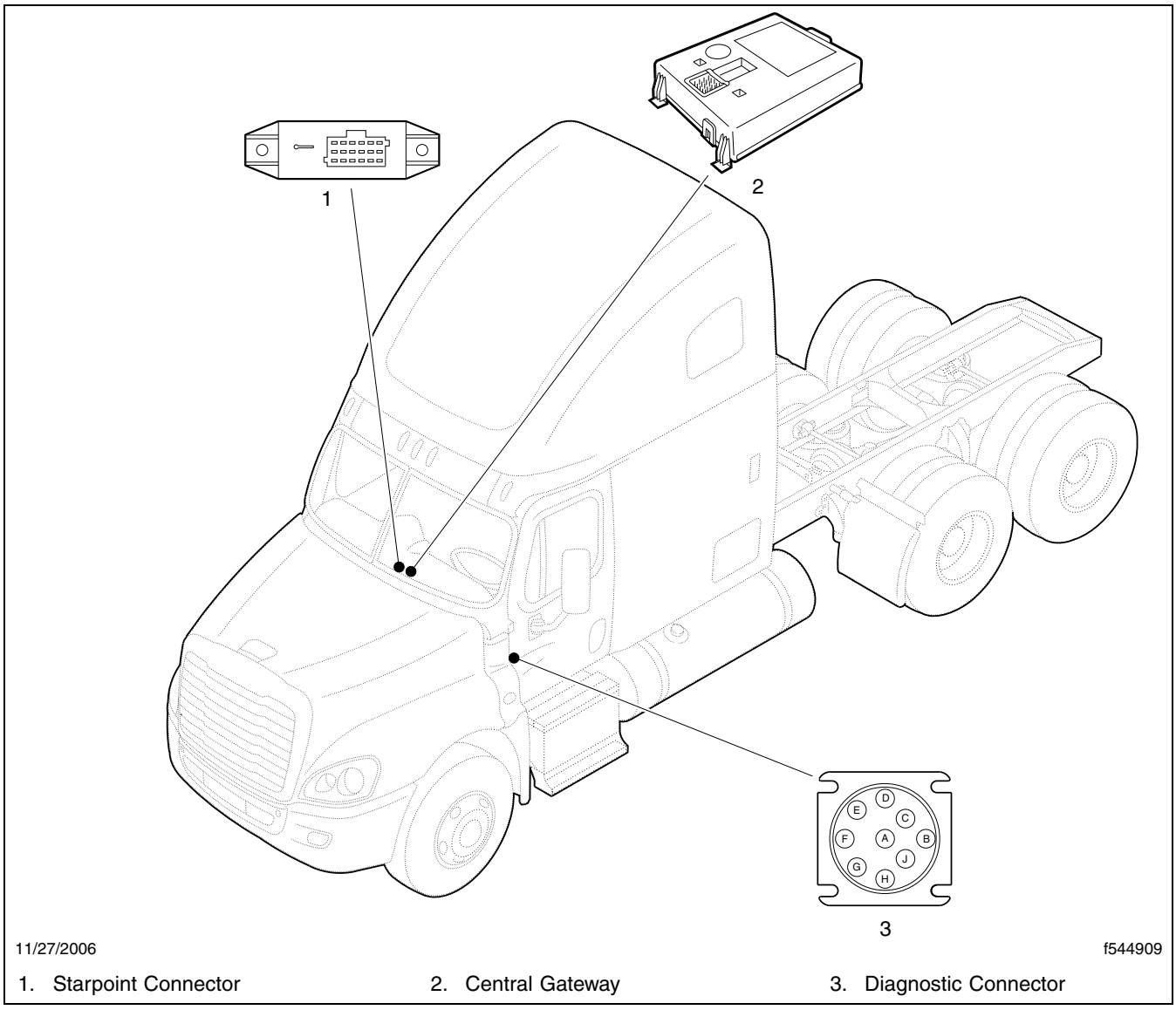


Fig. 2, Datalink Network Topology

510 — Related Subjects

- **G02.01 — Electrical System and Main PDM Overview**
- **G02.02 — Datalink Communication Structure**
- **G02.03 — Central Gateway**
- **G02.04 — SAM Cab**
- **G02.05 — SAM Chassis**
- **G02.06 — Modular Switch Field**
- **G03.03 — Datalink, Cabin CAN**
- **G04.03 — CAN Fault Codes**

600 — Component Locations



1. Starpoint Connector
2. Central Gateway
3. Diagnostic Connector

Fig. 3, Component Locations

601 — Component Details

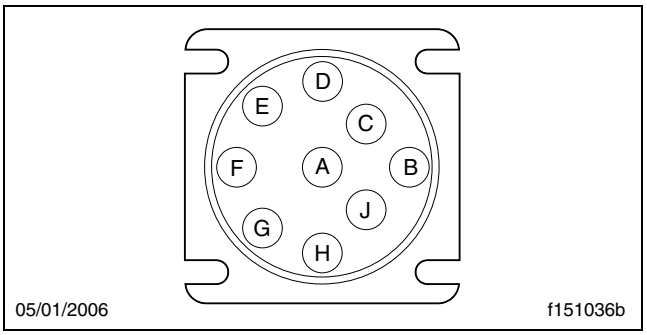


Fig. 5, Diagnostic Connector

Diagnostic Connector	
Pin	**Function**
A	Battery (–)
B	Battery (+)
C	J1939 CAN High (+)
D	J1939 CAN Low (–)
E	CAN Shield (ground)
F	J1708/J1587 (+)
G	J1708/J1587 (–)
H	Diagnostic CAN High (+)
J	Diagnostic CAN Low (–)

Table 2, Diagnostic Connector

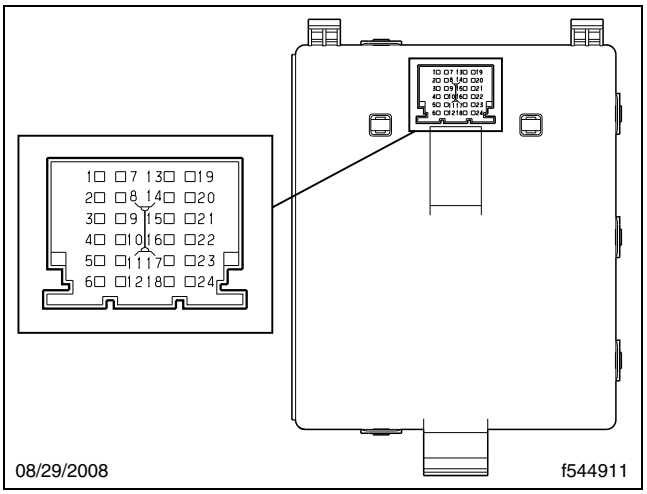
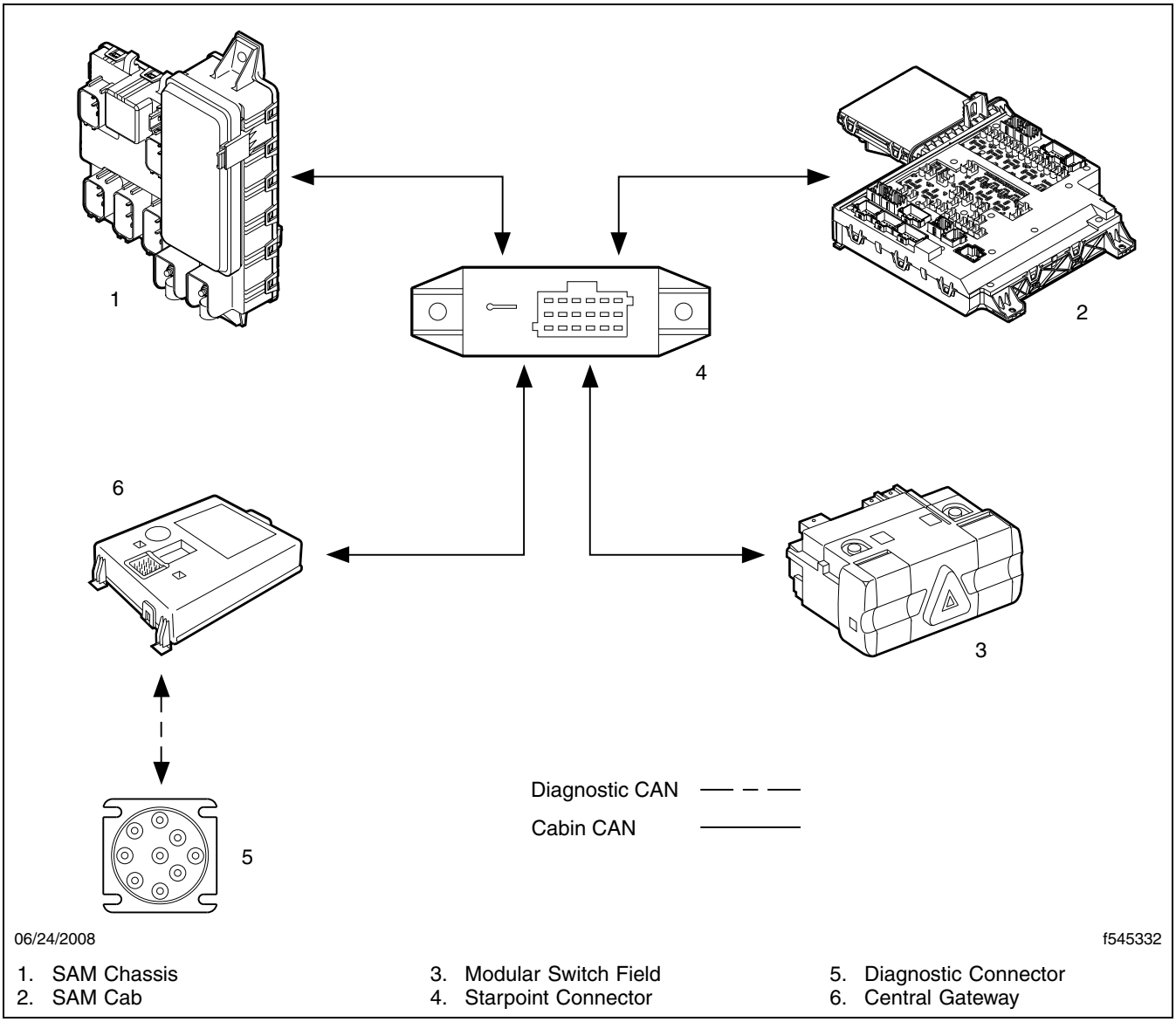


Fig. 6, Central Gateway Module, Cabin CAN Pins



1. SAM Chassis
2. SAM Cab
3. Modular Switch Field
4. Starpoint Connector
5. Diagnostic Connector
6. Central Gateway

Fig. 4, CAN Datalinks

CGW ECU (single connector)	
Pin	**Function**
1	Battery Power
7	Ground
18	Diagnostic CAN_L
23	Diagnostic CAN_H

Table 3, CGW ECU (single connector)

700 — Diagnostic Tools Required

- ServiceLink
- DataLink Monitor
- Digital Multimeter

701 — Overview of CAN Datalinks

Diagnostic CAN datalink wiring runs from pins H and J in the diagnostic connector to the Central Gateway (CGW). The CGW maintains an internal resistance of 60 ohms for the Diagnostic CAN datalink wiring, similar to a J1939 terminating resistance.

Cabin CAN datalink wiring runs from each of the connected ECUs to the starpoint connector. The starpoint connector maintains an internal resistance of 60 ohms for each connection to an ECU, similar to a J1939 terminating resistance.

The following ECUs are connected to the Cabin CAN datalink:

- Central Gateway (CGW)
- Modular Switch Field (MSF) Master ECU
- SAM Cab
- SAM Chassis

Applicable Modules

Refer to the **Table 4** for drawings specific to the affected vehicle vehicle.

Component Module Locations	
Component	**Location**
General Cabin CAN and Diagnostic CAN datalink harness drawings, schematics and installation drawings, including the Starpoint Connector.	Module 160
Central Gateway (CGW)	Module 835
Modular Switch Field (MSF)	Module 860
SAM Cab	Module 32A
SAM Chassis	Module 32K

Table 4, Component Module Locations

702 — Possible Causes

- Wiring
- Diagnostic Connector
- Central Gateway

703 — Symptoms

Symptoms of a Malfunctioning Diagnostic CAN Datalink:

Cannot connect ServiceLink to any CAN ECUs. See **Table 5** for faults related to Diagnostic CAN wiring failures.

Symptoms of a Malfunctioning Cabin CAN Datalink

- Vehicle systems, especially functions controlled by ECUs on J1939 or J1587, may not operate properly if they are dependent on information coming from the CAN ECUs. For example:
  - Engine controller may report faults due to missing input information expected from the MSF.
  - HVAC system may not work properly and HVAC controller(s) may report faults due to missing input information from the SAM Cab.
- ECU connection behavior seen in ServiceLink:
  - CAN protocol: ServiceLink may connect to the Central Gateway only. The SAM Cab, SAM Chassis, and/or Modular Switch Field may not appear in roll call and would be reported as "MISSING" in the "Problem ECU" table.
  - J1939 and J1708 protocols: Able to connect normally.

Refer to **G03.03 — Datalink, Cabin CAN** for CAN faults related to Cabin CAN wiring or communication failures.

Symptoms of a Missing CAN ECU

NOTE: The below assume these ECUs are detected as missing from the Cabin CAN datalink individually, not at the same time.

Missing SAM Cab

Refer to **C06.09 — Powernet Management** for the "Emergency Power System" information. This subject details the vehicle behavior when a SAM Cab is missing due to a Cabin CAN communication failure.

