Table of Contents

1. FAN WIRING — INTERNATIONAL ENGINES

1.1. FAN SOLENOID CIRCUIT FUNCTIONS

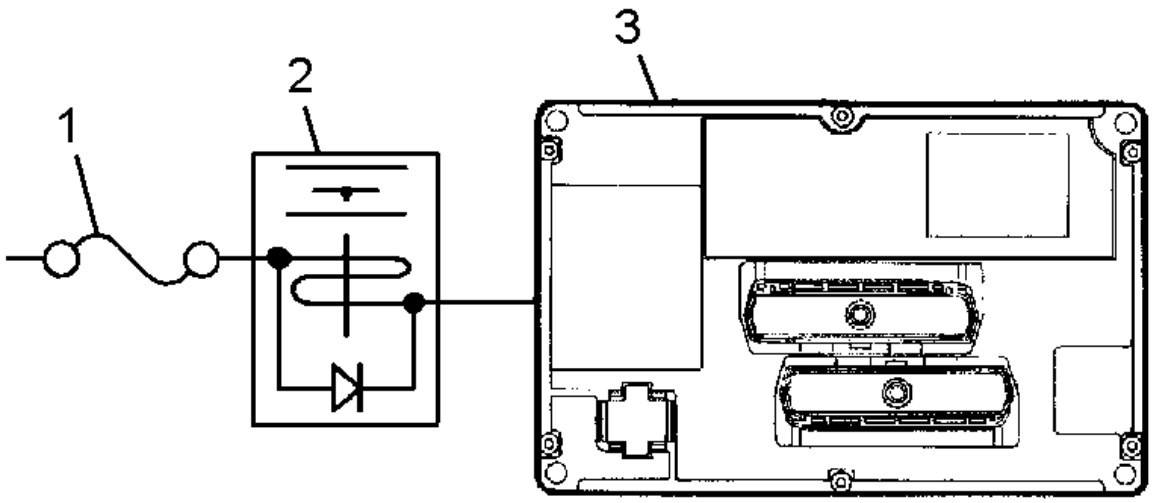

Figure 162 Fan Solenoid Function Diagram

1. 10 AMP FUSE W/SOLENOID OR 5 AMP FUSE W/CLUTCH IN ENGINE POWER DISTRIBUTION CENTER
2. FAN SOLENOID
3. ENGINE CONTROLLER

On vehicles with optional air activated fans (The majority of the vehicles are built with standard viscous drive fans that have no electrical controls). The engine controller monitors engine coolant, intake manifold temperature, and air conditioning head pressure. When any of these systems operate beyond their set parameters, the engine controller will control turning the fan off by energizing a solenoid to control air pressure to the fan. In the event of a solenoid circuit fault the fan will remain on continuously.

The engine controller turns the fan on under the following conditions:

If the engine speed is less than 2250 RPM or the engine is running **and any of the following conditions exists:**

Coolant temperature sensor is greater than 96°C (205°F) **or**

There is an active engine diagnostic code for the coolant temperature sensor **or**

The retarder solenoid signal is active (high mode) for more than 10 seconds with coolant temperature sensor greater than 80°C (176°F) **or**

The ESC sends a command, on the drivetrain 1939 data link, to the engine controller (required when high AC compressor pressure is sensed).

The engine controller turns the fan off under the following conditions:

Engine speed is greater than 2300 RPM **and all of the following conditions exists:**

Coolant temperature sensor is less than 92°C (198°F) **and**

No active coolant temperature sensor diagnostic code **and**

Retarder solenoid signal is active (high mode) with coolant temperature sensor less than 75°C (167°F) **and**

The ESC is not sending a command to the engine controller (high AC compressor pressure is not sensed) **and**

The engine has been running at least two seconds.

NOTE – Once the engine controller has turned the fan on, the fan will remain on for a minimum of 180 seconds to avoid unnecessary fan clutch cycling (except at engine start-up — it will run for only two seconds after the engine starts). The 180 second time interval is a programmable feature in the engine controller.

1.2. DIAGNOSTICS

Should the fan solenoid fail to shut off the fan when expected, the problem could be attributed to open or shorted wiring in the power circuits from the fuse, an open or short in the circuit between the fan air solenoid and the Engine controller, a blown fuse, a failed solenoid or a missing signal from the engine controller.

The ESC will not log any faults for the fan solenoid circuits. However, an open circuit or short to ground in the fan solenoid circuitry can be detected by the engine controller while retrieving “flash codes”.

Fan Solenoid Preliminary Check

Table 114 Fan Solenoid Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Test drive vehicle to insure fan is not shutting off as expected.	Check fan operation.	Fan is not operating correctly.	Go to next step.	Fan is operating correctly. Problem does not exist or is intermittent.

Table 114 Fan Solenoid Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
2.	On	Retrieve “flash codes” and check for code 246. Go to Engine Controller Diagnostic Trouble Codes. (See ENGINE CONTROLLER DIAGNOSTIC TROUBLE CODES , page 341)	Count flashes on check engine warning lamp.	“Flash code” 246 is not active.	Go to next step.	“Flash code” is active. Go to FAULT DETECTION MANAGEMENT I6 WITH FAN SOLENOID(See FAULT DETECTION MANAGEMENT I6 WITH FAN SOLENOID, page 342)or FAULT DETECTION MANAGEMENT V8–AVNT WITH FAN CLUTCN(See FAULT DETECTION MANAGEMENT V8–AVNT with Fan Clutch, page 344)
3.	On	Are other engine diagnostic trouble codes are active?	Check warning lamps for other diagnostic trouble codes.	No other engine diagnostic trouble codes are active.	Go to next step.	Refer to the appropriate engine manual to troubleshoot condition setting the code.
4.	On	If the fan never shuts off and no diagnostic trouble codes are active, check for air pressure to solenoid and through solenoid when it is energized.	Check air pressure through solenoid.			

1.3. ENGINE CONTROLLER DIAGNOSTIC TROUBLE CODES

To display diagnostic codes, set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch simultaneously for at least 3 seconds. The diagnostic trouble codes are read by counting the number of light flashes. The following sequence occurs:

The red "ENGINE" light will flash one time. This indicates the beginning of Active diagnostic trouble codes.

The yellow "ENGINE" light will flash repeatedly signaling the active diagnostic trouble codes. All codes are three digits. The number of flashes should be counted in sequence. At the end of each digit of the code there will be a short pause. For example, the code 246 will be sent as two flashes, (a pause), four flashes, (a pause), and six flashes.

After each active code is displayed, the red "ENGINE" light will flash once to indicate the next active code.

Once all active codes have been displayed, the red "ENGINE" light will flash twice to indicate the beginning of Inactive codes.

Inactive codes will be displayed in the same manner as active codes. Once the Inactive codes have been displayed, the red "ENGINE" light will flash three times to indicate that all the stored diagnostic trouble codes have been displayed.

After all repairs have been made, the engine diagnostic trouble codes may be cleared by putting the key switch in the accessory position, turning on the left turn signal and pressing the cruise on and set switches simultaneously for 3 seconds.

Table 115 Fan Solenoid Codes

FAULT CODE	FAULT DESCRIPTION
246	Fan Output Circuit Check Fault
This fault is logged when there is a short to ground or an open in the in the circuits from the engine controller, through the fan solenoid to battery voltage. Go to FAULT DETECTION MANAGEMENT I6 WITH FAN SOLENOID(See FAULT DETECTION MANAGEMENT I6 WITH FAN SOLENOID, page 342)or FAULT DETECTION MANAGEMENT V8–AVNT WITH FAN CLUTCN(See FAULT DETECTION MANAGEMENT V8–AVNT with Fan Clutch, page 344)	

1.4. FAULT DETECTION MANAGEMENT I6 WITH FAN SOLENOID

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A failure in the I6 fan solenoid circuits will be apparent when the fan doesn’t turn off as expected. The ESC will not log any faults for the fan solenoid circuits. However, an open circuit or short to ground in the fan solenoid circuits can be detected by the engine controller during an “on demand” engine standard test. See the appropriate engine manual for details.

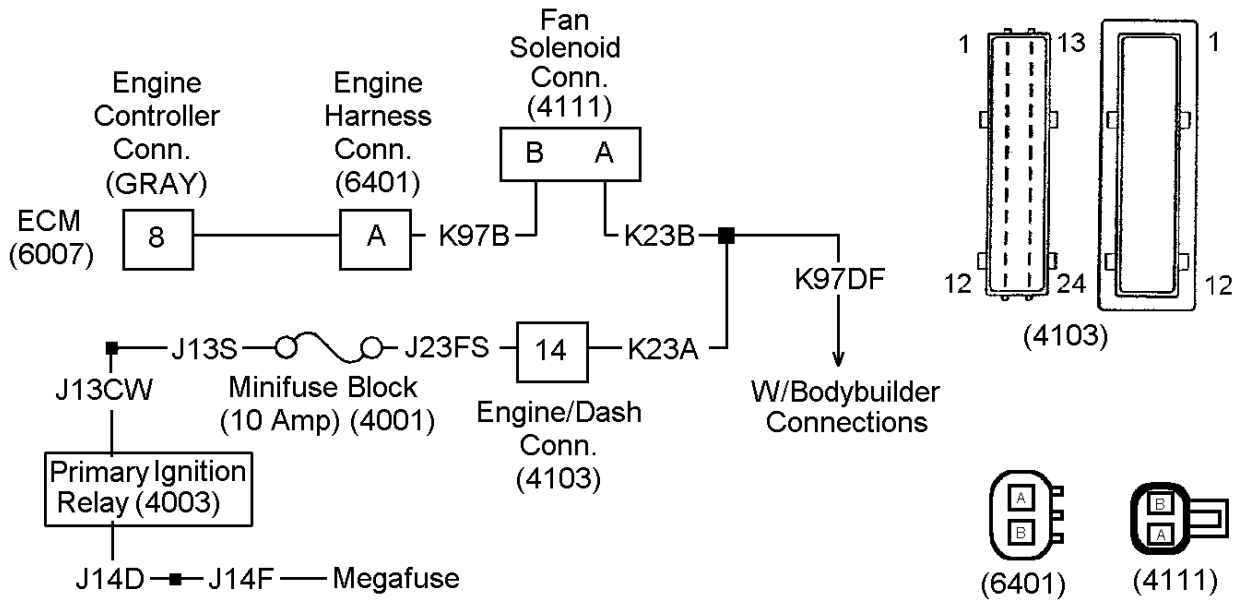

Figure 163 I6 with Fan Solenoid Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

(4001) FAN SOLENOID FUSE, 10 AMP W/SOLENOID
LOCATED IN ENGINE COMPARTMENT POWER DISTRIBUTION CENTER
(4003) PRIMARY IGNITION RELAY
LOCATED IN ENGINE COMPARTMENT POWER DISTRIBUTION CENTER
(4103) ENGINE/DASH HARNESS CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(4111) FAN AIR SOLENOID CONNECTOR
LOCATED NEAR ENGINE FAN DRIVE
(6007) (GRAY) ENGINE CONTROLLER (ECM) CONNECTOR
CONNECTS TO ENGINE CONTROLLER
(6401) MELROSE ENGINE HARNESS CONNECTOR
LOCATED NEAR ENGINE FAN DRIVE

Table 116 I6 with Fan Solenoid Wiring Harness Connector Checks

International Engine Controller Diagnostic Trouble Codes		
246	The Engine Fan Control relay failed the output circuit check during a Key On Engine Off Standard Test. **NOTE: For test purposes EFC solenoid can be turned On/Off through the Output State Test.**	
Key on Engine Off - Voltage Checks at Fan Air Solenoid Connector (4111)		
Check with fan solenoid Disconnected, Ignition Key ON (Engine Off).		
Test Points	Spec.	Comments
B to Ground.	0 v	If voltage present, check for short to power

Table 116 I6 with Fan Solenoid Wiring Harness Connector Checks (cont.)

A to Ground.	12 ± 1.5 volts	If voltage is missing, check fuse and/or circuit or open/shorts If voltage is present, check for open in circuits between engine controller and solenoid.
NOTE: Normal fan on temperature is 212°F (100°C). Normal fan off temperature is 207.5°F (97.5°C)		

1.5. EXTENDED DESCRIPTION

When the key is on, the fan solenoid is supplied battery voltage at connector (4111) from a 10 amp fuse in the engine compartment power distribution center and powered through closed contacts of the energized primary ignition relay (4003).

The engine controller will supply a ground to connector (4111) to energize the solenoid, turning off the fan.

1.6. FAULT DETECTION MANAGEMENT V8–AVNT WITH FAN CLUTCH

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A failure in the V8–AVNT fan clutch circuits will be apparent when the fan doesn't turn off as expected. The ESC will not log any faults for the fan solenoid circuits. However, an open circuit or short to ground in the fan solenoid circuits can be detected by the engine controller during an "on demand" engine standard test. See the appropriate engine manual for details.

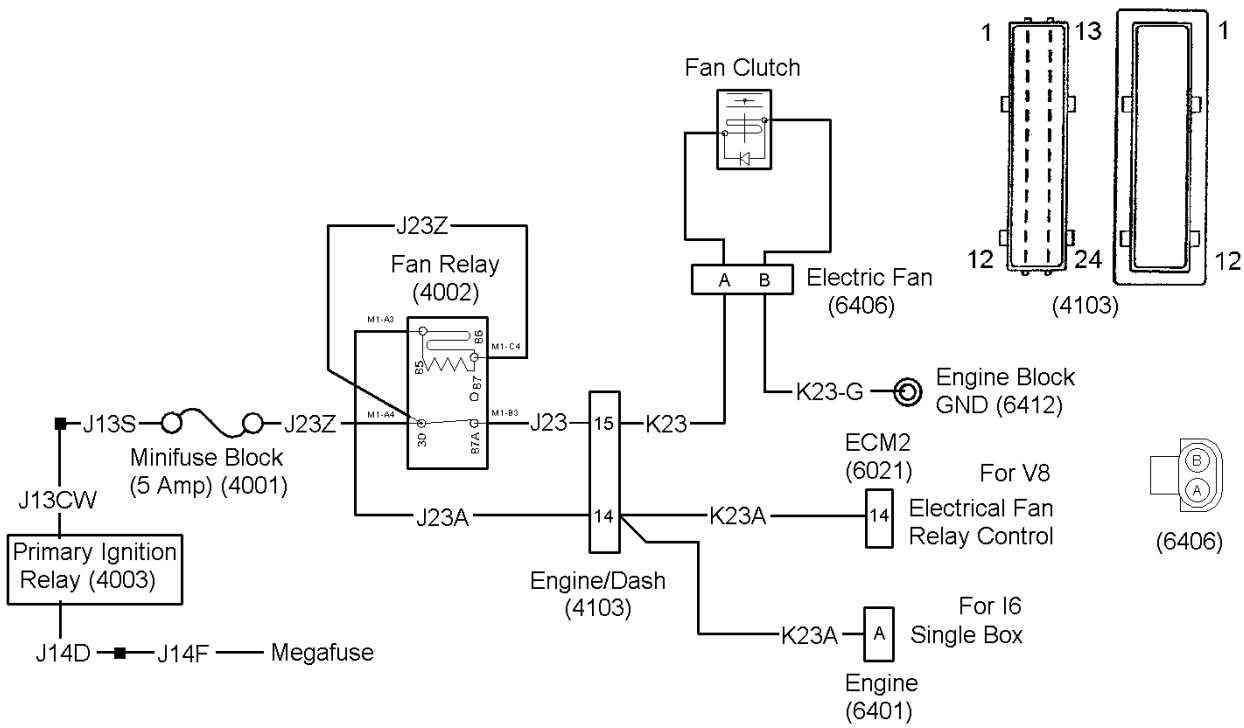

Figure 164 V8–AVNT with Fan Clutch Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

(4001) FAN CLUTCH FUSE, 5 AMP W/CLUTCH
LOCATED IN ENGINE COMPARTMENT POWER DISTRIBUTION CENTER
(4002) FAN RELAY
LOCATED IN ENGINE COMPARTMENT POWER DISTRIBUTION CENTER
(4003) PRIMARY IGNITION RELAY
LOCATED IN ENGINE COMPARTMENT POWER DISTRIBUTION CENTER
(4103) ENGINE/DASH HARNESS CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(6021) ECM2 ELECTRIC FAN RELAY CONTROL CONNECTOR
CONNECTS TO ENGINE CONTROLLER
(6312) ENGINE BLOCK GND
CONNECTS TO ENGINE
(6406) ELECTRIC FAN CLUTCH DRIVE CONNECTOR
LOCATED ON ENGINE FAN DRIVE

Table 117 V8–AVNT with Fan Clutch Wiring Harness Connector Checks

International Engine Controller Diagnostic Trouble Codes	
246	The Engine Fan Control relay failed the output circuit check during a Key On Engine Off Standard Test. **NOTE: For test purposes EFC solenoid can be turned On/Off through the Output State Test.**
Key on Engine Off - Voltage Checks at Fan Clutch Connector (6406)	

Table 117 V8–AVNT with Fan Clutch Wiring Harness Connector Checks (cont.)

Check with Fan Clutch Disconnected, Ignition Key ON (Engine Off).		
Test Points	Spec.	Comments
B to Ground.	0 v	If voltage present, check for short to power
A to Ground.	12 ± 1.5 volts	If voltage is missing, check fuse and/or circuit or open/shorts If voltage is present, check for open in circuits between engine controller and solenoid.
NOTE: Normal fan on temperature is 212°F (100°C). Normal fan off temperature is 207.5°F (97.5°C)		

1.7. EXTENDED DESCRIPTION

When the key is on, the fan clutch is supplied battery voltage at connector (6406) through closed contacts of the deenergized fan relay (4002) from a 5 amp fuse in the engine compartment power distribution center and powered the through closed contacts of the energized primary ignition relay (4003).

The engine controller will supply a ground to energize fan relay (4002) opening the contacts of the fan relay (4002), removing power from connector (6406) to deenergize the clutch, turning off the fan.

1.8. COMPONENT LOCATIONS

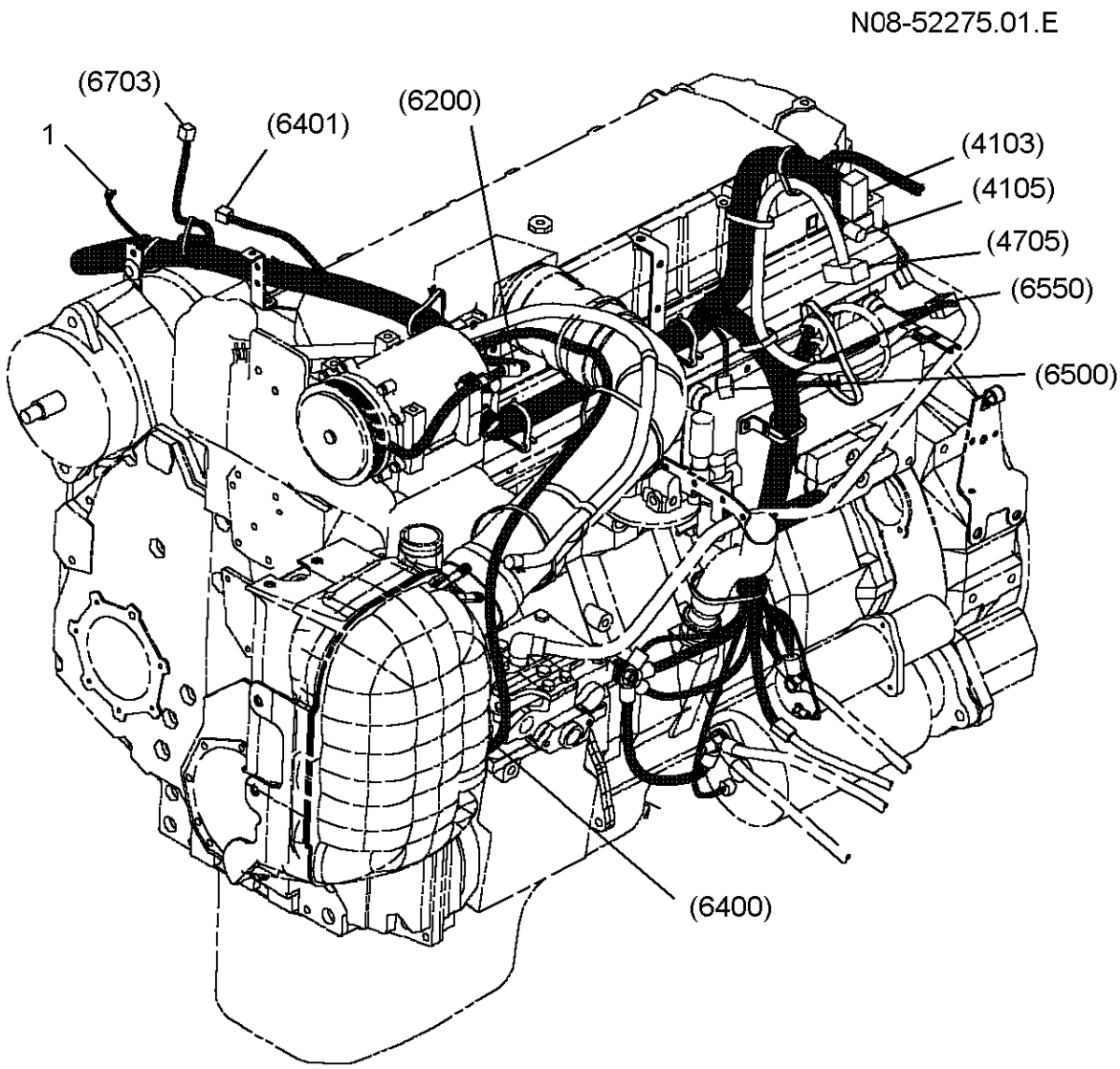

Figure 165 Engine Wiring

1. CIRCUIT TO OPTIONAL ALTERNATOR WARNING LIGHT
(4103) ENGINE/DASH CONNECTOR
(4105) ECM POWER/STARTER CONNECTOR
(4705) 8–WAY OR 24– WAY TRANSMISSION/DASH CONNECTOR
(6200) AIR CONDITIONER COMPRESSOR CLUTCH CONNECTOR
(6400) LOW COOLANT LEVEL SENSOR CONNECTOR
(6401) MELROSE ENG HARN CONNECTOR
(6500) EXHAUST BRAKE CONNECTOR
(6550) ETHER START THERMOSTATIC SWITCH CONNECTOR
(6703) AMBIENT AIR TEMP SENSOR CONNECTOR

