

Electrical System and Main PDM Overview

G02.01

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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.

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

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- Load Disconnect Switch, Module 293
- Trailer PDM, Module 296

503 — 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.

504 — 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).

505 — 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.

506 — 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.

507 — 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**.

508 — PDM Diagram

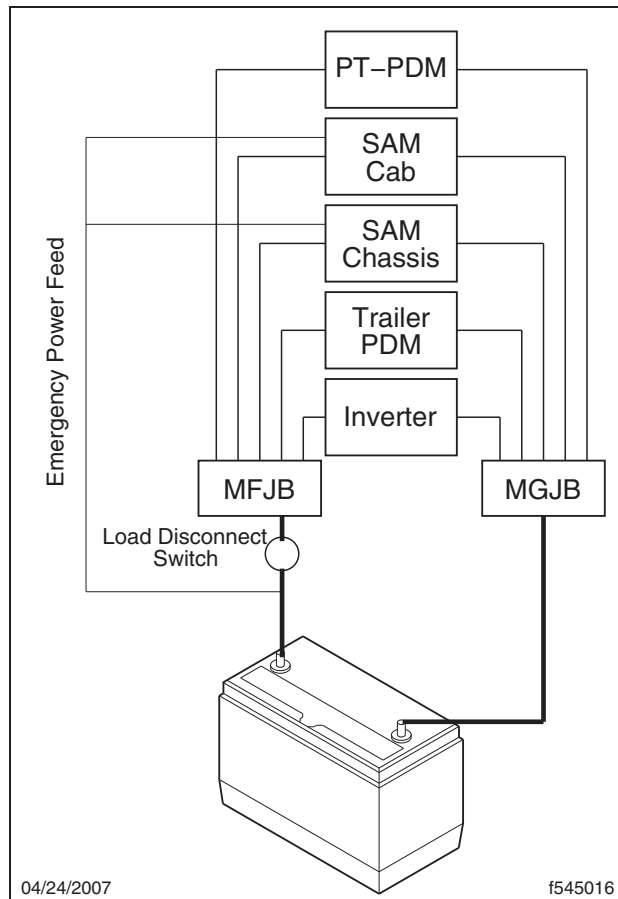


Fig. 1, PDM Diagram

509 — Related Subjects

- G02.04 — SAM Cab
- G02.05 — SAM Chassis
- P01.01 — Starting and Charging

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600 — Component Locations

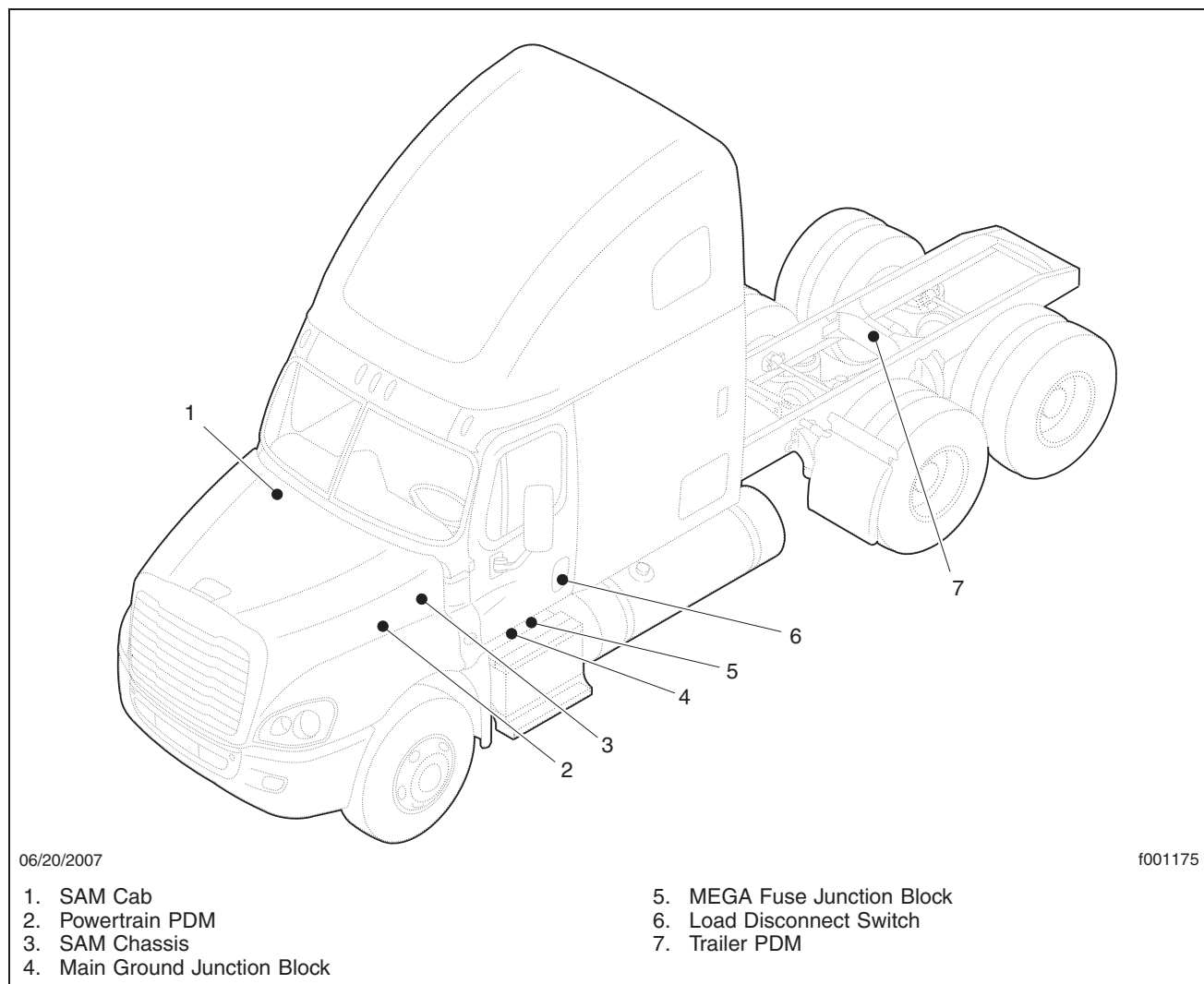


Fig. 2, Component Locations

601 — Component Details

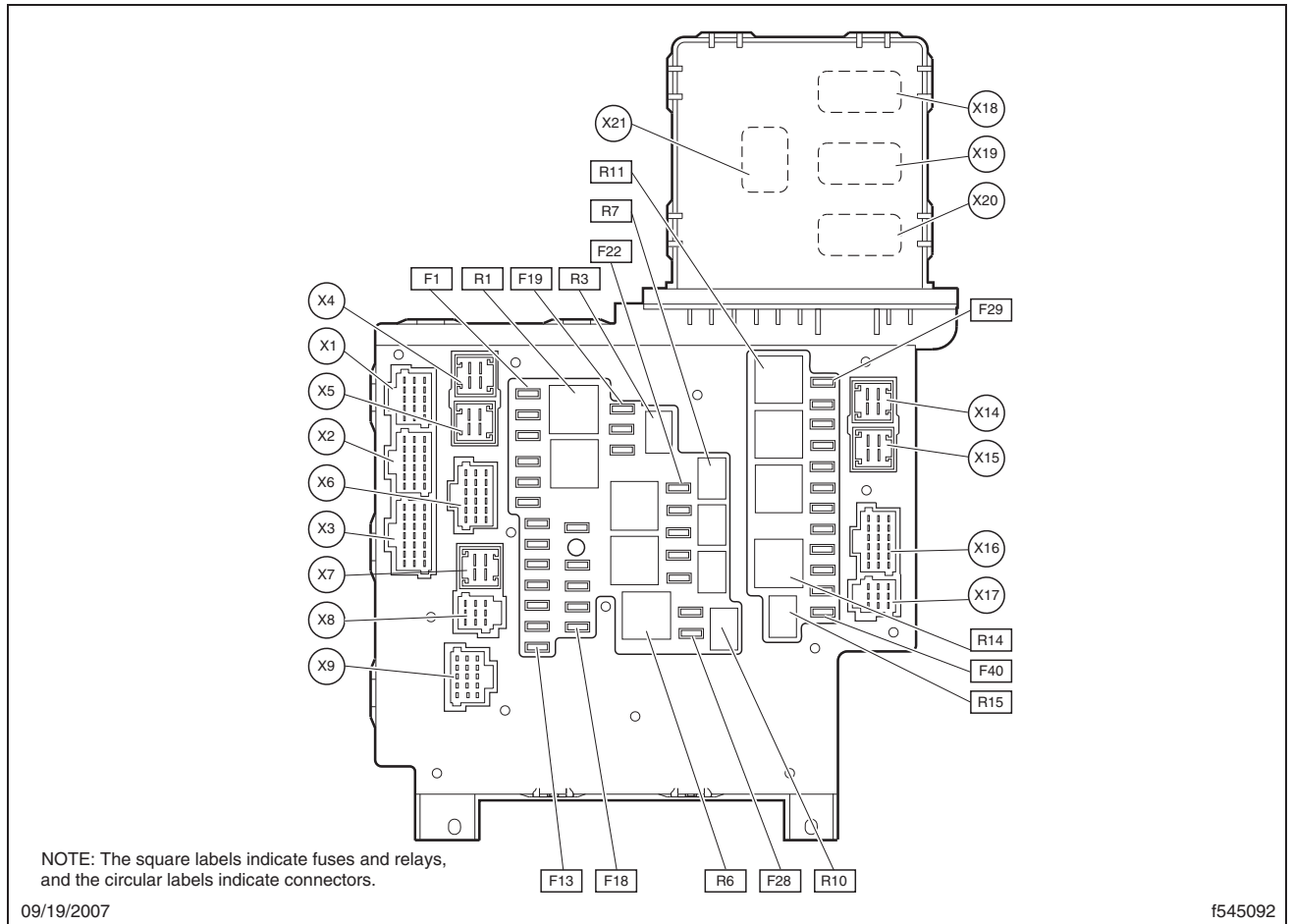


Fig. 3, SAM Cab Fuses and Relays (top)

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Electrical System and Main PDM Overview

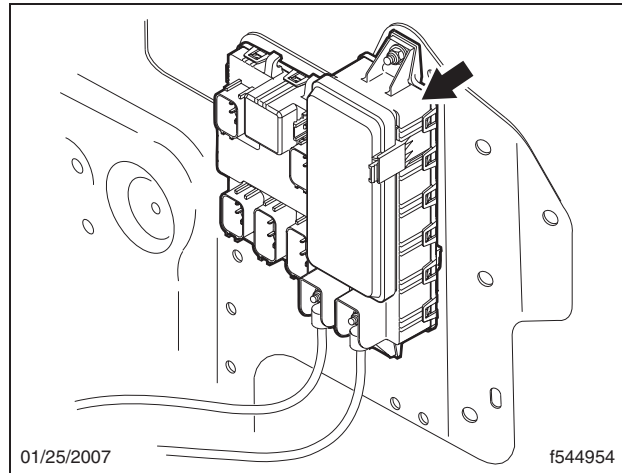


Fig. 4, SAM Chassis

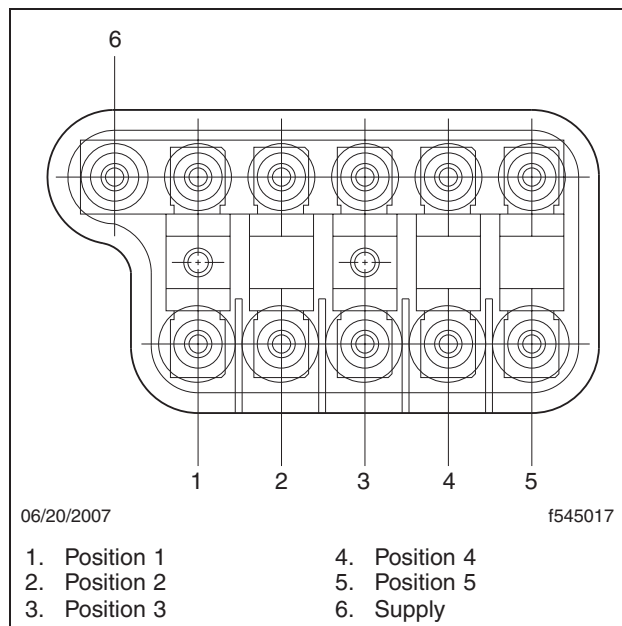


Fig. 5, MEGA Fuse Junction Block

Electrical System and Main PDM Overview

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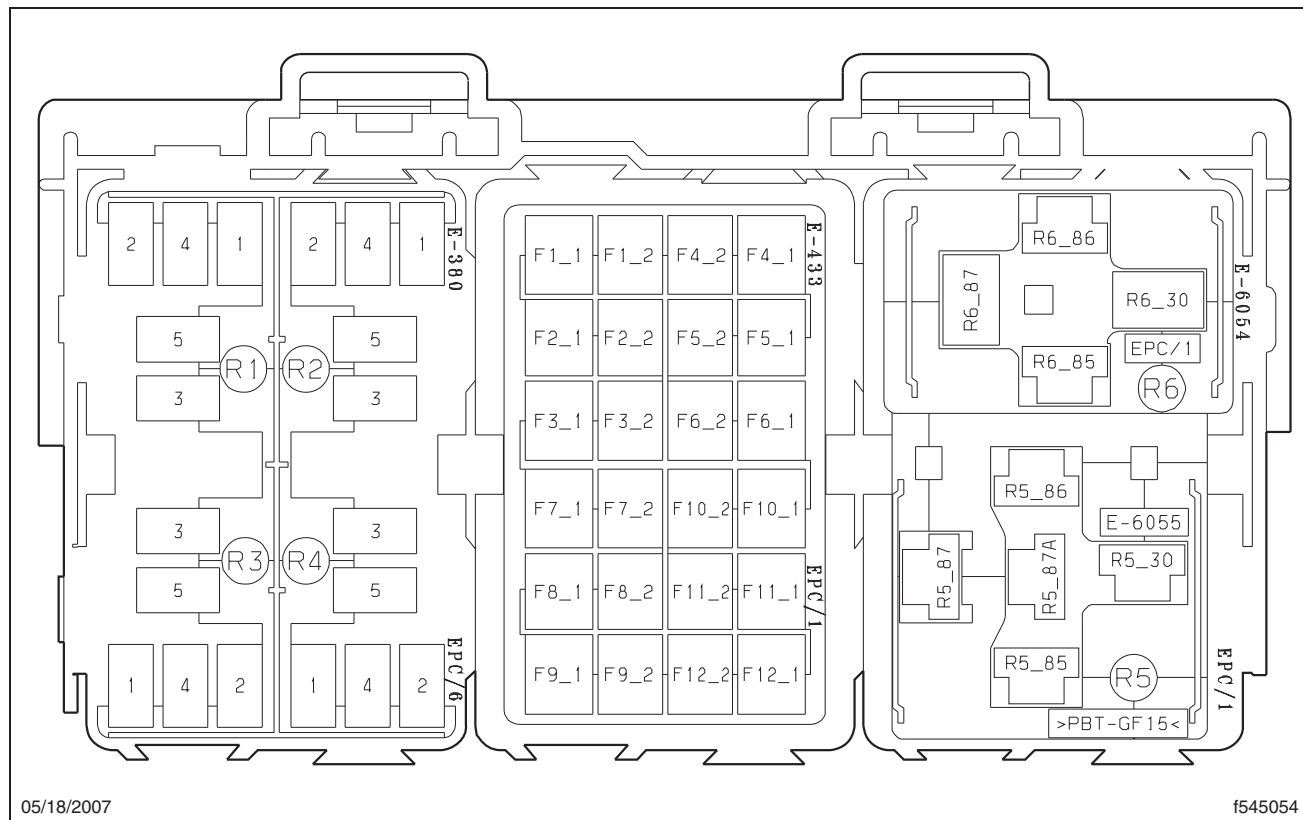


Fig. 6, Powertrain PDM

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.

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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

800 — 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
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 2, SAM Cab Relays

Electrical System and Main PDM Overview

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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)
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)

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SAM Cab Fuses	
Part	Name
F38	DR CTRL R (20A)
F39	PWR WINDOW R (15A)
F40	PWR WINDOW L (15A)

Table 3, SAM Cab Fuses

801 — 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
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)

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SAM Chassis Fuses	
Part	Name
F13	TRLR TAIL (20A)
F14	TRLR PWR (30A)

Table 5, SAM Chassis 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 6, 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
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

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Powertrain PDM Fuses and Relays	
Part	Name
R5	N/A
R6	70A IGN RELAY

Table 7, Powertrain PDM Fuses and Relays

Datalink Communication Structure

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Datalink Communication Structure

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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-

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Datalink Communication Structure

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

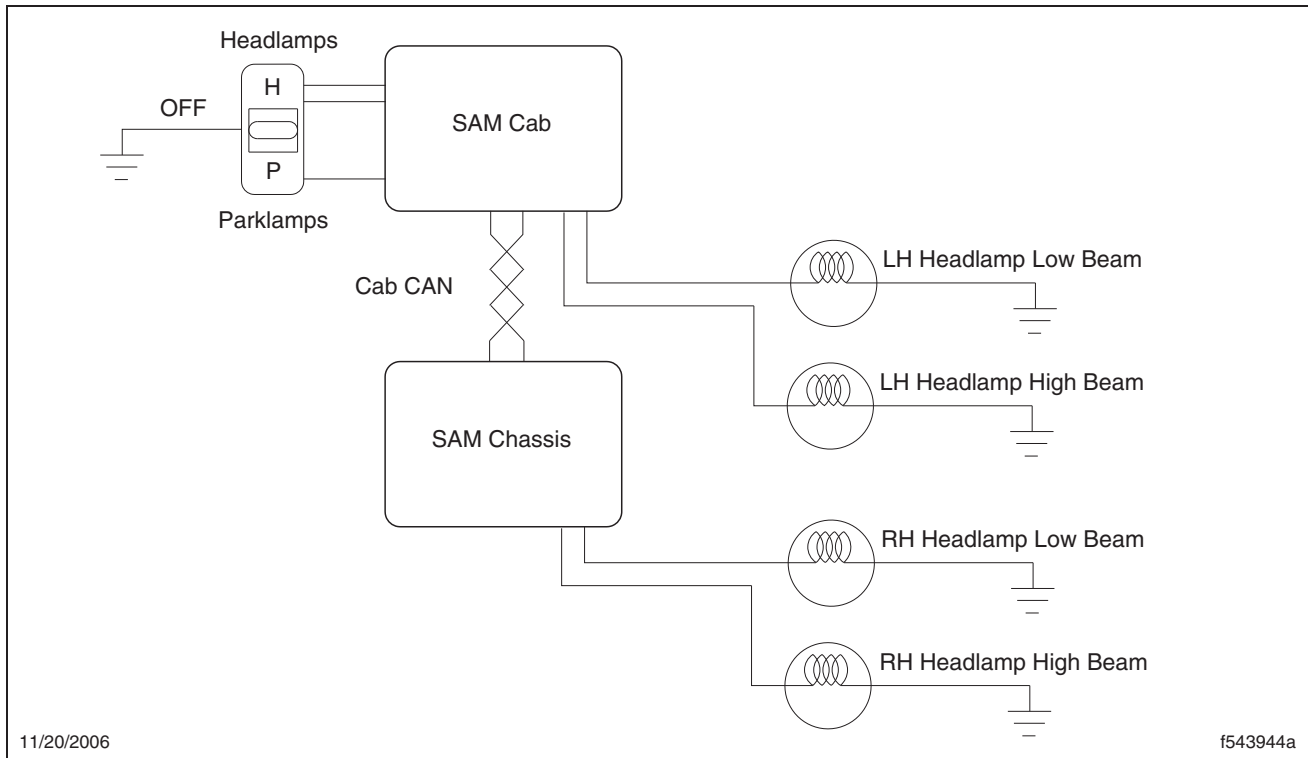


Fig. 1, Example of Multiplexed System with ECUs and Electrical Components

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.

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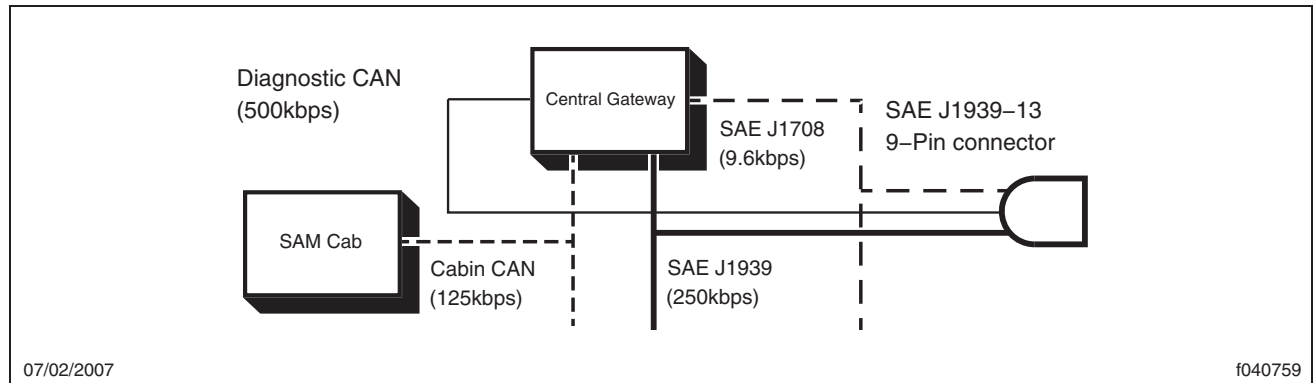


Fig. 2, Central Gateway, Diagnostic Connector, and Vehicle Datalinks

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.