Refer to **G03.03 — Datalink, Cabin CAN** for possible faults (SPN 524033, FMI 31).

Missing SAM Chassis

Refer to **C06.09 — Powernet Management** for the "Emergency Power System" information. This subject details the vehicle behavior when a SAM Chassis is missing due to a Cabin CAN communication failure.

Refer to **G03.03 — Datalink, Cabin CAN** for possible faults (SPN 524071, FMI 31).

Missing Modular Switch Field (MSF) master ECU

All functions where input switches are controlled by the MSF will not work:

- Stalk Switch functions (Turn Signals, Wiper Motor, Wiper Washer, High Beam, Flash-to-Pass)
- Hazard Lights function
- Rotary (Headlamp) Switch functions (Low and High Beam Headlights, Fog Lamps, Marker/License/Clearance Lamps)
- Steering Wheel Switch functions (Engine Brake, Marker Interrupt, ICU message center toggle +/–, Cruise Control)

- Sub bus switch functions

As a safety precaution, after about 10 seconds of the MSF being detected as missing from Cabin CAN, the SAM Cab and SAM Chassis will turn ON the following lights:

- Headlight Low Beams
- Marker Lights (tractor and trailer)
- Tail Lights (tractor and trailer)
- Clearance Lights

The check engine light turns ON because the engine controller is missing information from the MSF switch inputs. The engine controller may also report active faults due to this condition.

Refer to **G03.03 — Datalink, Cabin CAN** for possible faults (SPN 524049, FMI 31).

Missing Central Gateway

Vehicle systems may not operate properly due to information not being routed to or from the CAN ECUs. Examples include the following:

- Engine controller may report faults due to missing input information expected from the MSF.
- HVAC system may not work properly and HVAC controller(s) may report faults due to missing input information from the SAM Cab.
- MSF messages not being routed from CAN to J1939 or J1587:
  - – Steering wheel switches
  - – Engine Brake not working
  - – ICU Menu toggle (+/–) not working
  - – Engine Brake "Low/Med/High" dash switch (sub bus switch) not working

Refer to **G03.03 — Datalink, Cabin CAN** for possible faults (SPN 524037, FMI 31).

704 — CAN Fault Codes

Refer to **G03.03 — Datalink, Cabin CAN** for additional faults relating to Cabin CAN datalink wiring and ECUs. IMPORTANT: The batteries must be disconnected prior to any resistance tests being performed. Failure to do so may result in inconclusive resistance measurements."

Table 5 lists faults for the following ECUs:

- 37 – Central Gateway (CGW)

NOTE: Unless otherwise specified, all voltage measurements reference system ground.

IMPORTANT: The batteries **must** be disconnected prior to any resistance tests being performed. Failure to do so may result in inconclusive resistance measurements.

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Details**
37	523510	31	pin 18 pin 13	—	—	Diagnostic CAN Performance	Diagnostic CAN performance failure (communication is not possible) occurs when the Diagnostic CAN High is shorted to GND, the Diagnostic CAN Low is shorted to BAT, or the Diagnostic CAN Low is shorted to Diagnostic CAN High.
Action: Disconnect the batteries and measure the resistance between pins H and J at the diagnostic connector. If 60 ohms is not detected, troubleshoot the Diagnostic CAN datalink wiring or a short to BAT and GND. An open circuit and high shorted to low is also a cause. Troubleshoot the Diagnostic CAN high wiring between diagnostic connector pin H and CGW pin 23. Troubleshoot the Diagnostic CAN low wiring between diagnostic connector pin J and CGW pin 18.							

Table 5, CAN Fault Codes

705 — Diagnostic CAN Troubleshooting

1. Refer to **703 — Symptoms** to review ECU behavior to assist in narrowing down the suspect ECU or datalink.

   1.1 Connect the vehicle to ServiceLink.

   1.2 Verify ServiceLink is communicating with the Central Gateway. The CAN Datalink will show connectivity on the ECU List General Info screen. The Central Gateway will appear under the CAN ECU's detected table.

   Is connection to the Central Gateway successful?

   YES → The problem is with the Cabin CAN datalink. Refer to **G03.03 – Datalink, Cabin CAN**.

   NO → Go to test 2.

2. Troubleshoot Diagnostic CAN wiring

   2.1 Turn the key switch to the OFF position and disconnect the batteries.

   2.2 Using a multimeter measure the resistance at the diagnostic connector on pin H and J.

   2.3 Compare the resistance values to **Table 6**.

Datalink Communication Rates	
Result	**Possible Cause**
60 Ohms ± 6	The diagnostic CAN datalink is intact, showing proper resistance.
0	Diagnostic CAN (+) and (–) wires are shorted.
"OL" (open load) or very high resistance value.	Open connection between the Diagnostic CAN (+) or (–) wires and the CGW.

Table 6, Datalink Communication Rates

Does the resistance read 60 ohms?

YES → There is no problem with Diagnostic CAN wiring. The problem is with the interface between the vehicle to diagnostic computer or the Central Gateway. Check datalink, power and ground wires on the Central Gateway.

NO → Go to test 3.

3. Perform a continuity test.

   3.1 Perform a continuity test between diagnostic connector Pin H and CGW connector pin 23.

   3.2 Perform a continuity test between diagnostic connector Pin J and CGW connector pin 18.

   Is continuity (low resistance) detected?

   YES → No further testing is necessary.

   NO → Repair the affected harness.

800 — Resistors

The Diagnostic CAN datalink uses a 60-ohm load resistor value (similar to the "terminating resistors" on the J1939 datalink), which is built into the central gateway ECU.

801 — Datalink Wire Colors

Datalink Wire Colors		
Datalink	**Wire Color**	
	High	**Low**
Cabin CAN	Light Blue	White
Diagnostic CAN	Brown with Light Blue Stripe	Brown with White Stripe

Table 7, Datalink Wire Colors

802 — Datalink Communication Rates

Datalink Communication Rates	
Datalink	**Kilobits Per Second**
Cabin CAN	125
Diagnostic CAN	500

Table 8, Datalink Communication Rates

803 — ECU Identification on Datalinks

NOTE: Parenthesis indicate ECU may appear under these identifiers in the given protocol based on message routing behavior by the CGW.

ECU Identification on Datalinks			
ECU Description	**J1587 MID***	**J1939 SA†**	**CAN SA†**
SAM Cab	(249)	(33)	33
SAM Chassis	(216)	(71)	71
Modular Switch Field	(164)	(49)	49
Central Gateway	(206)	(37)	37

* Message Identifier
† Source Address

Table 9, ECU Identification on Datalinks

Table of Contents

500 — Terms and Abbreviations

CAN—Controller Area Network

CGW—Central Gateway

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

Diagnostic Connector—A 9-pin diagnostic connector used for troubleshooting the electrical system.

ECU—Electronic Control Unit, typically connected to a datalink.

MID—Message Identifier. Indicates numeric assignment for a device that communicates on J1587.

MSF—Modular Switch Field

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

Parameter—A parameter is a specific value that is assigned to a feature or function of the vehicle, and allows the customer to choose how that particular feature or function will work on the vehicle.

SA—Source Address; indicates numeric assignment for a device that communicates on J1939 or CAN.

SAE—Society of Automotive Engineers

SAM—Signal Detect and Actuation Module

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

SFU—Switch Field Unit; see MSF.

501 — General Information

This subject contains a master list of all known possible J1587 faults for the Cascadia. For engine faults (MID128), refer to the engine manufacturer’s diagnostic tools and documentation.

Fault codes appearing on either the ICU or ServiceLink J1587 fault screens must be verified as faults from a J1587 ECU, and not a "routed fault." A routed fault is a fault that the Central Gateway routed from another protocol to the ICU or the J1587 fault screen.

502 — Routed Faults

The Central Gateway (CGW) routes and translates messages between the J1939, J1708, Cabin CAN, and Diagnostic CAN datalinks.

To verify whether a J1587 fault is routed, perform one of the following steps:

- Use **Table 1** to confirm that the ECU MID is for an ECU that is physically connected to J1587.
- Connect to ServiceLink. In ServiceLink, routed faults appear in grey text. Select a different protocol until ECU faults appear in black text. Seeing a fault in ServiceLink’s J1587 fault screen in black text verifies that

the fault is from a J1587 ECU, and verifies that J1587 is the correct protocol to view for troubleshooting that fault or ECU.

The CGW has the following wiring connections:

- Each datalink on the vehicle: J1708, J1939, Cabin CAN, and Diagnostic CAN.
- On the Diagnostic CAN, the CGW has a direct connection to the diagnostic connector.
- On the Cabin CAN, the CGW is directly connected to the starpoint connector.

The CGW has the following main functions:

- Routes and translates messages between datalinks.
- Interfaces between off-board tools and Cabin CAN ECUs.
- Provides faults for any missing Cabin CAN ECUs.

In some cases, the Cabin CAN ECUs need information from J1939 or J1708 ECUs. Information sent by the J1939 or J1708 ECU is picked up by the CGW and passed to the appropriate Cabin CAN ECU. The reverse occurs when a J1939 or J1708 ECU needs information from a CAN ECU.

Routing Active CAN Faults

If a CAN ECU generates an active fault, the CGW will route up to one active fault for that ECU on to J1939 or J1708, for display on the instrument cluster (ICU) message center, which does not have a direct connection to CAN. This is to alert the driver that the ECU has an active fault.

When a CAN ECU generates an active fault:

- J1939 displays up to one active fault for that CAN ECU under the J1939 source address for that CAN ECU. SAM Cab, for example, is SA 33. Accurate SPN and FMI information for that fault is also displayed.
- J1708 displays up to one active fault for that CAN ECU under the MID for that CAN ECU. SAM Cab, for example, is MID 249. Accurate SID/PID or FMI information is not displayed for that fault. It appears under the generic SID of "254", and the FMI may or may not be accurate.

Routing Active J1939 Faults

If a J1939 ECU generates an active fault, the CGW will route up to one active fault for that ECU on J1708, for display on the instrument cluster (ICU) message center. This alerts the driver that the ECU has an active fault,

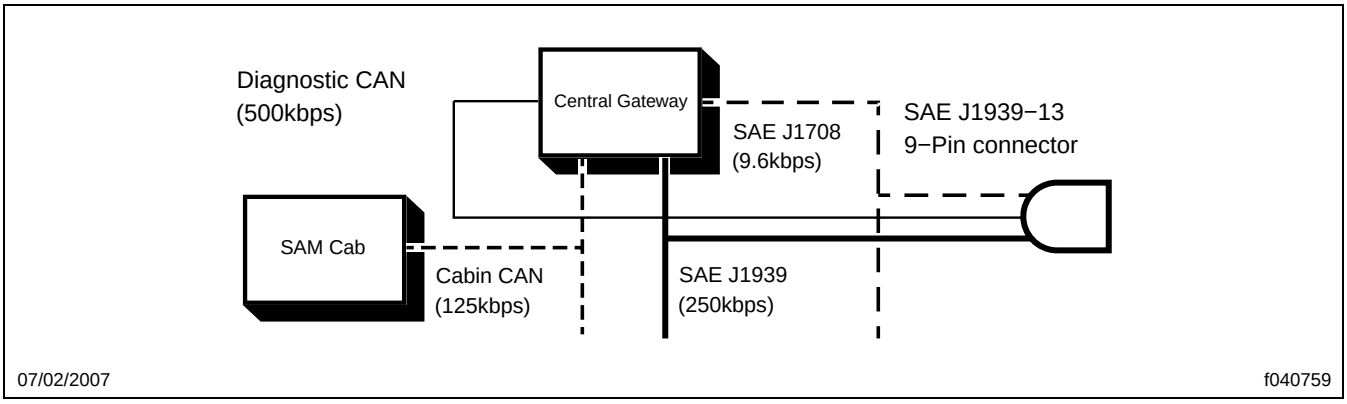


Fig. 1, Central Gateway, Diagnostic Connector, and Vehicle Datalinks

especially if the ICU has a J1708 connection only. When a J1939 ECU generates an active fault, there may be up to one active fault on J1708 for that CAN ECU under the MID for that CAN ECU. The HVAC front control unit, for example, is MID 146. Accurate information for SID/PID or FMI is not displayed for that fault. It appears under the generic SID of "254", and the FMI may or may not be accurate.

For more information regarding message routing behavior by the CGW, refer to **G02.03 – Central Gateway**.

503 — ECU Identification on Datalinks

The information in **Table 1** identifies which ECU is reporting the fault, and which datalink protocol to load in ServiceLink to get accurate fault information for troubleshooting that ECU.

NOTE: Items in parenthesis indicate a message that is routed through the CGW from an ECU that is not physically connected to the J1587 datalink.

ECU Identification on Datalinks

ECU Description	CAN ID	J1939 SA	J1587 MID	Comments
SAM Cab	33	(33)	(249)	—
SAM Chassis	71	(71)	(216)	—
Modular Switch Field (MSF)	49	(49)	(164)	—
Central Gateway (CGW)	37	(37)	(206)	—
Engine Control 1	—	0	128	—
Engine Control 2	—	1	175	—
Transmission	—	3	130	—
ABS	—	11	136	—
Retarder, Engine	—	12	173	—
Instrument Cluster	—	23*	140	—
Navigation	—	28	162	—
Engine Display	—	40	171	—
HVAC, Front	—	25	(146)	CGW reporting MID 146; there is no physical J1708 connection.
HVAC, Rear	—	58	(200)	CGW reporting MID 200; there is no physical J1708 connection.
Radio	—	76	(221)	CGW reporting MID 221; there is no physical J1708 connection.
Collision Warning	—	42	(219)	CGW reporting MID 219; there is no physical J1708 connection.
Qualcomm	—	75	181	—
Lane Guidance	—	232	—	—

ECU Identification on Datalinks				
ECU Description	**CAN ID**	**J1939 SA**	**J1587 MID**	**Comments**
Front Airbag Sensor	—	—	232	—
Roll Sensor Module	—	—	254	—

* ICU4M Only.