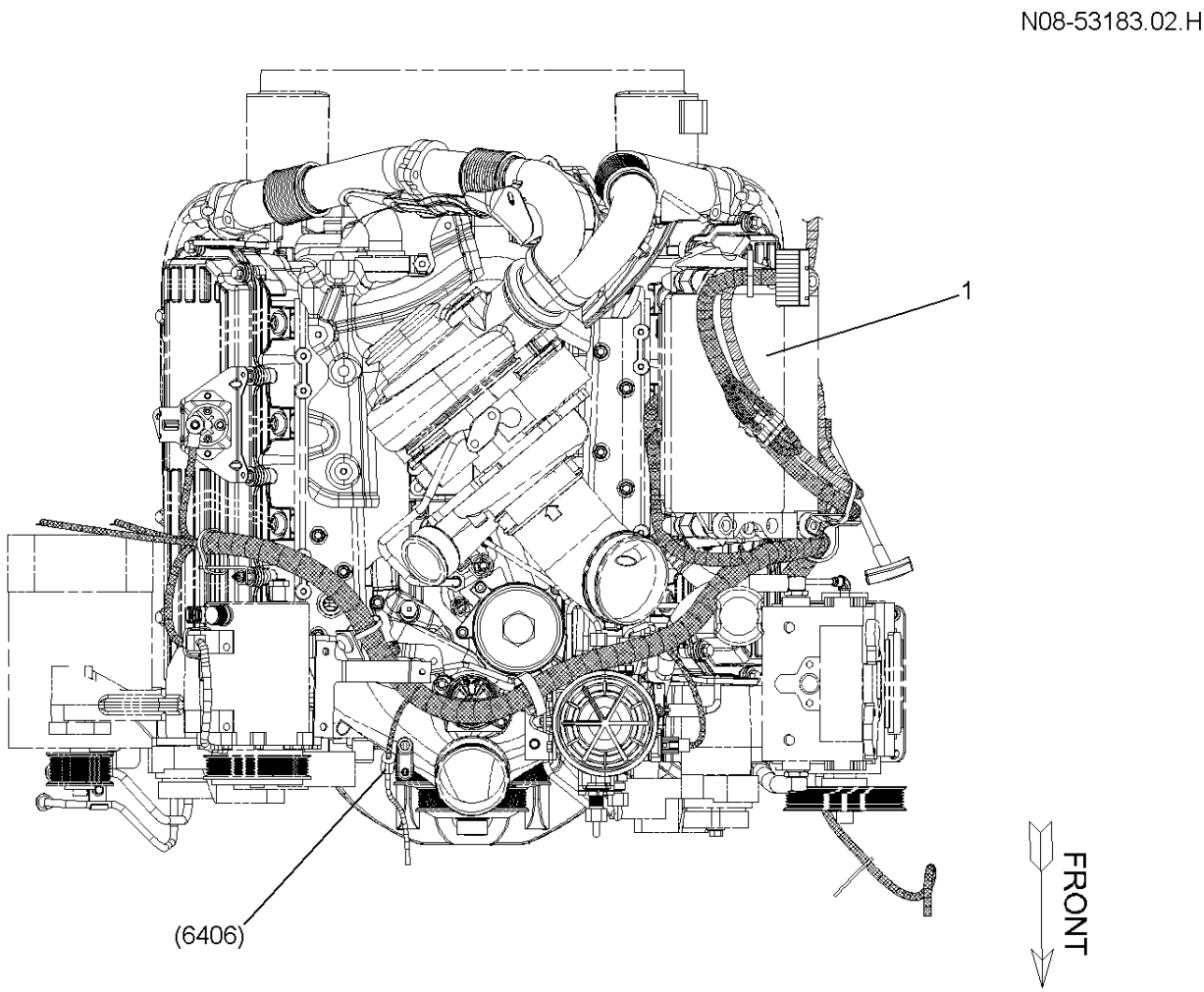

Figure 166 V8–AVNT with Fan Clutch

1. (6021) ENGINE CONTROLLER MODULE ECM2
(6406) ELECTRICALMAGNETIC FAN CIRCUIT K23–G OF ENGINE HARNESS TO FAN PIGTAIL

2. ETHER START

2.1. CIRCUIT FUNCTIONS

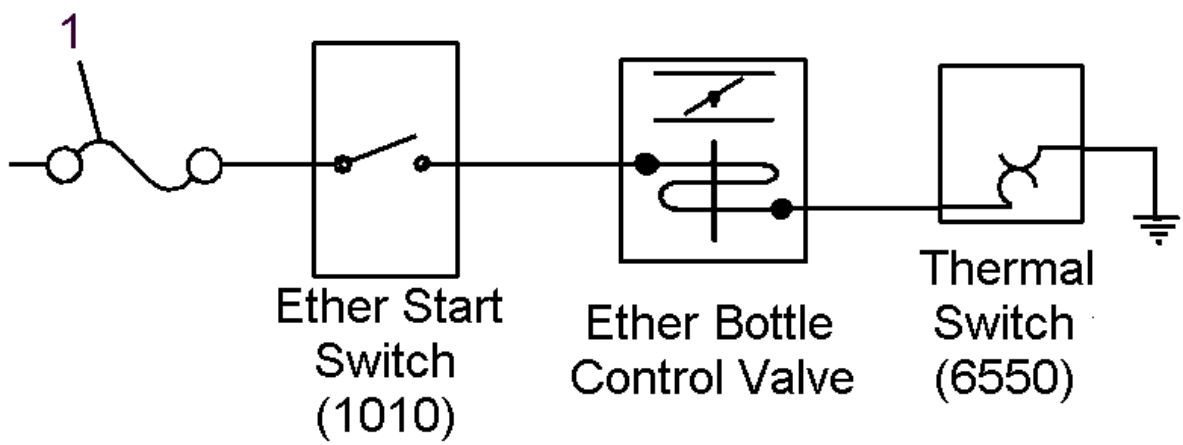

Figure 167 Ether Start Function Diagram

1. 10 AMP (F33) FUSE BLOCK #3 (1013) IN CAB POWER DISTRIBUTION CENTER
2. (8400) ETHER START
3. (1010) ETHER START SWITCH
4. ETHER BOTTLE CONTROL VALVE
5. (6550) THERMAL SWITCH

When the ether start system is activated a measured amount of ether will be injected into the engine intake. This will assist starting the engine during cold weather.

The system will only function if engine temperature is less than 4.4°C (40°F).

The ether bottle control valve is directly controlled by the ether start switch on the instrument panel. A thermal switch will prevent the valve from activating when the temperature is too high.

2.2. DIAGNOSTICS

The ESC will not log any faults for the ether start circuits.

Ether Start Preliminary Check

Table 118 Ether Start Preliminary Check Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify the ether injection system is not working.	Check system operation.	Ether is not injected when engine temperature is in the allowed range.	Go to next step.	Ether injector is working.
2.	Off	Check if ether bottle is empty.		Ether bottle is empty.	Replace ether bottle.	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 350)

2.3. FAULT DETECTION MANAGEMENT

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A failure in the ether start circuits will be apparent when the ether bottle doesn't inject ether during cold starting.

Insure the ether bottle is not empty before troubleshooting this system.

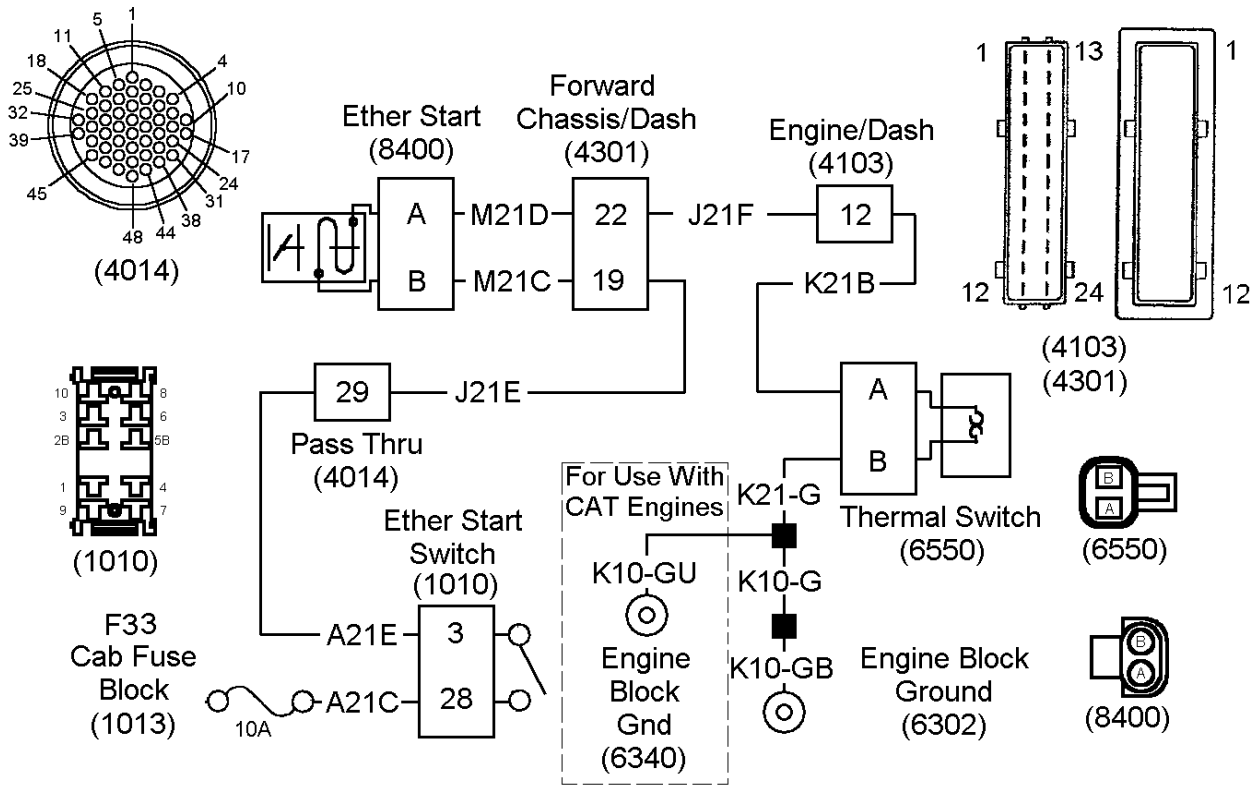

Figure 168 Ether Start Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

F33 CAB FUSE BLOCK #3 (1013)
IN CAB POWER DISTRIBUTION CENTER
(1010) ETHER START SWITCH
LOCATED ON INSTRUMENT PANEL
(4014) PASS THROUGH CONNECTOR
LOCATED ON DASH PANEL ABOVE ESC
(4103) ENGINE/DASH HARNESS CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(4301) FORWARD CHASSIS/DASH PASS CONNECTOR
LOCATED IN ENGINE COMPARTMENT NEAR LEFT FRAME RAIL
(6302), (6340) ENGINE BLOCK GND
CONNECTS TO ENGINE
(6550) THERMAL SWITCH
LOCATED NEAR ENGINE ECM
(8400) ETHER START
LOCATED ON ETHER CONTROL VALVE

Table 119 Ether Start Wiring Harness Connector Checks

Check with Ether Start Harness Connector (8400) Disconnected, Ignition Key ON (Engine Off). **NOTE – This feature will not work if the temperature is above 4.4°C (40°F). A jumper must be installed between the cavities of thermal switch connector (6550) to bypass the thermal switch when the temperature is to high.**		
Test Points-	Spec.	Comments
Ether start connector (8400) cavity B to ground, with ether switch activated.	12 ± 1.5 volts	If voltage is incorrect, check for open or short to ground in circuits between cavity B and the ether start switch terminal 3. Also check for defective switch, failed circuits to the switch from the fuse or a blown fuse.
Ether start connector (8400) cavity B to A, with ether switch activated.	12 ± 1.5 volts	If voltage is missing, check for open in circuits between cavity A and the thermal switch. Also check for failed thermal switch or failed circuits between the thermal switch and ground. If voltage is present, ether start circuits check good. Consider replacing the ether start valve.

2.4. EXTENDED DESCRIPTION

If the engine temperature is below 4.4°C (40°F), a ground from the engine block ground (6302) (with CAT engines (6340)) will be applied to ether start valve connector (8400).

When the key is on and the ether start switch is activated, battery voltage will be supplied from fuse F33 to ether start valve connector (8400). This will open the valve which will inject a measured shot of ether into the intake manifold.

2.5. COMPONENT LOCATIONS

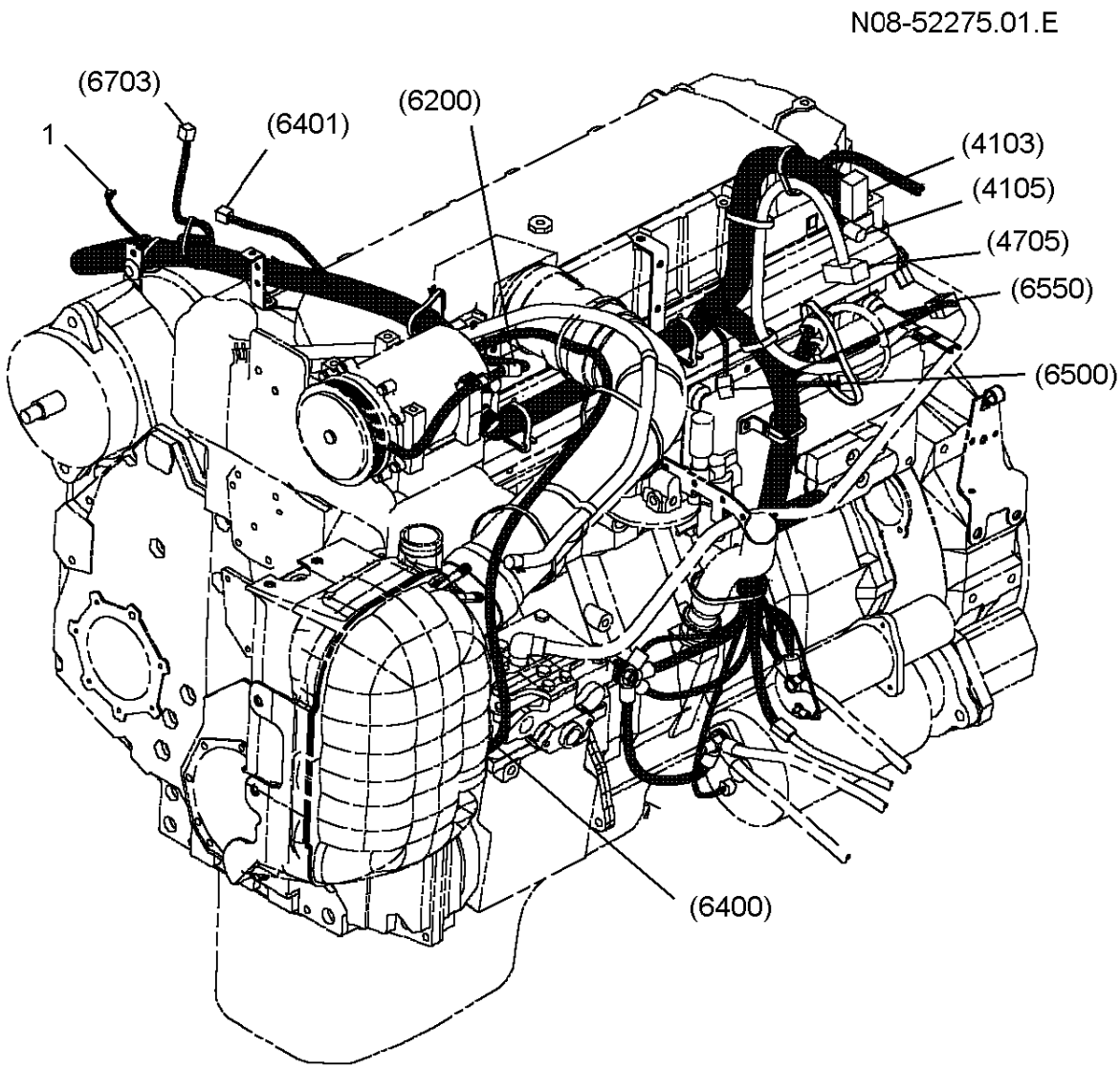

Figure 169 Engine Wiring

1. CIRCUIT TO OPTIONAL ALTERNATOR WARNING LIGHT
(4103) 24– WAY ENGINE CONNECTOR
(4105) 3–WAY ENGINE CONNECTOR
(4705) 8–WAY OR 24– WAY TRANSMISSION CONNECTOR
(6200) AIR CONDITIONER COMPRESSOR CLUTCH CONNECTOR
(6400) COOLANT LEVEL SENSOR CONNECTOR
(6401) MELROSE CONNECTOR (TO AIR FAN SOLENOID)
(6500) EXHAUST BRAKE CONNECTOR
(6550) ETHER START THERMOSTATIC SWITCH CONNECTOR
(6703) 24– WAY ENGINE CONNECTOR

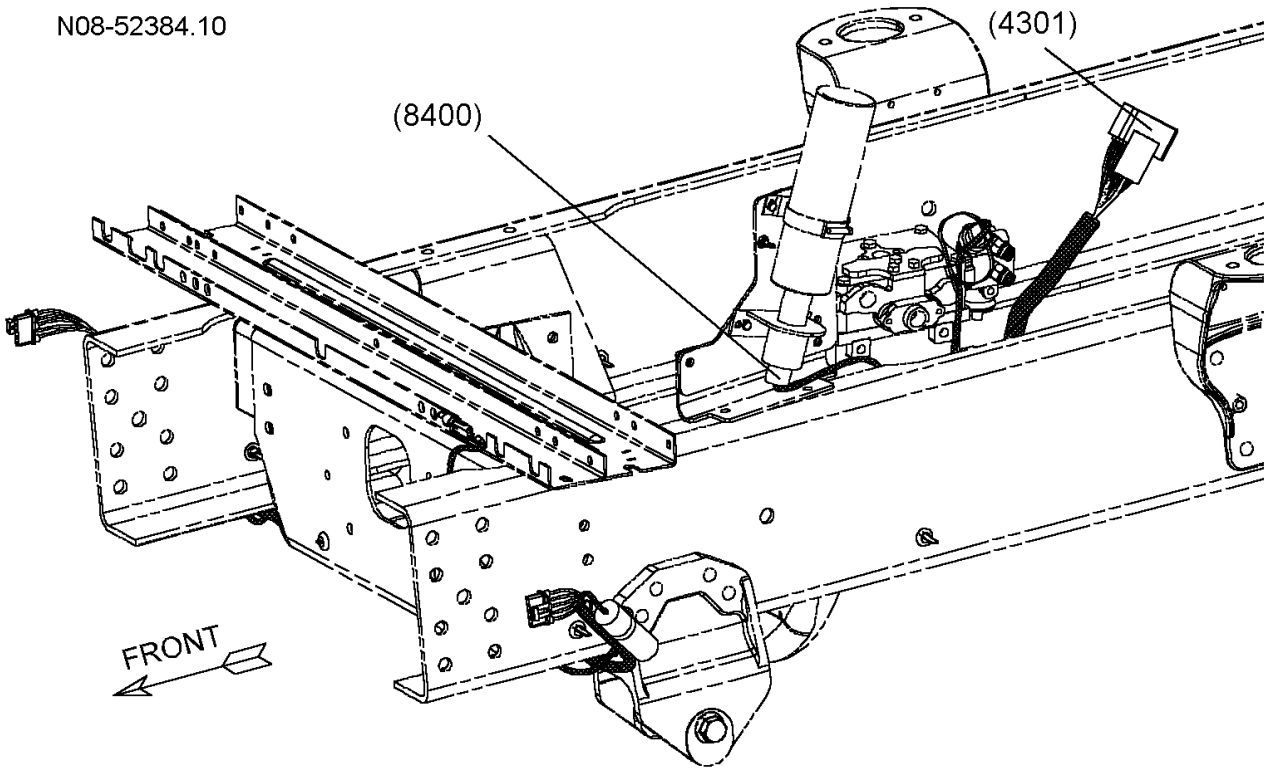

Figure 170 Typical Ether Start Bottle Location

(4301) FORWARD CHASSIS/DASH CONNECTOR
(8400) ETHER BOTTLE CONTROL VALVE CONNECTOR

3. SNOW VALVE (ENGINE INTAKE)

3.1. CIRCUIT FUNCTIONS

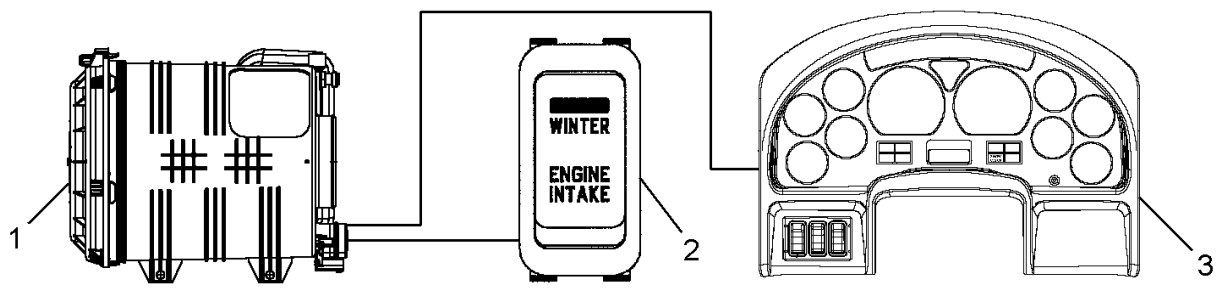

Figure 171 Snow Valve (Engine Intake) Functional Diagram

1. AIR INTAKE FILTER
2. SNOW VALVE (WINTER/ENGINE INTAKE/SUMMER) SWITCH
3. ELECTRONIC GAUGE CLUSTER

The snow valve (engine intake) feature turns a drum inside the air cleaner to divert air intake from outside of the vehicle to inside the engine compartment. This prevents heavy snow from clogging the air intake.