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Datalink Communication Structure

505 — Cabin CAN Datalink

The Cabin CAN datalink does not have a direct connection to the diagnostic connector. Therefore, an off-board tool (such as ServiceLink) 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, such as ServiceLink, 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, such as ServiceLink, 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.

508 — ECU Configuration

All ECUs connected to the Cabin CAN datalink can have their software "flashed" using ServiceLink.

All ECUs connected to the Cabin CAN datalink, except for the CGW, have parameters that can be configured.

Some J1939 and J1587/J1708 ECUs may be reprogrammed (flashed), or have parameters configured, using ServiceLink or the ECU manufacturer's proprietary off-board tool. For more information, refer to the applicable

Datalink Communication Structure

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subjects in this manual, and the ServiceLink User Documentation (available via the "Help" drop-down menu in ServiceLink).

509 — Datalink Network Topology

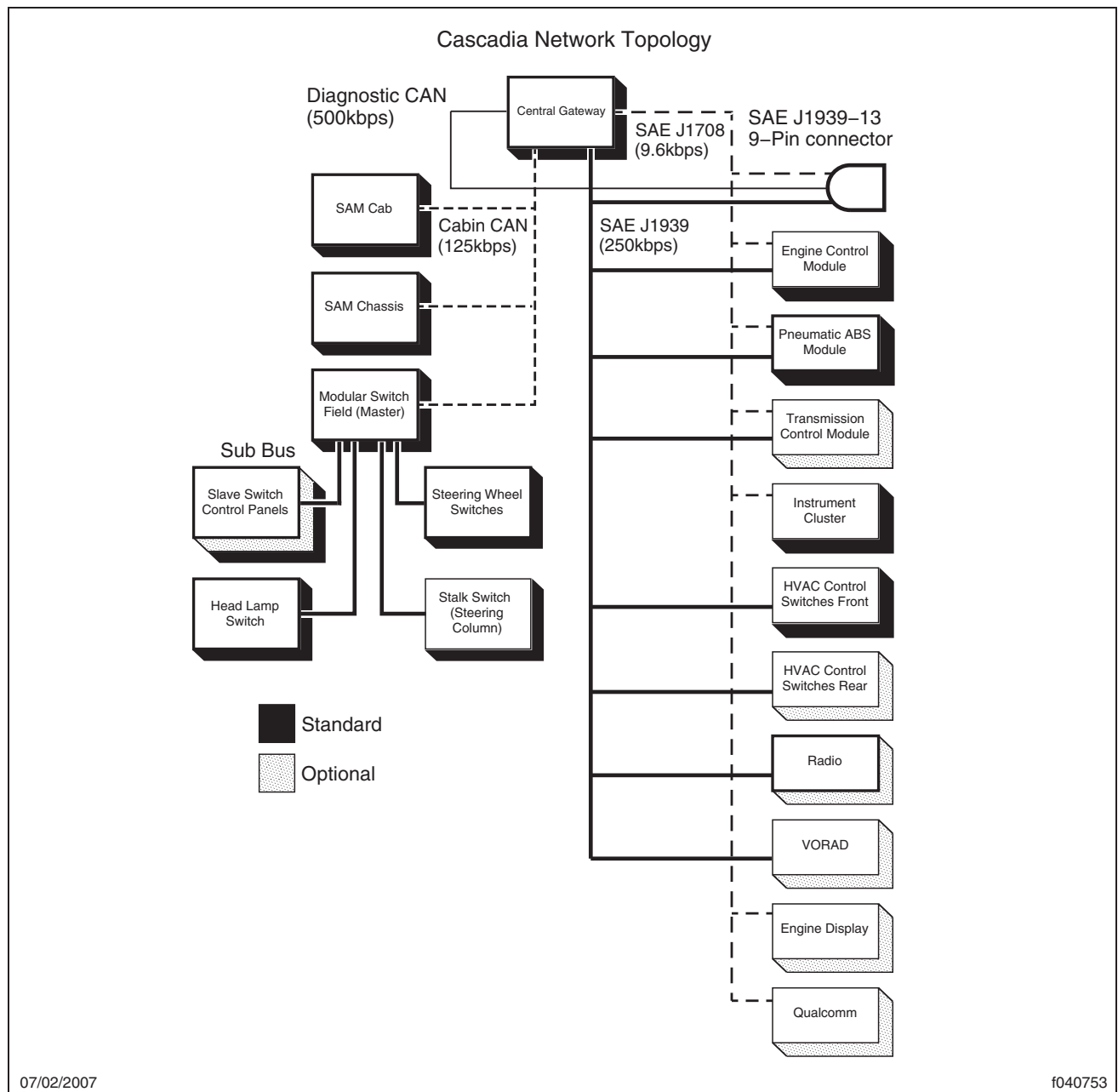


Fig. 3, Datalink Network Topology

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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

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600 — Component Locations

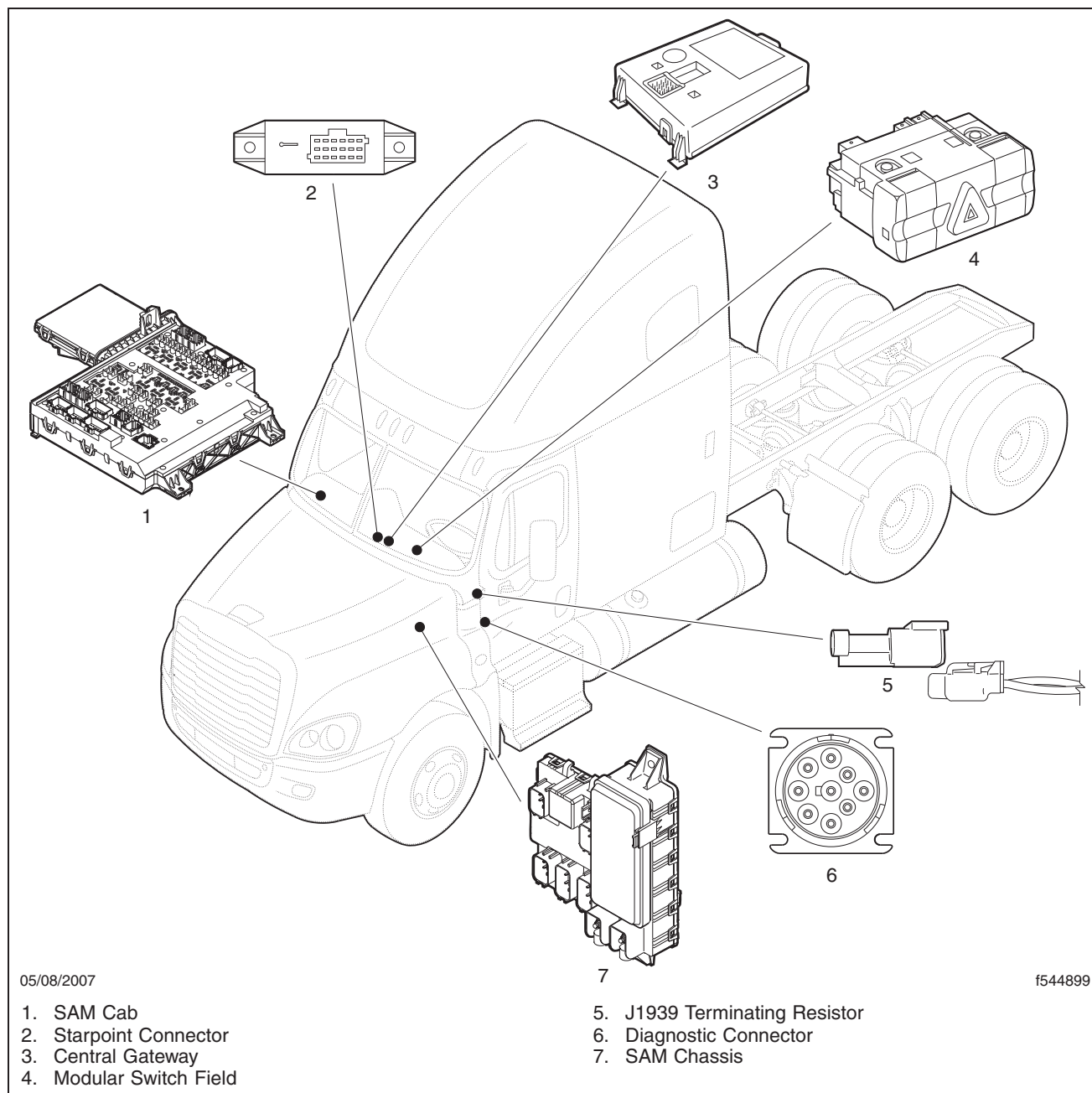


Fig. 4, Component Locations

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601 — Component Details

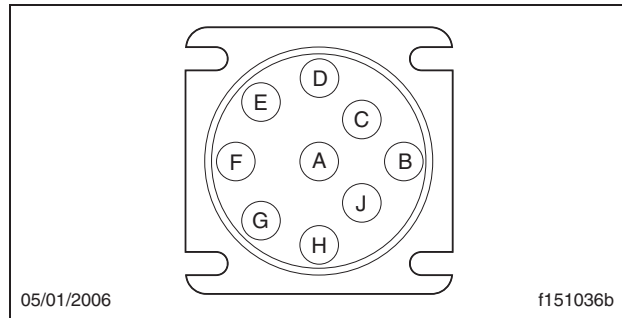


Fig. 5, Diagnostic Connector

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

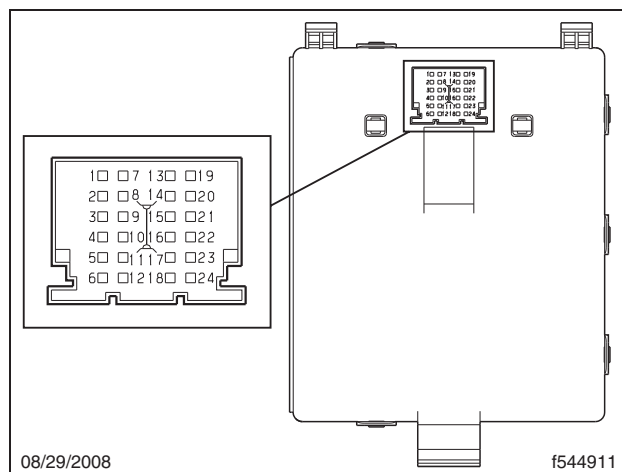


Fig. 6, Central Gateway Module, Cabin CAN Pins

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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)

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Datalink Communication Structure

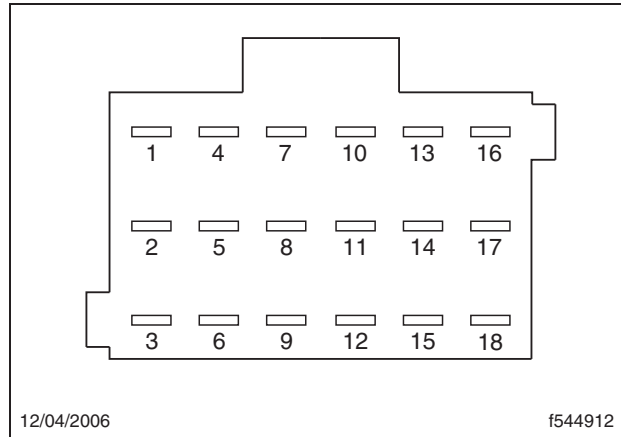


Fig. 7, Starpoint Connector

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)

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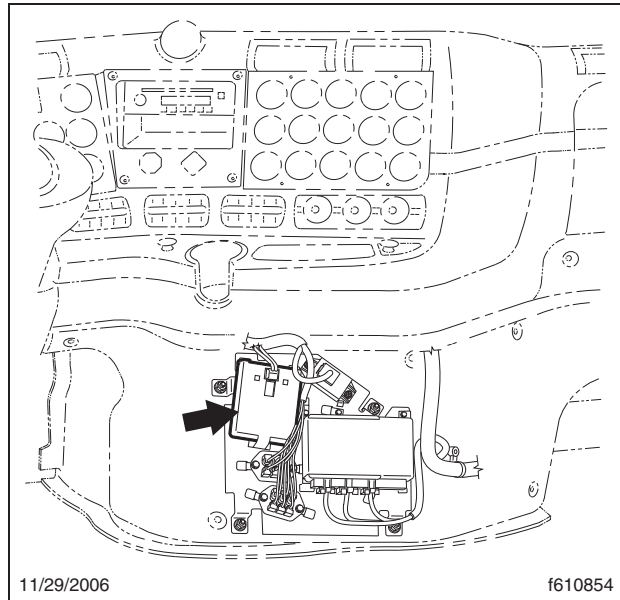


Fig. 8, Central Gateway

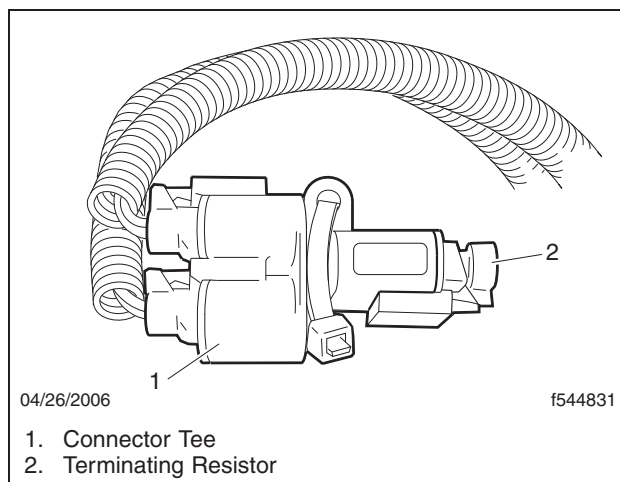


Fig. 9, Connector Tee

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Datalink Communication Structure

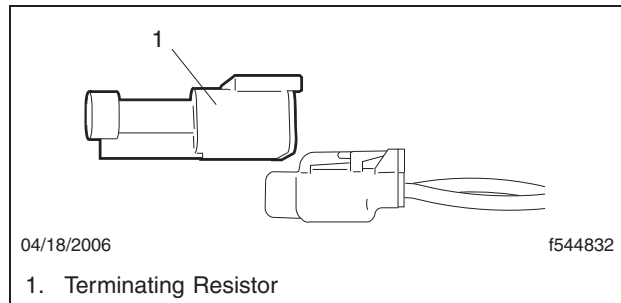


Fig. 10, Terminating Resistor

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

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

Datalink Communication Structure

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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

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Datalink Communication Structure

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

Central Gateway

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Central Gateway

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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 is an ECU (Electronic Control Unit), also called the "Central Gateway" (CGW) 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.

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Central Gateway

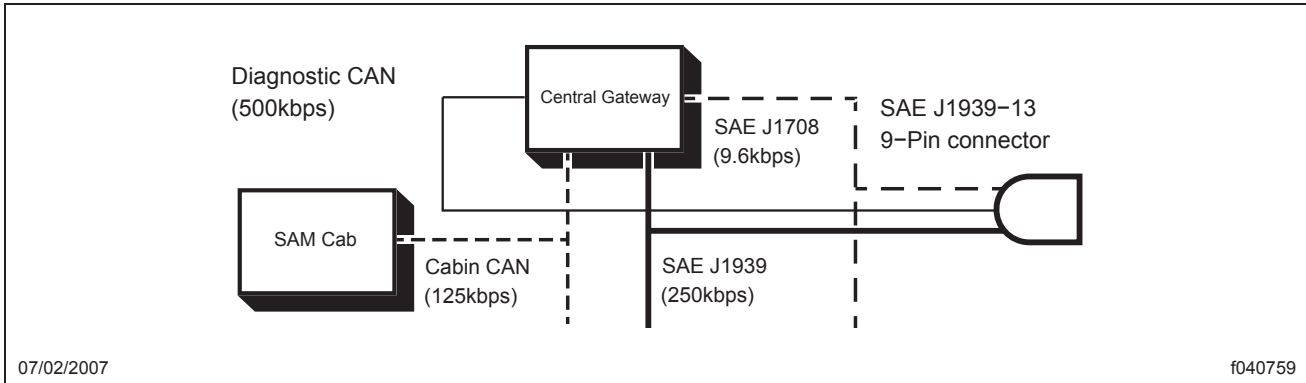


Fig. 1, Central Gateway, Diagnostic Connector, and Vehicle Datalinks

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.

The CGW receives battery power and ground from the SAM Cab; power comes through a 2A fuse (F20) on the SAM Cab.

502 — Routing and Translating Messages Between Datalinks

The primary function of the CGW is to connect the four datalinks on the vehicle, and to route and translate the datalink messages between them.

The J1939, J1708, Cabin CAN, and Diagnostic CAN datalinks have different characteristics, but they all work together to control the vehicle. The CGW acts as a translator between the communication protocols used on the various datalinks.

In some instances, the Cabin CAN ECUs need information from J1939 or J1708 ECUs. In these cases, information is sent by the J1939 or J1708 ECU. The CGW picks up the information and 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.

An example of Cabin CAN and J1939 interaction is the optional cruise control feature. The Engine ECU on the J1939 datalink broadcasts a message containing vehicle speed. The SAM Cab ECU on the Cabin CAN datalink uses the vehicle speed information to perform the cruise control feature. The vehicle speed message flows from the engine ECU to the SAM Cab as follows:

1. The engine ECU broadcasts the vehicle speed message on J1939.
2. The vehicle speed message is picked up by the CGW, from J1939 datalink.
3. The central gateway translates the vehicle speed message from J1939's communication protocol to the Cabin CAN communication protocol.
4. The central gateway routes the vehicle speed message to the Cabin CAN datalink.
5. The vehicle speed message is received by the SAM Cab ECU, and the information is used for cruise control logic.

Central Gateway

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

The CGW acts as the interface between ECUs on the Cabin CAN and the outside world. Unlike the J1708 and J1939 datalink, the Cabin CAN datalink does not have its own direct connection to the diagnostic connector. Instead, it is connected to the CGW, which in turn has a direct connection to the diagnostic connector via the Diagnostic CAN datalink.

The CGW separates the Cabin CAN from off-board tools and acts as a firewall, which protects Freightliner's proprietary Cabin CAN datalink from "public" access. This allows for better protection from electrical damage and better control of electrical capabilities, which leads to higher reliability for the ECUs.

504 — ECU Monitoring

The CGW monitors for any missing Cabin CAN ECUs. Each missing Cabin CAN ECU is described in a CAN fault code generated by the CGW.

The CGW monitors all messages on the Cabin CAN datalink to see if an ECU stops sending messages. If this happens, the CGW will report a fault code that a particular ECU is missing. The possible fault codes for missing ECUs are listed in **702 — Fault Codes**.

The ECU monitoring function stops when:

- under or over voltage is detected;
- the Cabin CAN stops communicating.

505 — ECU Configuration

The diagnostic protocol used for troubleshooting or configuring the Central Gateway is the Controller Area Network (CAN).

The Central Gateway does not have any parameters to configure.

The Central Gateway 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 CGW in the following cases:

- **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 software 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.
- **Replacement of the Central Gateway:** Flashing ensures that the most recent software is on the installed ECU.
- **As a last resort:** Troubleshooting has narrowed the problem down to being at the Central Gateway itself and no other mechanical or electrical causes for the symptom have been identified. As a last resort before swapping the ECU, flashing the CGW software with the same version may help in the case it became corrupt during the course of normal vehicle operation.

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.