Table 1, ECU Identification on Datalinks

The following examples demonstrate how to identify and diagnose faults using **Table 1**.

- J1708 Fault: MID 146, SID 254, FMI 03
  - – MID 146 is the Front HVAC.
  - – The Front HVAC is diagnosed using J1939.
  - – Load the J1939 fault screen in ServiceLink for diagnostic information.
- J1939 Fault: SA 49, SPN 168, FMI 03
  - – SA 49 is the Modular Switch Field (MSF).
  - – The MSF is diagnosed using the CAN protocol.
  - – Load the CAN fault screen in ServiceLink for diagnostic information.
- J1708 Fault: MID 216, SID 254, FMI 14
  - – MID 216 is the SAM Chassis.
  - – The SAM Chassis is diagnosed using the CAN protocol.
  - – Load the CAN fault screen in ServiceLink for diagnostic information.
- J1708 Fault: MID 136, SID 123, FMI 02
  - – MID 136 is the ABS module.
  - – The ABS is diagnosed using the J1708 protocol.
  - – Load the J1708 fault screen in ServiceLink for diagnostic information.

504 — J1587 Failure Mode Identifiers

Failure Mode Identifiers (FMIs)	
FMI	**Description**
00	Data valid but above normal operational range (engine overheating).
01	Data valid but below normal operational range (engine oil pressure too low).
02	Data erratic, intermittent, or incorrect.
03	Voltage above normal, or shorted high.
04	Voltage below normal, or shorted low.
05	Current below normal, or open circuit.
06	Current above normal, or grounded circuit.

Failure Mode Identifiers (FMIs)	
FMI	**Description**
07	Mechanical system not responding properly.
08	Abnormal frequency, pulse width, or period.
09	Abnormal update rate.
10	Abnormal rate of change.
11	Failure mode not identifiable.
12	Bad intelligent device or component.
13	Out of Calibration.
14	Special Instructions.
15	Reserved for future assignment by SAE.

Table 2, Failure Mode Identifiers (FMIs)

505 — ICU3 Roll Call Faults

On vehicles equipped with the ICU3 instrument cluster, messages from both the engine and ABS on the J1587 datalink are transmitted when the vehicle powers up. If the ICU3 does not receive messages from one or both, it displays "no EnG" and/or "no ABS" faults. If there is no communication between the ICU3 and the J1587 datalink, the ICU displays the message "no DATA". Engine and ABS roll call messages are accompanied by a roll call fault that is only displayed on the ICU driver display screen. Refer to **Table 3** for a list of faults.

NOTE: Roll call faults "ECU 128 SID 254 FAIL 07" and "AbS 136 SID 254 FAIL 07" originate from the ICU, and are only displayed on the ICU driver display screen. The faults will not show up in ServiceLink or any other tool that reads J1587 datalink faults.

If the ICU3 detects an active fault from one of the active faults on the J1587 datalink, it displays a message that contains both an abbreviation of the ECU with the fault, and its MID. Refer to **Table 4** for a list of messages.

For more information, refer to **C01.01 — ICU3**.

506 — ICU4 J1587 Datalink Roll Call Faults

The ICU4 is programmed to detect the engine ECM on the J1587 datalink. Any other ECUs that the ICU detects on the J1587 datalink will be "learned." The ICU will attempt to detect these "learned" ECUs, in addition to the engine ECM on roll call at every subsequent power up. The ICU4M learns and detects up to four components on the J1939 datalink, which includes the front HVAC controller, the rear HVAC controller, the MSF, and the Collision Warning System (VORAD).

If the ICU does not detect an expected ECU on roll call, it will report it on the display. These faults are not displayed in ServiceLink. The ICU4 reports roll call faults with three screens on the display. The first screen shows one of the messages in the "Message" column of **Table 5**. This indicates the J1587 MID of the ECU that is not reporting on roll call. The following two screens report the SID and FMI. Roll call faults have a SID 254 and FMI 07.

NOTE: The ABS and engine ECM do not report the actual MID on the screen, but instead report "no Abs" or "no ENG" to indicate the MIDs of those ECUs.

507 — ICU4M J1587 Datalink Roll Call Faults

The entire roll call fault on the ICU4M is displayed on a single screen. All J1587 datalink roll call faults have a SID 254 and FMI 07. Refer to **Table 6** for more information.

For more information on ICU4/ICU4M roll call faults, refer to **C01.02 — ICU4/ICU4M Instrument Cluster**.

508 — Related Subjects

- **G02.02 — Datalink Communication Structure**
- **G02.04 — SAM Cab**
- **G02.05 — SAM Chassis**
- **G02.06 — Modular Switch Field**
- **G03.01 — Datalink, J1587/J1708**
- **G03.02 — Datalink, J1939**
- **G03.03 — Datalink, Cabin CAN**
- **G03.04 — Datalink, Diagnostic CAN**
- **C01.01 — ICU3**
- **C01.02 — ICU4/ICU4M**

700 — J1587 Fault Codes

J1587 Fault Codes				
MID	**SID/PID**	**FMI**	**Fault Description**	**Reference Subjects**
136	001–006	01	Incorrect air gap.	**H01.01 – ABS and Roll Stability Control System**
136	001–006	02	Incorrect tire size.	
136	001–006	03	Sensor shorted to power.	
136	001–006	04	Short to Ground.	
136	001–006	05	Open Circuit.	
136	001–006	06	Short Circuit.	
136	001–006	07	Damaged Tone Ring.	
136	001–006	08	Excessive Wheel Slip.	
136	001–006	09	Wire Mismatch.	
136	001–006	10	Speed Signal Drop Out.	
136	001–006	11	Abnormal Speed.	
136	001–006	12	Frequency Too High.	
136	007–010	03	Short to Power.	
136	007–010	05	Open Circuit.	
136	007–010	06	Short to Ground.	
136	13	03	Retarder Relay Circuit – short to power.	
136	13	05	Retarder Relay Circuit – open circuit.	
136	13	06	Retarder Relay Circuit – short to ground.	
136	14	04	Low voltage or open circuit.	
136	14	05	Ground circuit open or high resistance; verify that the batteries are not disconnected or shut off, otherwise results may be misleading.	
136	14	06	Internal relay does not open.	
136	15	03	ATC Valve ground circuit shorted to power.	
136	15	05	ATC Valve High Impedance.	
136	15	06	ATC Valve ground circuit shorted to ground.	
136	18	03	Short to Power.	
136	18	05	Open Circuit.	
136	18	06	Short to Ground.	
136	231	02	J1939 speed plausibility error; This fault indicates a discrepancy between vehicle speed reported on J1939 and ABS sensed vehicle speed.	
136	231	05	J1939 – open/short.	
136	231	06	J1939 – open/short. Code 136s231 05 may be active as well.	
136	231	07	J1939 time out. Fault occurs if engine retarder sends message incorrectly.	

J1587 Fault Codes				
MID	**SID/PID**	**FMI**	**Fault Description**	**Reference Subjects**
136	231	08	J1939 time out. Fault occurs if engine retarder sends message incorrectly.	**C07.08 — SRS System**
136	231	09	J1939 time out. Fault occurs if engine or transmission sends message incorrectly.	
136	231	10	J1939 time out. Fault occurs if exhaust retarder sends a message incorrectly.	
136	231	12	J1939 internal error.	
136	251	03	Overvoltage –Voltage to ECU was too high for more than 5 seconds.	
136	254	05	ABS/ATC ECU, no loads.	
136	254	08	Excessive Wheel Slip.	
136	254	09	Modulator valve actuated too long.	
136	254	07	ABS Missing.	
136	254	02	EEPROM, Wheel parameter incorrect.	
136	254	12	EEPROM, Checksum/internal error.	
136	254	13	Accelerator out of range.	
136	254	14	ECU mounting/accelerometer plausibility.	
140	p168	01	ICU3 voltage is too low (less than 10.5 volts).	**C01.01 — ICU3**
140	s240	12	ICU3 program memory failure; odometer read/write to EEPROM fails. When this failure occurs, the ICU is unable to display the fault on the LCD, but the fault displays in ServiceLink. When this fault is active, the LCD display shows a series of seven hyphens "- - - - - - -".	
140	s254	12	ICU3 Controller Failure; ICU self-test "detectschecksum errors".	

J1587 Fault Codes				
MID	**SID/PID**	**FMI**	**Fault Description**	**Reference Subjects**
140	p077	05	Forward rear-axle temperature sensor – open.	**C01.02 — ICU4/ICU4M**
140	p077	06	Forward rear-axle temperature sensor – shorted.	
140	p078	05	Rear rear-axle temperature sensor – open.	
140	p078	06	Rear rear-axle temperature sensor – shorted.	
140	p96	05	Fuel level sensor – open.	
140	p96	06	Fuel level sensor – shorted.	
140	p168	01	Lightbar voltage too low (less than 10.5 volts).	
140	p177	05	Transmission oil temperature sensor – open.	
140	p177	06	Transmission oil temperature sensor – shorted.	
140	s240	12	LBCU program memory failure.	
140	s254	12	LBCU controller failure.	
232	s001	03	Airbag igniter circuit – shorted to power.	**C07.08 — SRS System**
232	s001	04	Airbag igniter circuit – shorted to ground.	
232	s001	05	Airbag igniter circuit – open circuit.	
232	s001	06	Airbag igniter circuit – shorted.	
232	s240	14	Frontal collision detected.	
232	s254	07	Frontal Crash Sensor (Safety Restraint System 1); not detected by the ICU on Roll Call.	
254	s001	05	Driver seat igniter loop – open.	
254	s001	06	Driver seat igniter loop – shorted.	
254	s002	05	Driver side airbag igniter loop – open.	
254	s002	06	Driver side airbag igniter loop – shorted.	
254	s003	05	Passenger seat igniter loop – open.	
254	s003	06	Passenger seat igniter loop – shorted.	
254	s004	05	Passenger side airbag igniter loop – open.	
254	s004	06	Passenger side airbag igniter loop – shorted.	
254	s240	14	Rollover or frontal crash detected.	
254	s254	07	Roll Sensor Module (Safety Restraint System 2) – Not Detected by ICU on Roll Call.	
254	s254	12	Rollover module – bad device or component.	

Table 3, J1587 Fault Codes

NOTE: For engine-related faults, refer to the engine manufacturer's diagnostic software.

701 — Displayed Roll Call Messages

Displayed Roll Call Messages	
Displayed Message	**Description**
no EnG	The ICU is unable to communicate with the engine control module on the J1587 datalink. This is followed by a roll call fault on the driver display. The roll call fault may be displayed as one of the following: **no EnG SID 254 FAIL 07** or **ECU 128 SID 254 FAIL 07**.
no ABS	The ICU is unable to communicate with the ABS on the J1587 datalink. This is followed by a roll call fault on the driver display. The roll call fault may be displayed as one of the following: **no ABS SID 254 FAIL 07** or **AbS 136 SID 254 FAIL 07**.
no DATA	The ICU is not communicating with the J1587 datalink.

Table 4, Displayed Roll Call Messages

NOTE: For engine-related faults, refer to the engine manufacturer's diagnostic software.

702 — ICU3 J1587 Fault Messages After Power On Sweep

NOTE: For engine-related faults, refer to the engine manufacturer's diagnostic software.