The feature is controlled by a Winter/Engine Intake/Summer switch on the instrument panel connected directly to the snow valve module.

A snow valve warning light in the instrument cluster, directly controlled by the snow valve module, should illuminate when the snow valve is turning or movement is blocked. The switch indicator will light when the valve is completely closed.

The snow valve motor is protected by a thermal switch.

The snow valve module is not repairable. If it fails, it will have to be replaced.

3.2. DIAGNOSTICS

The ESC will not log any diagnostic trouble codes for snow valve circuits.

Snow Valve Preliminary Check

Table 120 Snow Valve Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify the snow valve is not working.	Check system operation.	Snow valve warning light does not correspond to switch position or intake air is not redirected.	Go to next step.	Snow valve is working.
2.	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 355)					

3.3. FAULT DETECTION MANAGEMENT

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A failure in the snow valve circuits will be apparent when the snow valve warning lamp doesn't illuminate when the show valve Winter/Engine Intake/Summer switch is on, or the lamp doesn't go out when the snow valve Winter/Engine Intake/Summer switch is off.

Failures in snow valve circuits could be attributed to a mechanical blockage, a blown fuse, a burned out indicator lamp, open circuits, circuits shorted to ground, or a failed module.

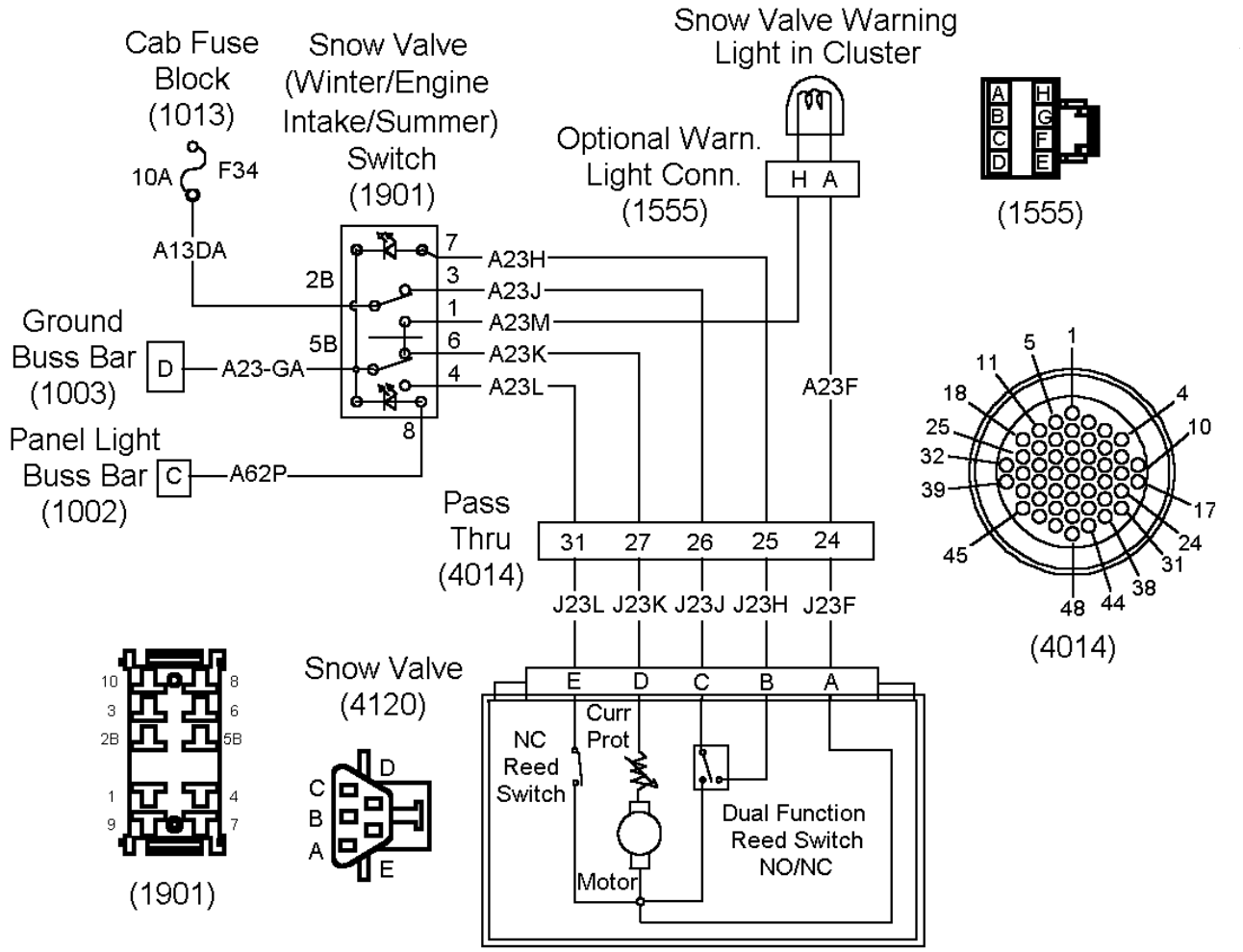

Figure 172 Snow Valve Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

F34 CAB FUSE BLOCK #3 (1013)
IN CAB POWER DISTRIBUTION CENTER
(1002) PANEL LIGHT BUSS BAR
LOCATED IN INSTRUMENT PANEL
(1003) GROUND BUSS BAR
LOCATED IN INSTRUMENT PANEL
(1555) OPTIONAL WARNING LIGHT CONNECTOR
LOCATED ON INSTRUMENT CLUSTER
(1901) SNOW VALVE (WINTER/ENGINE INTAKE/SUMMER) SWITCH
LOCATED ON INSTRUMENT PANEL
(4014) PASS THROUGH CONNECTOR
LOCATED ON DASH PANEL ABOVE ESC
(4120) SNOW VALVE CONNECTOR
LOCATED ON AIR CLEANER

Table 121 Snow valve Module Wiring Harness Connector Checks

Check with Snow Valve Harness Connector (4120) Disconnected, Ignition Key ON. Insure snow valve fuse F34 is not blown		
Test Points-	Spec.	Comments
Snow valve harness connector (4120) cavity C to ground.	12 ± 1.5 volts with switch ON. 0 volts with switch OFF.	If voltage is incorrect, check for open or short to ground in circuits between (4120) cavity C and snow valve switch (1901) terminal 3. Also check for defective switch, failed circuits to the switch from the fuse or a blown fuse.
Snow valve harness connector (4120) cavity C to D.	12 ± 1.5 volts with switch ON. 0 volts with switch OFF.	If voltage is incorrect, check for open or short to ground in circuits between (4120) cavity D and snow valve switch (1901) terminal 6. Also check for defective switch or failed circuits to the switch from ground buss.
Snow valve harness connector (4120) cavity A to ground.	12 ± 1.5 volts with switch OFF. 0 volts with switch ON.	If voltage is incorrect, check for open or short to ground in circuits between (4120) cavity A and snow valve switch (1901) terminal 7. Also check for defective switch, Burned out warning lamp, failed circuits to the switch from the fuse, or a blown fuse.
Snow valve harness connector (4120) cavity A to E.	12 ± 1.5 volts with switch OFF. 0 volts with switch ON.	If voltage is incorrect, check for open or short to ground in circuits between (4120) cavity E and snow valve switch (1901) terminal 4. Also check for defective switch or failed circuits to the switch from ground buss.
Snow valve harness connector (4120) cavity A to B.	12 ± 1.5 volts with switch OFF. 0 volts with switch ON.	If voltage is incorrect, check for open or short to ground in circuits between (4120) cavity B and snow valve switch (1901) terminal 7. Also check for defective switch, open indicator LED or failed circuits to the switch from ground buss.
If voltages check good and there is no mechanical obstructions, consider replacing the snow valve.		

3.4. EXTENDED DESCRIPTION

The snow valve switch (1901) receives battery voltage from fuse F34 on terminal 2B.

The switch receives ground from ground buss bar (1002) on terminal 5B.

When the switch is OFF, battery voltage is applied to terminal C of the snow valve module and the snow valve motor. The switch also applies ground to terminal A, to D and the other side of the motor. This will spin the drum inside the air cleaner to open the valve until it opens a reed switch to open the circuit.

When the switch is ON, battery voltage is applied through the warning light to terminal A of the snow valve module and the snow valve motor. The switch also applies ground to terminal E and the other side of the motor. This will spin the drum inside the air cleaner to close the valve until it opens a reed switch to open the circuit.

3.5. COMPONENT LOCATIONS

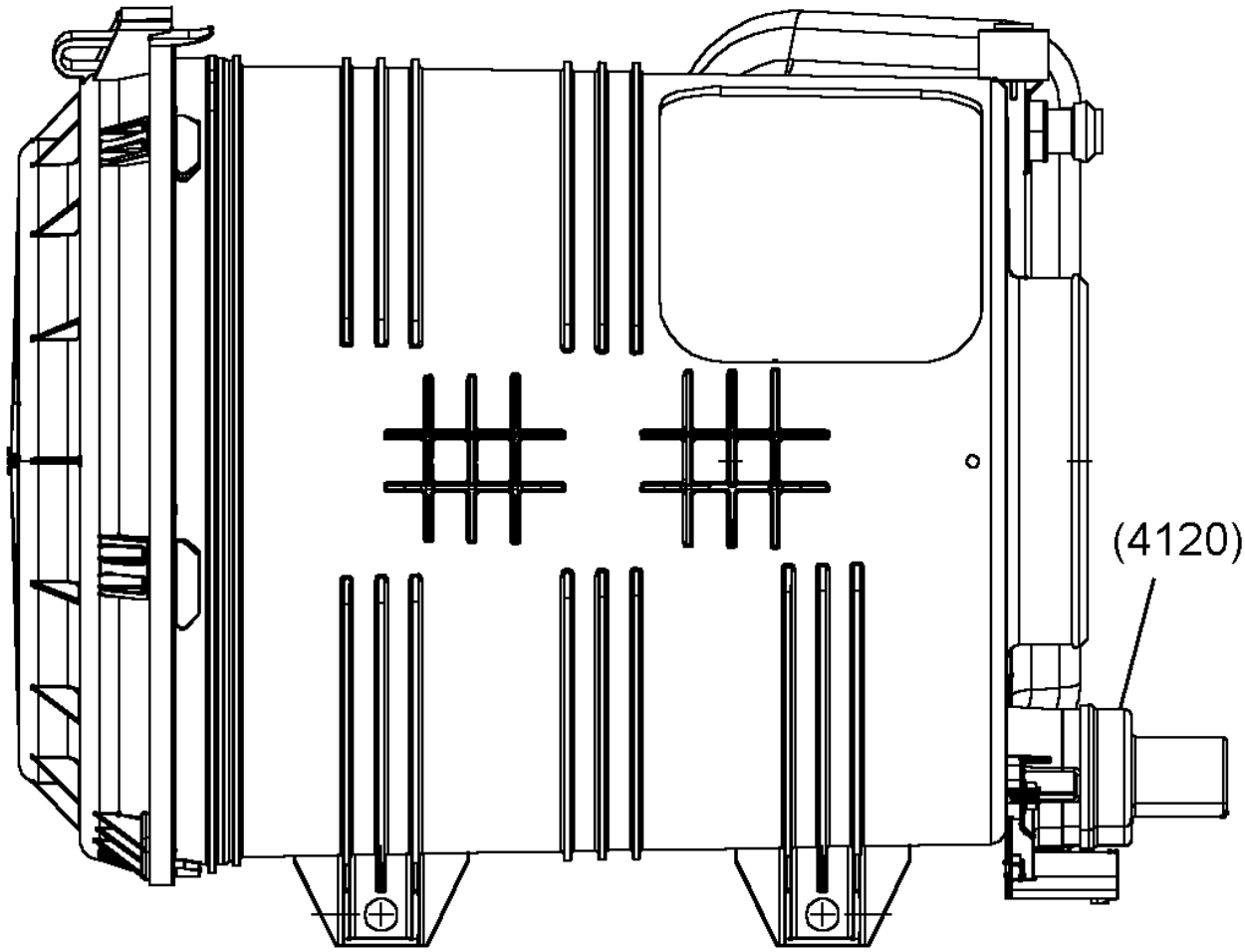

Figure 173 Air Intake Filter with Snow Valve

(4120) SNOW VALVE MODULE

4. FAN WIRING — CAT AND CUMMINS

4.1. FAN SOLENOID CIRCUIT FUNCTIONS

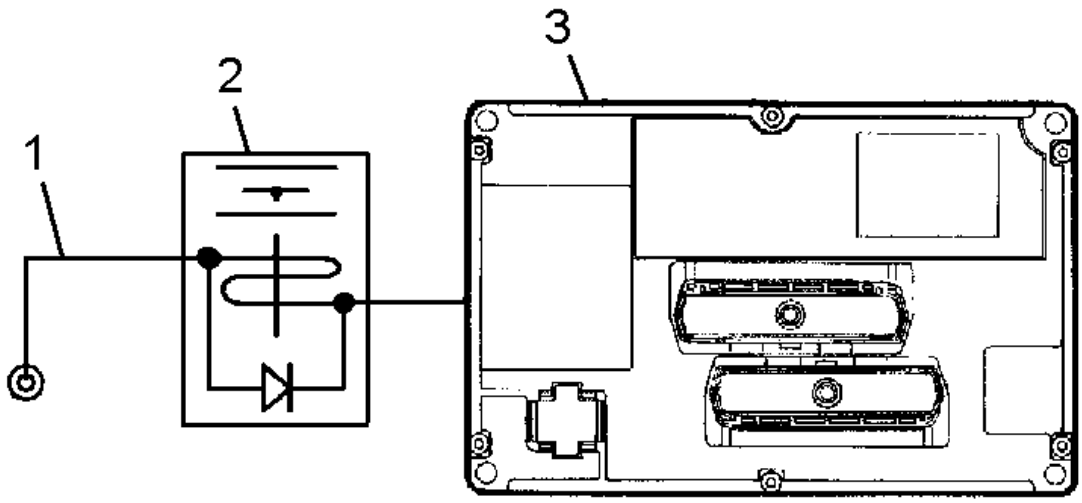

Figure 174 Fan Solenoid Function Diagram

1. ENGINE BLOCK GROUND
2. FAN SOLENOID
3. ENGINE CONTROLLER

On vehicles with optional air activated fans (the majority of the vehicles are built with standard viscous drive fans that have no electrical controls). The engine controller monitors engine coolant, intake manifold temperature, and air conditioning head pressure. When any of these systems operate beyond their set parameters, the engine controller will control turning the fan off by energizing a solenoid to control air pressure to the fan. In the event of a solenoid circuit fault the fan will remain on continuously.

The engine controller turns the fan on under the following conditions:

If the engine speed is less than 2250 RPM or the engine is running **and any of the following conditions exists:**

Coolant temperature sensor is greater than 96°C (205°F) **or**

There is an active engine diagnostic code for the coolant temperature sensor **or**

The retarder solenoid signal is active (high mode) for more than 10 seconds with coolant temperature sensor greater than 80°C (176°F) **or**

The ESC sends a command, on the drivetrain 1939 data link, to the engine controller (required when high AC compressor pressure is sensed).

The engine controller turns the fan off under the following conditions:

Engine speed is greater than 2300 RPM **and all of the following conditions exists:**

Coolant temperature sensor is less than 92°C (198°F) **and**

No active coolant temperature sensor diagnostic code **and**

Retarder solenoid signal is active (high mode) with coolant temperature sensor less than 75°C (167°F) **and**

The ESC is not sending a command to the engine controller (high AC compressor pressure is not sensed) **and**

The engine has been running at least two seconds.

NOTE – Once the engine controller has turned the fan on, the fan will remain on for a minimum of 180 seconds to avoid unnecessary fan clutch cycling (except at engine start-up — it will run for only two seconds after the engine starts). The 180 second time interval is a programmable feature in the engine controller.

4.2. DIAGNOSTICS

Should the fan solenoid fail to shut off the fan when expected, the problem could be attributed to open or shorted wiring in the ground circuits to the engine block ground, an open or short in the circuit between the fan air solenoid and the Engine controller, a failed solenoid or a missing signal from the engine controller.

The ESC will not log any faults for the fan solenoid circuits. However, an open circuit or short to ground in the fan solenoid circuitry can be detected by the engine controller while retrieving “flash codes”.

Fan Solenoid Preliminary Check

Table 122 Fan Solenoid Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Test drive vehicle to insure fan is not shutting off as expected.	Check fan operation.	Fan is not operating correctly.	Go to next step.	Fan is operating correctly. Problem does not exist or is intermittent.
2.	On	Retrieve “flash codes” and check for code 246. Go to Engine Controller Diagnostic Trouble Codes. (See ENGINE CONTROLLER DIAGNOSTIC TROUBLE CODES , page 361)	Count flashes on check engine warning lamp.	“Flash code” 246 is not active.	Go to next step.	“Flash code” is active. Go to FAULT DETECTION MANAGEMENT (See FAULT DETECTION MANAGEMENT, page 362)

Table 122 Fan Solenoid Preliminary Check (cont.)

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
3.	On	Are other engine diagnostic trouble codes are active?	Check warning lamps for other diagnostic trouble codes.	No other engine diagnostic trouble codes are active.	Go to next step.	Refer to the appropriate engine manual to troubleshoot condition setting the code.
4.	On	If the fan never shuts off and no diagnostic trouble codes are active, check for air pressure to solenoid and through solenoid when it is energized.	Check air pressure through solenoid.			

4.3. ENGINE CONTROLLER DIAGNOSTIC TROUBLE CODES

To display diagnostic codes, set the parking brake and turn the Ignition key “ON”. Then press the Cruise “ON” switch and the Cruise “Resume” switch simultaneously for at least 3 seconds. The diagnostic trouble codes are read by counting the number of light flashes. The following sequence occurs:

The red "ENGINE" light will flash one time. This indicates the beginning of Active diagnostic trouble codes.

The yellow "ENGINE" light will flash repeatedly signaling the active diagnostic trouble codes. All codes are three digits. The number of flashes should be counted in sequence. At the end of each digit of the code there will be a short pause. For example, the code 246 will be sent as two flashes, (a pause), four flashes, (a pause), and six flashes.

After each active code is displayed, the red "ENGINE" light will flash once to indicate the next active code.

Once all active codes have been displayed, the red "ENGINE" light will flash twice to indicate the beginning of Inactive codes.

Inactive codes will be displayed in the same manner as active codes. Once the Inactive codes have been displayed, the red "ENGINE" light will flash three times to indicate that all the stored diagnostic trouble codes have been displayed.

After all repairs have been made, the engine diagnostic trouble codes may be cleared by putting the key switch in the accessory position, turning on the left turn signal and pressing the cruise on and set switches simultaneously for 3 seconds.

Table 123 Fan Solenoid Codes

FAULT CODE	FAULT DESCRIPTION
246	Fan Output Circuit Check Fault
This fault is logged when there is a short to ground or an open in the in the circuits from the engine controller, through the fan solenoid to battery voltage. Go to FAULT DETECTION MANAGEMENT (See FAULT DETECTION MANAGEMENT, page 362)	

4.4. FAULT DETECTION MANAGEMENT

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A failure in the Caterpillar or Cummins ISM Engine fan solenoid circuits will be apparent when the fan doesn't turn off as expected. The ESC will not log any faults for the fan solenoid circuits. However, an open circuit or short to ground in the fan solenoid circuits can be detected by the engine controller during an "on demand" engine standard test. See the appropriate engine manual for details.