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Central Gateway

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

507 — Datalink Network Topology

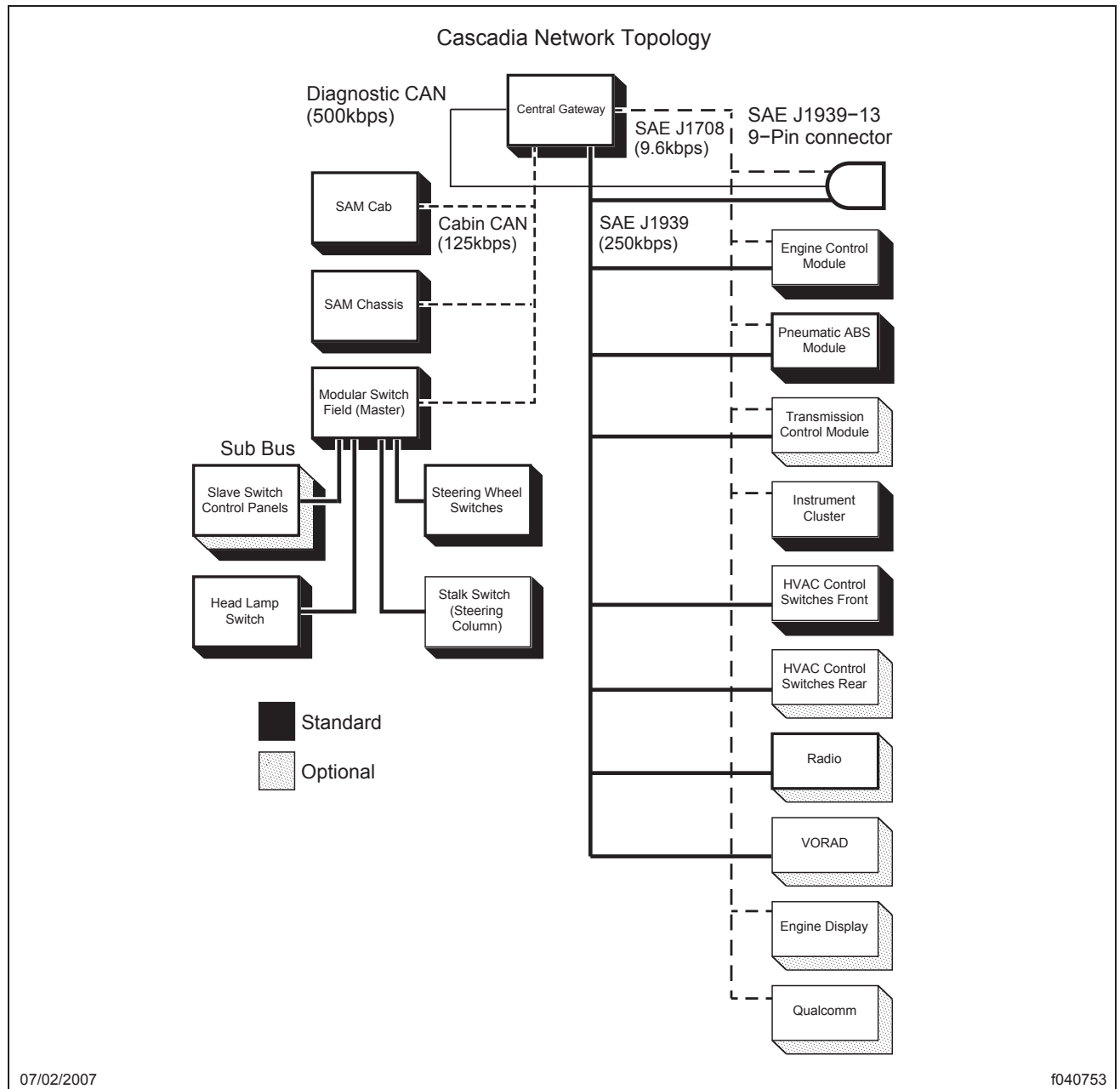


Fig. 2, Datalink Network Topology

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Central Gateway

600 — Component Locations

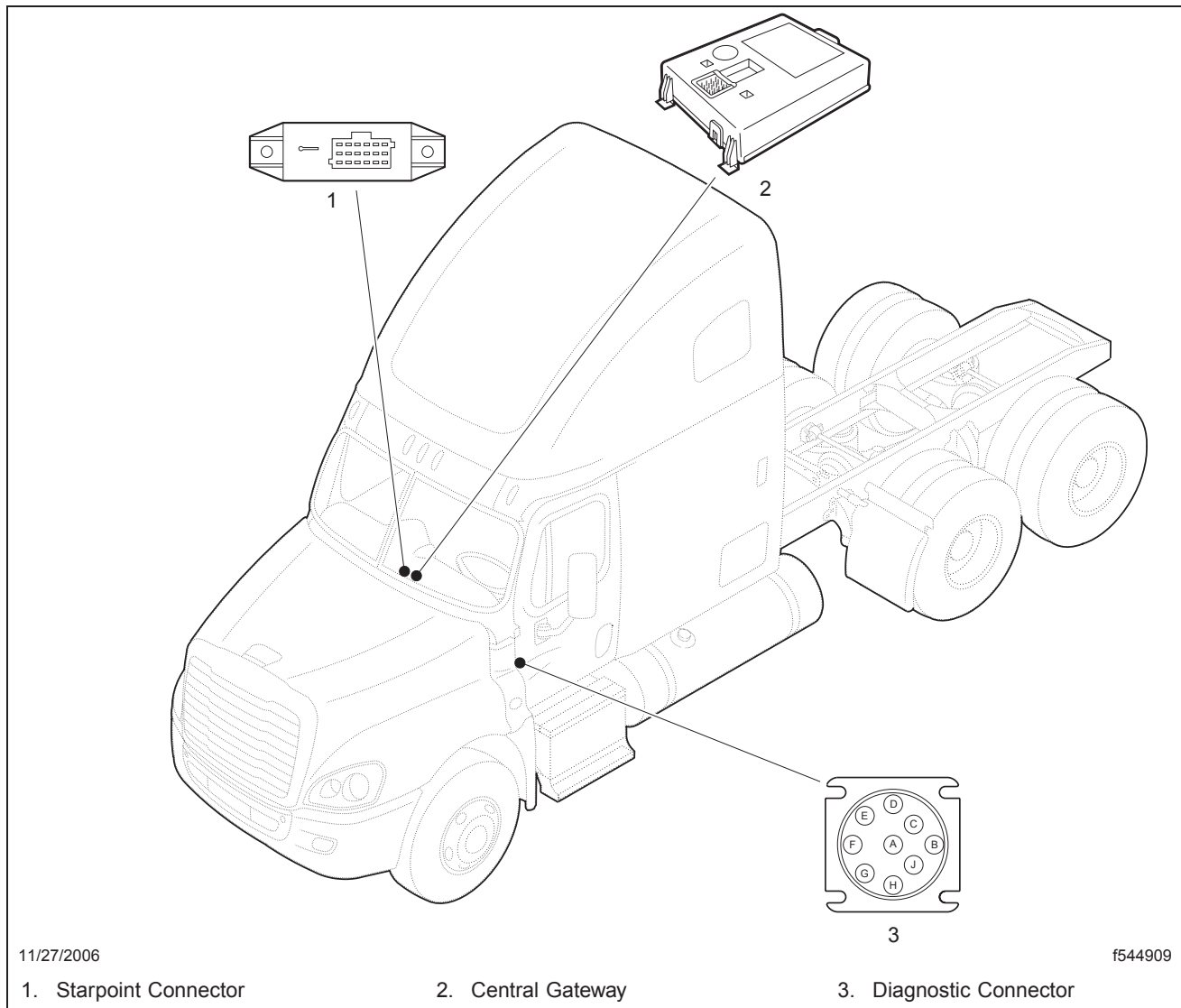


Fig. 3, Component Locations

601 — Component Details

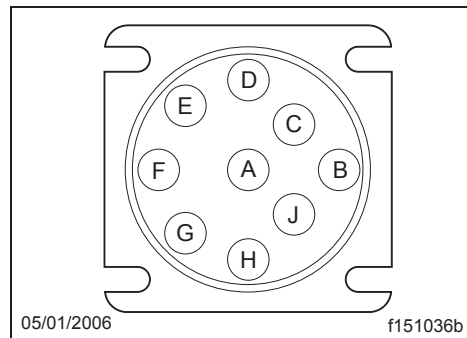


Fig. 4, Diagnostic Connector

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

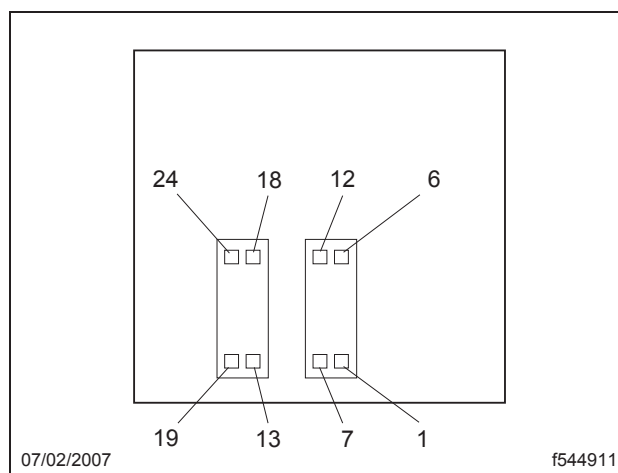


Fig. 5, Central Gateway Module, Cabin CAN Pins

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Central Gateway

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)

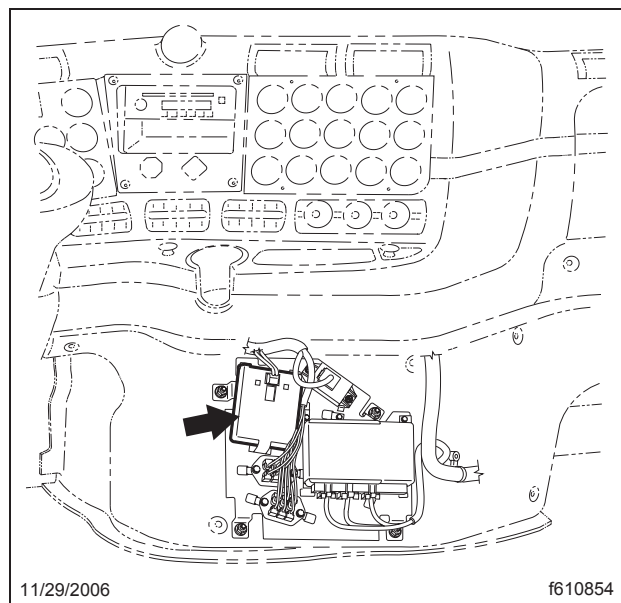


Fig. 6, Central Gateway

700 — Required Tools

- ServiceLink

701 — Possible Causes

- Fuse F20 (CGW power) on the SAM Cab
- Wiring

Central Gateway

G02.03

- Starpoint Connector (Cabin CAN)
- CGW
- J1939 Terminating Resistors
- J1587/J1708 Junction Block
- Diagnostic Connector
- Cabin CAN ECUs

702 — Fault Codes

Fault Codes				
SA	SPN	FMI	Fault Description	Fault Trigger
37	168	4	Battery Power—Voltage below normal or shorted to low	CGW battery power (pin 1) fell below the lower limit of the system voltage range: 9V.
37	168	3	Battery Power—Voltage above normal or shorted to high	CGW battery power (pin 1) exceeded the upper limit of the system voltage range: 16V.
37	628	12	Program Memory—Bad intelligent device or component	The memory in the CGW has a problem.
37	523510	31	Diagnostic CAN Performance	Cabin CAN performance failures (communication is not possible) occur when: • Diagnostic CAN High is shorted to GND • Diagnostic CAN Low is shorted to BAT • Diagnostic CAN Low is shorted to Diagnostic CAN High
37	523511	31	Cabin CAN Performance	Cabin CAN performance failures (communication is not possible) occur when: • Cabin CAN High is shorted to GND • Cabin CAN Low is shorted to BAT • Cabin CAN Low is shorted to Cabin CAN High
37	523512	31	J1939 CAN Performance	J1939 CAN performance failures (communication is not possible) occur when: • J1939 CAN High is shorted to GND • J1939 CAN Low is shorted to BAT • J1939 CAN Low is shorted to J1939 CAN High
37	523513	31	J1708 Performance	J1708 performance errors occur when: • The busload (i.e. amount of data traffic) on J1708 is too high. • The CAN datalinks (Cabin CAN, Diagnostic CAN, J1939 CAN) have extremely high busload.*

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Central Gateway

Fault Codes				
SA	SPN	FMI	Fault Description	Fault Trigger
37	524033	31	Lost communication with SAM_CAB	Trigger: The fault is triggered when the CGW does not see any messages from the SAM Cab for at least 20 seconds. The fault becomes historic as soon as the CGW sees messages from the SAM Cab. Vehicle Behavior: The 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. Possible Causes: The SAM Cab is not connected to the Cabin CAN datalink, or does not have power. Action: Check wiring from the Cabin CAN to the SAM Cab, and the CGW. Check the SAM Cab power supply cables.
37	524049	31	Lost communication with MSF	Trigger: The fault is triggered when the CGW does not see any messages from the MSF for at least 20 seconds. The fault becomes historic as soon as the CGW sees 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 CGW. Check MSF power supply.
37	524071	31	Lost communication with SAM_CHAS	Trigger: The fault is triggered when the CGW does not see any messages from the SAM Chassis for at least 20 seconds. The fault becomes historic as soon as the CGW sees 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. Possible Causes: The SAM Chassis is not connected to the Cabin CAN datalink, or does not have power. Action: Check wiring from the Cabin CAN to the SAM Chassis, and the CGW. Check the SAM Chassis power supply cables.

* High bus load on a datalink may be caused by a faulty ECU, which broadcasts erroneous data, clogging up communication on the datalink.

Table 3, Fault Codes

SAM Cab

G02.04

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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

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 identifies 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 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

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.

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SAM Cab

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 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 configuring 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 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 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, flashing 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 fix 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 flash 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

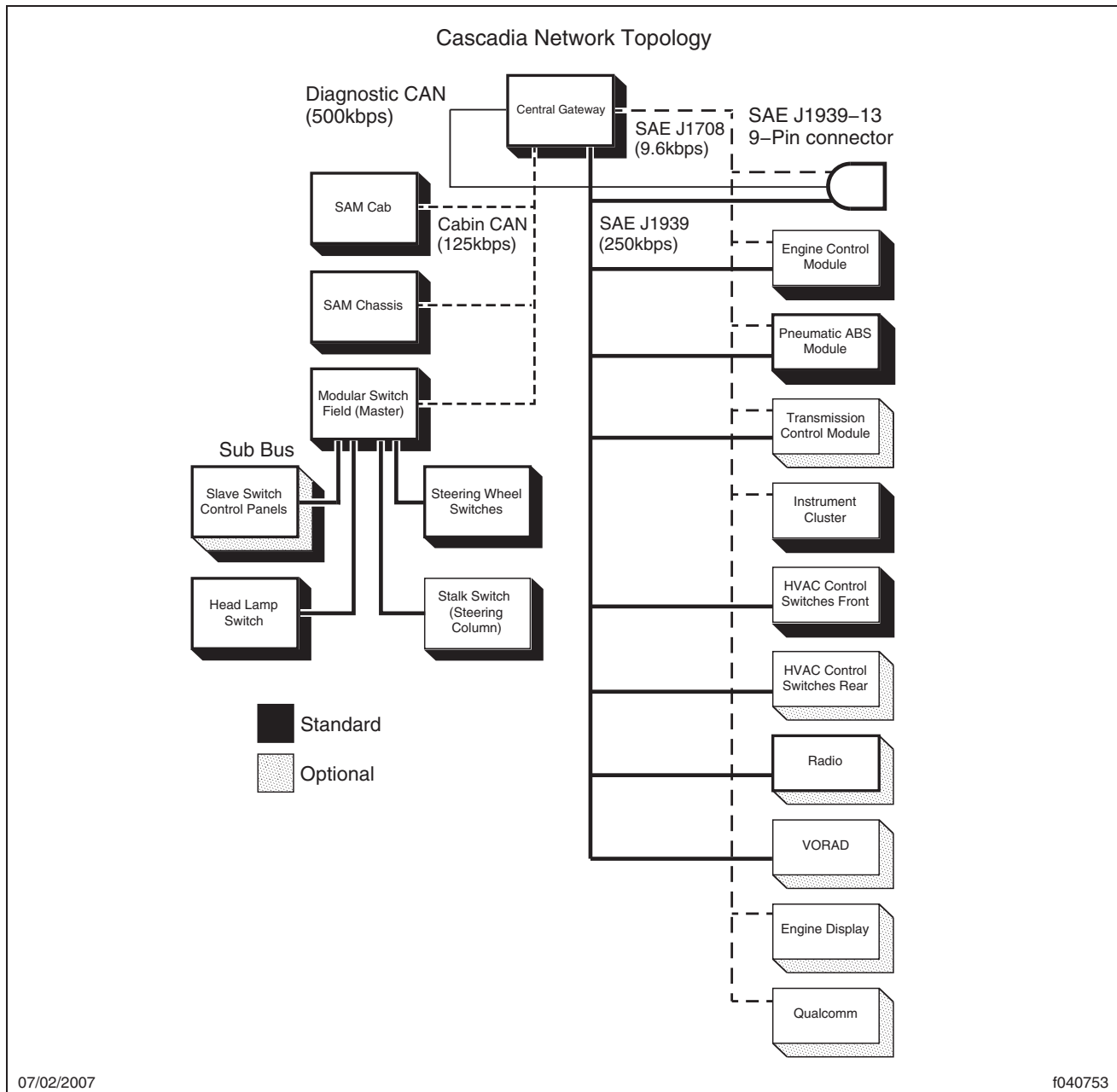


Fig. 1, Datalink Network Topology

600 — Component Locations

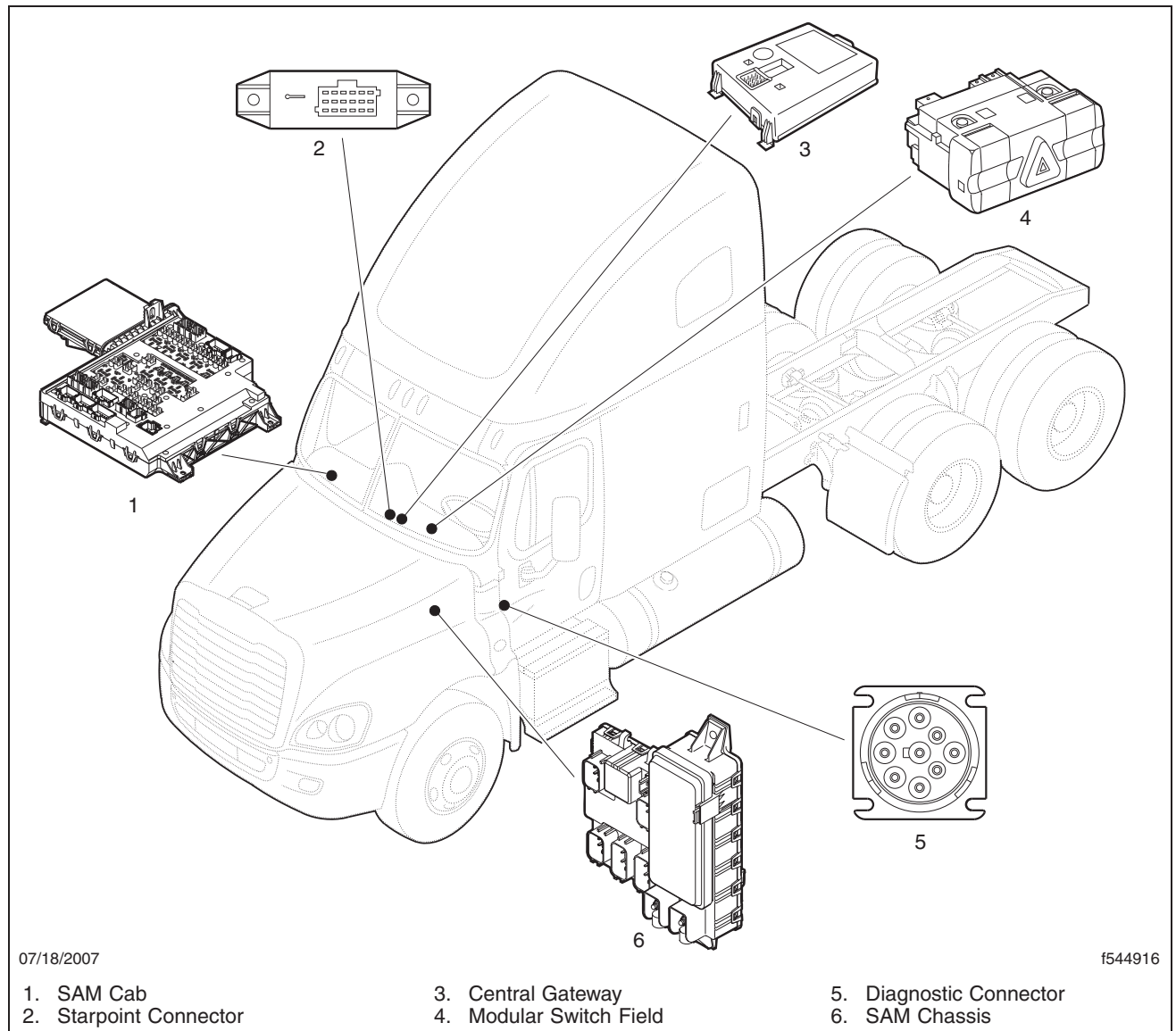


Fig. 2, Component Locations

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

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SAM Cab

601 — Component Details

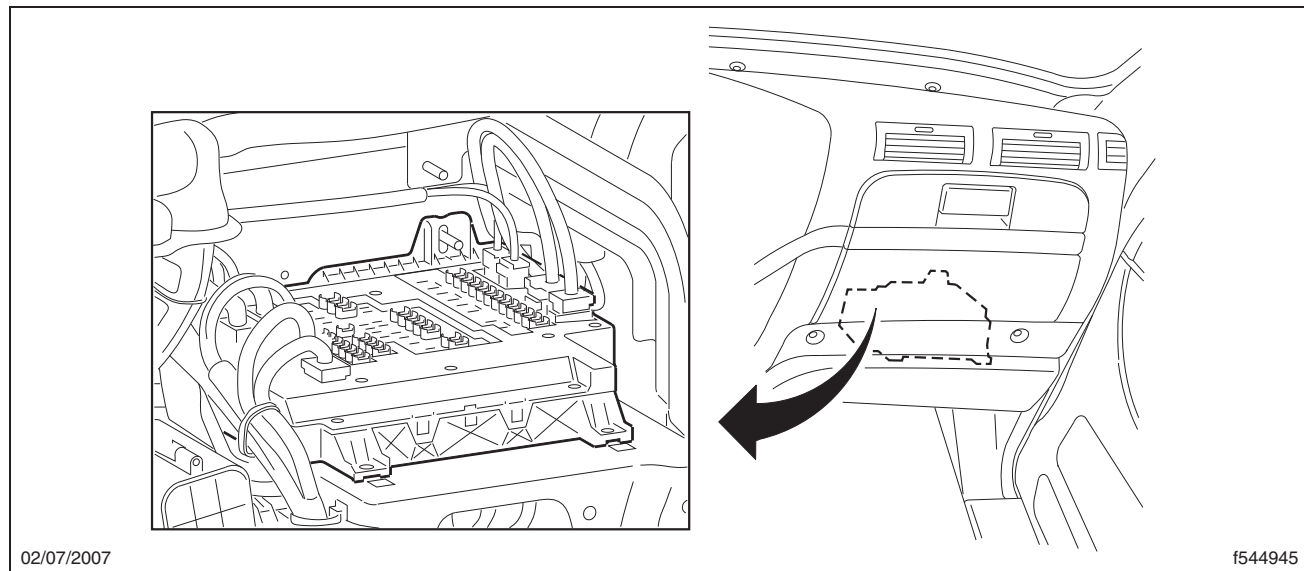


Fig. 3, SAM Cab

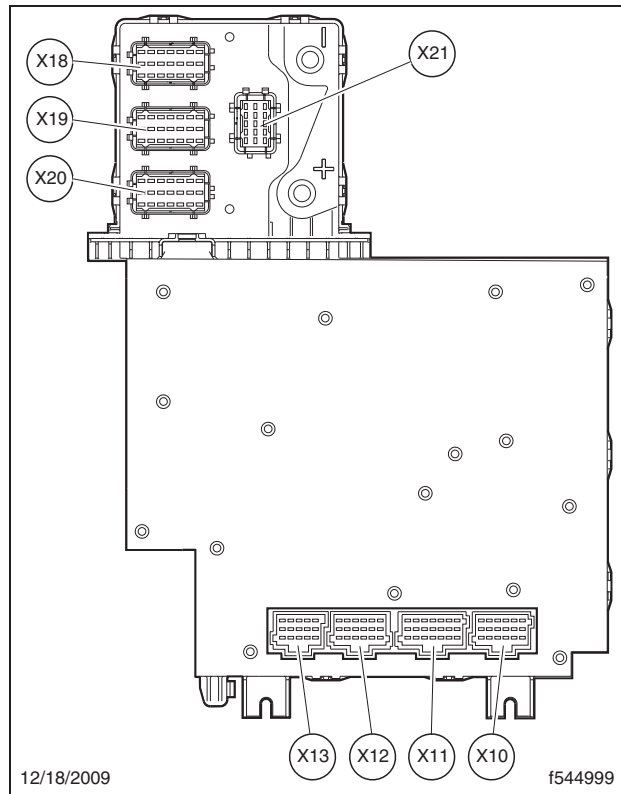


Fig. 4, SAM Cab Connectors (top view)