ICU3 J1587 Fault Messages After Power On Sweep	
Message	**System With Active Fault**
AbS 136	Antilock Brake System
APU 190	Air Conditioning Protection Unit
Cab 249	SAM Cab
CdU 219	Collision Detection Unit (VORAD)
CEL 231	Cellular Phone
CGU 206	Central Gateway
CHS 216	SAM Chassis
ECU 128	Engine Control Unit (engine control module)
ICU 140	Instrument Cluster Unit (ICU4/4M)
rAd 221	Radio
SAT 181	Satellite Communications (Qualcomm)
Sbu 232	Seat Belt Unit (SPACE/Airbag system)

ICU3 J1587 Fault Messages After Power On Sweep	
Message	**System With Active Fault**
SdU 236	Step Deployment Unit, Driver Side (not used)
SdU 237	Step Deployment Unit, Passenger Side (not used)
SFU 164	Modular Switch Field
SYS ###	Generic (system not defined in this table)
tCU 130	Transmission Control Unit
tSU 223	Transmission Shift Unit

Table 5, ICU3 J1587 Fault Messages After Power On Sweep

703 — ICU4 J1587 Datalink Roll Call Faults

ICU4 J1587 Datalink Roll Call Faults			
Message	**SID**	**FMI**	**System Not Responding to Roll Call**
No Data	—	—	No ECUs on the J1587 datalink are responding
No ABS	SID 254	FAIL 07	Antilock Brake System (ABS)
No ENG	SID 254	FAIL 07	Engine Control Module 1
ECU 173	SID 254	FAIL 07	Retarder, Engine
ECU 175	SID 254	FAIL 07	Engine Control Module 2
APU 190	SID 254	FAIL 07	Air Conditioning Protection Unit
CAB 249	SID 254	FAIL 07	SAM Cab
CDU 219	SID 254	FAIL 07	Collision Detection Unit (VORAD)
CEL 231	SID 254	FAIL 07	Cellular Phone
CGU 206	SID 254	FAIL 07	Central Gateway
RAD 221	SID 254	FAIL 07	Radio
SAT 181	SID 254	FAIL 07	Satellite Communications
CHS 216	SID 254	FAIL 07	SAM Chassis
SBU 232	SID 254	FAIL 07	Seat Belt Unit (SPACE/ Airbag system)
SDU 236	SID 254	FAIL 07	Step Deployment Unit, Driver Side (not used)
SDU 237	SID 254	FAIL 07	Step Deployment Unit, Passenger Side (not used)
SFU 164	SID 254	FAIL 07	Modular Switch Field

ICU4 J1587 Datalink Roll Call Faults			
Message	**SID**	**FMI**	**System Not Responding to Roll Call**
SYS ###	SID 254	FAIL 07	Generic (system not defined in this table)
TCU 130	SID 254	FAIL 07	Transmission Control Unit
TSU 223	SID 254	FAIL 07	Transmission Shift Unit

Table 6, ICU4 J1587 Datalink Roll Call Faults

704 — ICU4M J1587 Datalink Roll Call Faults

ICU4M J1587 Datalink Roll Call Faults	
Fault	**System not Responding to Roll Call**
128s254 07	Engine Control Module 1
130s254 07	Transmission Control Unit
136s254 07	Antilock Brake System (ABS)
162s254 07	Navigation
171s254 07	Engine Display
173s254 07	Retarder, Engine
175s254 07	Engine Control Module 2
164s254 07	Modular Switch Field (MSF)
181s254 07	Satellite Communications (Qualcomm)
190s254 07	Air Conditioning Protection Unit
206s254 07	Central Gateway
216s254 07	SAM Chassis
219s254 07	Collision Detection Unit (VORAD)
221s254 07	Radio
223s254 07	Transmission Shift Unit
231s254 07	Cellular Phone
232s254 07	Seat Belt Unit (SPACE/Airbag system)
236s254 07	Step Deployment Unit, Driver Side (not used)
237s254 07	Step Deployment Unit, Passenger Side (not used)
249s254 07	SAM Cab

Table 7, ICU4M J1587 Datalink Roll Call Faults

Table of Contents

500 — Terms and Abbreviations

CAN—Controller Area Network

CGW—Central Gateway

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

Diagnostic Connector—A 9-pin diagnostic connector used for troubleshooting the electrical system.

ECU—Electronic Control Unit, typically connected to a datalink.

MID—Message Identifier. Indicates numeric assignment for a device that communicates on J1587.

MSF—Modular Switch Field

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

Parameter—A parameter is a specific value that is assigned to a feature or function of the vehicle, and allows the customer to choose how that particular feature or function will work on the vehicle.

SA—Source Address; indicates numeric assignment for a device that communicates on J1939 or CAN.

SAE—Society of Automotive Engineers

SAM—Signal Detect and Actuation Module

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

501 — General Information

This subject contains a master list of all known possible J1939 faults for the Cascadia. For engine faults (SA 0), refer to the engine manufacturer’s diagnostic tools and documentation.

Fault codes appearing on either the ICU or ServiceLink J1587 fault screens must be verified as faults from a J1939 ECU, and not a "routed fault." A routed fault is a fault that the Central Gateway routed from another protocol to the ICU or the J1939 fault screen.

502 — Routed Faults

The Central Gateway (CGW) routes and translates messages between the J1939, J1708, Cabin CAN, and Diagnostic CAN datalinks.

To verify whether a J1939 fault is routed, perform one of the following steps:

- Use **Table 1** to confirm that the ECU MID is for an ECU that is physically connected to J1939.
- Connect to ServiceLink. In ServiceLink, routed faults appear in grey text. Select a different protocol until ECU faults appear in black text. Seeing a fault in ServiceLink’s J1939 fault screen in black text verifies that the fault is from a J1939 ECU, and verifies that J1939 is the correct protocol to view for troubleshooting that fault or ECU.

The CGW has the following wiring connections:

- Each datalink on the vehicle: J1708, J1939, Cabin CAN, and Diagnostic CAN.
- On the Diagnostic CAN, the CGW has a direct connection to the diagnostic connector.
- On the Cabin CAN, the CGW is directly connected to the starpoint connector.

The CGW has the following main functions:

- Routes and translates messages between datalinks.
- Interfaces between off-board tools and Cabin CAN ECUs.
- Provides faults for any missing Cabin CAN ECUs.

In some cases, the Cabin CAN ECUs need information from J1939 or J1708 ECUs. Information sent by the J1939 or J1708 ECU is picked up by the CGW and passed to the appropriate Cabin CAN ECU. The reverse occurs when a J1939 or J1708 ECU needs information from a CAN ECU.

Routing Active CAN Faults

If a CAN ECU generates an active fault, the CGW will route up to one active fault for that ECU on to J1939 and J1708 for display on the instrument cluster (ICU) message center, which does not have a direct connection to CAN. This is to alert the driver that the ECU has an active fault.

NOTE: On the Cascadia, the ICU4M simply reads the faults on the datalink and will display 2 messages (a J1708 and a J1939) for the same fault, since the fault is transmitted on both the J1708 and J1939 datalink.

When a CAN ECU generates an active fault:

- J1939 displays up to one active fault for that CAN ECU under the J1939 source address for that CAN ECU. SAM Cab, for example, is SA 33. Accurate SPN and FMI information for that fault is also displayed.
- J1708 displays up to one active fault for that CAN ECU under the MID for that CAN ECU. SAM Cab, for example, is MID 249. Accurate SID/PID or FMI information is not displayed for that fault. It appears under the generic SID of "254", and the FMI may or may not be accurate.

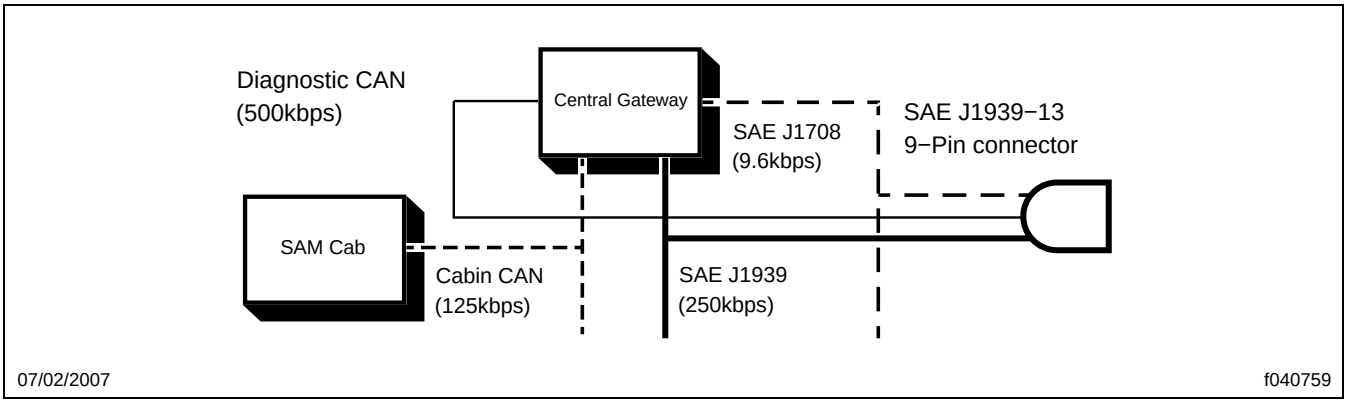


Fig. 1, Central Gateway, Diagnostic Connector, and Vehicle Datalinks

Routing Active J1939 Faults

If a J1939 ECU generates an active fault, the CGW will route up to one active fault for that ECU onto J1708, for display on the instrument cluster (ICU) message center. This is to alert the driver that the ECU has an active fault, especially if the ICU has a J1708 connection only. When a J1939 ECU generates an active fault, there may be up to one active fault on J1708 for that CAN ECU under the MID for that CAN ECU. HVAC Front Control Unit, for example, is MID 146. Accurate information for SID/PID or FMI is not displayed for that fault. It appears under the generic SID of "254", and the FMI may or may not be accurate.

For more information regarding message routing behavior by the CGW, refer to **G02.03 – Central Gateway**.

503 — ECU Identification on Datalinks

The information in **Table 1** identifies which ECU is reporting the fault, and which datalink protocol to load in ServiceLink to get accurate fault information for troubleshooting that ECU.

NOTE: Items in parenthesis indicate a routed message from an ECU that is not physically connected, but reported by the CGW.

ECU Identification on Datalinks

ECU Description	CAN ID	J1939 SA	J1587 MID	Comments
SAM Cab	33	(33)	(249)	—
SAM Chassis	71	(71)	(216)	—
Modular Switch Field (MSF)	49	(49)	(164)	—
Central Gateway (CGW)	37	(37)	(206)	—
Engine Control 1	—	0	128	—
Engine Control 2	—	1	175	—
Transmission	—	3	130	—
ABS	—	11	136	—
Retarder, Engine	—	15	173	—
Instrument Cluster	—	23*	140	—
Navigation	—	28	162	—
Engine Display	—	40	171	—
HVAC, Front	—	25	(146)	CGW reporting MID 146; there is no physical J1708 connection.
HVAC, Rear	—	58	(200)	CGW reporting MID 200; there is no physical J1708 connection.
Radio	—	76	(221)	CGW reporting MID 221; there is no physical J1708 connection.
Collision Warning	—	42	(219)	CGW reporting MID 219; there is no physical J1708 connection.
Qualcomm	—	75	181	—

ECU Identification on Datalinks				
ECU Description	**CAN ID**	**J1939 SA**	**J1587 MID**	**Comments**
Lane Guidance	—	232	—	—
Front Airbag Sensor	—	—	232	—
Roll Sensor Module	—	—	254	—

* ICU4M Only.

Table 1, ECU Identification on Datalinks

The following examples demonstrate how to diagnose faults using **Table 1**.

- J1708 Fault: MID 146, SID 254, FMI 03
  - – MID 146 is the Front HVAC.
  - – The Front HVAC is diagnosed using J1939.
  - – Load the J1939 fault screen in ServiceLink for diagnostic information.
- J1939 Fault: SA 49, SPN 168, FMI 03
  - – SA 49 is the Modular Switch Field (MSF).
  - – The MSF is diagnosed using the CAN protocol.
  - – Load the CAN fault screen in ServiceLink for diagnostic information.
- J1708 Fault: MID 216, SID 254, FMI 14
  - – MID 216 is the SAM Chassis.
  - – The SAM Chassis is diagnosed using the CAN protocol.
  - – Load the CAN fault screen in ServiceLink for diagnostic information.
- J1708 Fault: MID 136, SID 123, FMI 02
  - – MID 136 is the ABS module.
  - – The ABS is diagnosed using the J1708 protocol.
  - – Load the J1708 fault screen in ServiceLink for diagnostic information.

504 — J1939 Failure Mode Identifiers

Failure Mode Identifiers (FMIs)	
FMI	**Description**
00	Data valid but above normal operational range–Most severe level.
01	Data valid but below normal operational range–Most severe level.
02	Data erratic, intermittent, or incorrect.
03	Voltage above normal, or shorted high.
04	Voltage below normal, or shorted low.
05	Current below normal, or open circuit.

Failure Mode Identifiers (FMIs)	
FMI	**Description**
06	Current above normal, or grounded circuit.
07	Mechanical system not responding, or out of adjustment.
08	Abnormal frequency, pulse width, or period.
09	Abnormal update rate.
10	Abnormal rate of change.
11	Root cause not known.
12	Bad intelligent device or component.
13	Out of Calibration.
14	Special Instructions.
15	Data valid but above normal operational range–Least severe level.
16	Data valid but above normal operational range–Moderately severe level.
17	Data valid but below normal operational range–Least severe level.
18	Data valid but below normal operational range–Moderately severe level.
19	Received network data in error.
20-30	Reserved for future assignment by SAE.
31	Condition exists.

Table 2, Failure Mode Identifiers (FMIs)

505 — ICU4M J1939 Datalink Roll Call Faults

The ICU4M is programmed to learn several ECMs on the J1708 datalink. See **Table 3**. The ICU4M also learns and detects 2 ECUs on the J1939 datalink for roll call. These ECUs are the MSF (SA 49) and the Collision Warning System (VORAD - SA 42). Since the MSF is required to read faults, there is no way of displaying a roll call fault for SA 49

The ICU4M expects to detect these "learned" ECUs and the engine ECM on roll call at every subsequent power up. If the ICU does not detect an expected ECU on roll call, it reports the fault on the display. These faults are not displayed in ServiceLink. Typical ICU4M J1939 roll call faults are displayed as "SA – SPN 639 FMI 7", and J1708 faults are displayed as "MID s254 FMI 07". As with any fault reported on the ICU4M, the entire fault is shown on a single screen. All J1939 datalink roll call faults have a SPN 639 and FMI 7, and J1708 faults have SID 254 and FMI 07.

For more information on roll call faults, refer to **C01.02 — ICU4/ICU4M**.

J1708 Display Message	
Device	**Display Message**
Engine	ENG Controller NoRESP 128s254 07
Transmission	Trans Controller NoRESP 130s254 07
ABS	Brake Controller NoRESP 136s254 07

J1708 Display Message	
Device	**Display Message**
ACPU	A/C Controller NoRESP 190s254 07
SAM Chassis	CHASS Controller NoRESP 216s254 07
Transmission Shift Unit	TSU Controller NoRESP 223s254 07
Cellular	Phone Controller NoRESP 231s254 07
SPACE	SPACE Controller NoRESP 232s254 07
SDU 1	STEP1 Controller NoRESP 236s254 07
SDU 2	STEP2 Controller NoRESP 237s254 07
SAM Cab	SAM Controller NoRESP 249s254 07

Table 3, J1708 Display Message

J1939 Display Message	
Device	**Display Message**
MSF	SA 49*
Collision Warning System	Radar SA42 SPN000639 J1939 Network 07

* SA 49 roll call error cannot be displayed; a functional J1939 MSF message is required to navigate to the diagnostic errors.