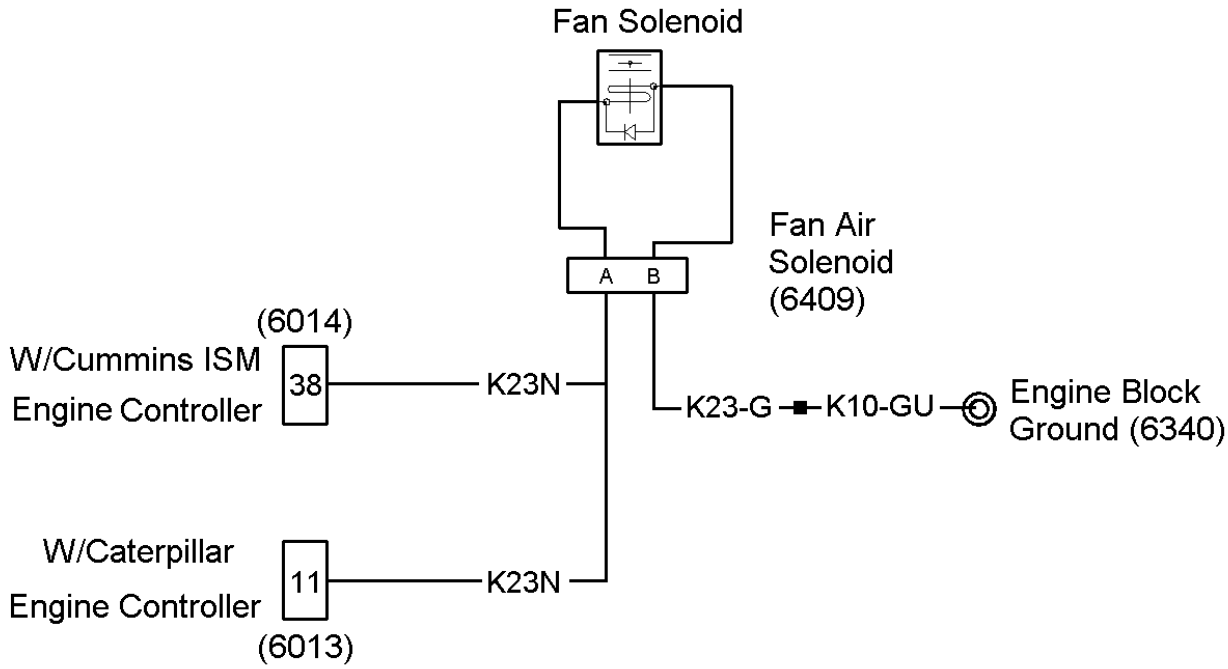

Figure 175 Caterpillar or Cummins ISM Engine with Fan Solenoid Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

(6013) W/CATERPILLAR ENGINE CONTROLLER CONNECTOR
CONNECTS TO ENGINE CONTROLLER
(6014) W/CUMMINS ISM ENGINE CONTROLLER CONNECTOR
CONNECTS TO ENGINE CONTROLLER
(6409) FAN AIR SOLENOID CONNECTOR
LOCATED NEAR ENGINE FAN DRIVE
(6340) ENGINE BLOCK GROUND
LOCATED NEAR ENGINE ECM

Table 124 Caterpillar or Cummins ISM Engine with Fan Solenoid Wiring Harness Connector Checks

Caterpillar or Cummins ISM Engine Controller Diagnostic Trouble Codes		
246	The Engine Fan Control relay failed the output circuit check during a Key On Engine Off Standard Test. **NOTE: For test purposes EFC solenoid can be turned On/Off through the Output State Test.**	
Key on Engine Off - Voltage Checks at Fan Air Solenoid Connector (6409)		
Check with fan solenoid Disconnected, Ignition Key ON (Engine Off).		
Test Points	Spec.	Comments
B to Ground.	0 v	If voltage present, check for short to power

Table 124 Caterpillar or Cummins ISM Engine with Fan Solenoid Wiring Harness Connector Checks (cont.)

A to Ground.	12 ± 1.5 volts	If voltage is missing, check fuse and/or circuit or open/shorts If voltage is present, check for open in circuits between engine controller and solenoid.
NOTE: Normal fan on temperature is 212°F (100°C). Normal fan off temperature is 207.5°F (97.5°C)		

4.5. EXTENDED DESCRIPTION

When the key is on, the fan solenoid is supplied battery voltage at connector (6409) from a fuse in the engine compartment power distribution center.

The engine controller will supply a ground to connector (6409) to energize the solenoid, turning off the fan.

4.6. COMPONENT LOCATIONS

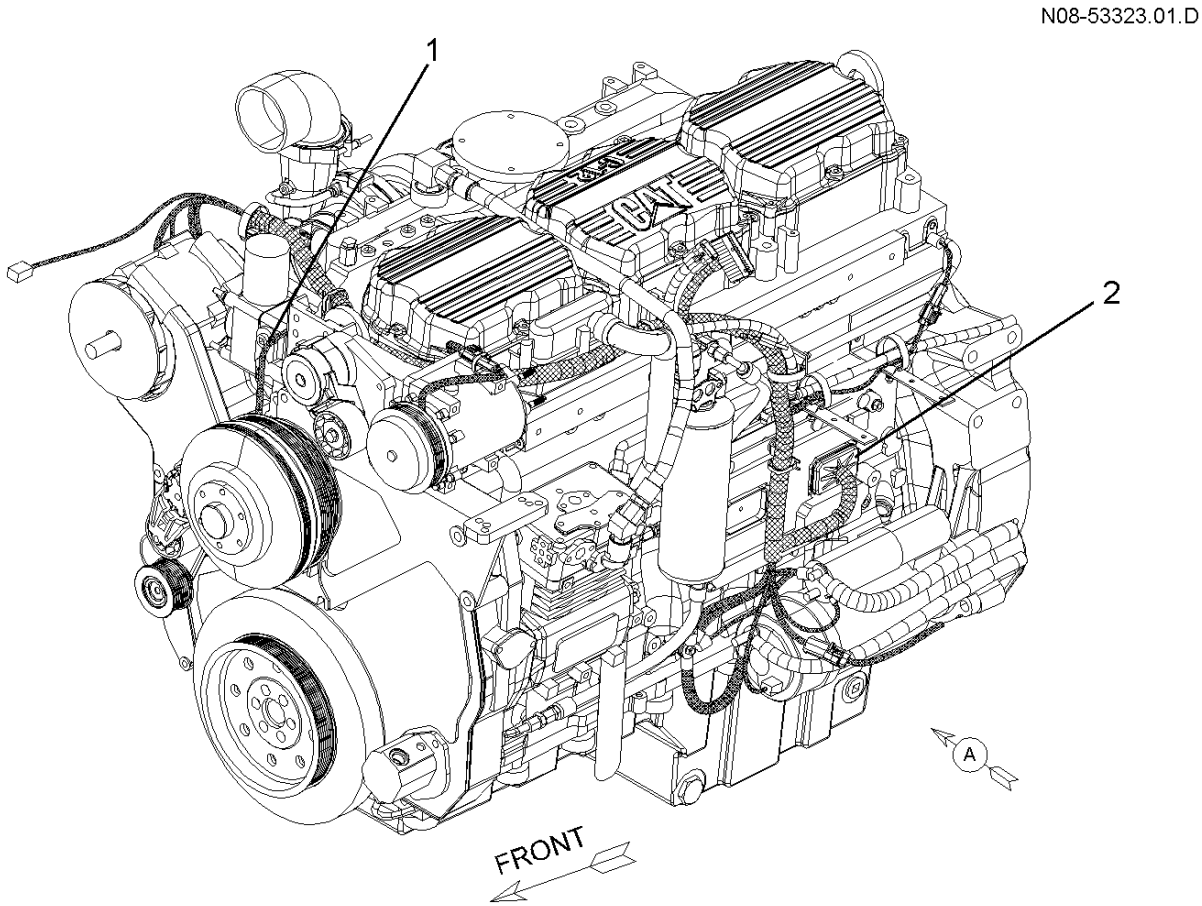

Figure 176 Caterpillar Engine Wiring

1. (6409) ELECTRICALMAGNETIC FAN CIRCUIT K23–G OF ENGINE HARNESS TO FAN PIGTAIL
2. (6013) ENGINE ECM

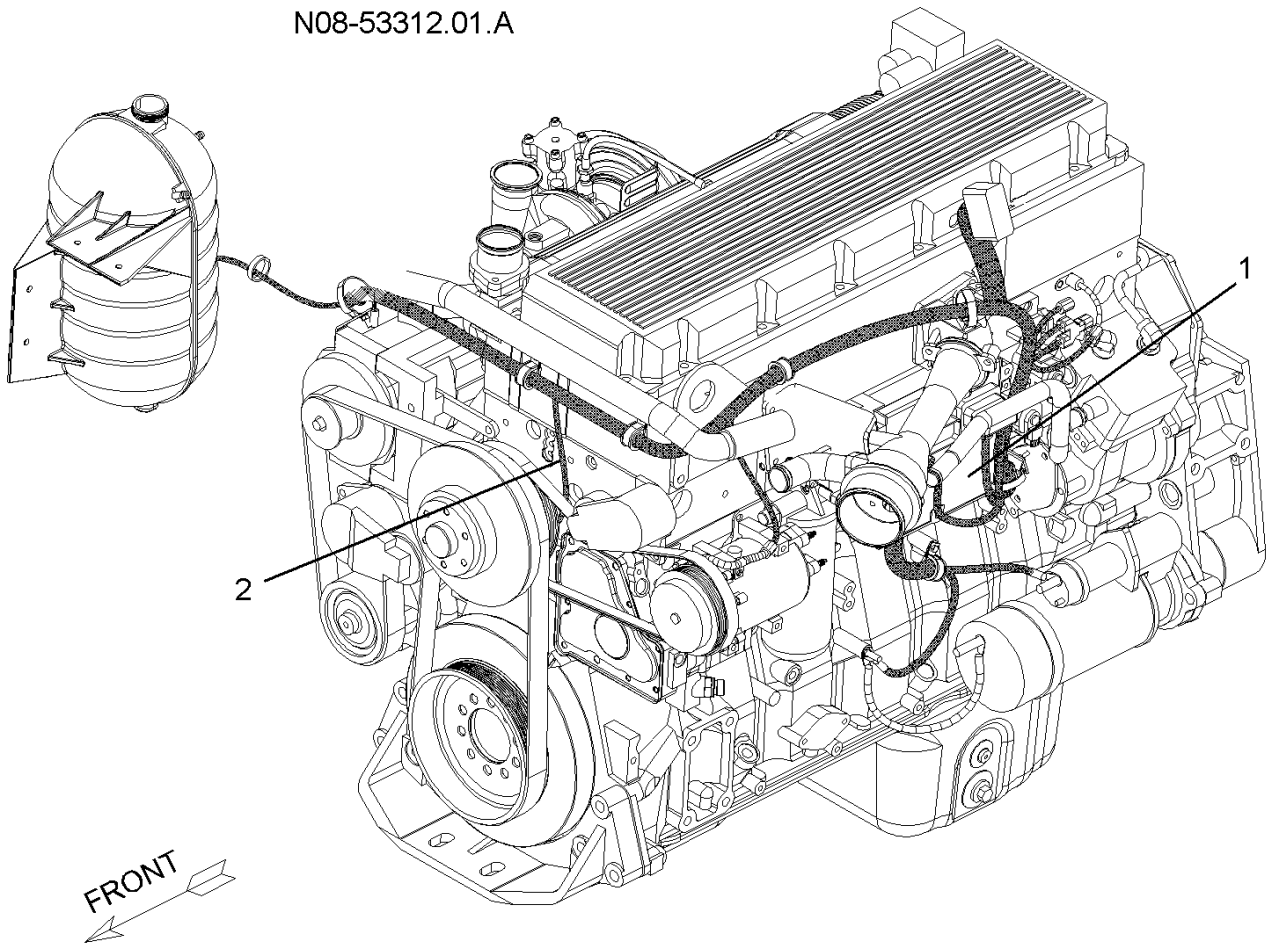

Figure 177 Cummins ISM Engine Wiring

1. (6014) ENGINE ECM
2. (6409) ELECTRICALMAGNETIC FAN CIRCUIT K23–G OF ENGINE HARNESS TO FAN PIGTAIL

5. I6-HEUI EXHAUST BRAKE

5.1. CIRCUIT FUNCTIONS

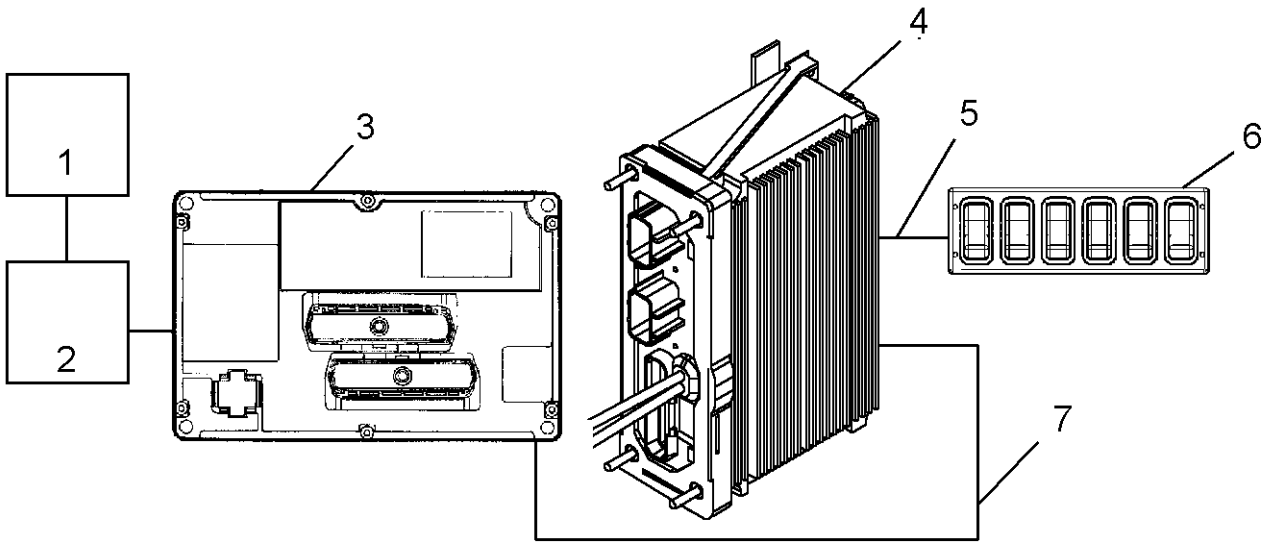

Figure 178 Exhaust Brake Functional Diagram

1. EXHAUST BRAKE SOLENOID
2. EXHAUST BRAKE RELAY
3. ENGINE CONTROL MODULE
4. ELECTRICAL SYSTEM CONTROLLER
5. SWITCH DATA LINK
6. SWITCH PACK
7. DRIVETRAIN 1939 DATA LINK

The exhaust brake uses exhaust to create back pressure in the cylinders, which makes the engine less efficient, thereby slowing the vehicle down.

When the exhaust brake switch in the cab is activated the switch pack will communicate with the ESC on the switch data link. The ESC will send a J1939 message to the engine controller requesting that the engine retarder be enabled. The engine ECM determines when the exhaust brake relay is energized. When the relay energizes, air pressure will be applied to the exhaust brake closing a valve and restricting exhaust flow.

The indicator of the exhaust brake switch should be “ON” if the switch is on and ignition is on. This will indicate that the exhaust brake is enabled. If a switch error occurs the indicator light on the switch should flash.

5.2. DIAGNOSTICS

The ESC will not log any diagnostic trouble codes for exhaust brake circuits. The ESC will diagnose switch errors in the switch pack.

The EZ-Tech running the "INTUNE" diagnostic software can be used to monitor commands into and out of the ESC. See the diagnostic software manual for details on using the software.

The engine controller will detect faults in the circuits to the exhaust brake relay coil. Refer to the applicable engine manual.

Exhaust Brake Preliminary Check

Table 125 Exhaust Brake Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify the exhaust brake is not working.	Check system operation.	Exhaust brake does not activate during deceleration or the indicator on the switch is not steadily illuminated.	Go to next step.	Exhaust brake is working.
2.	On	Is exhaust brake switch indicator steadily illuminated when the switch is on?	Check switch indicator.	Switch indicator is steadily illuminated.	Go to next step.	Refer to the Switch Pack Module section of this manual.(See SWITCH PACK MODULES, page 125)
3.	Go to Fault Detection Management. (See FAULT DETECTION MANAGEMENT, page 355)					

5.3. FAULT DETECTION MANAGEMENT

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A failure in the exhaust brake circuits will be apparent when the indicator on the exhaust brake switch doesn't illuminate when the exhaust brake switch and ignition are on, or the exhaust brake doesn't activate when the vehicle decelerates.

Failures in exhaust brake circuits could be attributed to a mechanical problem, a blown fuse, a burned out indicator lamp, open circuits, circuits shorted to ground, a failed relay or a problem with the engine controller.

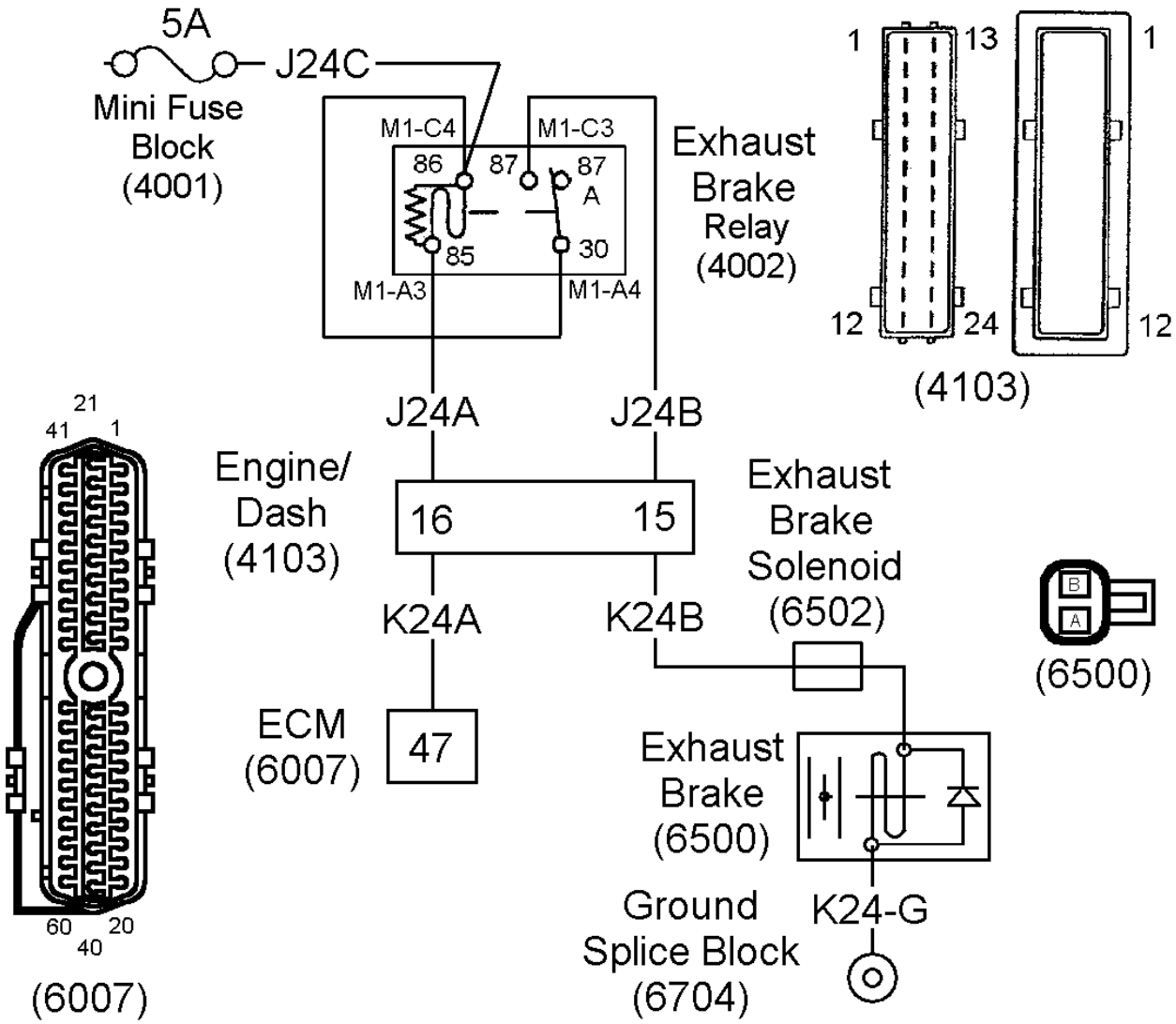

Figure 179 Exhaust Brake Circuits—Always Refer To Circuit Diagram Book For Latest Circuit Information

(4001) MINI FUSE BLOCK 5 AMP EXHAUST BRAKE FUSE
LOCATED IN ENGINE COMPARTMENT POWER DISTRIBUTION PANEL
(4002) EXHAUST BRAKE MICRO RELAY BLOCK
LOCATED IN ENGINE COMPARTMENT POWER DISTRIBUTION PANEL
(4103) ENGINE/DASH CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(6007) ECM CONNECTOR
LOCATED ON ECM
(6500) EXHAUST BRAKE SOLENOID CONNECTOR
LOCATED ON EXHAUST BRAKE SOLENOID
(6502) EXHAUST BRAKE SOLENOID CONNECTOR
LOCATED ON EXHAUST BRAKE SOLENOID
(6704) GROUND SPLICE BLOCK
LOCATED NEAR ENGINE ECM

Table 126 Exhaust Brake Relay Connector Checks

Check with Exhaust Brake Relay Removed and Ignition Key ON. Insure 5A exhaust brake relay fuse in engine compartment PDC is not blown. Bench check relay and replace if it has failed.(See BENCH TESTING RELAYS, page 29)		
Test Points-	Spec.	Comments
Socket cavity C4 to ground.	12 ± 1.5 volts.	If voltage is incorrect, check for open or short to ground in circuit J24C to the fuse. Also check for a blown fuse.
Socket cavity A4 to ground.	12 ± 1.5 volts.	If voltage is incorrect, check for open or short in circuit between A4 and C4.
Socket cavity A4 to C3.	12 ± 1.5 volts.	If voltage is incorrect, check for open or short to ground in circuits from C3 through exhaust brake solenoid (6502) and exhaust brake solenoid (6500) to the ground splice block.
Socket cavity A3 to ground.	12 ± 1.5 volts with exhaust brake inactive. 0 volts with exhaust brake active. Ground from ECM energizes relay.	If voltage is incorrect, check for open or short to ground in circuits between A3 the ECM. Also check for missing voltage from ECM.
If relay and voltages check good, relay circuits are good. Refer to the engine manual for further troubleshooting.		

5.4. EXTENDED DESCRIPTION

The exhaust brake relay fuse supplies ignition voltage to exhaust brake relay cavity C4 (relay coil) and A4 (relay common contact).

When the engine ECM determines the exhaust brake should be activated, the ECM will supply a ground to cavity A3 (relay coil) energizing the relay.