G02.04

SAM Cab

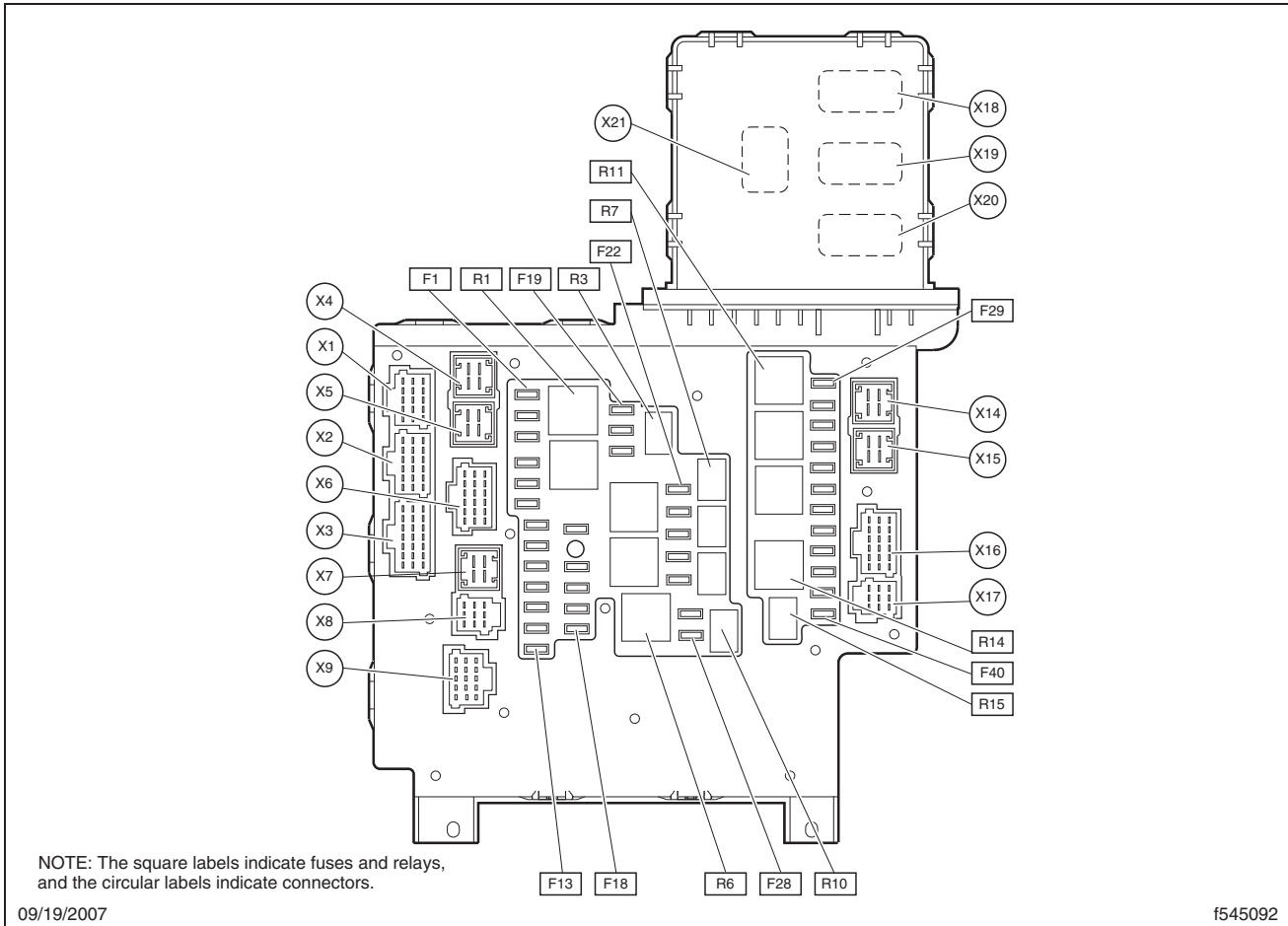


Fig. 5, SAM Cab Fuses and Relays (bottom view)

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.

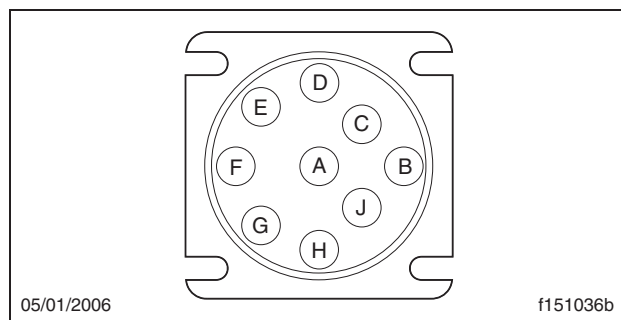


Fig. 6, Diagnostic Connector

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	—

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SAM Cab

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	—

SAM Cab

G02.04

Pinout Mapping				
Connector	Cavity Number	Function		
		Highline	Baseline	Midline
X3	8	Not Connected	Not Connected	—
X3	9	Amplifier 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	Amplifier 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	—

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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	—

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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	—

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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	—

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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	—

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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	—

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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	—

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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	—

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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

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SAM Cab

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	Amplifier 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

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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

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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

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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	Amplifier 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

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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 specific 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 configure 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

SAM Cab

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703 — Fault Codes

CAN Fault, SAM Cab				
SA	SPN	FMI	Fault Description	Fault Trigger
33	168	3	Electrical potential (voltage) – voltage above normal or shorted to high.	Trigger: SAM Cab battery voltage sensed to be above normal, or shorted to high. Action: Check power feed wiring to the SAM Cab, and alternator charging wiring.
33	168	4	Electrical potential (voltage) – voltage below normal or shorted to low.	Trigger: SAM Cabin battery voltage sensed to be below normal, or shorted to low. Action: Check power feed wiring to the SAM Cab, and alternator charging wiring.
33	520901	4	Door open driver side, pull down – voltage below normal, or shorted to low source.	Trigger: Driver side door open, pull down pin detected to be shorted to ground, or low source. Action: Check the wiring harness.
33	521109	2	Inside temperature sensor, feedback – data erratic, intermittent, or incorrect.	Trigger: A problem is detected with the inside temperature sensor feedback pin. Vehicle Behavior: Data is erratic, intermittent, or incorrect. Action: Check the wiring harness, especially for loose connections. Check the inside temperature sensor feedback pin.
33	521109	3	Inside temperature sensor feedback – voltage above normal, or shorted to high source.	Trigger: The inside temperature sensor feedback pin is shorted to battery, or high source. Vehicle Behavior: The displayed inside temperature is incorrect. Possible Cause: The feed cable to the inside temperature sensor feedback is shorted to battery. Or, the inside temperature sensor is out of order and shortens to battery. Action: Check the wiring to the inside temperature sensor feedback. Check the inside temperature sensor.
33	521109	4	Inside temperature sensor, feedback – voltage below normal, or shorted to low source.	Trigger: The inside temperature sensor feedback pin is shorted to ground, or low source. Vehicle Behavior: The displayed inside temperature is incorrect. Possible Cause: The feed cable to the inside temperature sensor feedback is shorted to ground. Or, the inside temperature sensor is out of order and shortens pin to ground. Action: Check the wiring to the inside temperature sensor feedback. Check the sensor inside temperature sensor.
33	521217	2	Clutch – data erratic, intermittent, or incorrect.	Trigger: A problem is detected with the clutch. Possible Cause: The switches 'Bottom of clutch (starter control)' and 'Top of clutch (cruise control disable)' are detected to be pressed at the same time. Or, the feed cable to 'Bottom of Clutch' and/or feed cable to 'Top of Clutch' has a short circuit. Action: Check the feed cables to 'Bottom of Clutch switch (starter control), and 'Top of Clutch switch (cruise control disable), and check clutch wiring.

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CAN Fault, SAM Cab				
SA	SPN	FMI	Fault Description	Fault Trigger
33	521402	3	CAN low – voltage above normal, or shorted to high source.	Trigger: The Cabin CAN Low (–) pin of SAM Cab 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 Cabin CAN harness, especially in connection to the SAM Cab. Verify proper connection of the Cabin CAN harness to the SAM Cab.
33	521402	4	CAN low – voltage below normal, or shorted to low source.	Trigger: The Cabin CAN Low (–) pin of SAM Cab is shorted to ground, or low 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 Cabin CAN harness, especially in connection to the SAM Cab. Verify proper connection of the Cabin CAN harness to the SAM Cab.
33	521403	3	CAN high – voltage above normal, or shorted to high source.	Trigger: The Cabin CAN High (+)pin of SAM Cab 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 Cabin CAN harness, especially in connection to the SAM Cab. Verify proper connection of the Cabin CAN harness to the SAM Cab.
33	521403	4	CAN high – voltage below normal, or shorted to low source.	Trigger: The Cabin CAN High (+)pin of SAM Cab is shorted to ground, or low 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 Cabin CAN harness, especially in connection to the SAM Cab. Verify proper connection of the Cabin CAN harness to the SAM Cab.
33	521805	4	Door open, passenger side, pull down – voltage below normal, or shorted to low source.	Trigger: Door open, passenger side. Pull-down pin detected to be shorted to ground, or low source. Action: Check the wiring harness.
33	521918	4	DRL – voltage below normal, or shorted to low source.	Trigger: DRL pins (for separate DRL lamps only) are detected to be shorted to ground, or low source. One or more of the DRL lamps are off. Action: Check the wiring harness.

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CAN Fault, SAM Cab				
SA	SPN	FMI	Fault Description	Fault Trigger
33	522003	4	Starter relay 3 – current above normal or grounded circuit.	Trigger: Starter relay 3 pin detected to have above normal current, or shorted to ground. Vehicle Behavior: The vehicle can no longer be started. Possible Cause: A wiring harness problem. Action: Check the starter relay circuit wiring.
33	523511	31	Cabin CAN Bus Performance – condition exists.	Trigger: A problem is detected with Cabin CAN performance. Vehicle Behavior: 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.
33	523541	2	Marker interrupt switch – data erratic, intermittent, or incorrect.	Trigger: A problem is detected with the marker interrupt switch, and may be detected to be pressed for longer than 30 seconds. Vehicle Behavior: The marker interrupt function is not working properly. Action: Check the steering wheel switch unit, and the MSF.
33	523550	7	Park position switch – mechanical system is not responding, or is out of adjustment	Trigger: A problem is detected with the wiper park position switch, causing the wiper to stop. Possible Cause: The wiring harness, a blocked or defective wiper, or the wiper switch is not working.
33	524037	31	Lost communication with CGW	Trigger: The SAM Cab did not receive heartbeat messages from the CGW. Possible Cause: A bad connection between the Cabin CAN datalink and the CGW, or a blown CGW power supply fuse on the SAM Cab. Action: Check the wiring harness, especially the Cabin CAN connection to CGW, and the CGW power supply.

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CAN Fault, SAM Cab				
SA	SPN	FMI	Fault Description	Fault Trigger
33	524049	31	Lost communication with MSF	Trigger: The SAM Cab 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. Possible Cause: A Cabin CAN datalink connection problem to MSF, or the MSF power supply fuse on SAM Cab is blown. Action: Check the wiring harness, especially the Cabin CAN connection to the MSF, and the MSF power supply.
33	524071	31	Lost communication with the SAM Chassis	Trigger: The SAM Cab did not receive heartbeat 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 the ICU turn signal indicators flash alternately. Possible Cause: The Cabin CAN datalink connection to the SAM Chassis, or the power supply to the SAM Chassis. Action: Check the Cabin CAN wiring harness, especially the Cabin CAN connection to the SAM Chassis. Check the SAM Chassis power supply.

Table 5, CAN Fault, SAM Cab

SAM Cab

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704 — Grounded Pins and Inputs

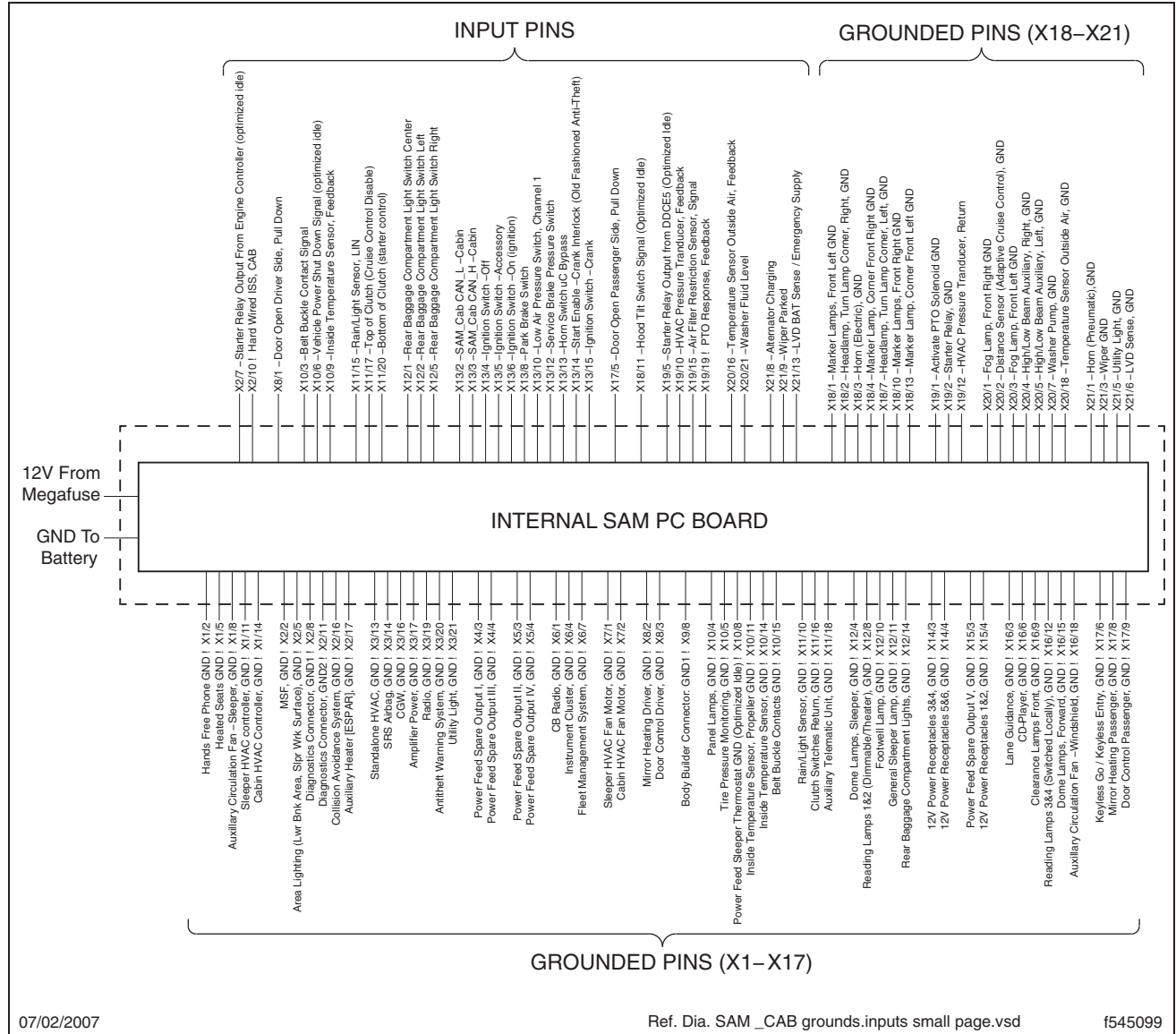
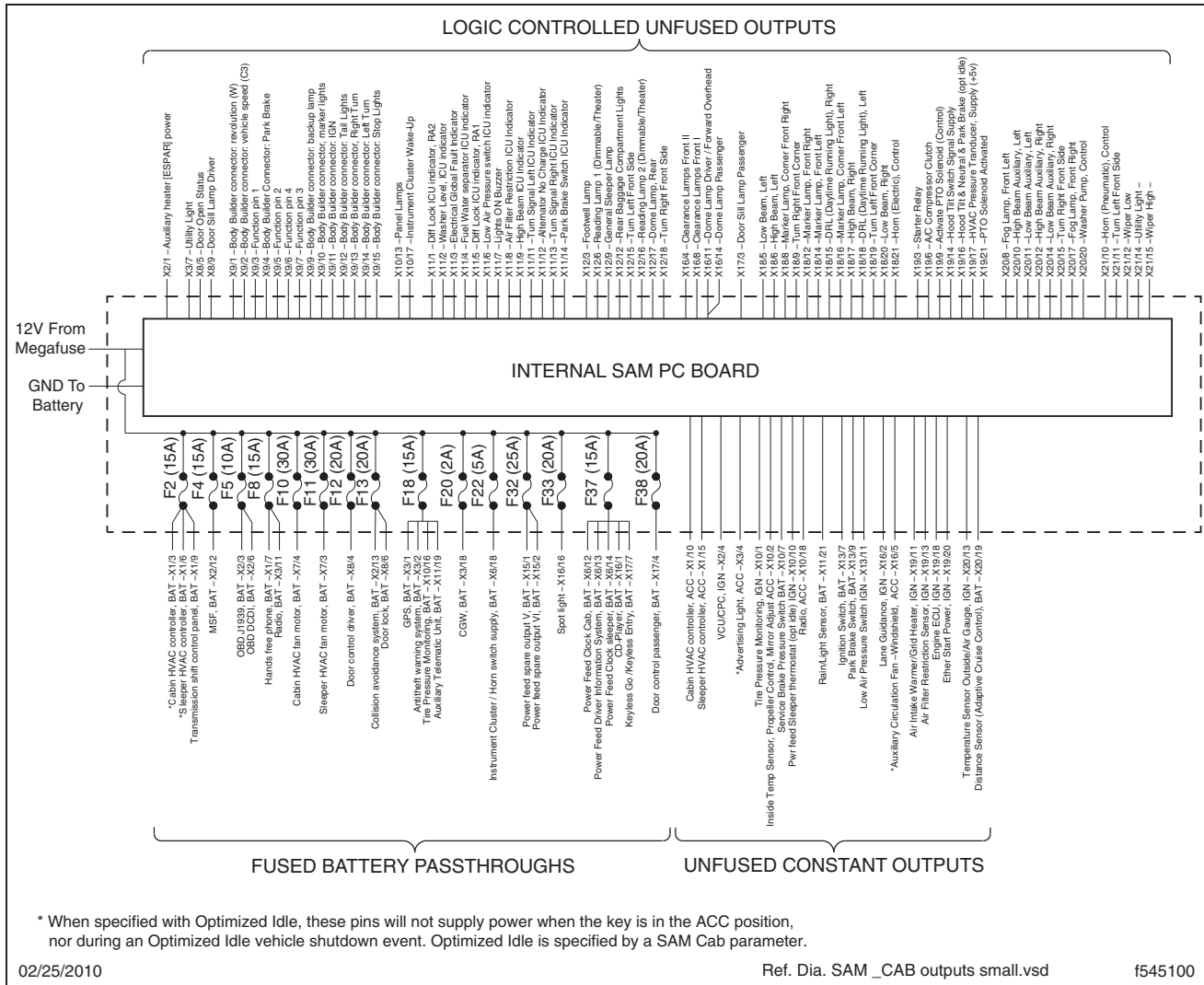


Fig. 7, Grounded Pins and Inputs

705 — Fused and FET Controlled Outputs



* When specified with Optimized Idle, these pins will not supply power when the key is in the ACC position, nor during an Optimized Idle vehicle shutdown event. Optimized Idle is specified by a SAM Cab parameter.