Table 4, J1939 Display Message

506 — Related Subjects

- **G02.02 — Datalink Communication Structure**
- **G02.04 — SAM Cab**
- **G02.05 — SAM Chassis**
- **G02.06 — Modular Switch Field**
- **G03.01 — Datalink, J1587/J1708**
- **G03.02 — Datalink, J1939**
- **G03.03 — Datalink, Cabin CAN**
- **G03.04 — Datalink, Diagnostic CAN**
- **C01.02 — ICU4/ICU4M**

700 — J1939 Fault Codes

NOTE: Refer to **C07.09 — Collision Warning System** for more information.

J1939 Fault Codes			
SA	**SPN**	**FMI**	**Fault Description**
25	70	09	Parking brake switch status message – abnormal update rate.
25	84	09	Vehicle speed – abnormal update rate.
25	110	09	Engine coolant temperature message – abnormal update rate.
25	158	03	FCU – voltage above normal.
25	158	04	FCU – voltage below normal.
25	168	09	SAM Cab battery voltage message – abnormal update rate.
25	171	09	Ambient air temperature – abnormal update rate.
25	190	09	Engine speed message – abnormal update rate.
25	629	12	FCU – bad intelligent device or component.
25	639	02	J1939 Datalink, intermittent or incorrect data.
25	876	01	A/C Clutch – protection mode (voltage too low).
25	876	02	A/C Clutch – data erratic, intermittent, or incorrect.
25	876	09	A/C Clutch – abnormal update rate.
25	876	11	A/C Clutch – root cause not known.
25	1547	04	Evaporator sensor-short to ground.
25	1547	05	Evaporator sensor short to battery, or open circuit.
25	1548	04	COTC sensor short to ground.
25	1548	05	COTC Sensor short to battery, or open circuit.
25	522510	0	High pressure sensor – data valid, but above normal operating range.
25	522510	01	High pressure sensor – data valid, but below normal operating range.
25	522510	02	High pressure sensor – data erratic, intermittent, or incorrect.
25	522510	09	High pressure sensor – abnormal update rate.
25	522510	11	High pressure sensor – root cause not known.
25	523307	09	Low air pressure switch status message – abnormal update rate.
25	523315	04	Stepper motor voltage supply driver – voltage below normal, shorted to low source or open circuit.
25	523318	02	Blower motor protection mode (voltage out of range).
25	523318	06	Blower motor protection mode (overcurrent or thermal protection).

J1939 Fault Codes			
SA	**SPN**	**FMI**	**Fault Description**
25	523318	07	Blower motor protection mode (speed mismatch or blocked rotor).
25	523329	02	Defrost door actuator data mismatch.
25	523329	03	Vehicle speed – abnormal update rate.
25	523329	04	Defrost door actuator, voltage below normal, open circuit.
25	523330	02	Blend door actuator, data mismatch.
25	523330	03	Blend door actuator, voltage above normal, or shorted to battery.
25	523330	04	Blend door actuator, voltage below normal, open circuit.
25	523331	02	Recirc door actuator, data mismatch.
25	523331	03	Recirc door actuator, voltage above normal, or shorted to battery.
25	523331	04	Recirc door actuator, voltage below normal, open circuit.
25	523332	02	Floor door actuator, data mismatch.
25	523332	03	Floor door actuator, voltage above normal, or shorted to battery.
25	523332	04	Floor door actuator, voltage below normal, open circuit.
42	639	02	One or more required messages missing from datalink.
42	639	09	No messages being received from the datalink.
42	639	13	Device cannot claim source address on datalink.
42	639	19	Messages received with incorrect data or marked as error.
42	886	07	FLR misaligned.
42	886	12	FLR internally defective.
42	886	13	FLR not configured properly
42	886	14	FLR blocked
42	898	13	Engine not configured for SmartCruise operation.
42	898	14	Engine not supported for SmartCruise operation
42	1563	13	VS-400 component detects incompatibility issue with other VS-400 devices.
58	158	03	ACU – voltage above normal.
58	158	04	ACU – voltage below normal.
58	609	12	ACU – bad intelligent device or component.
58	639	02	J1939 Datalink, intermittent or incorrect data.
58	1548	04	COTC sensor, short to ground.
58	1548	05	COTC sensor, short to battery or open circuit

J1939 Fault Codes			
SA	**SPN**	**FMI**	**Fault Description**
58	523315	04	Stepper motor voltage supply driver – voltage below normal, shorted to low source or open circuit.
58	523318	02	Blower motor, protection mode (voltage out of range).
58	523318	06	Blower motor, protection mode (overcurrent or thermal protection).
58	523318	07	Blower motor, protection mode (speed mismatch or blocked rotor).
58	523330	02	Blend door actuator, data mismatch.
58	523330	03	Blend door actuator, voltage above normal or shorted to battery.
58	523330	04	Blend door actuator, voltage below normal, open circuit.
76	520192	03	Left front speaker – short to BAT.
76	520192	04	Left front speaker – short to GND.
76	520192	05	Left front speaker – open circuit detected.
76	520192	06	Left front speaker – short circuit detected.
76	520193	03	Right front speaker – short to BAT.
76	520193	04	Right front speaker – short to GND.
76	520193	05	Right front speaker – open circuit detected.
76	520193	06	Right front speaker – short circuit detected.
76	520194	03	Left rear speaker – short to BAT.
76	520194	04	Left rear speaker – short to GND.
76	520194	05	Left rear speaker – open circuit detected
76	520194	06	Left rear speaker – short circuit detected.
76	520195	03	Right rear speaker – short to BAT.
76	520195	04	Right rear speaker – short to GND.
76	520195	05	Right rear speaker – open circuit detected.
76	520195	06	Right rear speaker – short circuit detected.
76	520196	14	Radio Display Fault.
76	520197	14	Stuck Radio Button(s).
76	520199	14	Generic Radio Fault.
76	520200	14	CD Mechanism.
140	639	2	One or more required messages missing from datalink.
140	639	9	No messages being received from the datalink.
140	639	13	Device cannot claim source address on datalink.
140	639	19	Messages received with incorrect data or marked as error.

J1939 Fault Codes			
SA	**SPN**	**FMI**	**Fault Description**
140	893	12	DIU internally defective.
140	1563	13	VS-400 component detects incompatibility issue with other VS-400 devices.
140	1703	03	External right speaker shorted high.
140	1703	04	External right speaker shorted low.
140	1703	05	External right speaker open.
140	1704	03	External left speaker shorted high.
140	1704	04	External left speaker shorted low.
140	1704	05	External left speaker open.

Table 5, J1939 Fault Codes

NOTE: Refer to engine manufacturer documentation or diagnostic software for engine faults.

ICU4M J1939 Roll Call Faults	
Fault	**Fault Description**
SA25 SPN639 F19	Front HVAC
SA42 SPN639 F19	Collision Warning System (VORAD)
SA49 SPN639 F19	Modular Switch Field (MSF)
SA58 SPN639 F19	Rear HVAC

Table 6, ICU4M J1939 Roll Call Faults

NOTE: Refer to **C01.02 — ICU4/ICU4M** for roll call messages.

Table of Contents

500 — Terms and Abbreviations

CAN—Controller Area Network

CGW—Central Gateway

Communication Protocol—A set of rules governing communication between electronic devices.

Datalink—A collection of wires, connecting system components, through which data is transmitted.

Diagnostic CAN—Datalink that runs from the diagnostic connector to the CGW.

Diagnostic Connector—A 9-pin diagnostic connector used for troubleshooting the electrical system.

ECU—Electronic Control Unit, typically connected to a datalink.

FMI—Failure Mode Indicator. The part of a J1587, J1939, and CAN fault code that identifies how part of a device, or item on a device, failed.

MID—Message Identifier

MSF—Modular Switch Field

Off-board tool—Typically refers to a PC-based application that communicates with the vehicle datalinks via a connection to the diagnostic connector.

Parameter—A parameter is a specific value that is assigned to a feature or function of the vehicle, and allows the customer to choose how that particular feature or function will work on the vehicle.

SA—Source Address; indicates numeric assignment for a device that communicates on J1939.

SAE—Society of Automotive Engineers

SAM—Signal Detect and Actuation Module

SAM Cab—Signal Detect and Actuation Module Cab ("SAM Cabin"); this ECU controls mainly cab-related functionality. See **G02.04 — SAM Cab** for more information.

SAM Chassis—Signal Detect and Actuation Module Chassis; this ECU controls mainly chassis-related functionality. See **G02.05 — SAM Chassis** for more information.

SID—Subsystem Identifier

SPN—Suspect Parameter Number. The part of a J1939 or CAN fault code that identifies how part of a device, or item on a device, failed.

501 — General Information

This subject contains a master list of all known CAN faults for the Cascadia. The CAN fault screen on ServiceLink is the only reliable place to find CAN fault information.

Fault codes appearing on either the ICU or ServiceLink J1939/J1708 fault screens must be verified as faults from a J1939 or J1708 ECU, and not a "routed fault". A routed fault is a fault that the Central Gateway routed from another protocol to the ICU or the J1939 and J1708 fault screen.

502 — Routed Faults

The Central Gateway (CGW) routes and translates messages between the J1939, J1708, Cabin CAN, and Diagnostic CAN datalinks.

To verify whether a J1939 or J1708 fault is routed, perform one of the following steps:

- Use **Table 1** to confirm that the ECU MID is for an ECU that is physically connected to J1939 or J1708.
- Connect to ServiceLink. In ServiceLink, routed faults appear in grey text. Select a different protocol until ECU faults appear in black text. Seeing a fault in ServiceLink's J1939 or J1708 fault screen in black text verifies that the fault is from a J1939 or J1708 ECU respectively, and verifies that current protocol selected is the correct protocol to view for troubleshooting that fault or ECU.

The CGW has the following wiring connections:

- Each datalink on the vehicle (J1708, J1939, Cabin CAN, and Diagnostic CAN).
- On the Diagnostic CAN, the CGW has a direct connection to the diagnostic connector.
- On the Cabin CAN, the CGW is directly connected to the starpoint connector.

The CGW has the following main functions:

- Routes and translates messages between datalinks.
- Interfaces between off-board tools and Cabin CAN ECUs.
- Provides faults for any missing Cabin CAN ECUs.

In some cases, the Cabin CAN ECUs need information from J1939 or J1708 ECUs. Information sent by the J1939 or J1708 ECU is picked up by the CGW and passed to the appropriate Cabin CAN ECU. The reverse occurs when a J1939 or J1708 ECU needs information from a CAN ECU.

Routing Active CAN Faults

If a CAN ECU generates an active fault, the CGW will route up to one active fault for that ECU on to J1939 or J1708, for display on the instrument cluster (ICU) message center, which does not have a direct connection to CAN. This is to alert the driver that the ECU has an active fault.

When a CAN ECU generates an active fault:

- J1939 displays up to one active fault for that CAN ECU under the J1939 source address for that CAN ECU. SAM Cab, for example, is SA 33. Accurate SPN and FMI information for that fault is also displayed.
- J1708 displays up to one active fault for that CAN ECU under the MID for that CAN ECU. SAM Cab, for example, is MID 249. Accurate SID/PID or FMI information is not displayed for that fault. It appears under the generic SID of "254", and the FMI may or may not be accurate.

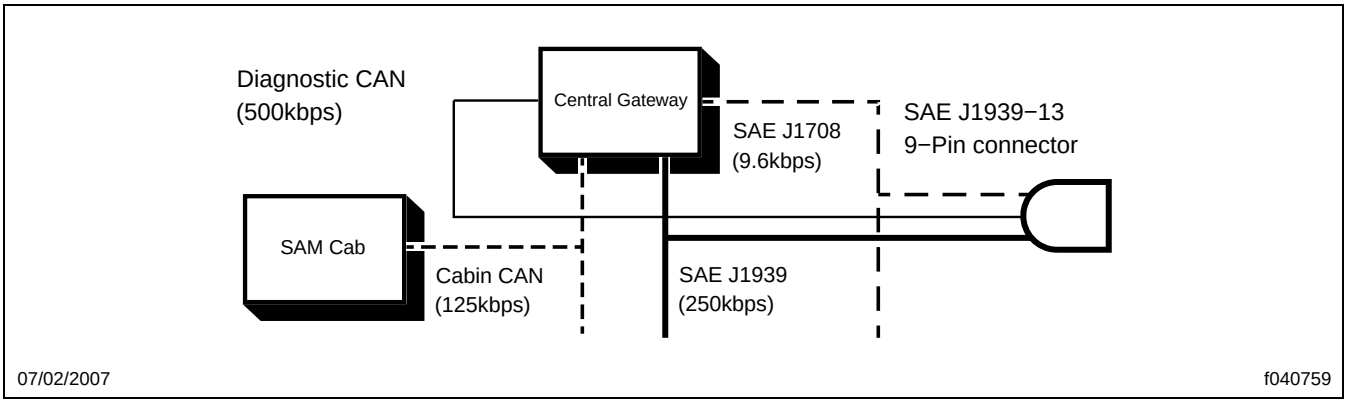


Fig. 1, Central Gateway, Diagnostic Connector, and Vehicle Datalinks

Routing Active J1939 Faults

If a J1939 ECU generates an active fault, the CGW will route up to one active fault for that ECU on J1708, for display on the instrument cluster (ICU) message center. This alerts the driver that the ECU has an active fault, especially if the ICU has a J1708 connection only. When a J1939 ECU generates an active fault, there may be up to one active fault on J1708 for that CAN ECU under the MID for that CAN ECU. The HVAC front control unit, for example, is MID 146. Accurate information for SID/PID or FMI is not displayed for that fault. It appears under the generic SID of "254", and the FMI may or may not be accurate.