The energized relay will apply ignition voltage to the exhaust brake solenoid terminal A, causing the solenoid to energize.

The energized solenoid will apply air pressure to the exhaust brake.

5.5. COMPONENT LOCATIONS

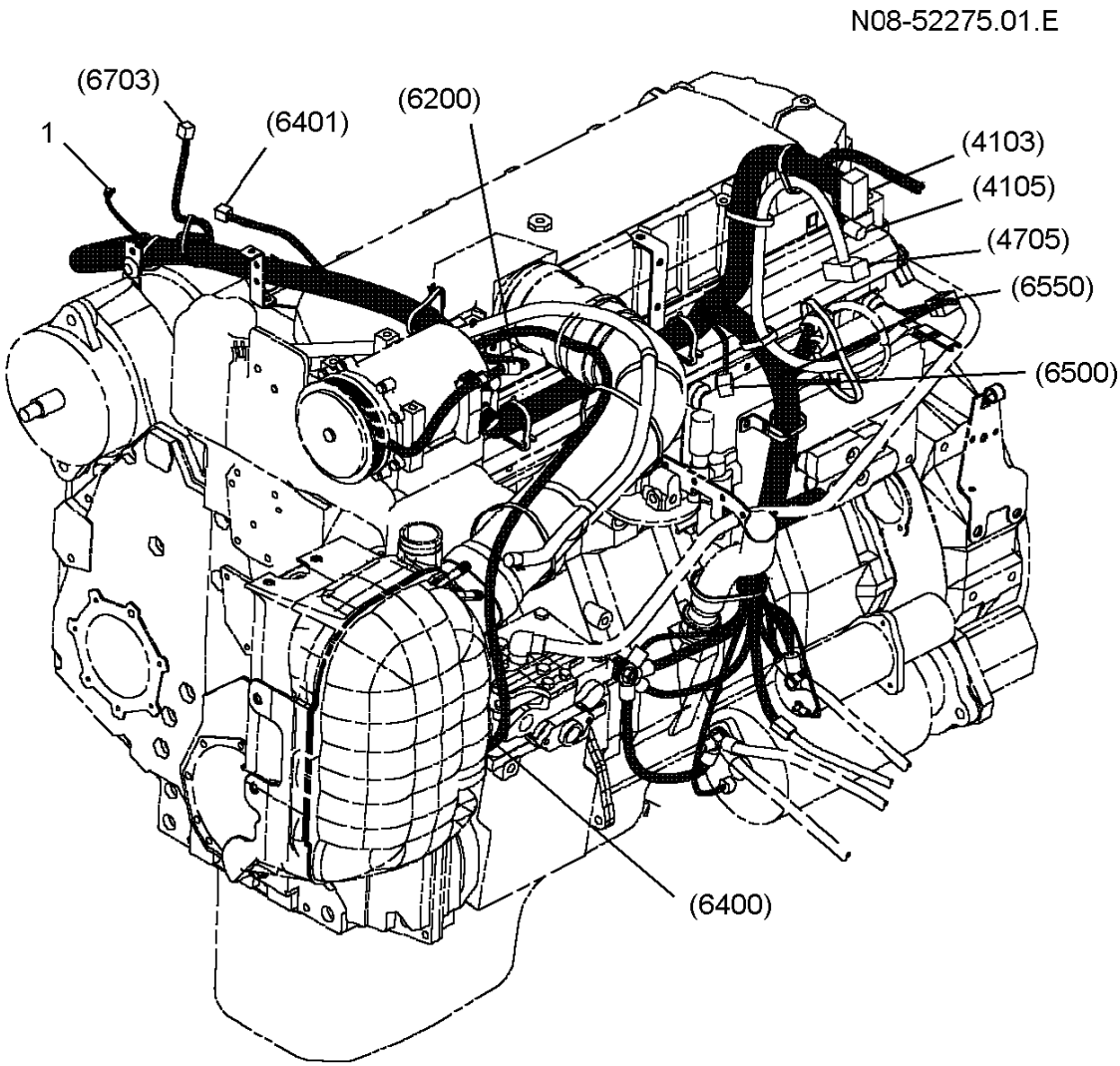

Figure 180 I6 Engine Wiring

1. CIRCUIT TO OPTIONAL ALTERNATOR WARNING LIGHT
(4103) 24– WAY ENGINE CONNECTOR
(4105) 3–WAY ENGINE CONNECTOR
(4705) 8–WAY OR 24– WAY TRANSMISSION CONNECTOR
(6200) AIR CONDITIONER COMPRESSOR CLUTCH CONNECTOR
(6400) COOLANT LEVEL SENSOR CONNECTOR
(6401) MELROSE CONNECTOR (TO AIR FAN SOLENOID)
(6500) EXHAUST BRAKE CONNECTOR
(6550) ETHER START THERMOSTATIC SWITCH CONNECTOR
(6703) 24– WAY ENGINE CONNECTOR

Table of Contents

1. BATTERY

Use with the applicable circuit diagram book for the vehicle being serviced.

1.1. BATTERY POWER

There are three main functions of the storage battery:

A. To supply power to the starter and ignition system so the engine can be cranked and started.

B. To supply extra power required when the vehicle's load requirements exceed the supply from the charging system.

C. To act as a voltage stabilizer by smoothing out or reducing temporary high voltage within the electrical system.

Vehicle batteries are connected in parallel with the positive battery cable connected to the cranking motor solenoid (B) terminal. Depending upon battery quantity and box location, some vehicles have two positive cables to the cranking motor solenoid. The additional cable reduces voltage drop during cranking.

The negative battery terminals are connected to the cranking motor ground stud (G).

In some cases, the negative battery terminals are also connected directly to the frame rail. The engine block ground, the cab, and the frame are also connected by ground cables or circuits to the cranking motor ground.

Remote Start Terminal

The remote starter terminal allows an external battery power source to either charge the vehicle batteries or assist in cranking the engine. Connect the external source positive cable to the remote start terminal and the external source negative cable to vehicle frame rail.

1.2. BATTERIES AND CABLES

Battery systems for these vehicles consist of two 12 volt maintenance free batteries or three 12 volt maintenance free batteries. Any optional batteries installed are also the maintenance free type.

WARNING – When handling batteries, always wear face or eye protection, have water supply available, assure good ventilation, and be sure no open flames are present.

A. Before beginning these test procedures, make sure the vehicle batteries are at 75% state of charge (SOC) or higher. This represents an open circuit voltage (OCV) of 12.4 volts. Batteries with an OCV of 12 volts or less are either completely discharged or have a dead cell.

B. Before beginning these test procedures, check any light or indicator lamp filaments that are suspected of being open (burned out). This is done to avoid unnecessary extensive circuit checks.

C. Before beginning these test procedures, inspect all connectors for loose or damaged pins, wires, etc. Refer to TEST EQUIPMENT AND CONNECTOR REPAIR section in Group 08 Electrical in the ISIS® Master Service Manual.

D. When the technician determines that a fuse is blown, while checking its condition, he is directed to locate the cause of the overload condition and to repair it. While no further instruction on this procedure is listed in the diagnostic tables, the common procedure is as follows: isolate sections of the circuit, by disconnecting connectors, and measure the resistance to ground to find the circuit that is shorted to ground. Then locate the damaged spot in the wire or connector and repair.

E. Diagnostics for circuits that are malfunctioning by sticking in the on position are generally not covered in detail. It is assumed that the technician knows to check for a malfunctioning switch, relay, or solenoid.

Battery Test Procedure

Test each battery separately.

1. Disconnect both battery terminal cables at each battery. Check each battery visually.

2. Examine the hydrometer eye (if no eye go to step 3).
   a. Eye shows green - go to step 4.
   b. Eye shows dark - recharge, then go to step 4.
   c. Eye shows yellow - replace battery.

3. Apply a 300A load for 15 seconds. Turn off load and wait one minute.
   a. If 12.4 volts or more - go to step 4.
   b. If less than 12.4 volts - recharge, then repeat step 3. If battery will not store charge above 12.4 volts, replace it.

4. Apply a test load equal to 50% of the battery CCA rating at 17.8°C (0°F). After 15 seconds,**with the load still applied**, measure and record terminal voltage _____. Turn the load off.

5. Estimate the battery temperature. If measured voltage does not meet or exceed the value shown in the following table, replace the battery.

Table 127 Battery Temperature Table

Temp.	21.1°C	10°C	–1.1°C	–9.4°C	-17.8° C
Temp.	70°F	50°F	30°F	15°F	0°F
Min. Volts	9.6	9.4	9.1	8.8	8.5

6. Clean all cable ends and terminals of the battery with a wire brush And reconnect battery.

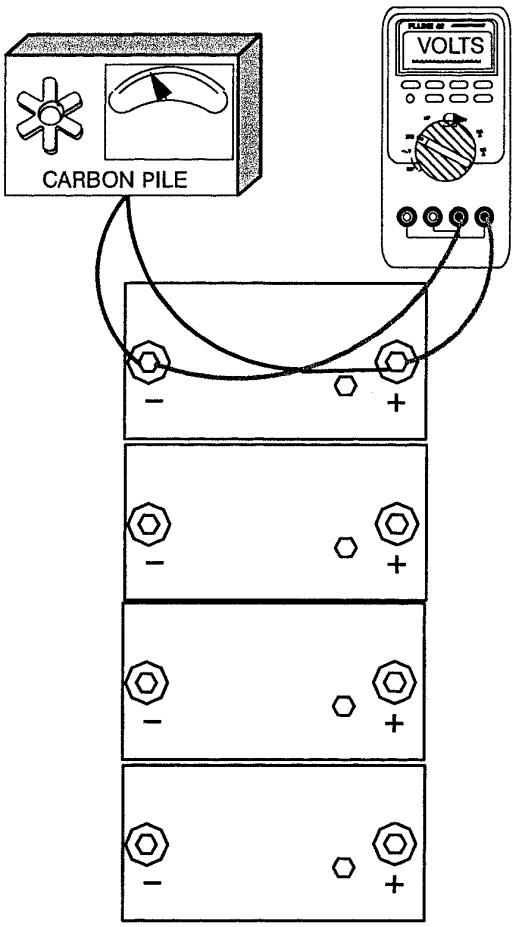

Figure 181 Battery Test Configuration

Battery Cable Voltage Loss Test

Slow cranking is often caused by high resistance in the battery cables or connections, especially in cold weather. After all batteries check good (Battery Test Procedure) and terminals are clean and tight, check the battery cables. To check battery cables place a specific load on the batteries at the starter and measure the voltage drop in each cable. This load will be supplied by the adjustable carbon pile.

The voltage drop in the positive cable plus the voltage drop in the negative cable equals the difference between the battery voltage and the starter voltage due to the cables. The maximum acceptable loss has been calculated only for the specific load specified in the test.

1. Tighten nuts holding battery cables to the solenoid and starter terminals.

   NOTE – The solenoid BAT terminal is at battery voltage when batteries are connected.

2. Connect carbon pile positive lead to start solenoid BAT terminal and negative lead to starter ground terminal.

3. Connect voltmeter from the starter solenoid “B” terminal to battery positive post.

4. Turn carbon pile on and adjust load to 500A. Read and record positive cable voltage drop. Turn off the load and allow carbon pile to cool.

5. Connect voltmeter from negative battery post to starter ground terminal. Attach leads directly to ground studs and not the cables.

6. Turn carbon pile on and adjust load to 500A. Read and record negative cable voltage drop. Turn off the load.

Positive Cable Voltage Loss (step 4) _____

plus Negative Cable Voltage Loss (step 6) _____

equals Total Cable Loss _____.

If system loss **is 0.6V or less**, go toStarting Motor System Circuits And Components.

If system loss**is greater than 0.6V**, repair or replace cable(s) with excessive voltage loss and retest.

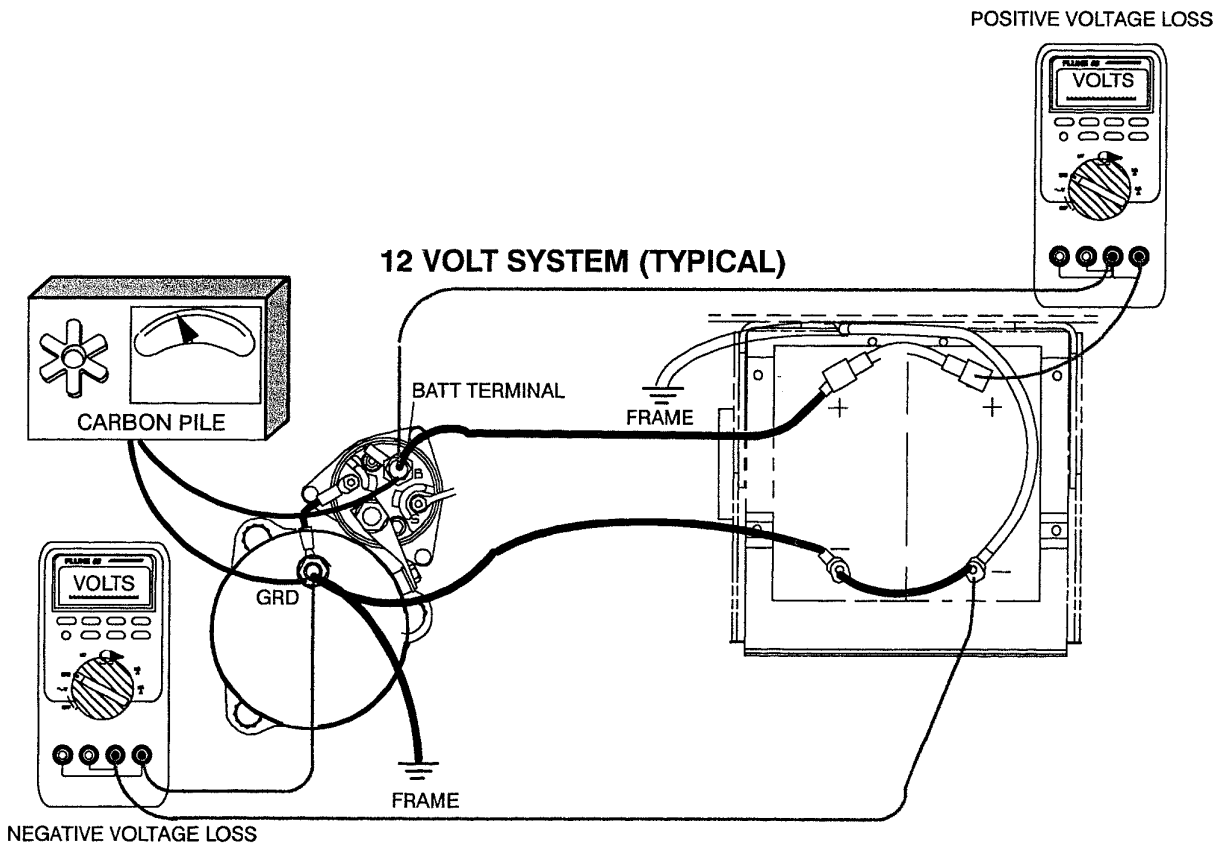

Figure 182 Battery Cable Voltage Loss Test

1.3. COMPONENT LOCATIONS

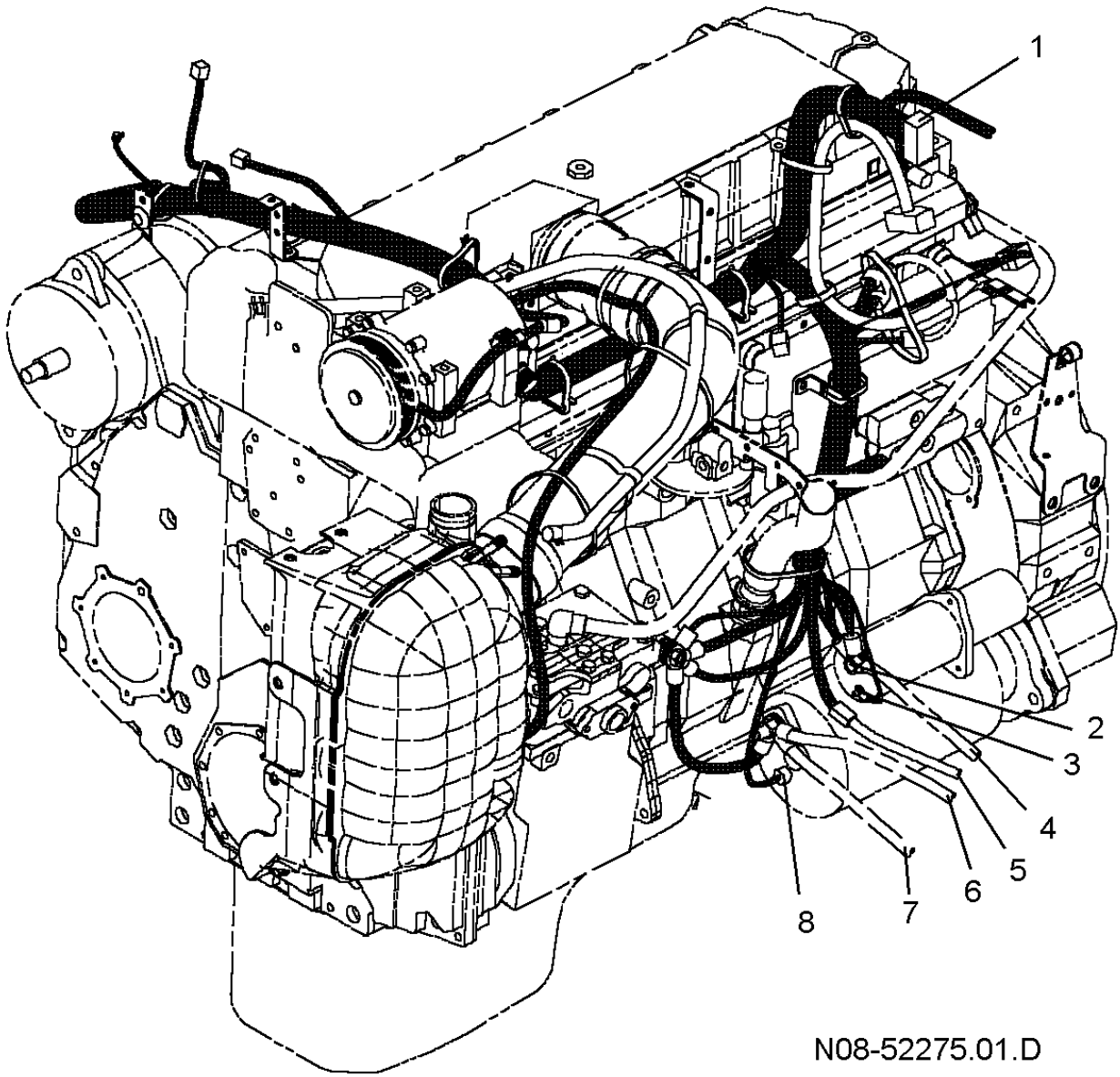

Figure 183 Cranking Motor Location

1. ENGINE/DASH CONNECTOR (4103)
2. B TERMINAL OF CRANKING MOTOR SOLENOID
3. S TERMINAL OF CRANKING MOTOR SOLENOID
4. TO BATTERY POSITIVE TERMINAL
5. ENGINE CONTROLLER CLEAN POWER AND GROUND
6. TO BATTERY NEGATIVE TERMINAL
7. TO FRAME GROUND
8. THERMAL OVERCRANK PROTECTION (6316)

2. CHARGING

The alternator generates alternating current which is subsequently converted to direct current. The function of the alternator is to supply power to the vehicle electrical system. Any current above the needs of the vehicle components is used to charge the batteries.

2.1. CHARGING CIRCUITS

For a complete discussion on operating principles for alternators, refer to Group 08 Electrical in the ISIS® Master Service Manual for the specific alternator being serviced.

International Engines

When the vehicle is running, the alternator supplies power through the alternator or (BAT) terminal, and circuit K2 to a splice. From the splice, current flows through 2 fusible links, K2–FL and K2A-FL to the crank motor solenoid battery stud. From this stud, current flows to the batteries through the positive battery cable. Power is also applied to maxi fuse block (4000) through circuit J14H and circuit J14F.

The alternator is grounded through the (GRD) terminal and circuit K2–G to the starter motor ground stud (G).

2.2. VEHICLE CHARGING SYSTEM

Batteries Undercharged

Before beginning test procedures: check battery cables and alternator wiring (especially grounds) for clean, tight connections. Wires and connectors should not be damaged or corroded.

Perform the following checks before removing the alternator from the vehicle.

1. Accessories having been left on for an extended time.

2. Check alternator drive belt tension (refer to GROUP 12 - ENGINE, Cooling in the ISIS® Master Service Manual for belt tension specifications). As a general rule, if the alternator fan can be rotated by pulling on the fan with one finger, the belt is too loose.

3. Inspect for defective batteries as described in Group 08 Electrical in the ISIS® Master Service Manual.

4. Wiring defects. Visually check wiring, clamps, and connections for clean, tight connections, free of damage and corrosion.

5. With the engine off, check voltage to ground at the BAT terminal of the alternator. A zero reading indicates an open in circuit 2, between the alternator and batteries.

6. A defective component or wiring defect may be causing a small current drain that is less than the fuse rating for the circuit so the fuse does not open. To locate the unwanted current drain:

   NOTE – Batteries should be fully charged for the following test.

   a. KEY OFF- Turn all accessories and controls off. Disconnect circuit 2 from the alternator B terminal.

   b. To check the entire system for current drains, insert the DMM leads in the COM and 10A fused jack on the meter. Set the meter to DC amps. Connect the meter in series with the alternator. If the meter leads are not connected with correct polarity, a (-) amp reading will be present.

c. Some current draw will be present. If the current draw is less than 0.3A move the lead from the 10A jack to the 320mA jack to read the exact current flow.

d. Refer to the Battery Power Distribution circuit diagrams in S08285. Remove the battery feed fuses one at a time, while monitoring the meter for any change in current flow. Note that some circuits (such as clock or radio or engine computer, etc.) should be drawing some current. Look for current draw in circuits that should not be active.