02/25/2010

Ref. Dia. SAM_CAB outputs small.vsd

f545100

Fig. 8, Fused and FET Controlled Outputs

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706 — Relayed Outputs

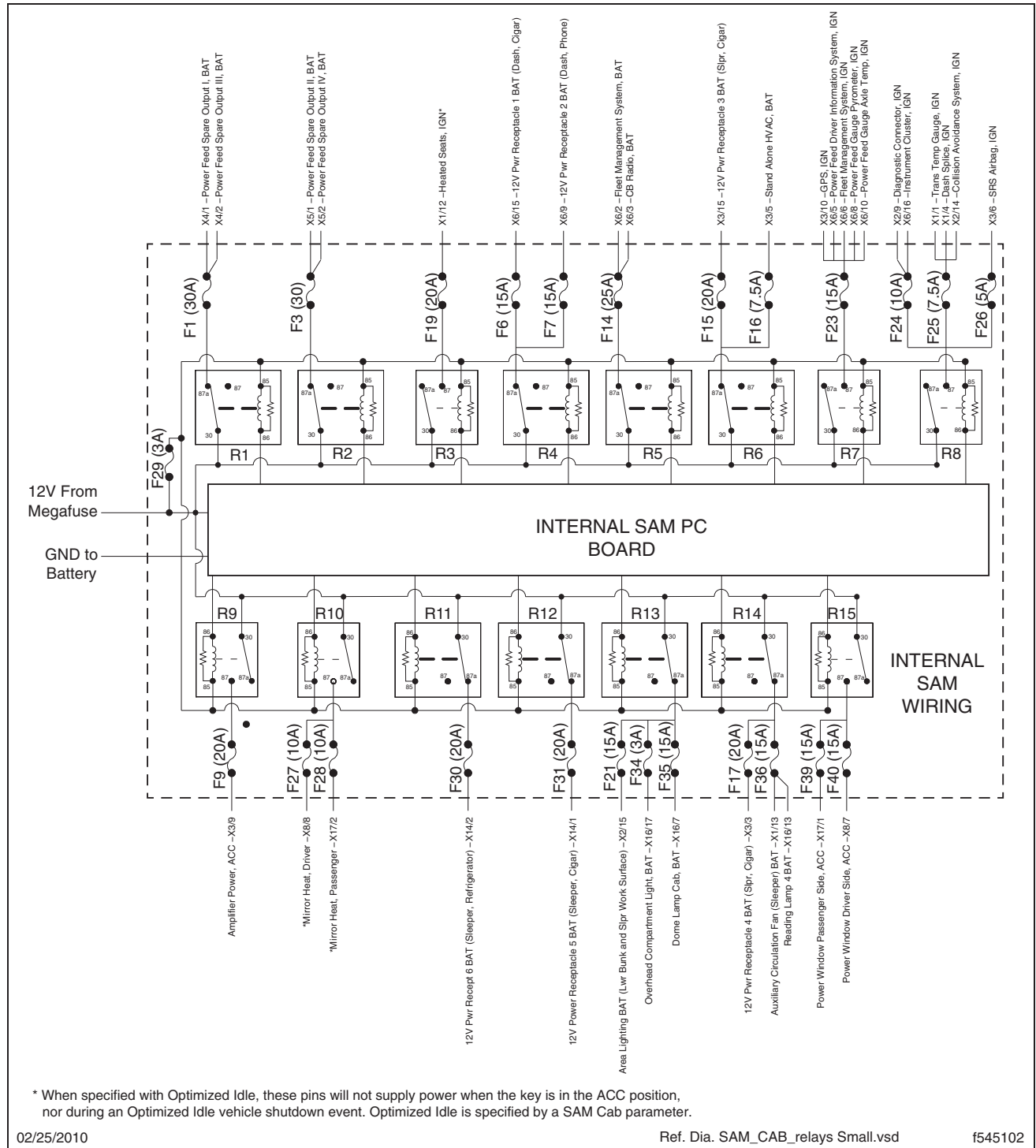


Fig. 9, Relayed Outputs

707 — Logic Controlled Unfused Outputs

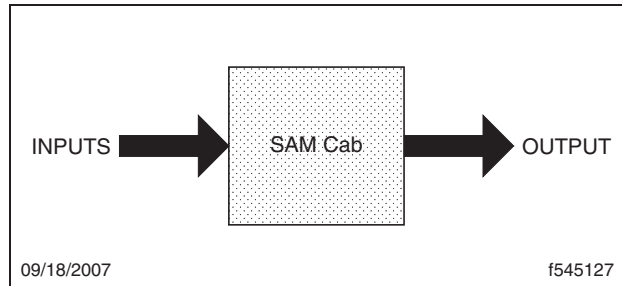


Fig. 10, SAM Unfused Inputs and Outputs

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 specific 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 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 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.

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- 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 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 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 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 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

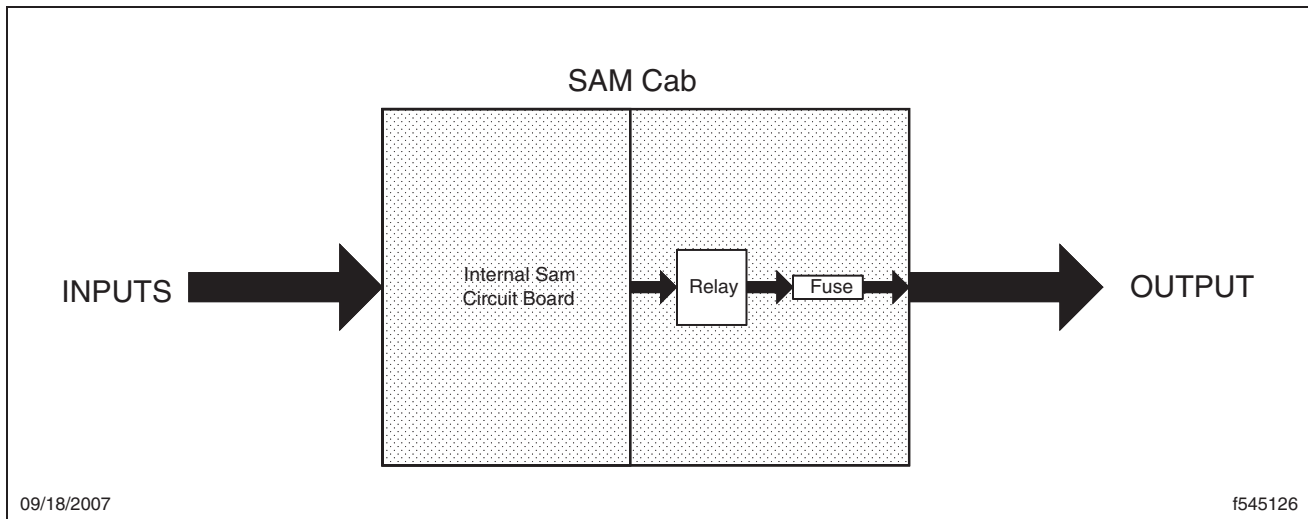


Fig. 11, SAM Fused Inputs and Outputs

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.

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- 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 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. 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.

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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

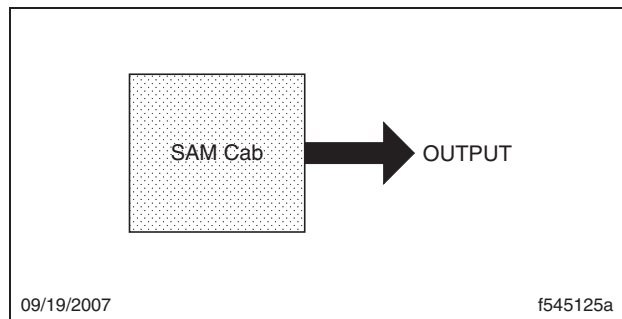


Fig. 12, SAM Unfused Constant Outputs

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

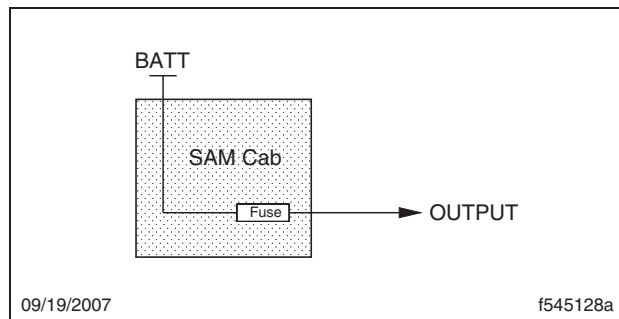


Fig. 13, Fused Battery Pass-Through Outputs

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.

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- **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	Amplifier Power, Accessory	o	20	27	20
X3	10	GPS (Global Positioning System), Ignition	o	1.07	1.4445	15

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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

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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

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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 (dimable/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 (dimable/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

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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 I	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

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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

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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

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SAM Chassis

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**.

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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.

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507 — Datalink Network Topology

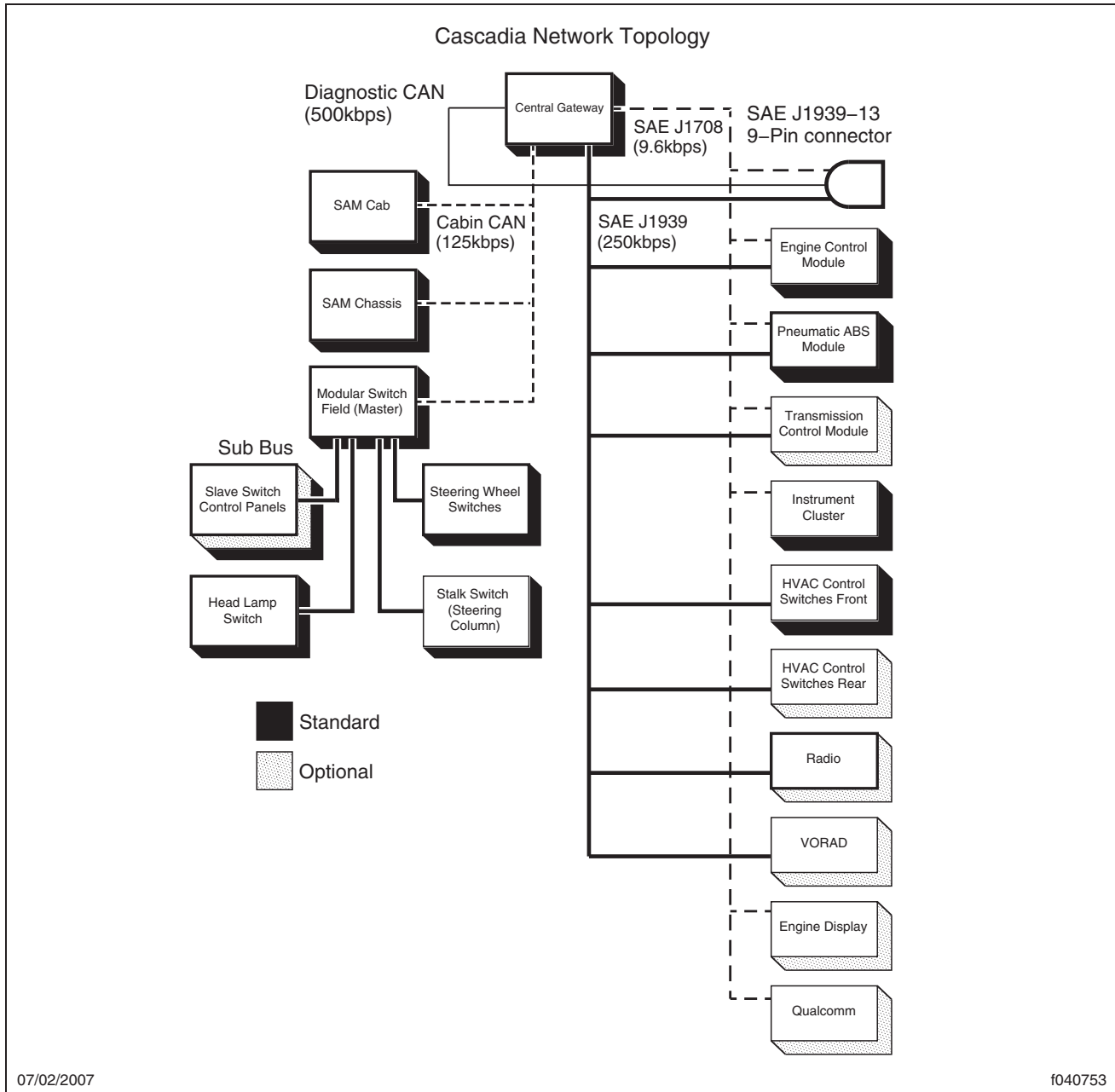


Fig. 1, Datalink Network Topology

600 — Component Locations

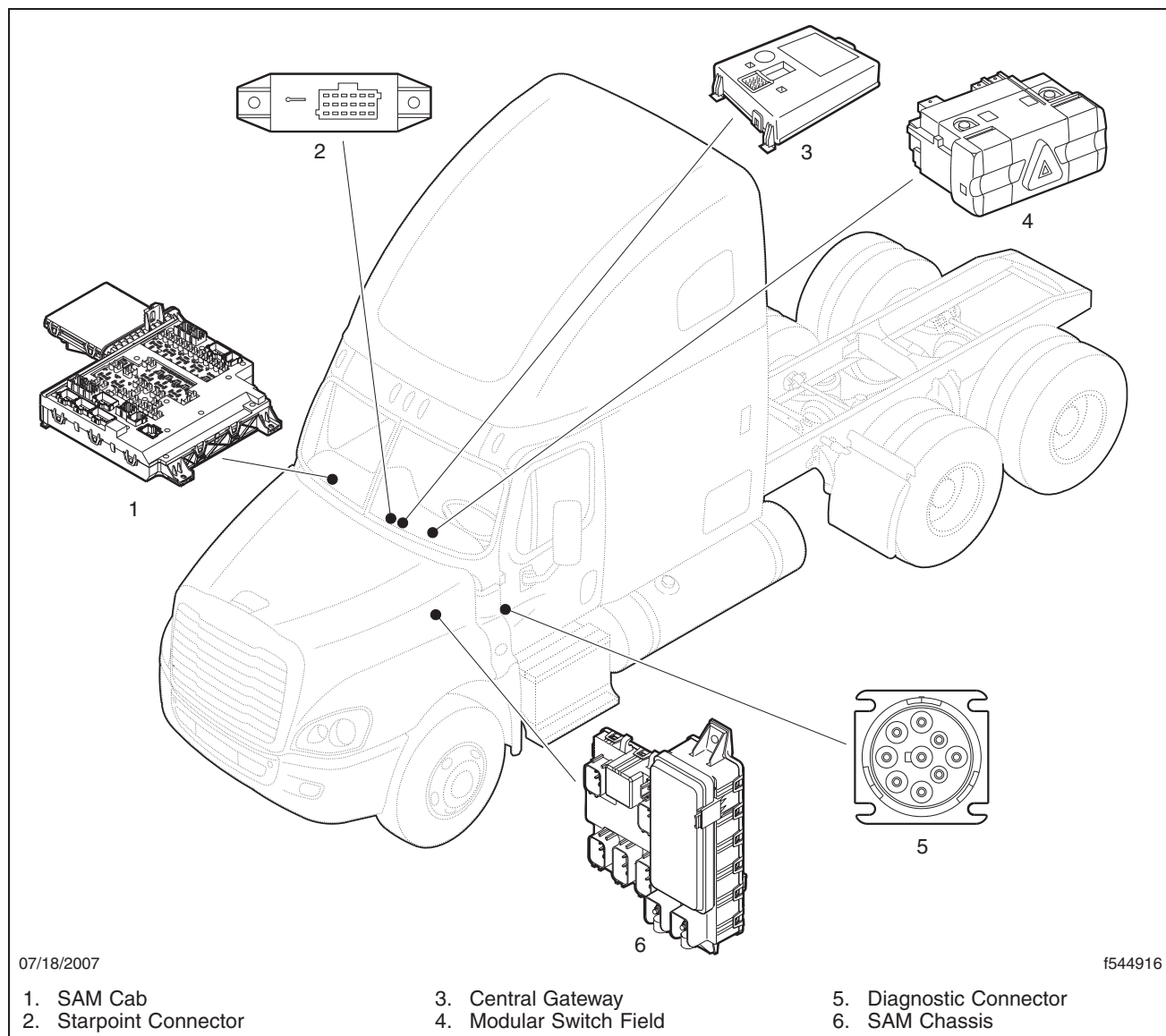


Fig. 2, Component Locations

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601 — Component Details

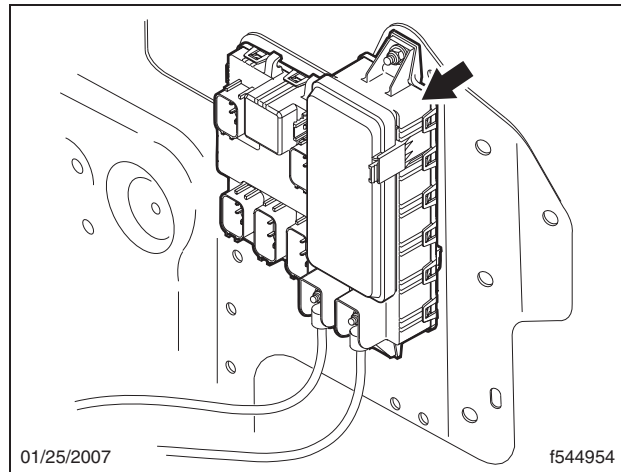


Fig. 3, View of the SAM Chassis on the Frontwall

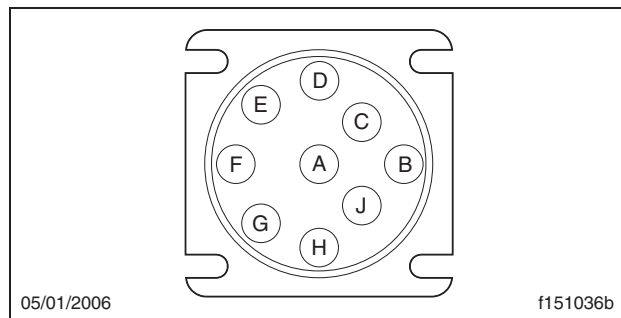


Fig. 4, Diagnostic Connector

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

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602 — Pinout Mapping

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

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

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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

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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)

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SAM Chassis

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

SAM Chassis

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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

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SAM Chassis

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
						X53		3	Rear View Camera
						F7	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

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- 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.