For more information regarding message routing behavior by the CGW, refer to **G02.03 – Central Gateway**.

503 — ECU Identification on Datalinks

The information in **Table 1** identifies which ECU is reporting the fault, and which datalink protocol to load in ServiceLink to get accurate fault information for troubleshooting that ECU.

ECU Identification on Datalinks

ECU Description	CAN ID	J1939 SA	J1587 MID	Comments
SAM Cab	33*	(33)	(249)	—
SAM Chassis	71*	(71)	(216)	—
Modular Switch Field (MSF)	49*	(49)	(164)	—
Central Gateway (CGW)	37*	(37)	(206)	—
Engine Control 1	0†	0*	128*	—
Engine Control 2	1†	1*	175*	—
Transmission	3†	3*	130*	—
ABS	11†	11*	136*	—
Retarder, Engine	12†	12*	173	—
Instrument Cluster	23†	23‡	140*	—
Navigation	28†	28*	162*	—
Engine Display	40†	40*	171*	—
HVAC, Front	25†	25*	(146)	CGW reporting MID 146; there is no physical J1708 connection.
HVAC, Rear	58†	58*	(200)	CGW reporting MID 200; there is no physical J1708 connection.
Radio	76†	76*	(221)	CGW reporting MID 221; there is no physical J1708 connection.
Collision Warning	42†	42*	(219)	CGW reporting MID 219; there is no physical J1708 connection.
Qualcomm	—	75*	181*	—
Lane Guidance	—	232*	—	—

ECU Identification on Datalinks				
ECU Description	**CAN ID**	**J1939 SA**	**J1587 MID**	**Comments**
Front Airbag Sensor	—	—	232*	—
Roll Sensor Module	—	—	254*	—

* Physically connected to datalink, reported by actual ECU
† Not physically connected, and not reported by the CGW.
‡ ICU4M Only.

Table 1, ECU Identification on Datalinks

NOTE: Items in parenthesis indicate a message that is routed to the CGW from an ECU that is not physically connected to the CGW.

The following examples demonstrate how to identify and diagnose faults using **Table 1**.

- J1708 Fault: MID 146, SID 254, FMI 03
  - – MID 146 is the Front HVAC.
  - – The Front HVAC is diagnosed using J1939.
  - – Load the J1939 fault screen in ServiceLink for diagnostic information.
- J1939 Fault: SA 49, SPN 168, FMI 03
  - – SA 49 is the Modular Switch Field (MSF).
  - – The MSF is diagnosed using the CAN protocol.
  - – Load the CAN fault screen in ServiceLink for diagnostic information.
- J1708 Fault: MID 216, SID 254, FMI 14
  - – MID 216 is the SAM Chassis.
  - – The SAM Chassis is diagnosed using the CAN protocol.
  - – Load the CAN fault screen in ServiceLink for diagnostic information.
- J1708 Fault: MID 136, SID 123, FMI 02
  - – MID 136 is the ABS module.
  - – The ABS is diagnosed using the J1708 protocol.
  - – Load the J1708 fault screen in ServiceLink for diagnostic information.

504 — ICU4M J1587 Datalink Roll Call Faults

The entire roll call fault on the ICU4M is displayed on a single screen. All J1587 datalink roll call faults have a SID 254 and FMI 07. Refer to **Table 2** for more information.

For more information on ICU4/ICU4M roll call faults, refer to **C01.02 — ICU4/ICU4M**.

505 — Related Subjects

- **G02.02 — Datalink Communication Structure**
- **G02.04 — SAM Cab**
- **G02.05 — SAM Chassis**
- **G02.06 — Modular Switch Field**
- **G03.01 — Datalink, J1587/J1708**
- **G03.02 — Datalink, J1939**
- **G03.03 — Datalink, Cabin CAN**
- **G03.04 — Datalink, Diagnostic CAN**

700 — CAN Fault Codes

NOTE: **Table 2** lists faults for the following ECUs:

- 33 – SAM Cab
- 37 – Central Gateway (CGW)
- 49 – Modular Switch Field (MSF)
- 71 – SAM Chassis