7. Perform Alternator Wiring Test — Part 1 below.

Alternator Tests

The alternator output must reach the batteries and accessory loads with a minimum amount of voltage loss. Any loss slows the rate of charge to the batteries and can cause the batteries to be undercharged. Discharged batteries can damage the starter and cause vehicle electrical components to operate improperly.

Most alternators control the maximum system voltage using a voltage regulator. Maximum voltage output is available at the alternator BAT terminal, but if any voltage is lost in the wiring, something less than the maximum will reach the batteries and load devices. The greatest losses occur when the charging system is outputting at the maximum rated level (amps).

Alternator Wiring Test — Part 1

Instead of using alternator current output, this test (and Alternator Wiring Test — Part 2 below) uses the same amount of current but draws it from the batteries (must be fully charged). Using the carbon pile load, the current flows in reverse through the circuit without the engine running.

1. Without the engine running, connect the carbon pile to the alternator output terminal and ground.

   NOTE – Alternator output is at battery voltage.

2. Connect voltmeter across battery.

3. Adjust the carbon pile to alternator rated output (amps). Rated output is stamped on the case or on a tag.

4. Measure and record BATTERY VOLTAGE. Turn the carbon pile off.

5. Move the voltmeter to the alternator, but do not connect to carbon pile clamps. Adjust carbon pile to rated output (amps) of the alternator.

6. Measure and record ALTERNATOR VOLTAGE. Turn carbon pile off.

BATTERY Voltage (step 4) _____

minus ALTERNATOR Voltage (step 6) _____

equals System Loss _____

If system loss **is 0.7 volt or less**, go to Alternator Replacement Test.

If system loss **is greater than 0.7 volt** go to Alternator Wiring Test — Part 2.

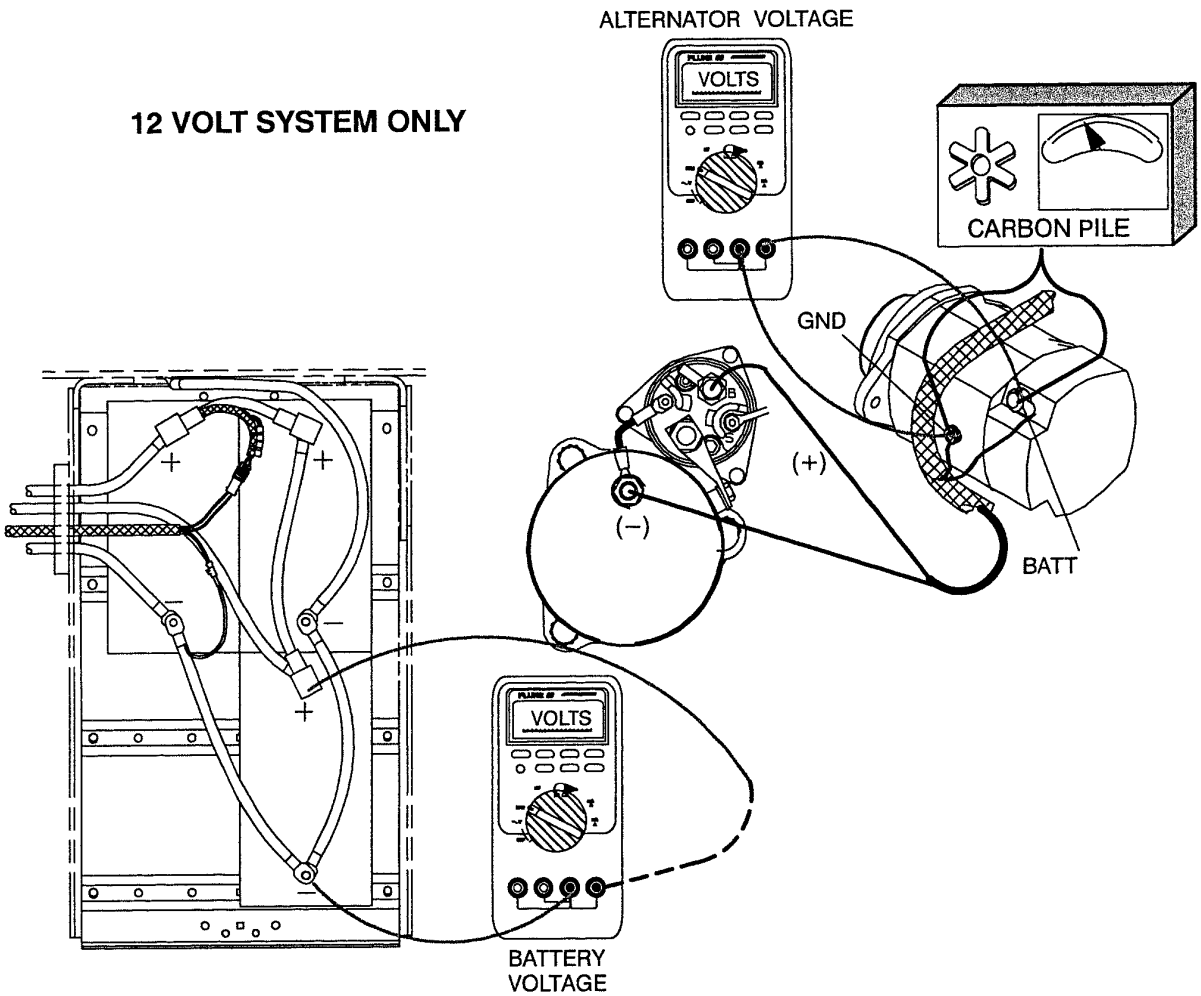

Figure 184 Alternator Wiring Test — Part 1

Alternator Wiring Test — Part 2 (12 volt System Only)

If system voltage is MORE than 0.7 volt in Alternator Wiring Test — Part 1, above, perform this test.

1. With the carbon pile still connected, connect Fluke 88 meter to alternator BAT terminal and to the positive battery terminal.

2. Adjust carbon pile to alternator rated output (amps). Measure and record POSITIVE CIRCUIT LOSS. Turn carbon pile off.

3. Connect the meter to the alternator ground and to the battery negative terminal.

4. Adjust the carbon pile to alternator rated output (amps). Measure and record NEGATIVE CIRCUIT LOSS. Turn carbon pile off.

   POSITIVE CIRCUIT LOSS (step 2) _____

plus NEGATIVE CIRCUIT LOSS (step 4) _____

equals TOTAL SYSTEM LOSS _____

If system loss **is 0.7 volt or less,** go to Alternator Replacement Test, below.

If system loss **is greater than 0.7 volt** , repair circuit(s) defects, then go to Alternator Replacement Test, below.

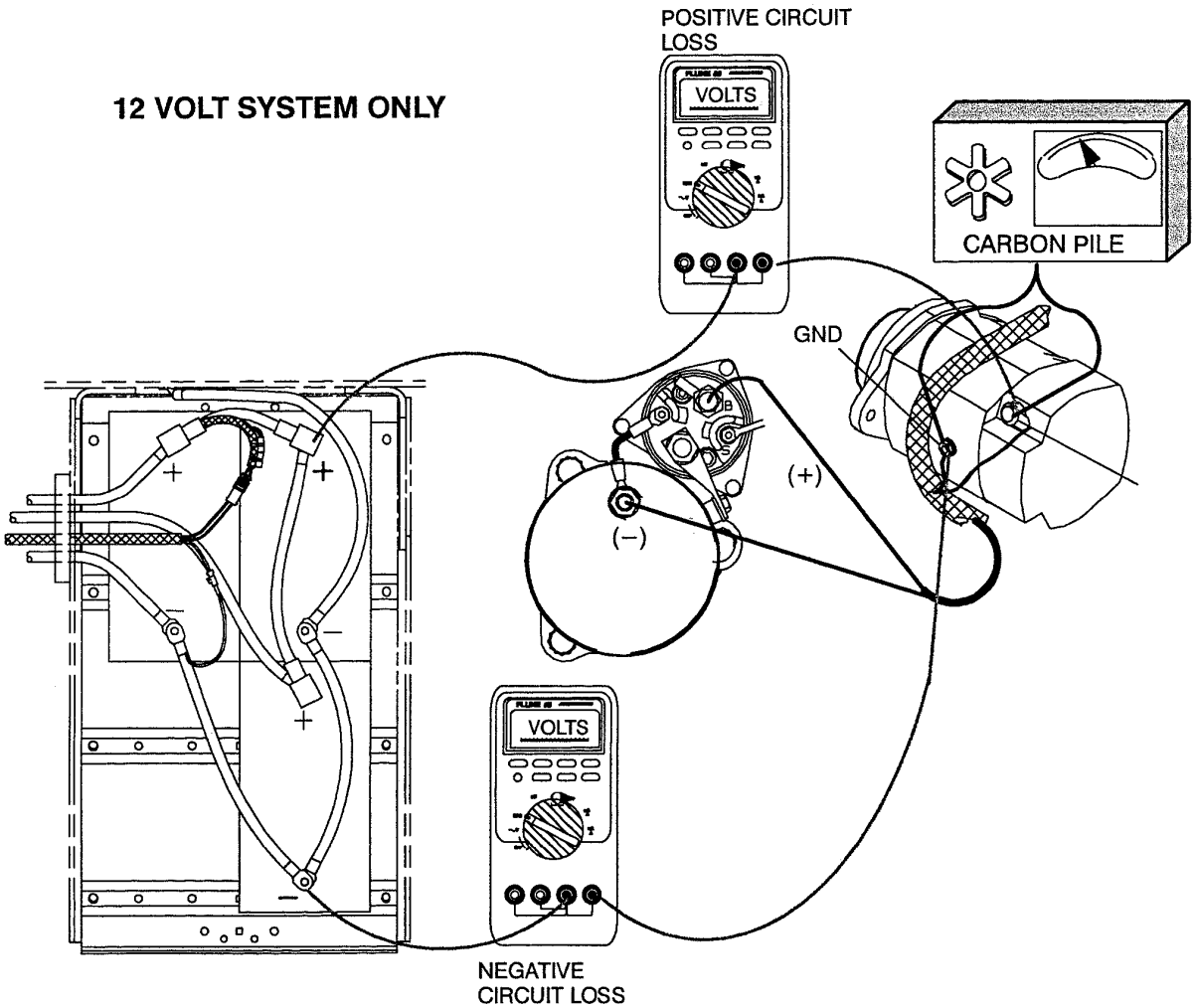

Figure 185 Alternator Wiring Test — Part 2 (12 volt System Only)

Alternator Replacement Test (12 volt System Only)

1. If the wiring tests have been performed (circuits OK), adjust alternator belt and tighten mounting bolts and ground connections.

2. With vehicle at shop temperature, connect the carbon pile and the ammeter as shown. To use an ammeter without induction clamp, connect meter leads to same terminals as the carbon pile.

3. With NO electrical loads turned on, start the engine. Fast idle until voltage stabilizes (does not increase for 2 minutes). Voltage then should not exceed 15 volts.

4. Speed up the engine and turn on the carbon pile until the ammeter shows output has reached the highest value. Record the value _____A. Turn off carbon pile and the engine.

5. Rated output is stamped on the alternator case or on a tag. If current output measured is not within 10% of rated output or the voltage exceeds 15 volts, replace the alternator.

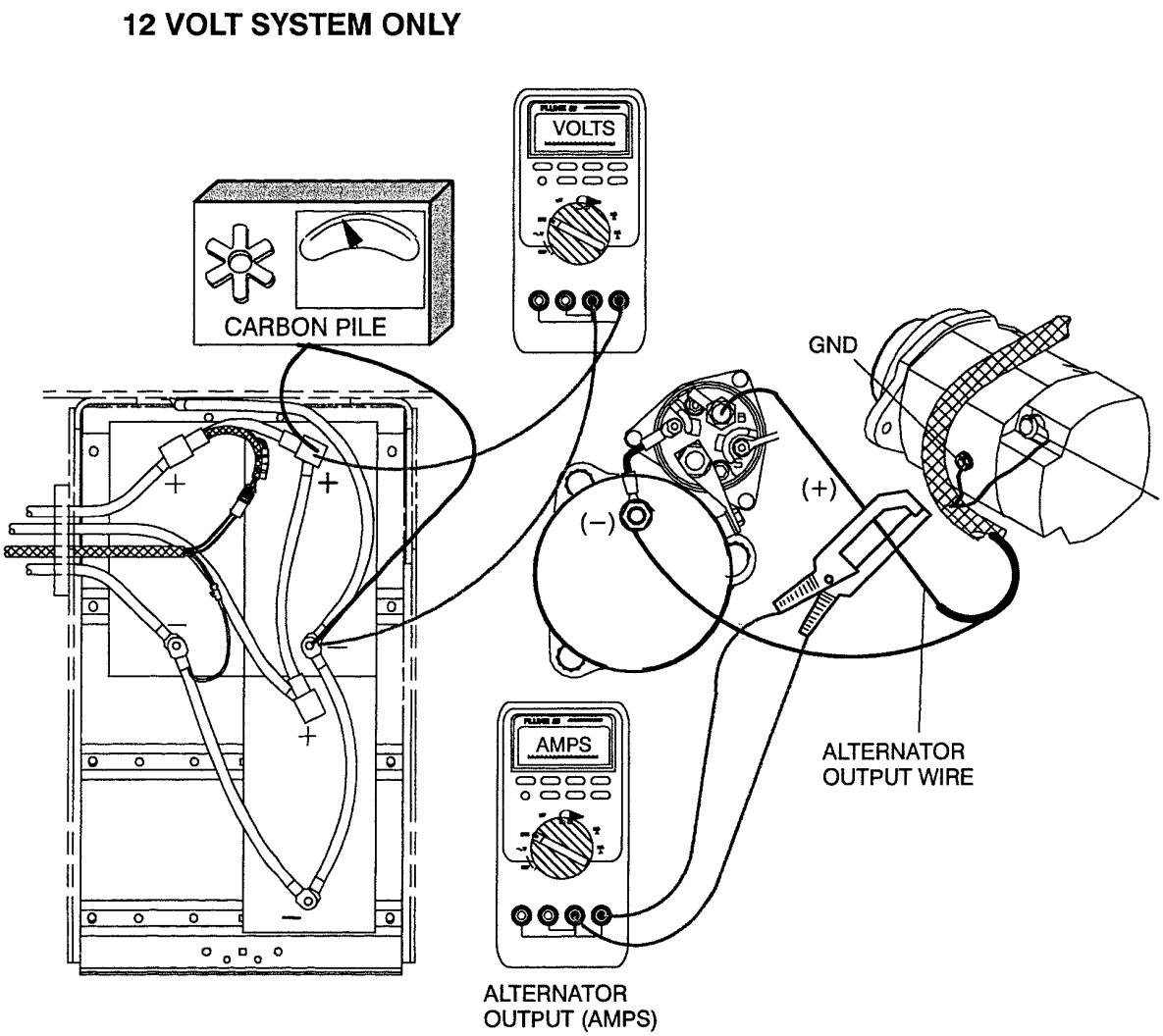

Figure 186 Alternator Replacement Test (12 Volt System Only)

2.3. COMPONENT LOCATIONS

N08-52775.03.B

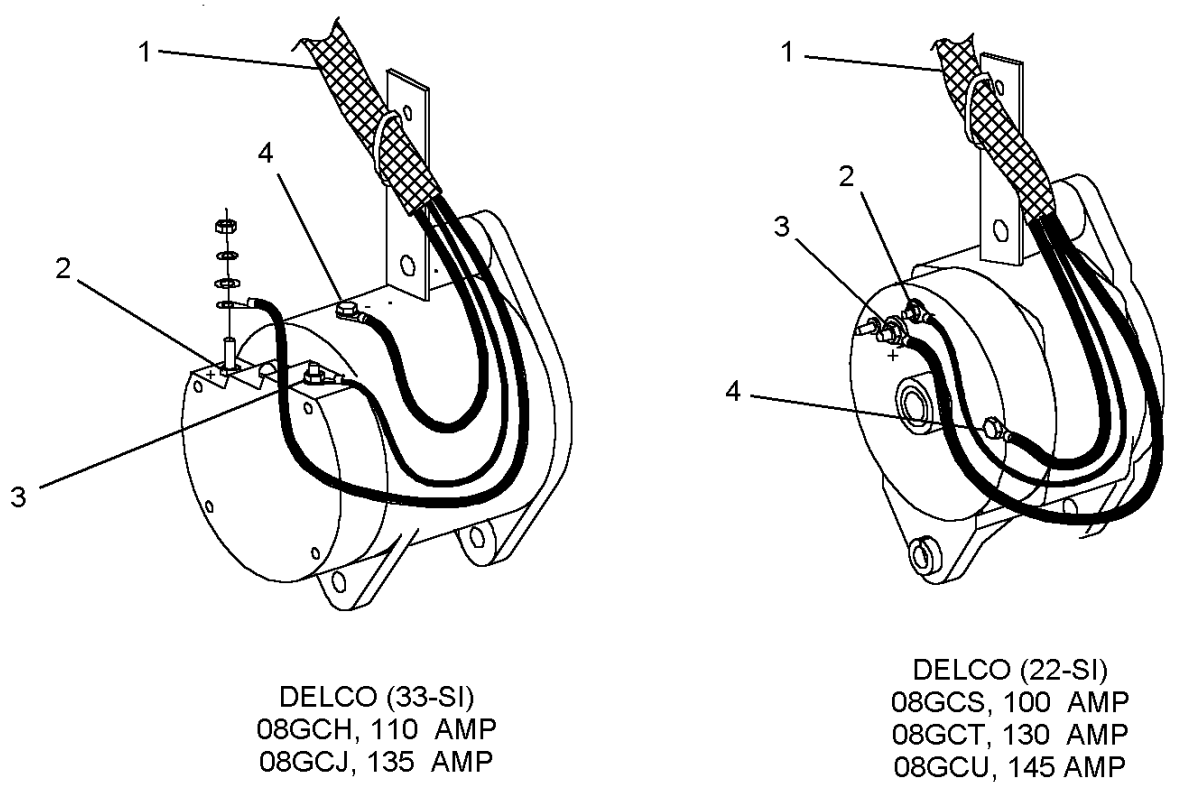

Figure 187 Delco Alternator Wiring With International Engines

1. ENGINE HARNESS
2. POSITIVE TERMINAL, CIRCUIT K2
3. NEGATIVE TERMINAL, CIRCUIT K2–G
4. I TERMINAL, CIRCUIT

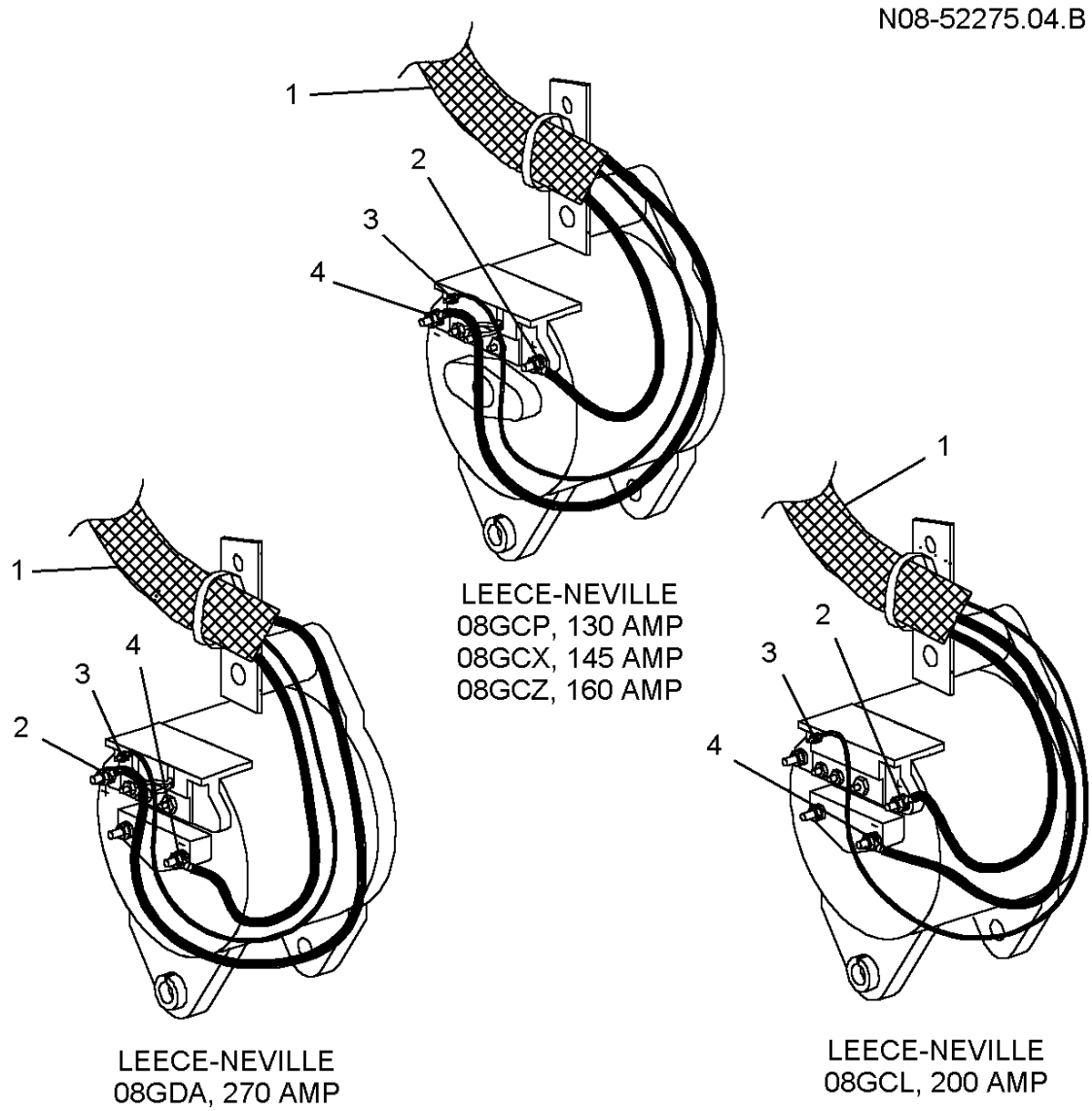

Figure 188 Leece–Neville Alternator Wiring With International Engines

3. ENGINE CRANKING

3.1. CIRCUIT FUNCTIONS

The cranking motor provides the rotation of the engine crankshaft, through the flywheel, that is needed to start the engine.