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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

SAM Chassis

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704 — Fused and Relayed Outputs

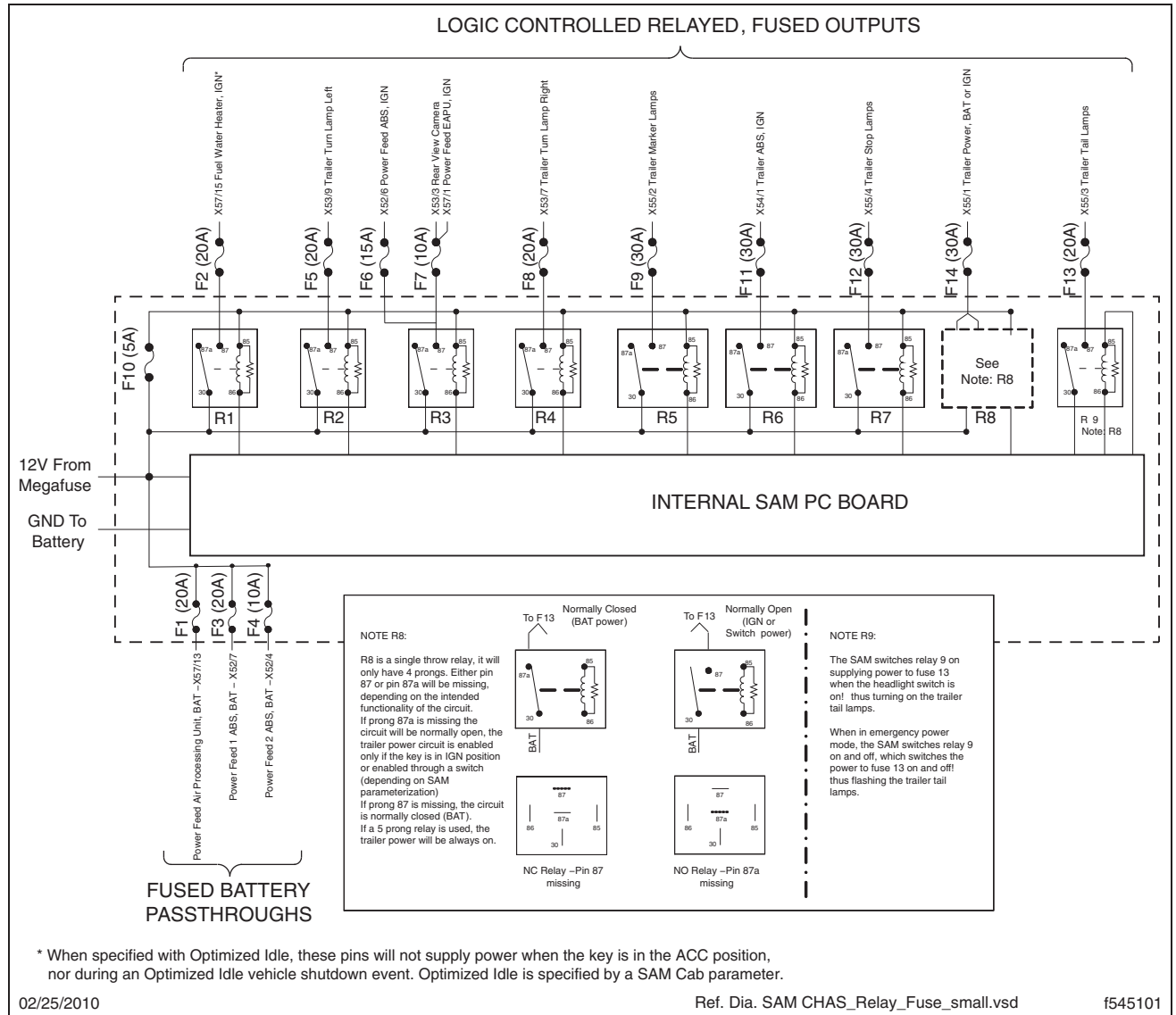


Fig. 5, Fused and Relayed Outputs

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SAM Chassis

705 — Unfused Outputs, Grounded Pins, and Inputs

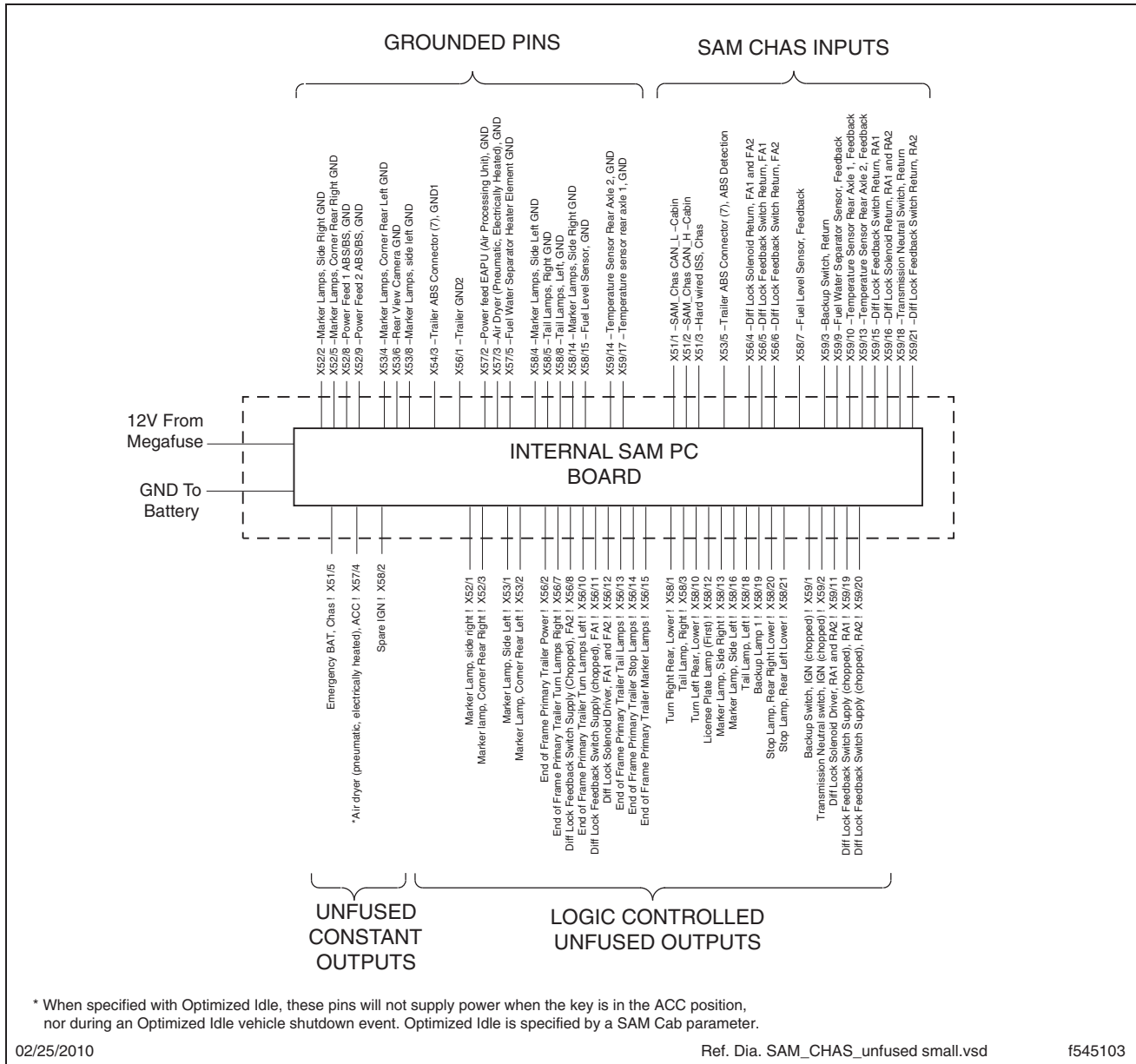


Fig. 6, Unfused Outputs, Grounded Pins, and Inputs

706 — Logic Controlled Unfused Outputs

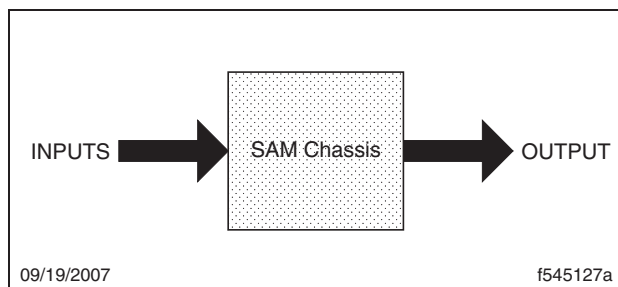


Fig. 7, SAM Unfused Inputs and Outputs

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.

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- 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

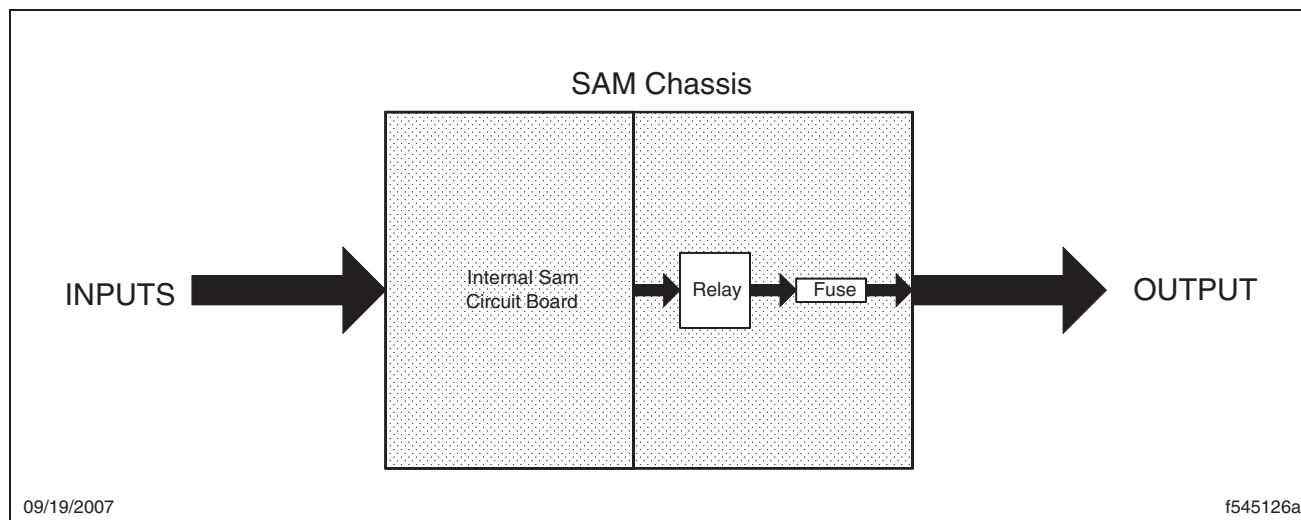


Fig. 8, SAM Fused Inputs and Outputs

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.

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SAM Chassis

- 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 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 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.

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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

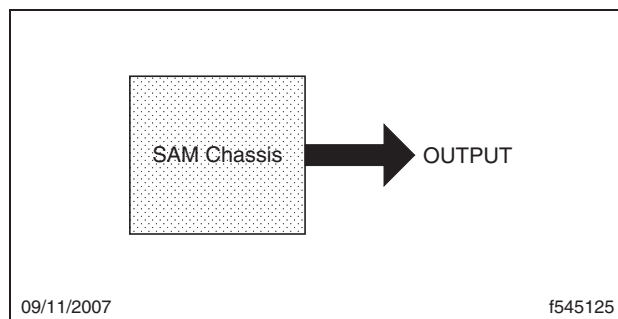


Fig. 9, SAM Unfused Constant Outputs

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.

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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

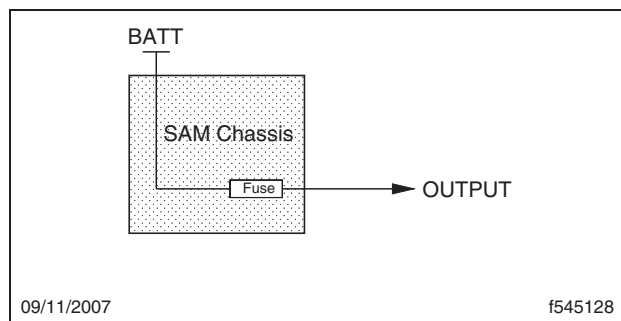


Fig. 10, Fused Battery Pass-Through Outputs

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.

Modular Switch Field

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Modular Switch Field

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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.

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) includes an MSF Master ECU, MSF slave panels, and various connected switches.

NOTE: This subject describes general operation and troubleshooting for switches in the modular switch field. To troubleshoot a specific switch's function, refer to the applicable troubleshooting subject.

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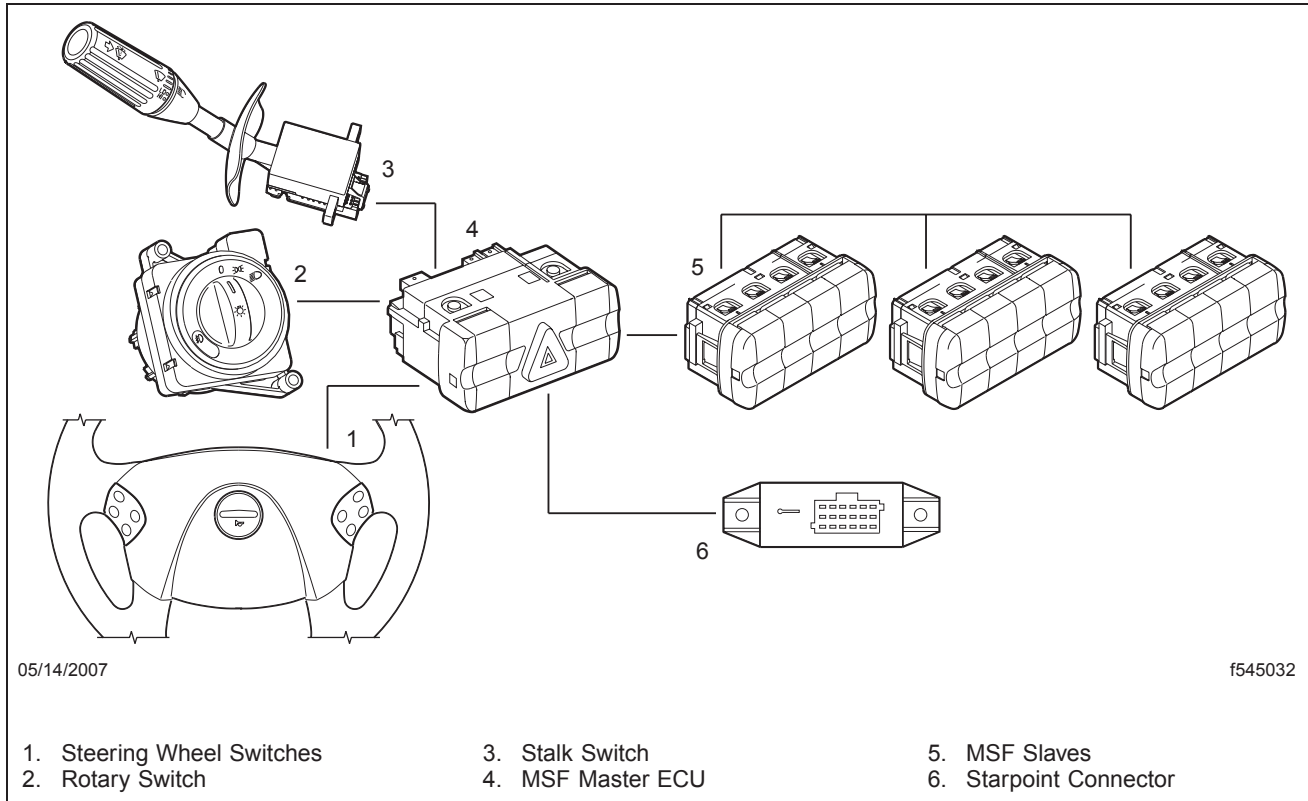


Fig. 1, Modular Switch Field

NOTE: The Starpoint Connector is not a part of the switch field, but 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 is also referred to as the "Master Control Module" or "Master Control Panel (MCP)."

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 houses the hazard switch. It also has housing for two "sub bus switches."

The MSF Master receives battery power and ground from the SAM Cab; power comes through a 15A fuse (F4) on the SAM Cab.

503 — MSF Switches

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

- Sub Bus Switches:
 - signal only (multiplexed)
 - hardwired (load-interrupting)

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- Other MSF Switches:
 - hazard switch
 - rotary switch (headlamps)
 - stalk switch
 - steering wheel switches

ECU parameters on 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**.

NOTE: The diagnostics, troubleshooting, and configuration in this subject apply only to switches that are a part of the modular switch field. Some switches in the vehicle are not part of the MSF, such as door switches, switches for mirror direction, ABS check, and possibly other aftermarket switches.

504 — Sub Bus Switches

MSF Slaves physically connect switches to the MSF Master via a three-wire proprietary "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 directly access this sub bus, but can troubleshoot the sub bus pins on the MSF Master and its connected sub bus switches via the MSF Master.

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.

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)

A list of sub bus switches currently connected to the vehicle, as well as the position of any signal switch, is viewable on the "Switches" screen, under the MSF icon on ServiceLink.

Hardwired switches do not have their position status (up, down, middle) available on the sub bus. They must be physically viewed to know their current position. This is because the MSF Master monitors the sub bus for a hardwired switch presence only; it does not monitor the switch position of a hardwired switch due to the way the hardwired switches are designed.

Differences between signal and hardwired switches are:

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- **Connection to external circuits:** hardwired switches are physically connected to the loads for which they are an input, as well as to the sub bus. Signal switches are physically connected to the sub bus only (not to any external circuits).
- **Position information:** signal switches have their position status (up, down, not pressed) viewable in ServiceLink on the MSF icon "Switches" screen. Hardwired switches do not, and must be looked at to know their position status.

Refer to **704 — 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:

- hazard switch
- rotary switch (headlamps)
- stalk switch
- steering wheel switches

All of these switches are physically connected to the MSF Master via wiring, not via the sub bus. An exception is the hazard switch, which is built directly into the MSF Master housing. For troubleshooting information about a switch's specific function, refer to that function's subject in this manual.

Rotary Switch: The rotary switch is also referred to as the "headlamp switch." The rotary switch is the input for marker, clearance, tail, and license plate lamps, and low- and high-beam headlamps. Depending on vehicle options, it may also be the input for fog lamps.

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 horizontal 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.

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 two signal wires, S1 and S2. These are resistive ladder logic inputs for the above functions, however they cannot be measured externally by a voltmeter due to diodes in the steering wheel switch circuitry. 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.

506 — MSF Slaves

The MSF slaves are simple housings for up to four switches. These connect to the wiring of the proprietary sub bus. The sub bus connects each switch to the MSF Master. MSF Slaves are sometimes also referred to as "Slave Control Panels" (SCP) or as "slaves."

There can be up to 9 slaves installed on a vehicle.

These slave housings can be connected to the MSF Master using the sub bus wiring by either of the following connection methods:

- Daisy chain.
- Direct connection to the MSF Master. The MSF Master has connections for up to six connection's slaves.

Both connection methods may be used at the same time. The maximum length of the sub bus is 40 meters.

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

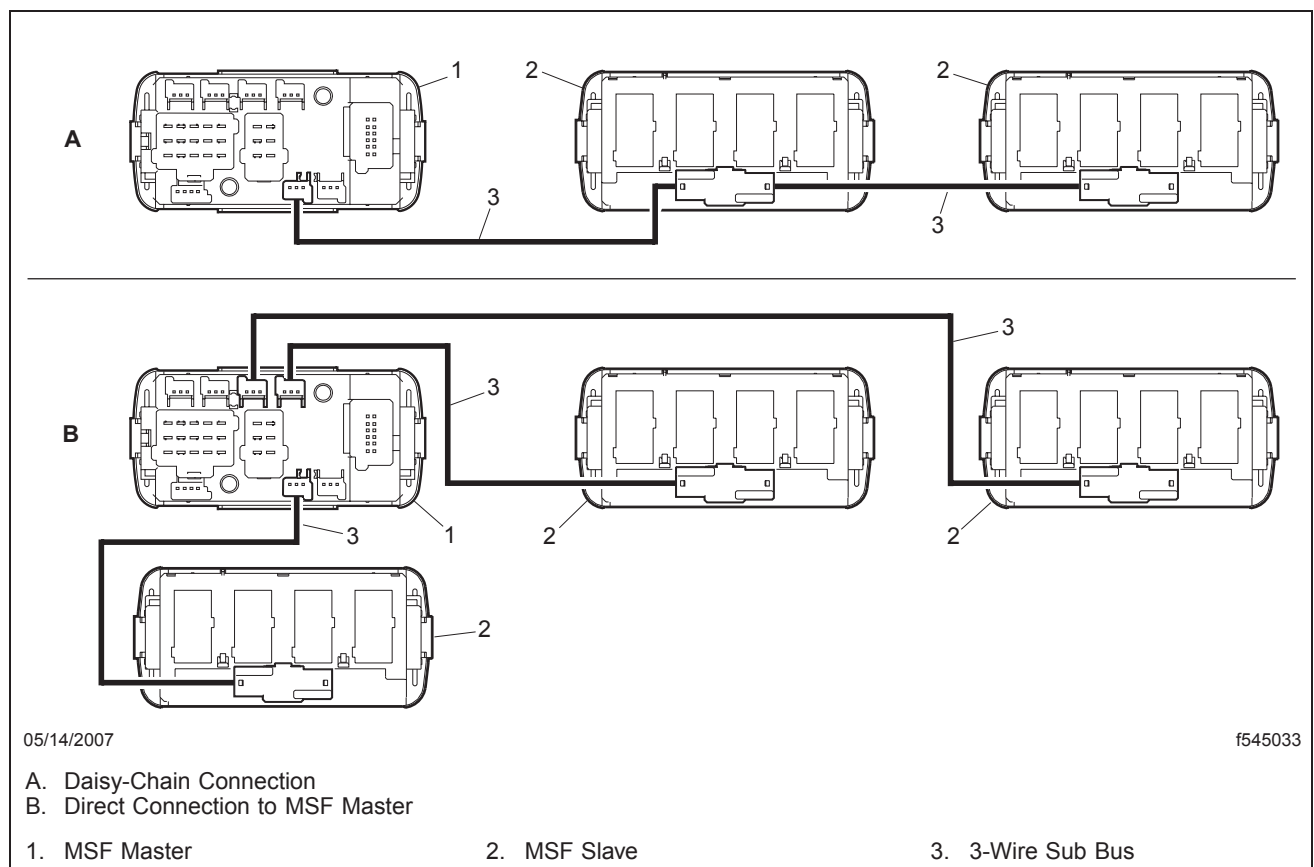


Fig. 2, MSF Slave Connection Methods

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507 — Datalink Network Topology

The MSF Master is the only component of the switch field that is physically connected to the Cabin CAN datalink. All other components of the switch field are not connected to any of the four datalinks. See **G02.02 — Datalink Communication Structure** for details.