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	168	3	—	—	—	Electrical Potential (Voltage) – Voltage above normal, or shorted to high source.	**P01.01 — Starting and Charging** **G02.04 — SAM Cab**
33	168	4	—	—	—	Electrical Potential (Voltage) – Voltage below normal, or shorted to low source.	**P01.01 — Starting and Charging** **P01.01 — Starting and Charging** **G02.04 — SAM Cab**
33	520201	4	conn X2, pin 14 conn X1, pin 4 conn X1, pin 1	F25	R8	Fuse group 25 – Voltage below normal, or shorted to low source.	**C07.09 — Collision Avoidance System** **G02.04 — SAM Cab**
33	520203	4	conn X1, pin 3 conn X1, pin 6 conn X1, pin 9	F2	—	Fuse group 2 – Voltage below normal, or shorted to low source.	**C02.01 — HVAC** **G02.04 — SAM Cab**
33	520288	4	conn X2, pin 1	—	—	Auxiliary heater – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	520304	3	conn X2, pin 4	—	—	VCU/CPC, IGN – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	520404	3	conn X3, pin 4	F17	R14	Advertising light, ACC – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	520404	4	conn X3, pin 4	—	—	Advertising light, ACC – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	520406	4	conn X3, pin 6	F26	R8	SRS airbag, IGN_X – Voltage below normal, or shorted to low source.	**C07.08 — SRS System** **G02.04 — SAM Cab**
33	520710	3	conn X3, pin 10 conn X6, pin 5 conn X6, pin 6 conn X6, pin 8 conn X6, pin 10 conn X6, pin 11	F23	R7	Fuse group 23 – Voltage above normal, or shorted to high source.	**P01.01 — Starting and Charging** **G02.04 — SAM Cab**
33	520710	4	conn X3, pin 10 conn X6, pin 5 conn X6, pin 6 conn X6, pin 8 conn X6, pin 10 conn X6, pin 11	F23	R7	Fuse group 23 – Voltage below normal, or shorted to low source.	**P01.01 — Starting and Charging** **G02.04 — SAM Cab**
33	520716	3	conn X1, pin 1 conn X1, pin 4 conn X2, pin 9 conn X2, pin 14 conn X3, pin 6 conn X6, pin 16	F24 ,F25	R8	Relay group 8 – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab** **C01.01 — ICU3** **C01.02 — ICU4/ICU4M Instrument Cluster** **C07.08 — SRS System** **C07.09 — Collision Warning System**
33	520716	4	conn X6 pin 16 conn X2, pin 9	F24	R8	Fuse group 24 – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab** **C01.01 — ICU3** **C01.02 — ICU4/ICU4M Instrument Cluster**
33	520905	3	conn X8, pin 5	—	—	Door open status – Voltage above normal, or shorted to high source.	**C05.01 — Dome Lighting** **G02.04 — SAM Cab**
33	520905	4	conn X8, pin 5	—	—	Door open status – Voltage below normal, or shorted to low source.	**C05.01 — Dome Lighting** **G02.04 — SAM Cab**
33	520908	3	conn X8, pin 8 conn X17, pin 2	F27, F28	R10	Mirror heating, driver and passenger – Voltage above normal, or shorted to high source.	**C06.05 — Heated Mirrors** **G02.04 — SAM Cab**
33	520908	4	conn X8, pin 8	F27	R10	Mirror heating, driver – Voltage below normal, or shorted to low source.	**C06.05 — Heated Mirrors** **G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	520909	4	conn X8, pin 9	—	—	Door sill lamp, driver – Voltage below normal, or shorted to low source.	**C05.01 — Dome Lighting** **G02.04 — SAM Cab**
33	521003	3	conn X9, pin 3	—	—	Function pin 1 – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521003	4	conn X9, pin 3	—	—	Function pin 1 – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	521004	3	conn X9, pin 4	—	—	Body builder connector: park brake – Voltage above normal, or shorted to high source.	**H01.05 — Parkinging Brake Warning System** **G02.04 — SAM Cab**
33	521004	4	conn X9, pin 4	—	—	Body builder connector: park brake – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	521005	3	conn X9, pin 5	—	—	Function pin 2 – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521005	4	conn X9, pin 5	—	—	Function pin 2 – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	521006	3	conn X9, pin 6	—	—	Function pin 4 – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521006	4	conn X9, pin 6	—	—	Function pin 4 – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	521007	3	conn X9, pin 7	—	—	Function pin 3 – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521007	4	conn X9, pin 7	—	—	Function pin 3 – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	521009	3	conn X9, pin 9	—	—	Body builder connector: backup lamp – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521010	3	conn X9, pin 10	—	—	Body builder connector: marker lights – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521011	3	conn X9, pin 11	—	—	Body builder connector: IGN_X – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	521012	3	conn X9, pin 12	—	—	Body builder connector: tail lights – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521102	3	conn X10, pin 2	—	—	Mirror adjust switch supply, ACC – Voltage above normal, or shorted to high source.	**C06.06 — Power Mirrors** **G02.04 — SAM Cab**
33	521102	4	conn X10, pin 2	—	—	Mirror adjust switch supply, ACC – Voltage below normal, or shorted to low source.	**C06.06 — Power Mirrors** **G02.04 — SAM Cab**
33	521107	3	conn X10, pin 7	—	—	Service brake pressure switch – Voltage above normal, or shorted to high source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521107	4	conn X10, pin 7	—	—	Service brake pressure switch – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521110	3	conn X20, pin 13	—	—	Ignition group 1 – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521110	3	conn X10, pin 10	—	—	Ignition group 1 – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521113	4	conn X10, pin 13	—	—	Panel lamps, 12 volt – Voltage below normal, or shorted to low source.	**C05.03 — Panel Backlighting** **G02.04 — SAM Cab**
33	521117	4	conn X10, pin 17	—	—	Wake-up (instrument cluster) – Voltage below normal, or shorted to low source.	**C05.03 — Panel Backlighting** **G02.04 — SAM Cab**
33	521202	3	conn X11, pin 2	—	—	Washer level, ICU indicator – Voltage above normal, or shorted to high source.	**C06.01 — Windshield Wiper/Washer** **G02.04 — SAM Cab**
33	521204	3	conn X11, pin 4	—	—	Fuel water separator ICU indicator – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521206	3	conn X11, pin 6	—	—	Low air pressure ICU indicator – Voltage above normal, or shorted to high source.	**H01.04 — Low Air Pressure Warning** **G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	521207	3	conn X11, pin 7	—	—	Lights ON buzzer – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521208	3	conn X11, pin 8	—	—	Air filter restriction ICU indicator – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521209	4	conn X11, pin 9	—	—	High beam ICU indicator – Voltage below normal, or shorted to low source.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521211	4	conn X11, pin 11	—	—	Turn signal, left ICU indicator – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521212	3	conn X11, pin 12	—	—	Alternator, no charge ICU indicator – Voltage above normal, or shorted to high source.	**P01.01 — Starting and Charging** **G02.04 — SAM Cab**
33	521213	4	conn X11, pin 13	—	—	Turn signal, right ICU indicator – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521214	3	conn X11, pin 14	—	—	Park brake, ICU indicator – Voltage above normal, or shorted to high source.	**H01.05 — Parking Brake Warning System** **G02.04 — SAM Cab**
33	521220	2	conn X11, pin 20 conn X11, pin 17	—	—	Top and bottom-of-clutch switch – Data erratic.	**P04.01 — Cruise Control** **G02.04 — SAM Cab**
33	521220	3	conn X11, pin 20 conn X11, pin 17	—	—	Top and bottom-of-clutch switch – Voltage above normal, or shorted to high source.	**P04.01 — Cruise Control** **G02.04 — SAM Cab**
33	521303	4	conn X12, pin 3	—	—	Footwell lamp – Voltage below normal, or shorted to low source.	**C05.01 — Dome Lighting** **G02.04 — SAM Cab**
33	521306	4	conn X12, pin 6	—	—	Reading lamp 1, zone 9 – Voltage below normal, or shorted to low source.	**C05.02 — Sleeper Lighting** **G02.04 — SAM Cab**
33	521309	4	conn X12, pin 9	—	—	General sleeper lamp, zone 4b – Voltage below normal, or shorted to low source.	**C05.02 — Sleeper Lighting** **G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	521312	3	conn X12, pin 12	—	—	Rear baggage compartment lights – Voltage above normal, or shorted to high source.	**C05.02 — Sleeper Lighting** **G02.04 — SAM Cab**
33	521312	4	conn X12, pin 12	—	—	Rear baggage compartment lights – Voltage below normal, or shorted to low source.	**C05.02 — Sleeper Lighting** **G02.04 — SAM Cab**
33	521315	3	conn X21, pin 11 conn X12, pin 15	—	—	Turn, left, front side – Voltage above normal, or shorted to high source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521315	4	conn X21, pin 11 conn X12, pin 15	—	—	Turn, left, front side – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521316	4	conn X12, pin 16	—	—	Reading lamp 2, zone 5 – Voltage below normal, or shorted to low source.	**C05.02 — Sleeper Lighting** **G02.04 — SAM Cab**
33	521317	4	conn X12, pin 17	—	—	Rear dome lamp, zone 4c – Voltage below normal, or shorted to low source.	**C05.02 — Sleeper Lighting** **G02.04 — SAM Cab**
33	521318	3	conn X12, pin 18 conn X20, pin 15	—	—	Turn, right, front side – Voltage above normal, or shorted to high source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521318	4	conn X12, pin 18 conn X20, pin 15	—	—	Turn, right, front side – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521402	3	conn X13, pin 2	—	—	CAN low – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab** **G02.04 — SAM Cab**
33	521403	4	conn X13, pin 3	—	—	CAN high – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	521405	2	conn X13, pin 5	—	—	Ignition switch pins (ACC, Off, Ignition On, Crank) – Data erratic, intermittent or incorrect.	**G02.04 — SAM Cab**
33	521405	2	conn X13, pin 15	—	—	Ignition switch pins (ACC, Off, Ignition On, Crank) – Data erratic, intermittent or incorrect.	**G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	521405	2	conn X13, pin 4	—	—	Ignition switch pins (ACC, Off, Ignition On, Crank) – Data erratic, intermittent or incorrect.	**G02.04 — SAM Cab**
33	521405	2	conn X13, pin 6	—	—	Ignition switch pins (ACC, Off, Ignition On, Crank) – Data erratic, intermittent or incorrect.	**G02.04 — SAM Cab**
33	521407	6	conn X13, pin 7	—	—	Ignition switch, BAT – Current above normal, or grounded circuit.	**G02.04 — SAM Cab**
33	521411	3	conn X13, pin 10	—	—	Chopped group 5 – Voltage above normal, or shorted to high source.	**H01.04 — Low Air Pressure Warning System** **G02.04 — SAM Cab**
33	521411	3	conn X13, pin 11	—	—	Chopped group 5 – Voltage above normal, or shorted to high source.	**H01.04 — Low Air Pressure Warning System** **G02.04 — SAM Cab**
33	521411	3	conn X13, pin 8 conn X13, pin 9 conn X13, pin 10 conn X13, pin 11 conn X19, pin 13 conn X18, pin 11 conn X19, pin 14	—	—	Chopped group 5 – Voltage above normal, or shorted to high source.	**H01.05 — Parking Brake Warning System** **H01.04 — Low Air Pressure Warning System** **G02.04 — SAM Cab**
33	521411	4	conn X13, pin 8 conn X13, pin 9 conn X13, pin 10 conn X13, pin 11 conn X19, pin 13 conn X18, pin 11 conn X19, pin 14	—	—	Chopped group 5 – Voltage below normal, or shorted to low source.	**H01.04 — Low Air Pressure Warning System** **H01.05 — Parking Brake Warning System** **G02.04 — SAM Cab**
33	521502	4	conn X14, pin 2	F30	R11	12 V power receptacle 6 – Voltage below normal, or shorted to low source.	**C06.08 — Cab Power Receptacles** **G02.04 — SAM Cab**
33	521702	3	conn X16, pin 2	—	—	Lane guidance, IGN – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	521702	4	conn X16, pin 2	—	—	Lane guidance, IGN – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	521704	3	conn X16, pin 4	—	—	Clearance lamps II – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	521705	4	conn X16, pin 5	—	—	Auxillary circulation fan, windshield, ACC – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	521708	3	conn X16, pin 8	—	—	Clearance lamps I – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.04 — SAM Cab**
33	521711	4	conn X16, pin 11 conn X16, pin 14	—	—	Dome lamps, driver and passenger – Voltage below normal, or shorted to low source.	**C05.01 — Dome Lighting** **G02.04 — SAM Cab**
33	521802	4	conn X17, pin 2	F28	R10	Mirror heating passenger – Voltage below normal, or shorted to low source.	**C06.05 — Heated Mirrors** **G02.04 — SAM Cab**
33	521803	4	conn X17, pin 3	—	—	Door sill lamp, passenger – Voltage below normal, or shorted to low source.	**C05.01 — Dome Lighting** **G02.04 — SAM Cab**
33	521905	3	conn X18, pin 5	—	—	Low beam, left – Voltage above normal, or shorted to high source.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521905	4	conn X18, pin 5	—	—	Low beam, left – Voltage below normal, or shorted to low source.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521905	5	conn X18, pin 5	—	—	Low beam, left – Current below normal, or open circuit.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521906	3	conn X18, pin 6	—	—	High beam, left – Voltage above normal, or shorted to high source.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521906	4	conn X18, pin 6	—	—	High beam, left – Voltage below normal, or shorted to low source.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521906	5	conn X18, pin 6	—	—	High beam, left – Current below normal, or open circuit.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521908	3	conn X18, pin 8	—	—	Marker lamp, corner, front right – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	521909	3	conn X18, pin 9	—	—	Turn, right, front corner – Voltage above normal, or shorted to high source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521909	4	conn X18, pin 9	—	—	Turn, right, front corner – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521909	5	conn X18, pin 9	—	—	Turn, right, front corner – Current below normal, or open circuit.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521912	3	conn X18, pin 12	—	—	Marker lamp, front right – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.04 — SAM Cab**
33	521914	3	conn X18, pin 14	—	—	Marker lamp, corner, front left – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.04 — SAM Cab**
33	521916	3	conn X18, pin 16	—	—	Marker lamp, corner, front left – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.04 — SAM Cab**
33	521917	3	conn X18, pin 17	—	—	High beam, right – Voltage above normal, or shorted to high source.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521917	4	conn X18, pin 17	—	—	High beam, right – Voltage below normal, or shorted to low source.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521917	5	conn X18, pin 17	—	—	High beam, right – Current below normal, or open circuit.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521919	3	conn X18, pin 19	—	—	Turn, left, front corner – Voltage above normal, or shorted to high source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521919	4	conn X18, pin 19	—	—	Turn, left, front corner – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521919	5	conn X18, pin 19	—	—	Turn, left, front corner – Current below normal, or open circuit.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.04 — SAM Cab**
33	521920	3	conn X18, pin 20	—	—	Low beam, right – Voltage above normal, or shorted to high source.	**C04.02 — Headlight System** **G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	521920	4	conn X18, pin 20	—	—	Low beam, right – Voltage below normal, or shorted to low source.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521920	5	conn X18, pin 20	—	—	Low beam, right – Current below normal, or open circuit.	**C04.02 — Headlight System** **G02.04 — SAM Cab**
33	521921	3	conn X18, pin 21	—	—	Horn, electric – Voltage above normal, or shorted to high source.	**C06.04 — Horn** **G02.04 — SAM Cab**
33	521921	5	conn X18, pin 21	—	—	Horn, electric – Current below normal, or open circuit.	**C06.04 — Horn** **G02.04 — SAM Cab**
33	521921	6	conn X18, pin 21	—	—	Horn, electric – Current above normal, or grounded circuit.	**C06.04 — Horn** **G02.04 — SAM Cab**
33	522003	3	conn X19, pin 3	—	—	Starter relay 3 – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	522003	4	conn X19, pin 3	—	—	Starter relay 3 – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	522006	3	conn X19, pin 6	—	—	A/C Compressor clutch – Voltage above normal, or shorted to high source.	**C02.01 — HVAC System** **G02.04 — SAM Cab**
33	522006	4	conn X19, pin 6	—	—	A/C Compressor clutch – Voltage below normal, or shorted to low source.	**C02.01 — HVAC System** **G02.04 — SAM Cab**
33	522006	5	conn X19, pin 6	—	—	A/C Compressor clutch – Current below normal, or open circuit.	**C02.01 — HVAC System** **G02.04 — SAM Cab**
33	522010	2	conn X19, pin 10	—	—	HVAC pressure transducer, feedback – Data erratic, intermittent or incorrect.	**C02.01 — HVAC System** **G02.04 — SAM Cab**
33	522018	3	conn X19, pin 18	—	—	Engine ECU, IGN – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	522108	3	conn X20, pin 8	—	—	Fog lamp, front left – Voltage above normal, or shorted to high source.	**C04.06 — Fog Lights** **G02.04 — SAM Cab**
33	522108	4	conn X20, pin 8	—	—	Fog lamp, front left – Voltage below normal, or shorted to low source.	**C04.06 — Fog Lights** **G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	522108	5	conn X20, pin 8	—	—	Fog lamp, front left – Current below normal, or open circuit.	**C04.06 — Fog Lights** **G02.04 — SAM Cab**
33	522110	3	conn X20, pin 10	—	—	High beam, auxiliary left – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	522110	4	conn X20, pin 10	—	—	High beam, auxiliary left – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	522111	3	conn X20, pin 11	—	—	Low beam, auxiliary left – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	522111	4	conn X20, pin 11	—	—	Low beam, auxiliary left – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	522112	3	conn X20, pin 12	—	—	High beam, auxiliary right – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	522112	4	conn X20, pin 12	—	—	High beam, auxiliary right – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	522114	3	conn X20, pin 14	—	—	Low beam, auxiliary right – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	522114	4	conn X20, pin 14	—	—	Low beam, auxiliary right – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	522116	2	conn X20, pin 16	—	—	Temperature sensor, outside air, feedback – Data erratic, intermittent or incorrect.	**C06.05 — Heated Mirrors** **G02.04 — SAM Cab**