The cranking motor circuits provide power to the cranking motor to turn over the crankshaft of the engine. If all other systems are operational, the engine will start.

Components of the system with International engines consist of the crank motor and solenoid, the key start switch (or push button), starter ISO & power relay, the engine electronic control module (ECM), and a clutch switch with a manual transmission or a neutral position signal with an automatic transmission.

NOTE – Vehicles with the Auto Neutral feature will also use a crank inhibit relay.

When the clutch pedal is pushed, or the automatic transmission is in park or neutral, or the EATON Autoshift transmission in neutral the engine controller will provide a ground to the starter ISO & power relay . When the key is in the start position, 12 volts will be applied to the relay causing it to energize. The energized relay will supply 12 volts to the cranking motor solenoid causing it to energize and apply battery voltage to the cranking motor.

NOTE – Cranking motors ending in a type 50, like 350 or 450, contain thermal overcrank protection.

On vehicles using starters with thermal overcrank protection, excessive cranking will cause cranking motor temperature to reach a pre-set thermal overcrank limit. The thermal switch will then open causing the motor to disengage. When the thermal switch opens it interrupts a ground signal from the engine controller to the coil of the starter relay, preventing it from energizing. When the crank motor cools, the switch closes, permitting the crank motor to operate again.

3.2. DIAGNOSTICS

Table 128 Cranking System Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify cranking system is inoperative.	Attempt to start vehicle.	Cranking motor is turning engine.	Engine cranks. Problem may be intermittent.	Go to next step.
2.	On	Determine if any other features are malfunctioning that may have common circuits. (Example: Missing ground common to several features.)	Check for other malfunc-tioning features.	No other features are malfunc-tioning.	Go to next step.	Identify and repair condition causing several features to be inoperative.
3.	On	Measure voltage at cranking motor solenoid while key is in start position?	Cranking motor solenoid terminal “S”.	12 ± 1.5 volts	Go to next step.	Go to Starter ISO & Power Relay Circuits. (See STARTER ISO & POWER RELAY CIRCUITS, page 389)
4.	Off	Measure voltage at cranking motor solenoid while key is in off position?	Cranking motor solenoid terminal “B”.	12 ± 1.5 volts	Go to Cranking Motor System Circuits And Components. (See CRANKING MOTOR SYSTEM CIRCUITS AND COMPONENTS, page 391)	Identify and repair cause of incorrect voltage to cranking motor “B” terminal from batteries.

3.3. STARTER ISO & POWER RELAY CIRCUITS

For complete information on operation and servicing cranking motors used on these vehicles, refer to Group 08 Electrical in the ISIS® Master Service Manual or the manufacturers service manual.

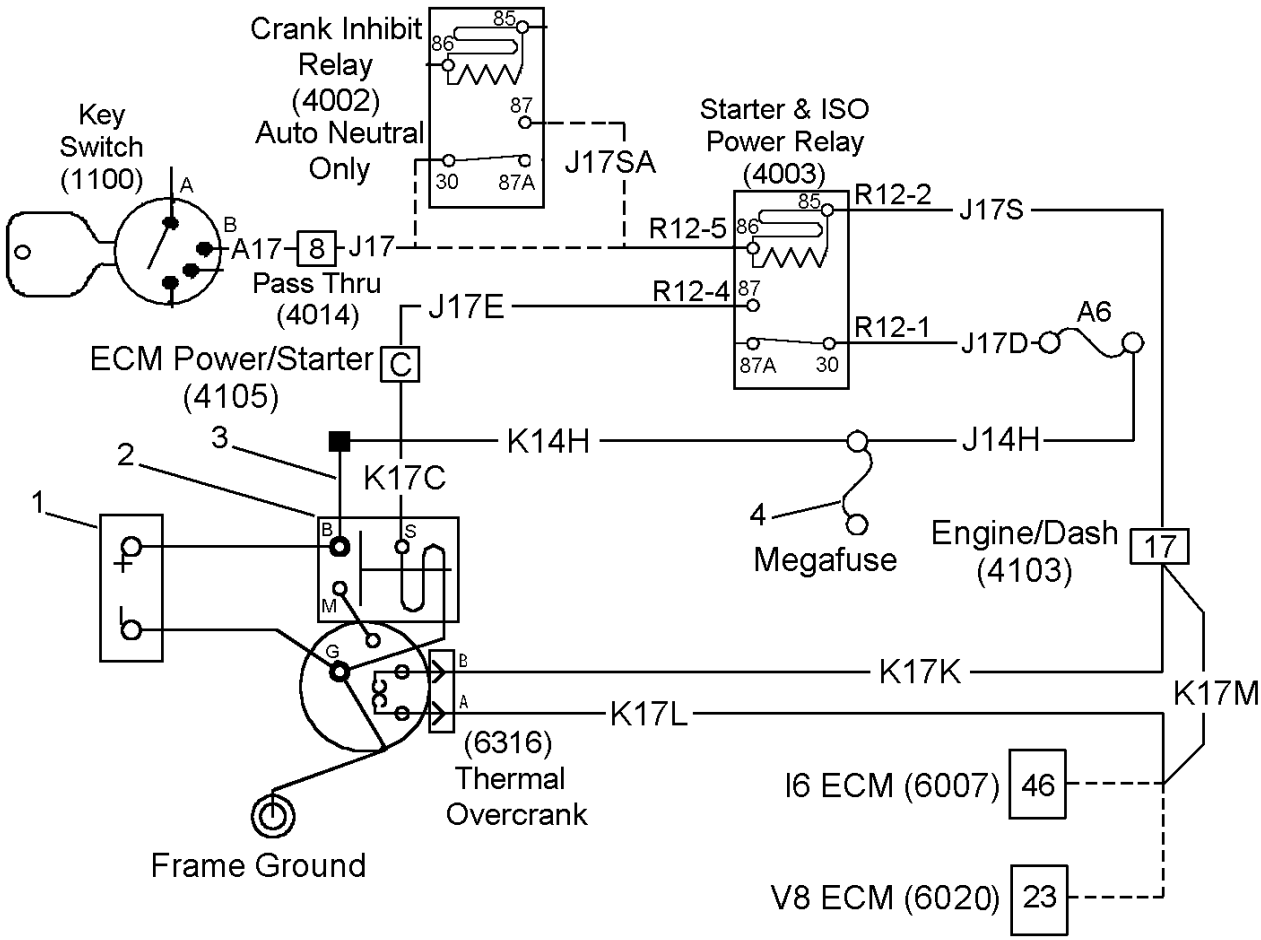

Figure 189 Starting Power Distribution Diagram

1. BATTERY
2. STARTER SOLENOID
   LOCATED ON STARTER
3. FUSIBLE LINK
4. MEGAFUSE

(1011), (1012), (1013), (1014) CAB FUSE BLOCKS
   LOCATED IN CAB PDC
(1100) KEY SWITCH CONNECTOR
(4000) A1-A6 MAXIFUSES
   LOCATED IN ENGINE PDC
(4002) CRANK INHIBIT MICRO RELAY USED WITH AUTO NEUTRAL ONLY
   LOCATED IN ENGINE PDC
(4003) START & ISO POWER RELAY R12
   LOCATED IN ENGINE PDC
(6316) THERMAL OVERCRANK
   LOCATED ON STARTER

Fault Detection Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

Battery power is always present at the crank motor solenoid (B) terminal through the positive battery cable. Power from the (B) terminal is supplied to start relay (R12) terminal through a fusible link, circuit K14H, circuit J14H, maxifuse A5 and circuit J17D.

On I6 engines the ground signal for starter and ISO relay (4003) R12 terminal 2 is supplied from engine controller connector (6007) terminal 46. The engine controller supplies a ground when the engine is not running. The clutch switch (depressed) or transmission circuits (in neutral) apply 12 volts to (6007) pin 26. On starters with thermal over crank protection, the thermal relay will open this circuit.

On V8 engines, ground signal for starter and ISO relay (4003) R-12 terminal 2 is supplied from engine controller connector (6020) terminal 23. The engine controller supplies a ground when the engine is not running. The clutch switch (depressed) or transmission circuits (in neutral) apply 12 volts to (6020) pin 8

The ground signal from the engine controller will be supplied when the clutch is engaged, or the automatic transmission is in neutral, or the EATON Autoshift transmission is in neutral.

On vehicles **without the auto neutral feature**, when the key switch (1100) is turned to the start position power is applied through circuit A17, through pass thorough connector (4014) and circuit J17 to starter relay R12 terminal 5. If the ground signal from the engine controller is present at R12 terminal 2, the relay will energize.

On vehicles **with the auto neutral feature**, when the key switch (1100) is turned to the start position power is applied through circuit A17, through pass thorough connector (4014) and circuit J17 to crank inhibit micro relay. When the crank inhibit relay is energized by signals from the transmission controller, power will be applied to starter relay R12 terminal 5. If the ground signal from the engine controller is present at R12 terminal 2, the relay will energize.

With the start relay energized, power flows through the ISO & power relay (4003) R12 contacts terminal 4, circuit J17E, ECM power starter connector (4101), and circuit K17C, to the (S) terminal of the crank motor solenoid which energizes the crank motor solenoid.

As long as the engine is running, the engine controller will not allow the cranking motor to be engaged.

Table 129 Starter ISO & Power Relay Circuit Tests

Starter ISO & Power Relay Connector (4003) R12 Voltage Checks Check with R12 removed and ignition on. Bench check relay and replace if it has failed.(See BENCH TESTING RELAYS, page 29) **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
	Bench test starter ISO & power relay.	If relay fails replace relay. If relay passes test, go to next step.

Table 129 Starter ISO & Power Relay Circuit Tests (cont.)

(4003) R12 cavity 1 to ground	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits between (4003) R12 and maxifuse A5. Also insure maxifuse has voltage to it and is not blown.
(4003) R12 cavity 1 to cavity 4	12 ± 1.5 volts	If voltage is missing, check for open in circuits between (4003) R12 cavity 4 and ground through the cranking motor solenoid.
(4003) R12 cavity 1 to cavity 2	With clutch pedal depressed, or automatic transmission in park, or autoshift transmission in neutral voltage should be 12 ± 1.5 volts	If voltage is missing, check for open in circuits between (4003) R12 cavity 2 and engine ECM or open/short in clutch switch or transmission circuits to the engine controller. Also check for open thermal switch if overcrank feature is installed.
Information on clutch and neutral circuits to the engine controller is provided at the following areas: Manual transmissions, refer to Clutch Switch Circuits. (See CLUTCH SWITCH, page 566) LCT transmissions, refer to Neutral and Back-Up Light Circuits. MD transmissions, refer to Neutral Signal Circuits. (See AUTOSHIFT RELAY CIRCUITS, page 1015) EATON Autoshift transmissions, refer to Autoshift Relay Circuits. (See AUTOSHIFT RELAY CIRCUITS, page 1015)		
(4003) R12 cavity 5 to ground	With key switch in ignition position, 12 ± 1.5 volts	If voltage is missing, check for open in circuits between (4003) R12 cavity 5 and key switch (1100) circuit A17. On vehicles with auto neutral, check crank inhibit relay and circuits.

3.4. CRANKING MOTOR SYSTEM CIRCUITS AND COMPONENTS

Cranking Motor Solenoid Circuit Test - Part 1 (With International Engine)

Refer to Cranking Motor Solenoid Circuit Test - Part 1 (With International Engine)

Starter shifting in and out, or not pulling in, is often caused by high resistance in the cranking motor solenoid circuit. When the solenoid circuit has excessive voltage loss, the cranking motor pinion may not engage the flywheel. If it does engage, it may drop out too soon when battery voltage drops. The solenoid circuit includes the starter ISO & power relay (located in the engine power distribution center) and circuits connected to the cranking motor solenoid.

On vehicles with **overcrank protection**, refer to Testing Thermal Overcrank Protection System **before performing this test**.

1. Disconnect starter relay circuit K17C from the starter solenoid “S” terminal.

2. Connect the carbon pile positive lead to circuit K17C and the negative lead to the cranking motor ground. Connect the positive lead of a DMM voltmeter to the solenoid “B” terminal. Connect negative lead of voltmeter to switch wire lead K17C (not to carbon pile clamp). Meter will show battery voltage.

3. Have an assistant turn the key switch to the start position or push start button. Voltmeter reading should be zero. You should hear the starter relay energize with a clicking sound. If the switch doesn't "click," either the starter relay switch is defective or there is no voltage from the key switch circuit (refer to Starter ISO & power relay circuits (See STARTER ISO & POWER RELAY CIRCUITS, page 389).

4. Turn on and adjust the carbon pile to 50 amp load (for no more than 10 seconds). Read and record _____voltage on voltmeter. Release start switch. Turn off and disconnect carbon pile and voltmeter.

If circuit loss **is 0.5 volt or less,** Starter solenoid circuitry is OK.

If circuit loss **is more than 0.5 volt**, go to Cranking Motor Solenoid Circuit Test — Part 2 (See Cranking Motor Solenoid Circuit Test - Part 2 (Wire Voltage Loss), page 393)

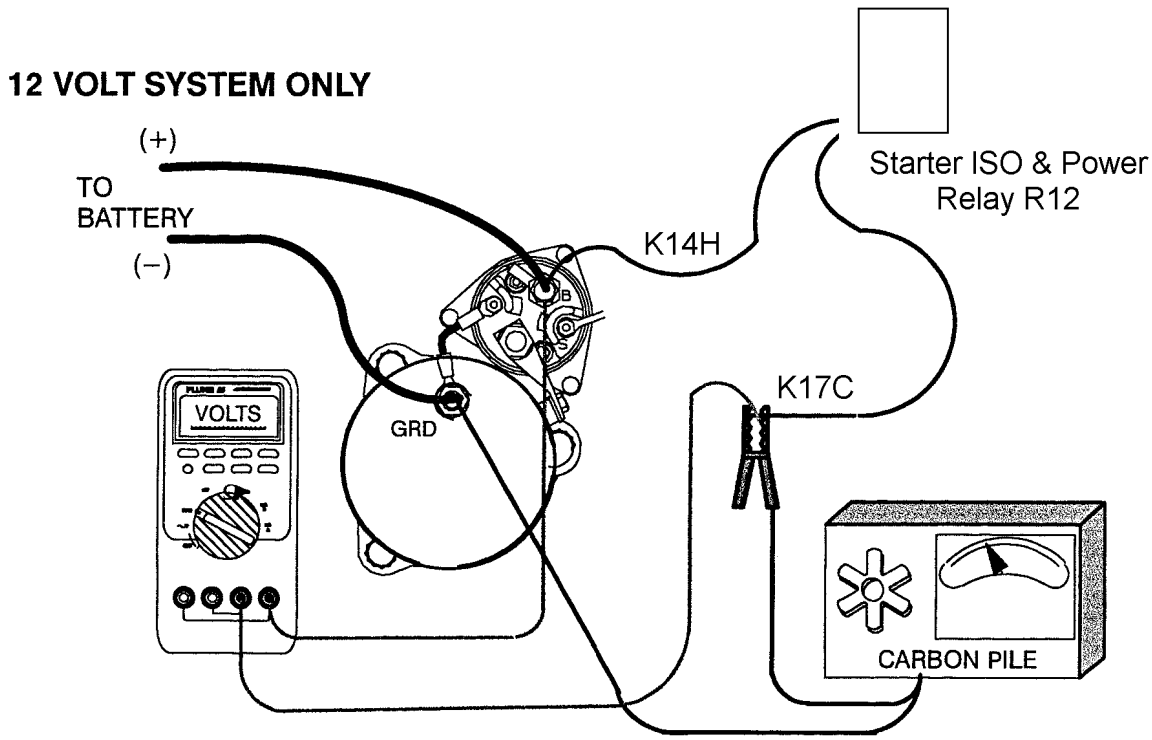

Figure 190 Cranking Motor Solenoid Circuit Test — Part 1 (With International Engine)

Cranking Motor Solenoid Circuit Test - Part 2 (Wire Voltage Loss)

Refer to Cranking Motor Solenoid Circuit Test - Part 2 (Wire Voltage Loss)

If the voltage loss in the previous Test was more than 0.5 volt, the loss is excessive. The loss may be from loose terminals, corrosion, or a worn out starter ISO & power relay. To locate the problem:

1. Disconnect circuit K17C from “S” terminal at Cranking Motor solenoid. Connect carbon pile to circuit K17C and to cranking motor ground terminal. Turn the carbon pile on (will show 0 amps).

2. Disconnect starter ISO & power relay R12 and install a jumper lead to R12 cavity 1, circuit J17D.

   NOTE – Test lead will be at battery voltage.

   Connect DMM from solenoid BAT terminal to starter ISO & power relay R12 cavity 1, circuit J17D (will show zero volts).

3. At relay connector, install other end of jumper lead to cavity 4 circuit J17E. Turn on and adjust carbon pile to 50 amp load (no more than 10 seconds). Read and record first wire voltage loss. Disconnect DMM.

4. At relay connector, connect DMM from cavity 1, J17E to circuit J17E at carbon pile. Connect to terminal and not to carbon pile clamp.

5. Turn on and adjust carbon pile to 50 amp load (no more than 10 seconds). Read and record second wire voltage loss. Disconnect and remove jumper lead and DMM.

First Wire Loss (step 3) _____

plus Second Wire Loss (step 5) _____

equals Total Wiring Loss = _____(0.4V maximum loss)

If wiring loss is **0.4 volt or less**, repair or replace wire(s), and retest per Cranking Motor Solenoid Circuit Test — Part 1, above.

If wiring loss is **more than 0.4 volt**, repair or replace wire(s), and retest per Part 1.

If retest results are still above 0.5 volt loss, replace starter relay and retest per Part 1.

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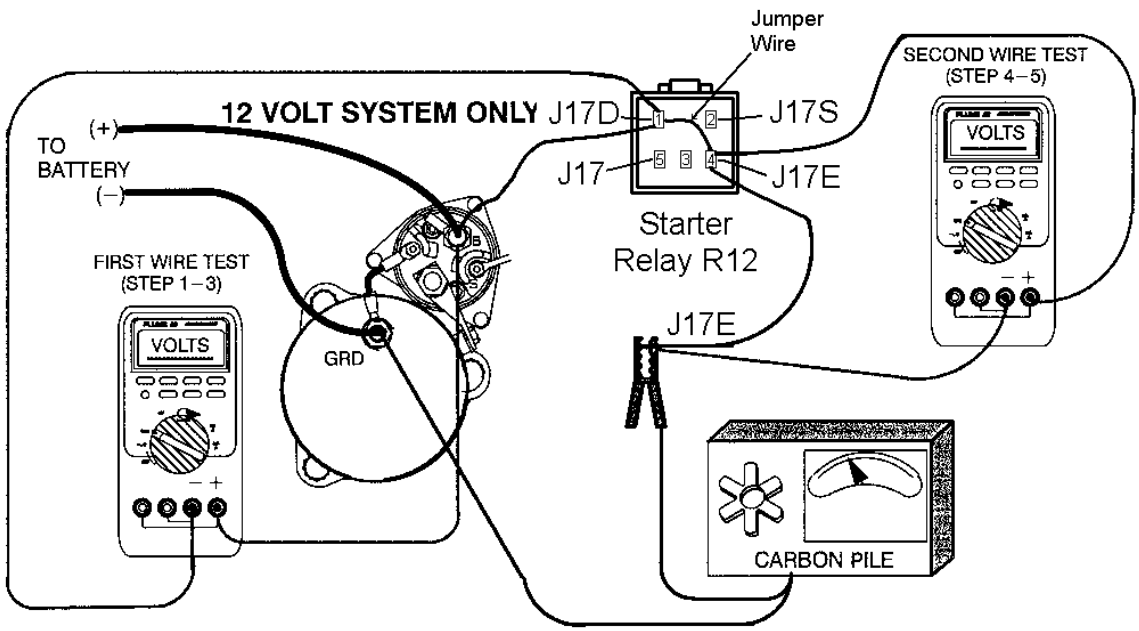

Figure 191 Cranking Motor Solenoid Circuit Test - Part 2 (Wire Voltage Loss) (With International Engine)

Cranking Motor Replacement Test

Refer to Cranking Motor Replacement Test.

A. COLD WEATHER START MAGNETIC SWITCH PROBLEMS

The start relay can fail to “hold in” during cold weather cranking due to low voltage, even though the switches and circuits check good. This failure sounds as though the cranking motor is failing to stay engaged to the flywheel. It is caused by low system voltage releasing the relay.

If this condition exists, momentarily install jumper wire from circuit J17D to 17E at starter ISO & power relay connector R12.

CAUTION – The studs or terminals are at battery voltage and the engine should crank when the jumper is connected. Remove jumper to stop cranking.

If the engine cranks properly with jumper in place, replace the relay.

B. CHECKING AVAILABLE VOLTAGE AT CRANKING MOTOR

If all previous tests have been performed, the vehicle batteries and cranking motor wiring have been checked. If the engine still cranks slowly, check available voltage at the cranking motor.