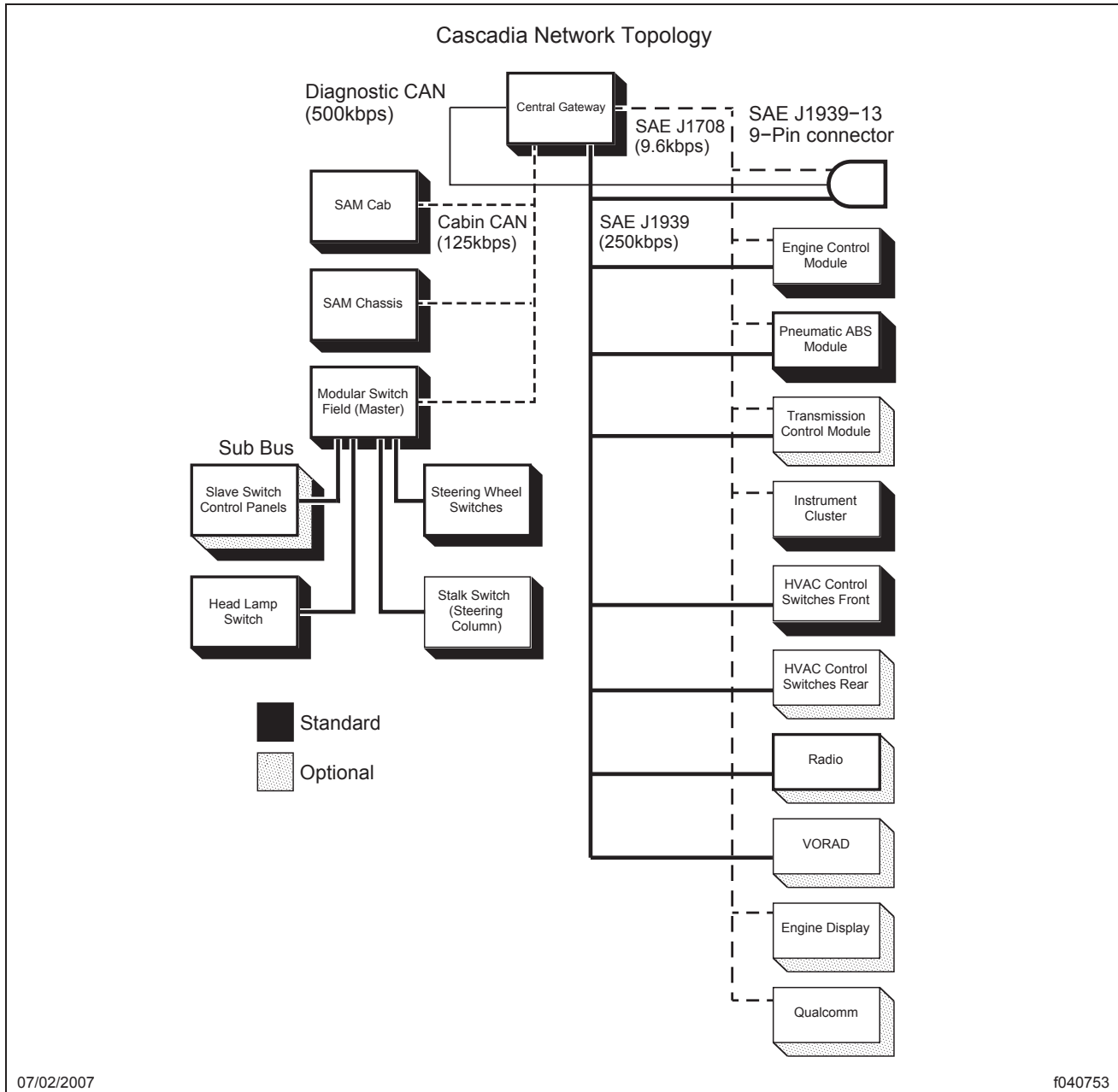


Fig. 3, Datalink Network Topology

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The Cabin CAN datalink wires run from the MSF Master to the Starpoint Connector, where it joins the rest of the Cabin CAN datalink.

508 — Datalink, Diagnostic CAN

Since there is no direct connection from the off-board tool to the Cabin CAN datalink, the Diagnostic CAN datalink runs from the diagnostic connector to the Central Gateway ECU (CGW). Its sole purpose is to connect the off-board tool (ServiceLink) to the CGW. In this way, the off-board tool can communicate with all of the Cabin CAN ECUs, such as the MSF Master.

509 — Controller Area Network (CAN)

Off-board tools such as ServiceLink use a communication protocol called CAN to communicate with the Cabin CAN ECUs. This is similar to how J1587 is used to communicate with ECUs connected to the J1708 datalink.

This applies to the SAM Cab, SAM Chassis, Modular Switch Field, and Central Gateway. Sometimes these ECUs are also called "CAN ECUs."

510 — Control Messaging and ECU Troubleshooting

ECU "control messaging" refers to the messages it sends to other ECUs to control the vehicle. This takes place over its connected datalink. However, an ECU's "troubleshooting datalink" refers to the datalink that an off-board tool, such as ServiceLink, uses to communicate and diagnose that ECU. See **Table 1**.

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

Faults from all ECUs can be viewed on ServiceLink.

511 — ECU Configuration

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

The MSF Master has parameters that can be viewed or changed for vehicle configuration. The MSF 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 MSF in the following cases:

- **As a last resort:** Troubleshooting has narrowed the problem down to being at the MSF itself and no other mechanical or electrical causes for the symptom have been identified. As a last resort, flashing the MSF 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.

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- **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 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 MSF, refer to the *ServiceLink User Guide* or *ServiceLink Help* user documentation, available in ServiceLink's "Help" menu.

512 — 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**
- **G03.03 — Datalink, Cabin CAN**
- **G03.04 — Datalink, Diagnostic CAN**
- **G04.03 — CAN Fault Codes**

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600 — Component Locations

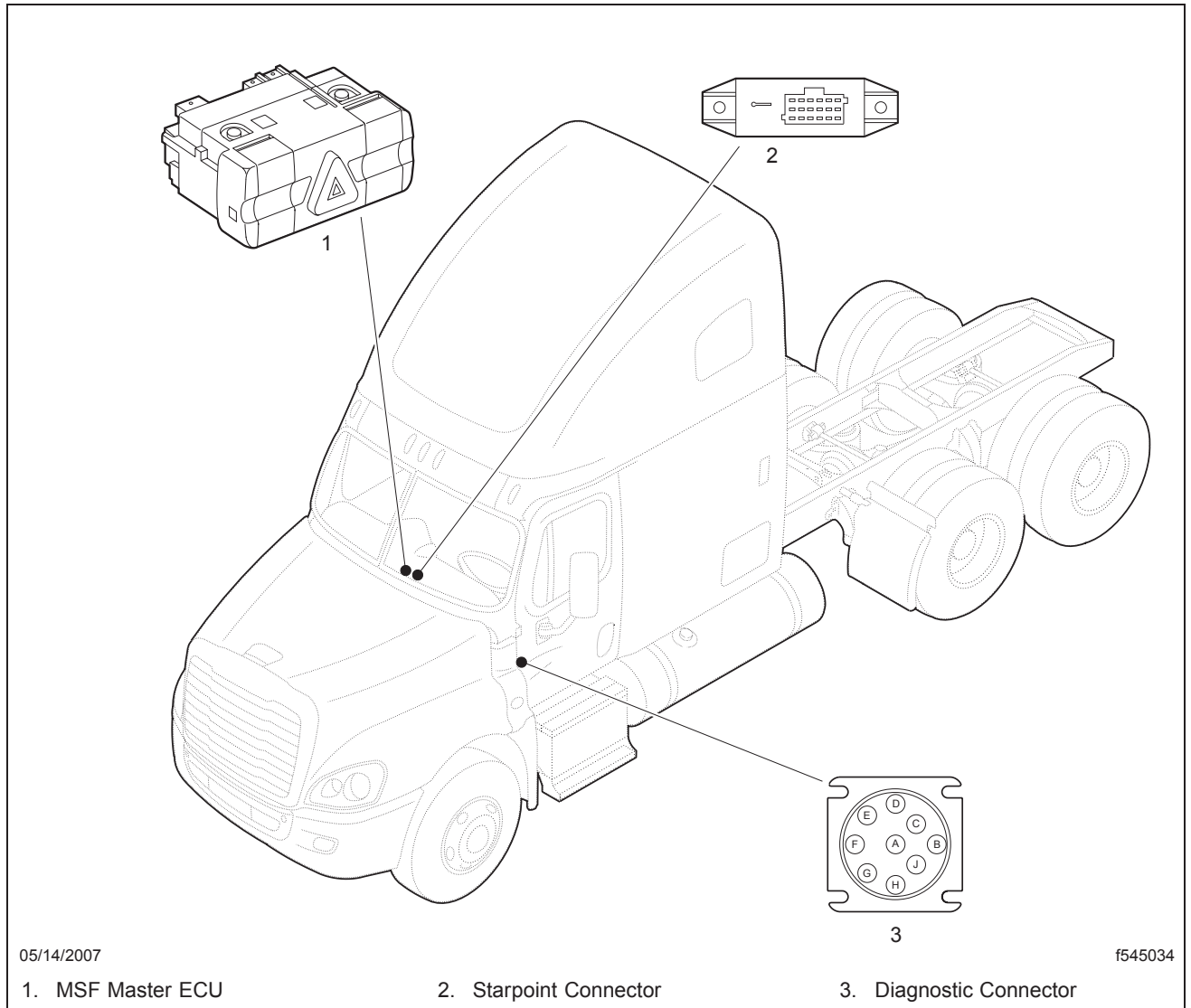


Fig. 4, Component Locations

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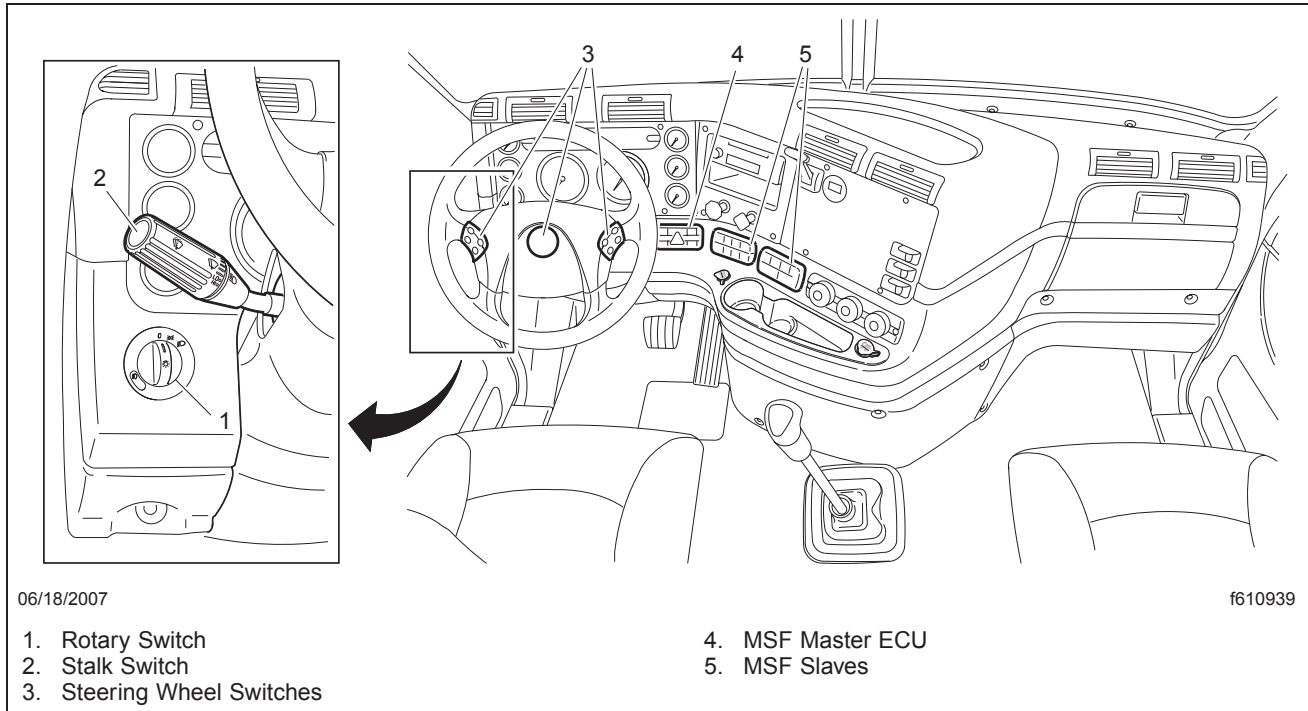


Fig. 5, Component Locations (cab)

601 — MSF Master Connector Pinouts

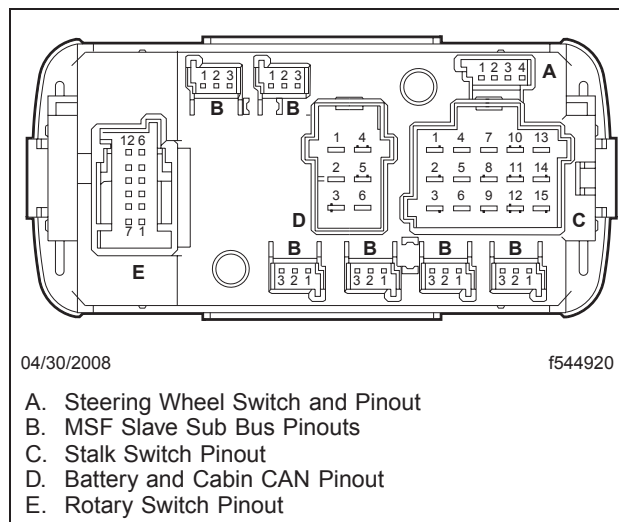


Fig. 6, MSF Master Connection Locations

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Connector A Pinout	
Pin	Function
1	Steering wheel, left switch signal (S2)
2	Backlighting PWM
3	Steering wheel, right switch signal (S1)
4	Ground

Table 2, Connector A Pinout

Connector B Pinout: MSF Slave Sub Bus Connector	
Pin	Function
1	Battery Power Supply from MSF Master
2	Sub bus signal from MSF Master
3	Ground from MSF Master

Table 3, Connector B Pinout: MSF Slave Sub Bus Connector

Connector C Pinout: Stalk Switch	
Pin	Function
1	Turn signal switch supply voltage
2	Left turn signal
3	Right turn signal
4	High beam flash signal
5	High beam signal
6	Low beam signal
7	Ignition Power
8	Binary Code Input A
9	Binary Code Input B
10	Not connected
11	Not connected
12	Washer signal
13	Not connected
14	Binary Code Input C
15	+12V ignition

Table 4, Connector C Pinout: Stalk Switch

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Connector D Pinout	
Pin	Function
1	Digital Input #1
2	Battery Power
3	Cabin CAN Low
4	Digital Input #2
5	Cabin CAN High
6	Ground

Table 5, Connector D Pinout

Connector E Pinout: Rotary Switch	
Pin	Function
1	Battery Power
2	Binary Code Input 1 (BC1)
3	Binary Code Input 2 (BC2)
4	Binary Code Input Version
5	Binary Code Common
6	Fog lamp signal
7	Backlighting PWM
8	Backlighting PWM
9	Not connected
10	Ground
11	Ground
12	Ground

Table 6, Connector E Pinout: Rotary Switch

MSF Slaves	
Pin	Function
1	Battery Power
2	Sub bus signal
3	Ground

Table 7, MSF Slaves

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602 — Signal-Only Sub Bus Switches

The signal-only sub bus switches are also called "multiplexed" or "MUX" switches.

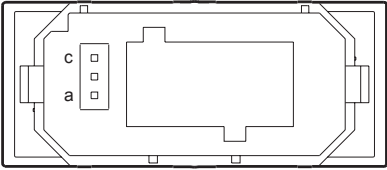
Signal-Only Sub Bus Switches	
	
05/15/2007	f545035
Pin	Function
A	Battery Power
B	Sub bus signal
C	Ground

Table 8, Signal-Only Sub Bus Switches

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603 — Hardwired Sub Bus Switches

For MSF hardwired sub bus switch pin functionality, refer to the MSF hardwired sub bus switch drawing A06–53783. Pin function will vary, based on the individual switch.

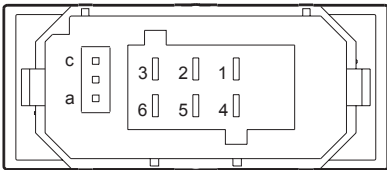
Hardwired Sub Bus Switches	
	
05/15/2007	f545036
Pin	Function
A	Battery Power
B	Sub bus signal
C	Ground
1	For MSF hardwired switch pin functionality, refer to the MSF hardwired sub bus switch drawing A06–53783. Pin function will vary, based on the individual switch.
2	
3	
4	
5	
6	

Table 9, Hardwired Sub Bus Switches

604 — Rotary Switch

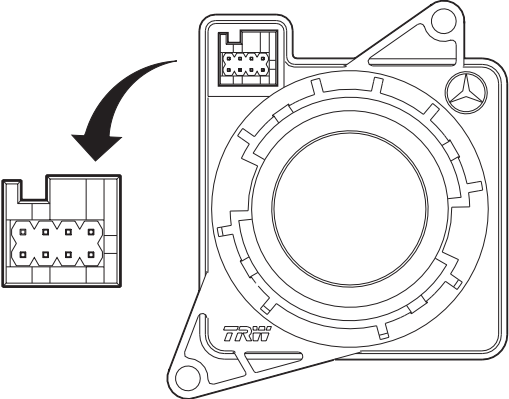
Rotary Switch	
	
05/15/2007	f545037
Pin	Function
1	Binary Code 1
2	Binary Code Common
3	Version
4	Fog Lamps/Road Lamps
5	Binary Code 2
6	Backlighting
7	Ground
8	Battery Power

Table 10, Rotary Switch

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605 — Stalk Switch

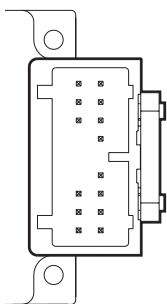
Stalk Switch	
	
05/15/2007	f545038
Pin	Function
1	Wiper switch, ignition power supply
2	Binary Code A
3	Binary Code B
4	Binary Code C
5	Washer signal
6	Not connected
7	Not connected
8	Not connected
9	Headlamp high beam flash signal
10	Headlamp high beam signal
11	Headlamp low beam signal
12	Left turn signal
13	Turn signal switch, power supply
14	Right turn signal

Table 11, Stalk Switch

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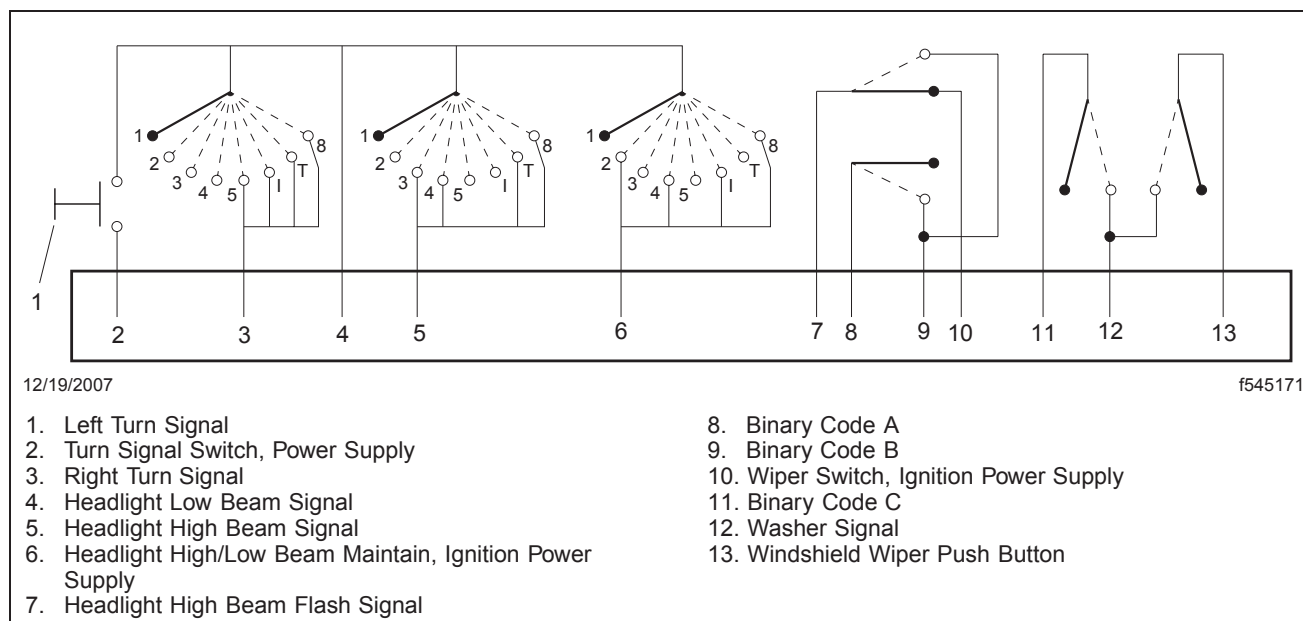


Fig. 7, Stalk Switch Internal Schematic

606 — Steering Wheel Switches

Steering Wheel Switches	
05/15/2007 f545039	
Pin	Function
1	Steering wheel, left switch signal (S2)
2	Backlighting PWM
3	Steering wheel, right switch signal (S1)
4	Ground