33	522117	3	conn X20, pin 17	—	—	Fog lamp, front right – Voltage above normal, or shorted to high source.	**C04.06 — Fog Lights** **G02.04 — SAM Cab**
33	522117	4	conn X20, pin 17	—	—	Fog lamp, front right – Voltage below normal, or shorted to low source.	**C04.06 — Fog Lights** **G02.04 — SAM Cab**
33	522117	5	conn X20, pin 17	—	—	Fog lamp, front right – Current below normal, or open circuit.	**C04.06 — Fog Lights** **G02.04 — SAM Cab**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
33	522119	4	conn X20, pin 19	—	—	Distance sensor (adaptive cruise control), BAT – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	522120	3	conn X20, pin 20	—	—	Washer pump – Voltage above normal, or shorted to high source.	**C06.01 — Windshield Wiper/Washer** **G02.04 — SAM Cab**
33	522120	4	conn X20, pin 20	—	—	Washer pump – Voltage below normal, or shorted to low source.	**C06.01 — Windshield Wiper/Washer** **G02.04 — SAM Cab**
33	522120	5	conn X20, pin 20	—	—	Washer pump – Current below normal, or open circuit.	**C06.01 — Windshield Wiper/Washer** **G02.04 — SAM Cab**
33	522121	3	conn X20, pin 21	—	—	Washer fluid level sensor – Voltage above normal, or shorted to high source.	**C06.01 — Windshield Wiper/Washer** **G02.04 — SAM Cab**
33	522209	2	conn X21, pin 9	—	—	Wiper parked – Data erratic, intermittent or incorrect.	**C06.01 — Windshield Wiper/Washer** **G02.04 — SAM Cab**
33	522214	3	conn X21, pin 14 conn X3, pin 7	—	—	Utility light – Voltage above normal, or shorted to high source.	**G02.04 — SAM Cab**
33	522214	4	conn X21, pin 14 conn X3, pin 7	—	—	Utility light – Voltage below normal, or shorted to low source.	**G02.04 — SAM Cab**
33	522214	5	conn X21, pin 14 conn X3, pin 7	—	—	Utility light – Current below normal, or open circuit.	**G02.04 — SAM Cab**
33	522215	3	conn X21, pin 15 conn X21, pin 12	—	—	Wiper high, and wiper low – Voltage above normal, or shorted to high source.	**C06.01 — Windshield Wiper/Washer** **G02.04 — SAM Cab**
33	522215	6	conn X21, pin 15 conn X21, pin 12	—	—	Wiper high, and wiper low – Current above normal, or grounded circuit.	**C06.01 — Windshield Wiper/Washer** **G02.04 — SAM Cab**
33	524037	31	—	—	—	Lost communication with CGW.	**G03.03 — Datalink, Cabin CAN**
33	524049	31	—	—	—	Lost communication with MSF.	**G03.03 — Datalink, Cabin CAN**
33	524071	31	—	—	—	Lost communication with SAM Chassis.	**G03.03 — Datalink, Cabin CAN**
37	168	3	pin 1	—	—	Electrical potential (voltage) – voltage shorted above normal or shorted to high.	**G02.03 — Central Gateway**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
37	168	4	pin 1	—	—	Electrical potential (voltage) – voltage shorted below normal or shorted to low.	**G02.03 — Central Gateway**
37	628	12	—	—	—	Program memory – Bad intelligent device or component.	**G02.03 — Central Gateway**
37	523510	31	pin 18, pin 23	—	—	Diagnostic CAN performance.	**G02.03 — Central Gateway** **G03.03 — Datalink, Cabin CAN**
37	523511	31	pin 14, pin 19	—	—	Cabin CAN performance.	**G02.03 — Central Gateway** **G03.03 — Datalink, Cabin CAN**
37	523512	31	pin 16, pin 21	—	—	J1939 CAN performance.	**G02.03 — Central Gateway** **G03.03 — Datalink, Cabin CAN**
37	523513	31	pin 2, pin 8	—	—	J1708 performance.	**G02.03 — Central Gateway** **G03.03 — Datalink, Cabin CAN**
37	524033	31	—	—	—	Lost communication with SAM Cab.	**G02.03 — Central Gateway** **G03.03 — Datalink, Cabin CAN**
37	524049	31	—	—	—	Lost communication with MSF.	**G02.03 — Central Gateway** **G03.03 — Datalink, Cabin CAN**
37	524071	31	—	—	—	Lost communication with SAM Chassis.	**G02.03 — Central Gateway** **G03.03 — Datalink, Cabin CAN**
49	168	3	conn D, pin 2	—	—	Electrical Potential (Voltage) – Voltage above normal, or shorted to high source.	**C02.06 — Modular Switch Field**
49	168	4	conn D, pin 2	—	—	Electrical Potential (Voltage) – Voltage below normal, or shorted to low source.	**C02.06 — Modular Switch Field**
49	520201	3	conn A, pin 2	—	—	Steering wheel switch, right – Voltage above normal or shorted to high source.	**P04.01 — Cruise Control** **C02.06 — Modular Switch Field**
49	520201	4	conn A, pin 2	—	—	Steering wheel switch, right – Voltage below normal or shorted to low source.	**P04.01 — Cruise Control** **C02.06 — Modular Switch Field**
49	520203	3	conn A, pin 1	—	—	Steering wheel switch, left – Voltage above normal or shorted to high source.	**P04.01 — Cruise Control** **C02.06 — Modular Switch Field**
49	520203	4	conn A, pin 1	—	—	Steering wheel switch, left – Voltage below normal or shorted to low source.	**P04.01 — Cruise Control** **C02.06 — Modular Switch Field**
49	520302	3	conn B, pin 2	—	—	Sub bus signal – Voltage above normal or shorted to high source.	**C02.06 — Modular Switch Field**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
49	520302	4	conn B, pin 2	—	—	Sub bus signal – Voltage below normal or shorted to low source.	**C02.06 — Modular Switch Field**
49	520404	3	conn C, pin 4	—	—	Stalk switch flash – Voltage above normal or shorted to high source.	**C04.02 — Headlight System** **C02.06 — Modular Switch Field**
49	520404	5	conn C, pin 4 pin 8, 9, 14	—	—	Stalk switch interrupt – Current below normal, or open circuit.	**C02.06 — Modular Switch Field**
49	520405	3	conn C, pin 5	—	—	Stalk switch, high beam – Voltage above normal or shorted to high source.	**C04.02 — Headlight System** **C02.06 — Modular Switch Field**
49	520413	4	conn C, pin 15	—	—	Stalk switch, wiper, common – Voltage below normal or shorted to low source.	**C02.06 — Modular Switch Field**
49	520601	4	conn E, pin 1	—	—	Headlamp switch +12V Battery – Voltage below normal or shorted to low source.	**C02.06 — Modular Switch Field**
49	520607	4	conn A, pin 2 conn E, pin 7	—	—	Backlighting – Voltage below normal or shorted to low source.	**C05.03 — Panel Backlighting** **C02.06 — Modular Switch Field**
49	523511	31	conn D, pin 3 conn D, pin 5	—	—	Cabin CAN Performance.	**C02.06 — Modular Switch Field**
49	523530	31	—	—	—	Sub bus switch missing.	**C02.06 — Modular Switch Field**
49	523531	31	—	—	—	Extra Sub bus switch.	**C02.06 — Modular Switch Field**
49	523543	2	conn E, pin 2 conn E, pin 3 conn E, pin 4 conn E, pin 5	—	—	Headlamp switch inputs – Data erratic, intermittent, or incorrect.	**C04.02 — Headlight System** **C02.06 — Modular Switch Field**
49	524033	31	—	—	—	Lost communication with SAM Cab.	**G03.03 — Datalink, Cabin CAN** **C02.06 — Modular Switch Field**
49	524037	31	—	—	—	Lost communication with CGW.	**G03.03 — Datalink, Cabin CAN** **C02.06 — Modular Switch Field**
49	524071	31	—	—	—	Lost communication with SAM Chassis.	**G03.03 — Datalink, Cabin CAN** **C02.06 — Modular Switch Field**
71	168	3	—	—	—	Electrical potential (voltage) – Voltage above normal or shorted to high source.	**P01.01 — Starting and Charging** **G02.05 — SAM Chassis**
71	168	4	—	—	—	Electrical Potential (Voltage) – Voltage below normal, or shorted to low source.	**P01.01 — Starting and Charging** **G02.05 — SAM Chassis**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
71	520201	3	conn X51, pin 1	—	—	CAN low – Voltage above normal, or shorted to high source.	**G02.05 — SAM Chassis**
71	520202	4	conn X51, pin 2	—	—	CAN high – Voltage below normal, or shorted to low source.	**G02.05 — SAM Chassis**
71	520301	3	conn X58, pin 13 conn X52, pin 1	—	—	Marker lamp, side right – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520301	4	conn X58, pin 13 conn X52, pin 1	—	—	Marker lamp, side right – Voltage below normal, or shorted to low source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520301	5	conn X58, pin 13 conn X52, pin 1	—	—	Marker lamp, side right – Current below normal, or open circuit.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520302	4	conn X52, pin 6	F6	R3	Power feed ABS/BS, IGN – Voltage below normal, or shorted to low source.	**H01.01 — ABS and Stability Control Systems** **G02.05 — SAM Chassis**
71	520303	3	conn X52, pin 3	—	—	Marker lamp, corner rear, right – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520303	4	conn X52, pin 3	—	—	Marker lamp, corner rear, right – Voltage below normal, or shorted to low source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520303	5	conn X52, pin 3	—	—	Marker lamp, corner rear, right – Current below normal, or open circuit.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520402	3	conn X53, pin 2	—	—	Marker lamp, corner rear, left – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520402	4	conn X53, pin 2	—	—	Marker lamp, corner rear, left – Voltage below normal, or shorted to low source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520402	5	conn X53, pin 2	—	—	Marker lamp, corner rear, left – Current below normal, or open circuit.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520407	3	conn X53, pin 7	F8	R4	Trailer, turn lamp, right – Voltage above normal, or shorted to high source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
71	520407	4	conn X53, pin 7	F8	R4	Trailer, turn lamp, right – Voltage below normal, or shorted to low source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520409	3	conn X53, pin 9	F5	R2	Trailer, turn lamp, left – Voltage above normal, or shorted to high source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520409	4	conn X53, pin 9	F5	R2	Trailer, turn lamp, left – Voltage below normal, or shorted to low source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520501	3	conn X54, pin 1	F11	R6	Trailer, ABS connector (7), IGN – Voltage above normal, or shorted to high source.	**H01.01 — ABS and Stability Control Systems** **G02.05 — SAM Chassis**
71	520501	4	conn X54, pin 1	F11	R6	Trailer, ABS connector (7), IGN – Voltage below normal, or shorted to low source.	**H01.01 — ABS and Stability Control Systems** **G02.05 — SAM Chassis**
71	520602	3	conn X55, pin 2	F9	R5	Trailer, marker lamps – Voltage above normal, or shorted to high source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520602	4	conn X55, pin 2	F9	R5	Trailer, marker lamps – Voltage below normal, or shorted to low source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520603	3	conn X55, pin 3	F13	R9	Trailer, tail lamps – Voltage above normal, or shorted to high source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520603	4	conn X55, pin 3	F13	R9	Trailer, tail lamps – Voltage below normal, or shorted to low source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520604	3	conn X55, pin 4	F12	R7	Trailer, stop lamps – Voltage above normal, or shorted to high source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520604	4	conn X55, pin 4	F12	R7	Trailer, stop lamps – Voltage below normal, or shorted to low source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520702	3	conn X56, pin 2	—	—	End-of-frame primary trailer power, IGN – Voltage above normal, or shorted to high source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
71	520707	4	conn X56, pin 7	—	—	End-of-frame primary trailer turn lamps, right – Voltage below normal, or shorted to low source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520707	5	conn X56, pin 7	—	—	End-of-frame primary trailer turn lamps, right – Current below normal, or open circuit.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520710	4	conn X56, pin 10	—	—	End-of-frame primary trailer turn lamps. left – Voltage below normal, or shorted to low source.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520710	5	conn X56, pin 10	—	—	End-of-frame primary trailer turn lamps. left – Current below normal, or open circuit.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520713	5	conn X56, pin 13	—	—	End-of-frame primary trailer tail lamps – Current below normal, or open circuit.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520714	5	conn X56, pin 14	—	—	End-of-frame primary trailer stop lamps – Current below normal, or open circuit.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520715	5	conn X56, pin 15	—	—	End-of-frame primary trailer marker lamps – Current below normal, or open circuit.	**C04.07 — Trailer Lights** **G02.05 — SAM Chassis**
71	520801	3	conn X52, pin 6 conn X53, pin 3 conn X57, pin 1	F6, F7	R3	Relay group 3 – Voltage above normal, or shorted to high source.	**H01.01 — ABS and Stability Control Systems** **G02.05 — SAM Chassis**
71	520801	4	conn X53, pin 3 conn X57, pin 1	F7	R3	Fuse group 7 – Voltage below normal, or shorted to low source.	**G02.05 — SAM Chassis**
71	520804	3	conn X57, pin 4	—	—	Air dryer (pneumatic, electrically heated), ACC – Voltage above normal, or shorted to high source.	**G02.05 — SAM Chassis**
71	520804	4	conn X57, pin 4	—	—	Air dryer (pneumatic, electrically heated), ACC – Voltage below normal, or shorted to low source.	**G02.05 — SAM Chassis**
71	520815	3	conn X57, pin 15	F2	R1	Fuel water separator heater element – Voltage above normal, or shorted to high source.	**G02.05 — SAM Chassis**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
71	520815	4	conn X57, pin 15	F2	R1	Fuel water separator heater element – Voltage below normal, or shorted to low source.	**G02.05 — SAM Chassis**
71	520901	3	conn X58, pin 1	—	—	Turn, right, rear lower – Voltage above normal, or shorted to high source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520901	4	conn X58, pin 1	—	—	Turn, right, rear lower – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520901	5	conn X58, pin 1	—	—	Turn, right, rear lower – Current below normal, or open circuit.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520903	3	conn X58, pin 3	—	—	Tail lamp, right – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520903	4	conn X58, pin 3	—	—	Tail lamp, right – Voltage below normal, or shorted to low source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520903	5	conn X58, pin 3	—	—	Tail lamp, right – Current below normal, or open circuit.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520910	3	conn X58, pin 10	—	—	Turn, left, rear lower – Voltage above normal, or shorted to high source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520910	4	conn X58, pin 10	—	—	Turn, left, rear lower – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520910	5	conn X58, pin 10	—	—	Turn, left, rear lower – Current below normal, or open circuit.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520912	3	conn X58, pin 12	—	—	License plate lamp – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520912	4	conn X58, pin 12	—	—	License plate lamp – Voltage below normal, or shorted to low source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520912	5	conn X58, pin 12	—	—	License plate lamp – Current below normal, or open circuit.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
71	520916	3	conn X53, pin 1 conn X58, pin 16	—	—	Marker lamp, side, left – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520916	4	conn X53, pin 1 conn X58, pin 16	—	—	Marker lamp, side, left – Voltage below normal, or shorted to low source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520916	5	conn X53, pin 1 conn X58, pin 16	—	—	Marker lamp, side, left – Current below normal, or open circuit.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520918	3	conn X58, pin 18	—	—	Tail lamp, left – Voltage above normal, or shorted to high source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520918	4	conn X58, pin 18	—	—	Tail lamp, left – Voltage below normal, or shorted to low source.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520918	5	conn X58, pin 18	—	—	Tail lamp, left – Current below normal, or open circuit.	**C04.05 — Tail and Marker Lights** **G02.05 — SAM Chassis**
71	520919	3	conn X58, pin 19	—	—	Backup lamp – Voltage above normal, or shorted to high source.	**C07.01 — Backup Lamps and Alarm** **G02.05 — SAM Chassis**
71	520919	4	conn X58, pin 19	—	—	Backup lamp – Voltage below normal, or shorted to low source.	**C07.01 — Backup Lamps and Alarm** **G02.05 — SAM Chassis**
71	520920	3	conn X58, pin 20	—	—	Stop lamp, right – Voltage above normal, or shorted to high source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520920	4	conn X58, pin 20	—	—	Stop lamp, right – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520920	5	conn X58, pin 20	—	—	Stop lamp, right – Current below normal, or open circuit.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520921	3	conn X58, pin 21	—	—	Stop lamp, left – Voltage above normal, or shorted to high source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520921	4	conn X58, pin 21	—	—	Stop lamp, left – Voltage below normal, or shorted to low source.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	520921	5	conn X58, pin 21	—	—	Stop lamp, left – Current below normal, or open circuit.	**C04.04 — Stop, Turn, and Hazard Lights** **G02.05 — SAM Chassis**
71	521001	3	conn X59, pin 1 conn X59, pin 3	—	—	Backup switch – Voltage above normal, or shorted to high source.	**C07.01 — Backup Lights and Alarm** **G02.05 — SAM Chassis**

CAN Fault Codes							
SA	**SPN**	**FMI**	**Conn/Pin**	**Fuse**	**Relay**	**Description**	**Subject**
71	521002	3	conn X59, pin 18 conn X59, pin 2	—	—	Transmission, neutral switch – Voltage above normal, or shorted to high source.	**P02.02 — Manual Transmission** **P02.03 — Automatic Manual Transmission with SmartShift** **G02.05 — SAM Chassis**
71	524033	31	—	—	—	Lost communication with SAM Cab.	**G03.03 — Datalink, Cabin CAN** **G02.05 — SAM Chassis**
71	524037	31	—	—	—	Lost communication with CGW.	**G03.03 — Datalink, Cabin CAN** **G02.05 — SAM Chassis**
71	524049	31	—	—	—	Lost communication with MSF.	**G03.03 — Datalink, Cabin CAN** **G02.05 — SAM Chassis**

Table 2, CAN Fault Codes