Table 12, Steering Wheel Switches

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607 — Clock Spring Connector

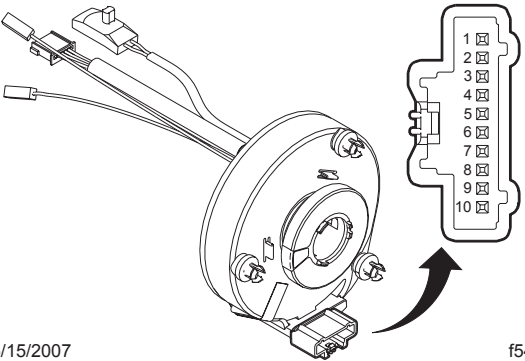
Clock Spring Connector	
 05/15/2007 f545040	
Pin	Function
1	Air bag (+), if used
2	Air bag (-), if used
3	Not used
4	Backlighting Ground
5	Steering wheel, right switch signal (S1)
6	Backlighting PWM
7	Steering wheel, left switch signal (S2)
8	Not used
9	Horn signal
10	Horn

Table 13, Clock Spring Connector

608 — Diagnostic Connector

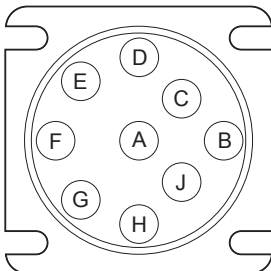
Diagnostic Connector	
	
05/01/2006	f151036b
Pin	Function
A	Ground
B	Battery +12V
C	J1939+
D	J1939-
E	J1939 (only if heavy cable is used)
F	J1587+
G	J1587-
H	Diagnostic CAN+
J	Diagnostic CAN-

Table 14, Diagnostic Connector

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609 — Starpoint Connector

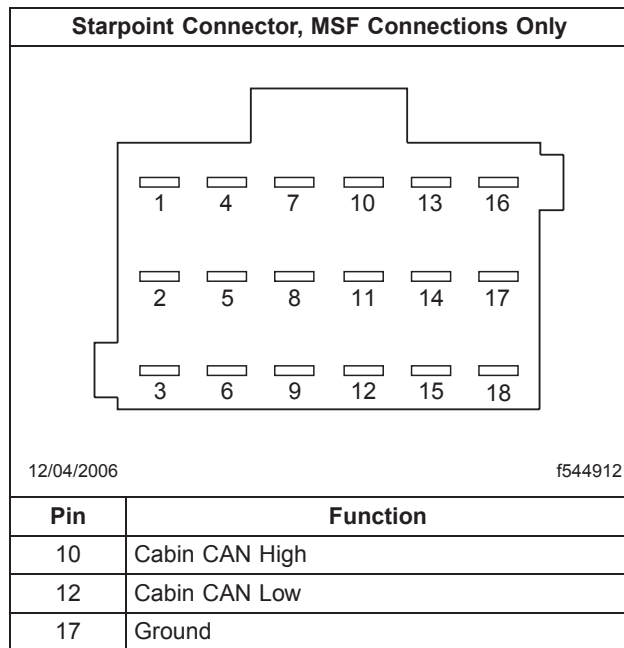


Table 15, Starpoint Connector, MSF Connections Only

700 — Troubleshooting Details

The diagnostic communication protocol used for troubleshooting or configuring the MSF Master and connected switches is CAN, via the Diagnostic CAN datalink. See **608 — Diagnostic Connector** 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 — Diagnostic Tools Required

- ServiceLink

702 — Possible Causes

- Fuse F4 (MSF power) on the SAM Cab
- Wiring
- Switches
- MSF Master Parameters
- Other ECUs on the Cabin CAN datalink
- Cabin CAN datalink

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703 — CAN 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	—	—	Electrical Potential (Voltage) — 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: With the key on, measure the voltage at MSF master conn D pin 2. If the voltage is greater than proper BAT voltage (10.5 to 15.5V), troubleshoot circuit 14F (mod 860) from the MSF master conn D pin 2 to SAM Cab conn 2 pin 12 for a short to BAT. Check SAM Cab fuse F4 (15A) for MSF power. Repair as required.							
49	168	4	conn D pin 2	—	—	Electrical Potential (Voltage) — Voltage below normal, or shorted to low source.	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 MSF master conn D pin 2. If the voltage is lower than 9V, 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	4	conn A pin 3	—	—	Steering wheel switch right — Voltage below normal or shorted to low source.	The signal to the steering wheel switches return a "Chopped supply" (squarewave signal) where the amplitude of the signal attenuated is differentiated by which switch is pushed. An unexpectedly small amplitude signal is being detected, or the battery source connector 1 pin 9 may be shorted to ground or fuse F2 might be blown.
Action: Check Fuse F4 for voltage. Use the "SteeringStalkRotaryHazard" template to verify the functionality of the switches. If the switches are not functioning properly, use a multimeter to check the amplitude of the chopped signal from the steering wheel. The signal should be greater than 10.5V amplitude. Push each button on the left side of the steering wheel. If no signal is present, search for short to ground in the applicable harness wires.							

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Modular Switch Field

CAN Fault Codes							
SA	SPN	FMI	Conn/Pin	Fuse	Relay	Description	Details
49	520203	3	conn A pin 1	—	—	Steering wheel switch left — Voltage above normal or shorted to high source.	A DC signal causes this fault. The signal to the steering wheel switches return a "Chopped supply" (squarewave signal) where the amplitude of the signal attenuated is differentiated by which switch is pushed.
Action: Use the "SteeringStalkRotaryHazard" template to verify the functionality of the switches. If the switches are not functioning properly, use a multimeter to check for DC offset from ground on connector A pin 1. If DC voltage is present, disconnect the steering wheel switches and retest for DC voltage to determine if the DC source is coming from the steering wheel switches. With DC voltage still present, disconnect the clockspring and retest. With DC voltage still present, trace the short to DC voltage to the short in the wire from connector A pin 1 to the steering wheel clockspring.							
49	520203	4	conn A pin 1	—	—	Steering wheel switch left — Voltage below normal or shorted to low source.	The signal to the steering wheel switches return a "Chopped supply" (squarewave signal) where the amplitude of the signal attenuated is differentiated by which switch is pushed. An unexpectedly small amplitude signal is being detected, or the battery source connector 1 pin 9 may be shorted to ground or fuse F2 might be blown.
Action: Check Fuse F4 for voltage. Use the "SteeringStalkRotaryHazard" template to verify the functionality of the switches. If the switches are not functioning properly, use a multimeter to check the amplitude of the chopped signal from the steering wheel. The signal should be greater than 10.5V amplitude. Push each button on the left side of the steering wheel. If no signal is present, search for short to ground in the applicable harness wires.							
49	520302	3	conn B pin 2	—	—	Sub bus signal — Voltage above normal or shorted to high source.	The fault becomes active when voltage at one of the MSF master's sub bus connectors (conn B) pin 2 (sub bus signal) is detected to be greater than 2V for at least 3 seconds. When fault is active, none of the functions work for multiplexed sub bus switches (A06-53782) connected to the faulty sub bus circuit. Functions for 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, measure for voltage > 2V at pin 2 for each sub bus connectors on the MSF master to find the problem connector. At the problem connector, perform a continuity test on circuit 507A from the MSF master conn B pin 2 to the connected MSF slave(s). Repair as required.							
NOTE: The sub bus can connect the MSF master to multiple MSF slaves via daisy chain. It may help to trace and map where all involved MSF slaves are on the vehicle, to find where a possible sub bus signal short may be. For example, the sub bus could connect to an MSF slave in the sleeper compartment where the short may be located.							

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CAN Fault Codes							
SA	SPN	FMI	Conn/Pin	Fuse	Relay	Description	Details
49	520302	4	conn B pin 2	—	—	Subbus signal — Voltage below normal or shorted to low source.	The fault becomes active when voltage at one of the MSF master's sub bus connectors (conn B) pin 2 (sub bus signal) is detected to be less than 4V for at least 3 seconds. When fault is active, none of the functions work for multiplexed sub bus switches (A06-53782) connected to the faulty sub bus circuit. Functions for hardwired sub bus switches (A06-53783) may still work. Use ServiceLink's MSF "Switches" screen to see which switches on the vehicle are hardwired.
Action: The MSF master has multiple 3-pin sub bus connectors (conn B). With the key ON, measure for voltage < 4V at pin 2 for each sub bus connectors on the MSF master to find the problem connector. At the problem connector, perform a continuity test on circuit 507A from the MSF master conn B pin 2 to the connected MSF slave(s). Repair as required.							
NOTE: The sub bus can connect the MSF master to multiple MSF slaves (daisy chained). It may help to trace and map where all involved MSF slaves are on the vehicle, to find where a possible sub bus signal short to GND may be. For example, the sub bus could connect to an MSF slave in the sleeper compartment where the short may be located.							
49	520404	3	conn C pin 4	—	—	Stalk switch flash — Voltage above normal or shorted to high source.	The fault is active when the voltage detected at connector C pin 5 at the MSF is high.
Action: Measure the voltage at MSF conn C pin 5. If the voltage detected is higher than BAT voltage, troubleshoot circuit 465A between MSF conn C pin 5, and stalk switch pin 10 for a short to BAT.							
49	520404	5	conn C pin 4 pin 8, 9, 14	—	—	Stalk switch interrupt — Current below normal, or open circuit.	An interruption is detected between the MSF master and the stalk switch.
Action: Troubleshoot circuit 473C between the MSF Master connector C and the stalk switch connector. Troubleshoot the following connector pairs for continuity: • MSF connector C pin 8 – stalk switch pin 2 • MSF connector C pin 9 – stalk switch pin 3 • MSF connector C pin 14 – stalk switch pin 4 Repair as required.							
49	520405	3	conn C pin 5	—	—	Stalk switch high beam — Voltage above normal or shorted to high source.	Stalk switch low/high beam is not functioning.
Action: Measure the voltage at the MSF conn C pin 5 and pin 6. If the voltage detected is greater than BAT voltage, troubleshoot circuit 465A between the MSF conn C pin 5 and the stalk switch pin 10, or the MSF conn C pin 6 and the stalk switch pin 11 for a short to BAT. Repair as required.							
49	520413	4	conn C pin 15	—	—	Stalk switch wiper common — Voltage below normal or shorted to low source.	Wipers will not function due to invalid stalk switch information.
Action: Troubleshoot for a short in circuit 433A between the MSF and the stalk switch. Test for short to ground on pin 1 in the stalk switch. Disconnect connector C from MSF and test for battery voltage on pin 1, as pin 1 supplies power to the stalk switch. See related information in Wipers Inoperative in All Modes.							

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CAN Fault Codes							
SA	SPN	FMI	Conn/Pin	Fuse	Relay	Description	Details
49	520601	4	conn E pin 1	—	—	Headlamp switch +12V Battery — Voltage below normal or shorted to low source.	The fault becomes active when voltage at conn E pin 1 (headlamp/ rotary switch power) is detected to be 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: With the key ON, measure the voltage at MSF master conn E pin 1 for BAT voltage. Perform a continuity test on circuit 20 (mod 311) from MSF master conn E pin 1 to the headlamp switch pin 8. Repair as required.							
49	520607	4	conn A, pin 2 conn E, pin 7	—	—	Backlighting — Voltage below normal or shorted to low source.	Backlighting on the steering wheel switches and the headlamp switch are not functioning.
Action: Troubleshoot circuit 29A between MSF connector E pin 7 and headlight switch pin 6 or circuit 474BA2 between MSF Steering wheel switches connector pin 2 and steering wheel switches connector pin 6 for a short to GND. Repair as required.							
49	523530	31	—	—	—	Sub bus switch missing.	This fault becomes active when the MSF Master does not sense one or more switches on the sub bus that it expects due to MSF parameter settings.
Action: With the key ON, connect to the vehicle with 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 and sub bus connections to the MSF master.							
49	523531	31	—	—	—	Extra Sub bus switch.	This fault becomes active when one or more sub bus switches are plugged in that do not have a corresponding MSF parameter set for availability.
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.	The fault becomes 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: With the key ON, check the headlamp/rotary switch connection. Check the connections of the wiring harness (mod 311) from the MSF conn E to the headlamp/rotary switch. Perform continuity tests on the involved pins (circuits 474B01, 474B02 and 474B05). Repair as required.							
49	524033	31	—	—	—	Lost communication with the SAM Cab.	Refer to G03.03 — Datalink, Cabin CAN for troubleshooting details on this fault.

Modular Switch Field

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CAN Fault Codes							
SA	SPN	FMI	Conn/Pin	Fuse	Relay	Description	Details
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

704 — 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 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.

G02.06

Modular Switch Field

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 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
Maximum number of MSF Slaves on a vehicle	9
Maximum current capacity for Hardwired switch (external circuits)	18A

Table 17, Sub Bus Switch Specifications

801 — Stalk Switch Binary Coded Pin Values

The following table shows the expected voltage values for the stalk switch binary coded inputs A, B and C to the MSF master. For binary coded input pin locations at the MSF master, refer to the pinout tables in **601 — MSF Master Connector Pinouts** for connector C, "Stalk Switch." For binary coded pin locations at the stalk switch, refer to **Table 11** in **605 — Stalk Switch**.

Stalk Switch, Binary Coded Pin values			
Stalk Switch Function	Binary Coded Pin values (in Volts)		
	C	B	A
OFF	0	0	0
Intermittent 1	0	0	12
Intermittent 2	0	12	0
Intermittent 3	0	12	12
Intermittent 4	12	0	0

Modular Switch Field

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Stalk Switch, Binary Coded Pin values			
Stalk Switch Function	Binary Coded Pin values (in Volts)		
	C	B	A
Intermittent 5	12	0	12
LOW	12	12	0
HIGH	12	12	12

Table 18, Stalk Switch, Binary Coded Pin values

802 — Rotary Switch Binary Coded Pin Values

The following table shows the expected voltage values for the rotary switch binary coded pins 1, 2 and Common, which are inputs to the MSF master. For binary coded input pin locations at the MSF master, refer to the pinout tables in **601 — MSF Master Connector Pinouts** for connector E, "Rotary Switch." For binary coded pin locations at the rotary switch, refer to **Table 10** in **604 — Rotary Switch**.

Rotary Switch, Binary Coded Input Pin Values				
Rotary Switch Position	"Binary Coded Input" Pin Values			Resultant Functionality
	BC1	BC2	BC Common	
Position 0	0	0	12	OFF
Position 1	12	0	12	Marker Lamps
Position 2	12	12	12	Marker and Head Lamps

Table 19, Rotary Switch, Binary Coded Input Pin Values

NOTE: The pin "Binary Coded Input Version" is used to indicate if the Rotary Switch has a position for Fog Lamps.

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Common Powertrain Controller

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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.

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.

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Common Powertrain Controller

600 — Component Locations

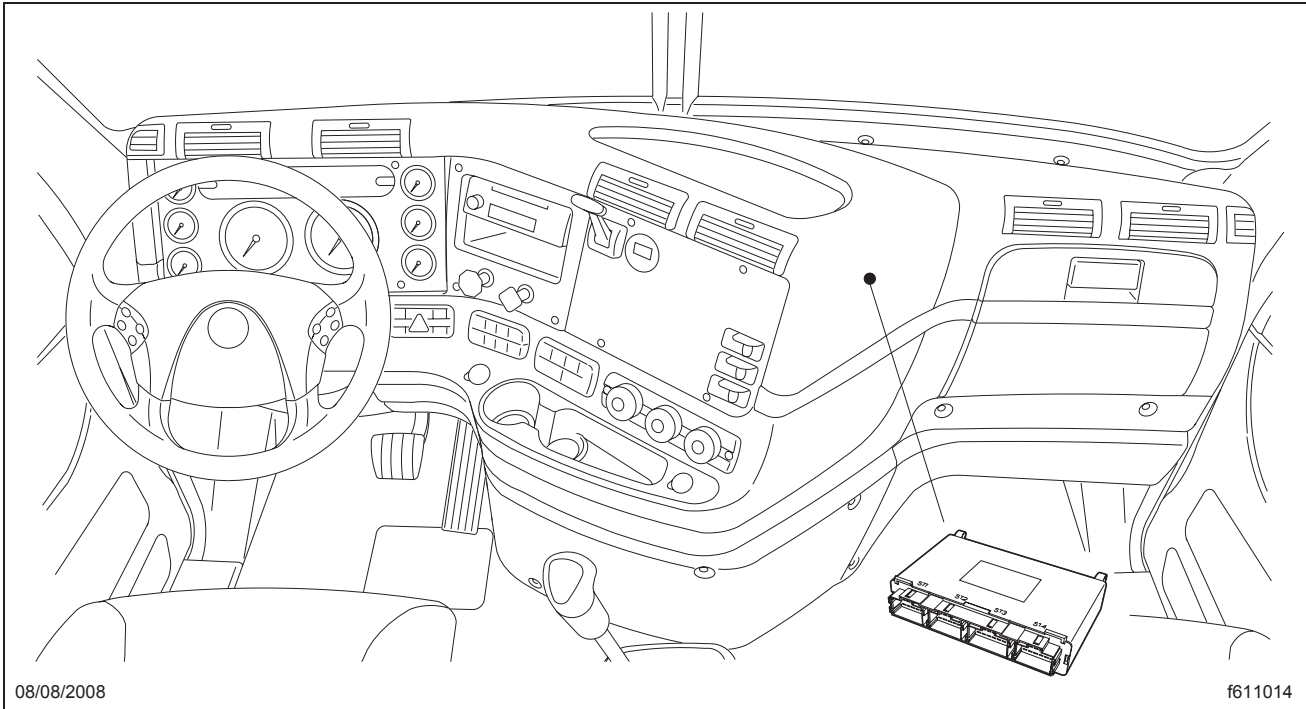


Fig. 1, Common Powertrain Controller

Common Powertrain Controller

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601 — Component Details

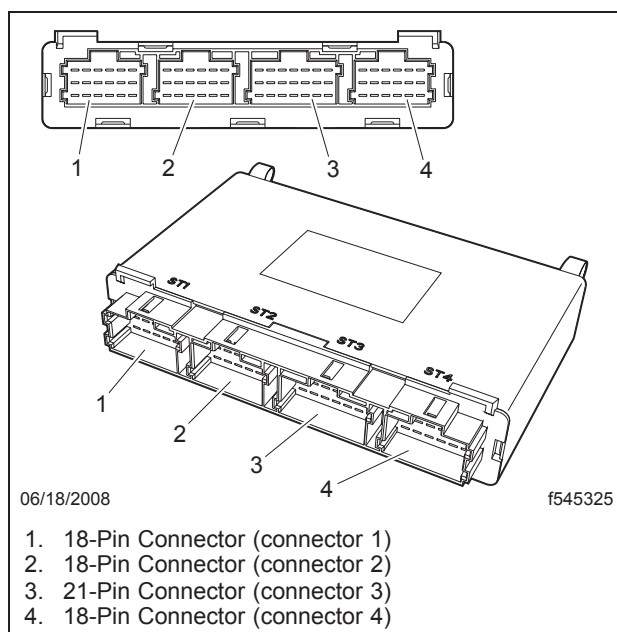


Fig. 2, CPC Connectors

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)

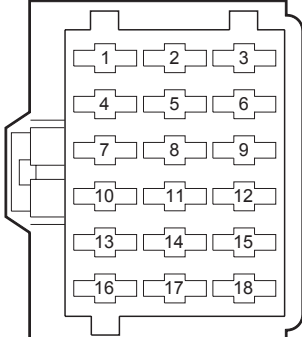
702 — Diagnostic Tests

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.

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800 — Specifications

Connector 1, 18-Pin			
Pin	Signal Type	Function	Connector
1/1	Digital Input_FLEX_01	Dual-Speed Axle	
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	

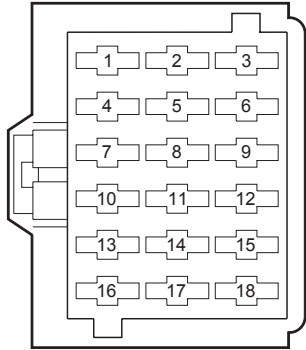
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Table 1, Connector 1, 18-Pin

Common Powertrain Controller

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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 (+)	

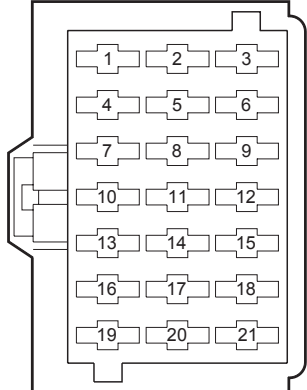
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Table 2, Connector 2, 18-Pin

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Connector 3, 21-Pin			
Pin	Signal Type	Function	Connector
3/1	Analog_In_01	OI Thermostat	
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	

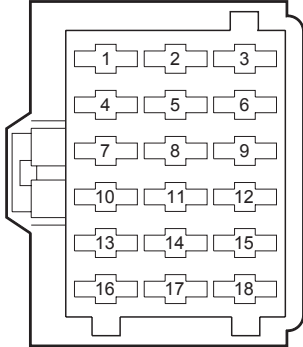
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Table 3, Connector 3, 21-Pin

Common Powertrain Controller

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Connector 4, 18-Pin			
Pin	Signal Type	Function	Connector
4/1	C_ECAN_L	Engine CAN (-)	
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	

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Table 4, Connector 4, 18-Pin