1. While cranking engine, measure voltage between the cranking motor solenoid “BAT” stud and cranking motor ground.
   a. If voltage is 9.0 volts or more, the problem must be in the cranking motor (or engine). Replace the cranking motor.
   b. If the voltage is less than 9.0 volts, go to step 2.

2. Check the interconnecting cable between the batteries. While cranking, measure the terminal voltage of each battery by touching voltmeter leads to the post of each battery.
   a. If the difference between any two battery readings in the same battery box is more than 0.5 volt or any cable is warm to the touch, replace the interconnecting cables.
   b. If cables check OK, the problem must be in the Cranking Motor (or engine). Replace the Cranking Motor.

F08266TS5

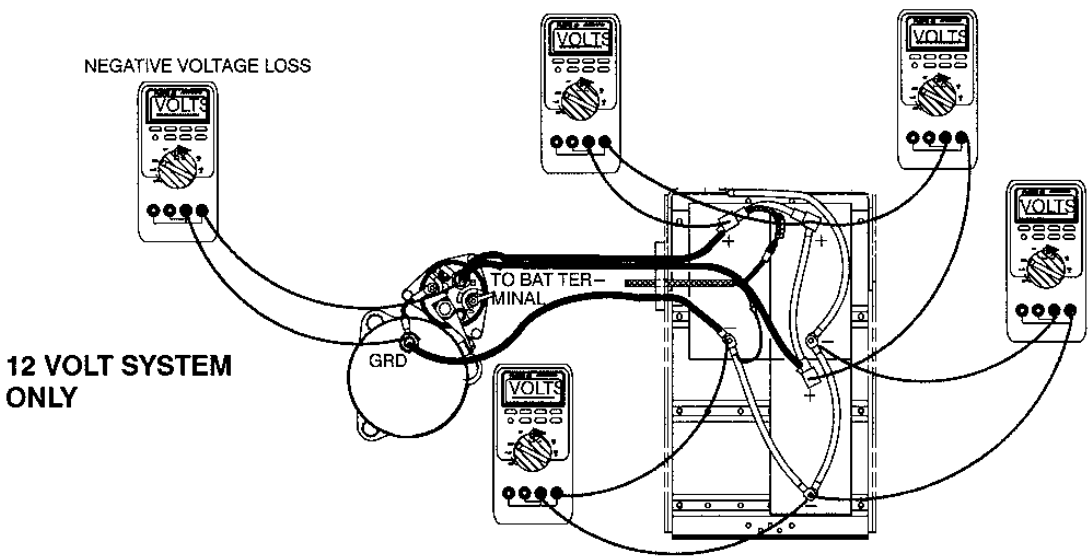

Figure 192 Cranking Motor Replacement Test

Testing Thermal Overcrank Protection System

The thermal overcrank circuit interrupts the ground signal from the engine controller to the starter ISO & power relay when the engine has been cranking to long and the starter is overheating. Problems with the circuits could be the result of a failed thermal switch or open or shorted circuits.

Table 130 Thermal Overcrank Circuit Tests

Thermal Overcrank Circuit Check with (6316) removed, key in start position and clutch pedal depressed or automatic transmission in PARK. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
Thermal overcrank connector on starter motor.	Resistance across terminals should be < 2 ohms when starter is cool.	If resistance is high, replace thermal switch. If relay passes test, go to next step.
(6316) harness connector R12 cavity B to ground.	12 ± 1.5 volts	If voltage is missing, check for open or short in circuits K17K or J17S between (6316) and starter relay (4003).
(6316) harness connector R12 cavity B to cavity A.	12 ± 1.5 volts	If voltage is missing, check for open in circuit K17L to engine controller. If circuit checks good refer to engine manual to troubleshoot missing ground from engine controller.

3.5. COMPONENT LOCATIONS

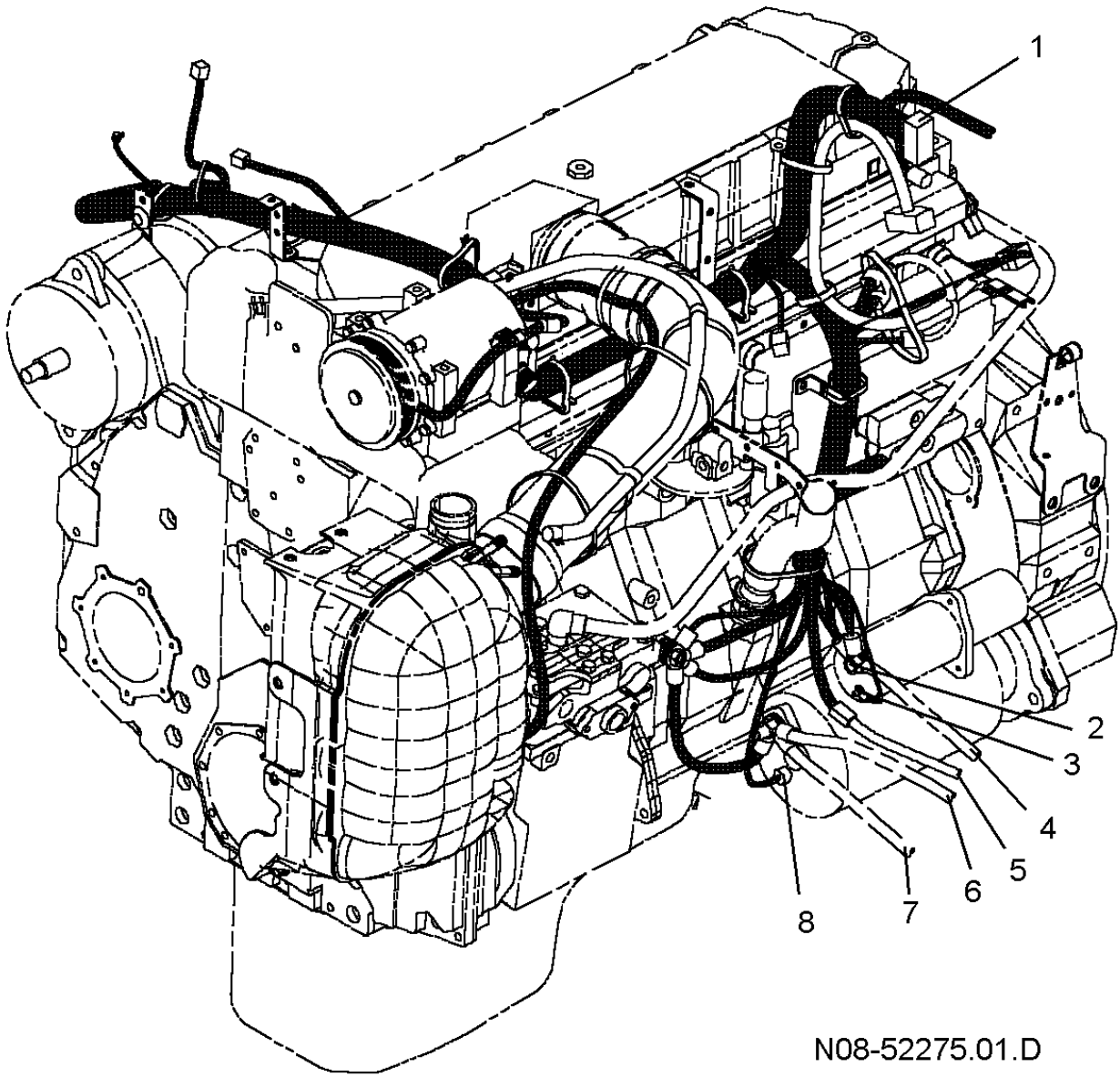

Figure 193 Cranking Motor Location

1. ENGINE/DASH CONNECTOR (4103)
2. B TERMINAL OF CRANKING MOTOR SOLENOID
3. S TERMINAL OF CRANKING MOTOR SOLENOID
4. TO BATTERY POSITIVE TERMINAL
5. ENGINE CONTROLLER CLEAN POWER AND GROUND
6. TO BATTERY NEGATIVE TERMINAL
7. TO FRAME GROUND
8. THERMAL OVERCRANK PROTECTION (6316)

Table of Contents

DESCRIPTION

Discussion of the engines, in this section, is limited to the engine electronic control module (ECM) power circuits and data link connectivity. The “CHECK ELEC SYSTEM “ warming lamp will illuminate when communication with the engine controller is lost. Diagnostic trouble codes (DTC’s) will also be logged. This could be the result of a communication problem, a power problem to the engine controller or an internal engine controller problem.

The engine controllers have their own diagnostic systems. For detailed information on engine diagnostics, refer to the appropriate engine manuals.

1. I6–HEUI ENGINES

Discussion of the I6–HEUI Engine, in this section, is limited to the engine electronic control module (ECM) power circuits and data link connectivity. The engine controller has its own diagnostic system and uses flash codes displayed by the ENGINE warning lights. For detailed information on engine diagnostics, refer to International Engine Diagnostic Manual EGES–230.

1.1. ENGINE CONTROL MODULE (ECM) POWER AND GROUND

Circuit Functions

The Electronic Engine Control Module (ECM) receives switched ignition voltage, through a 5 amp fuse, from the primary ignition relay, R9, in the engine compartment power distribution panel. The (ECM) also receives 12 volt operating power, with the key switch in the ignition position, through the ECM power relay from the battery. The circuitry is protected by a 40 amp fuse that is part of the battery cable assembly. The ECM ground is from the negative post of the batteries.

Diagnostics

A problem with power to the ECM will be apparent when the vehicle will not crank and the “CHECK ELEC SYS” warning lamp in the gauge cluster is constantly on.

The problem could be attributed to open or shorted wiring between the ECM and related power circuits, a blown fuse, a failed relay or a failure inside the ECM.

Several ESC diagnostic trouble codes (DTC’s) will be logged when there is no communication on the drivetrain 1939 data link between the ECM and the ESC or the EGC.

An electronic service tool, running the "INTUNE" diagnostic software, can be used to view diagnostic trouble codes. Refer to the “INTUNE” software manual

Table 131 Engine Electronic Control Module Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify “CHECK ELEC SYS” warning lamp is on and ECM is inoperative.	Visually check “CHECK ELEC SYS” warning lamp and attempt to start vehicle.	Engine cranks.	Go to Drivetrain 1939 Data Link(See DRIVETRAIN 1939 DATA LINK, page 60)	Go to Fault Detection Management.(See Fault Detection Management, page 402)

Fault Detection Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A fault in the ECM power circuits will be apparent when the engine will not start and there is no communication between the ECM and the ESC or EGC. Problems in the ECM power circuits could be attributed to a blown fuse, a short or an open circuit.

Refer to ECM Power Circuits.

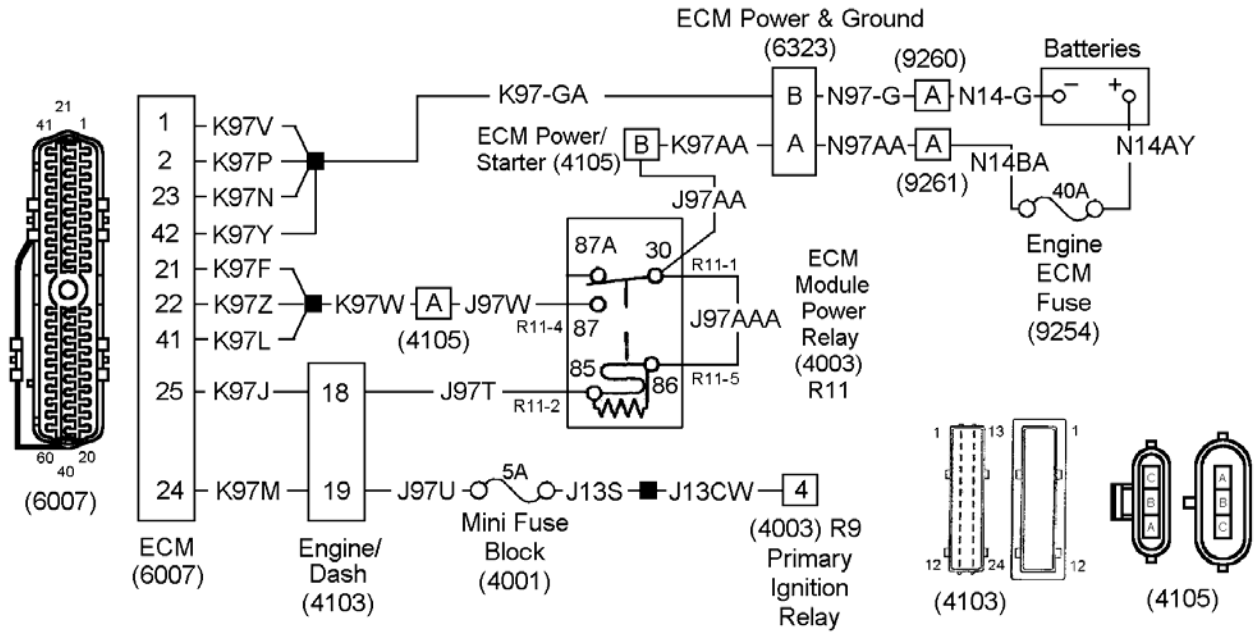

Figure 194 ECM Power Circuits

(4001) MINI FUSE BLOCK
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4003) (R11) ECM MODULE POWER RELAY
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4103) ENGINE/DASH CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(4105) ECM POWER/STARTER SOLENOID CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(6007) ENGINE ECM CONNECTOR
LOCATED ON ENGINE ECM
(6323) ENGINE MODULE POWER AND GROUND
LOCATED NEAR START MOTOR
(9254) ENGINE ECM FEED FUSE CONNECTOR
LOCATED IN BATTERY COMPARTMENT
(9260) BATTERY ECM NEGATIVE CONNECTOR
LOCATED IN BATTERY COMPARTMENT
(9261) BATTERY ECM POSITIVE CONNECTOR
LOCATED IN BATTERY COMPARTMENT

Table 132 ECM Power Circuit Tests

Diagnostic Trouble Codes	
639 14 4 240	Engine speed not communicated to the ESC
1705 14 150 2 (EGC Version 8.7)	Engine Controller not communicating with the EGC. Loss of communication in excess of 10 seconds. Bad drivetrain J1939 data link.

Table 132 ECM Power Circuit Tests (cont.)

2023 14 150 2 or 2023 14 250 2 (EGC Version 9.3 and later)	Engine Controller not communicating with the primary EGC (150) or secondary EGC (250) Loss of communication in excess of 10 seconds Bad drivetrain J1939 data link.
Due to the inaccessibility of ECM connector (6007), voltage checks will be performed at other connector locations. **ECM Power & Ground Connector (6323) Voltage Checks** Check with (6323) disconnected.	
Test Points	Spec. / Comments
(6323) harness to battery connector, cavity A to ground	12 ± 1.5 volts Positive battery feed to ECM If voltage is missing, check for blown fuse (9254) and short or open in circuit N97AA. A blown fuse could be the result of a short in any circuits between (6007) and the fuse.
(6323) harness to battery connector, cavity A to cavity B	12 ± 1.5 volts Negative battery feed to ECM If voltage is missing, check for open in circuit N97–G.
Due to the inaccessibility of ECM connector (6007), voltage checks will be performed at other connector locations. **Engine/Dash Connector (4103) Voltage Checks** Check with (6323) connected, ignition on, and (4103) disconnected.	
Test Points	Spec. / Comments
(4103) Harness to dash connector, pin 19 to ground	12 ± 1.5 volts Ignition feed to ECM If voltage is missing, check for blown fuse and short or open in circuit J97U.
(4103) Harness to dash connector, pin 18 to ground	12 ± 1.5 volts Battery voltage through ECM power relay coil. If voltage is missing check for open relay coil, open circuits or short to ground.
Due to the inaccessibility of ECM connector (6007), voltage checks will be performed at other connector locations. **ECM Power/Starter Solenoid Connector (4105) Voltage Checks** Check with (4103) connected, ignition on, and (4105) disconnected.	
Test Points	Spec. / Comments

Table 132 ECM Power Circuit Tests (cont.)

(4105) Harness to dash connector, pin A to ground	12 ± 1.5 volts	Battery feed to ECM from ECM power relay R11. Check for defective ECM Module Power relay R11 (4003).
ECM Module Power relay R11 (4003) Voltage Checks Check with relay removed, ignition key on and engine off. Bench check relay and replace if it has failed. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments
ECM Module Power relay R11 (4003) socket cavity 1 (relay 30) to ground.	12 ± 1.5 volts	If voltage is missing, check for open or shorts in circuits between relay socket and fuse.
ECM Module Power relay R11 (4003) socket cavity 2 (relay 85) to ground.	12 ± 1.5 volts	Voltage to relay coil from ESC. If voltage is missing, check for open or shorts in circuits between ECM and relay socket. Also insure proper voltage out of ECM connector (6007) pin 25.
ECM Module Power relay R11 (4003) socket cavity 2 (relay 85) to cavity 5 (relay 86).	12 ± 1.5 volts	Check ground to relay coil through ECM connector (6007) pin 25. If voltage is missing, check for open in circuits between ground and relay socket. If all voltages are good and the ECM is still not functioning, check for open circuits or shorts to ground at connector (6007). ECM may have failed. Refer to the Engine Diagnostic Manual EGES–230.

Extended Description

When the key is switched to the ignition position, the primary ignition relay R9 in the engine compartment should energize and apply voltage through the 5 amp minifuse to ECM connector (6007) pin 24. The ECM will then apply a ground to energize the ECM power relay R11. The contacts of the relay will apply battery voltage from engine ECM 40 amp fuse (9254) to ECM connector (6007) pins 21, 22, and 41.

Ground for the ECM is supplied from the negative terminal of the battery to ECM ECM connector (6007) pins 1, 2, 23, and 42.

Component Locations

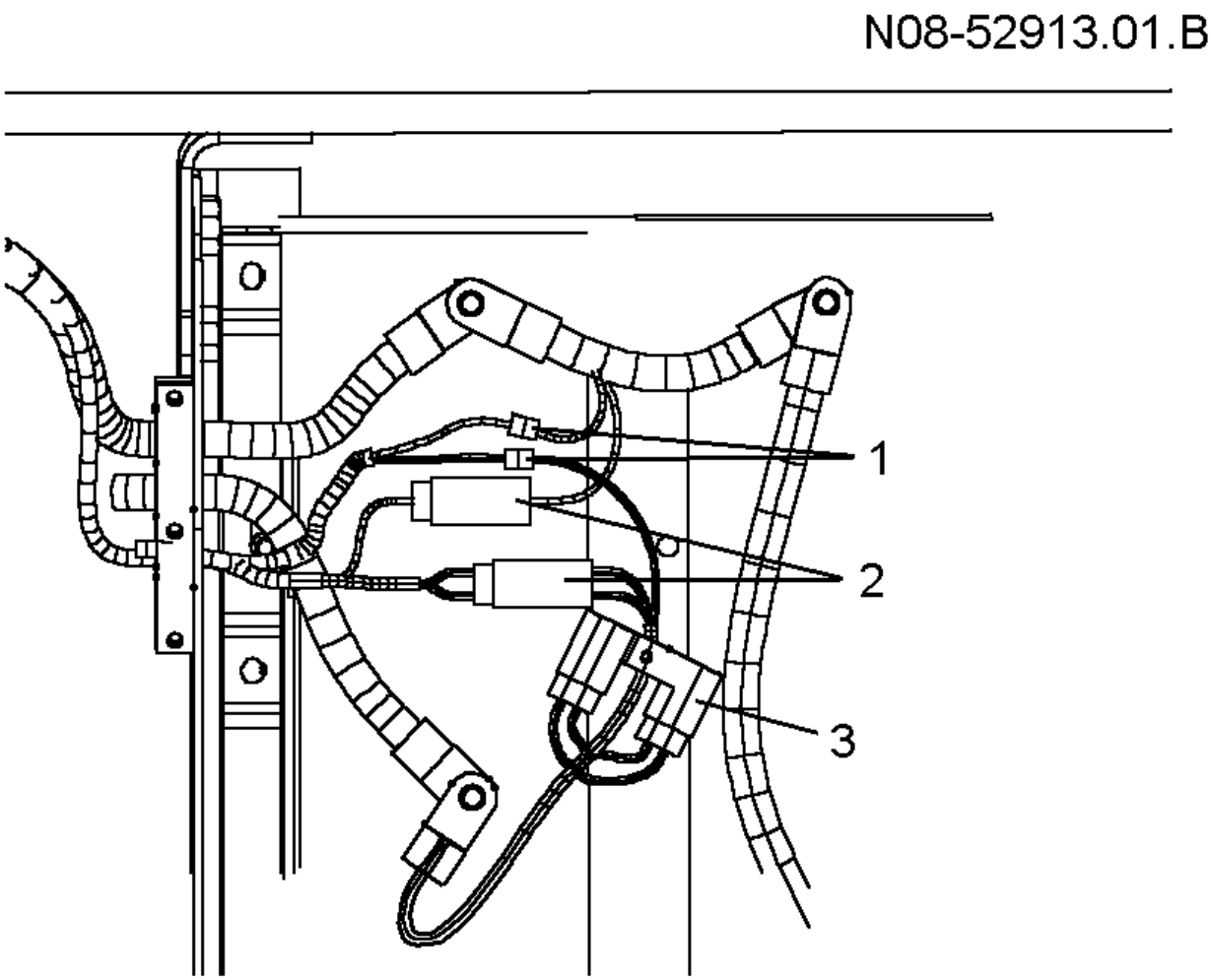

Figure 195 Engine ECM Power Battery Box Connectors (Typical)

1. 2–WAY RADIO CIRCUITS, N14HC TO POSITIVE AND N14–GD TO NEGATIVE TERMINALS ON THE BATTERY.
2. ENGINE ECM CLEAN POWER FEED.
3. 40 AMP FUSE FOR I6.

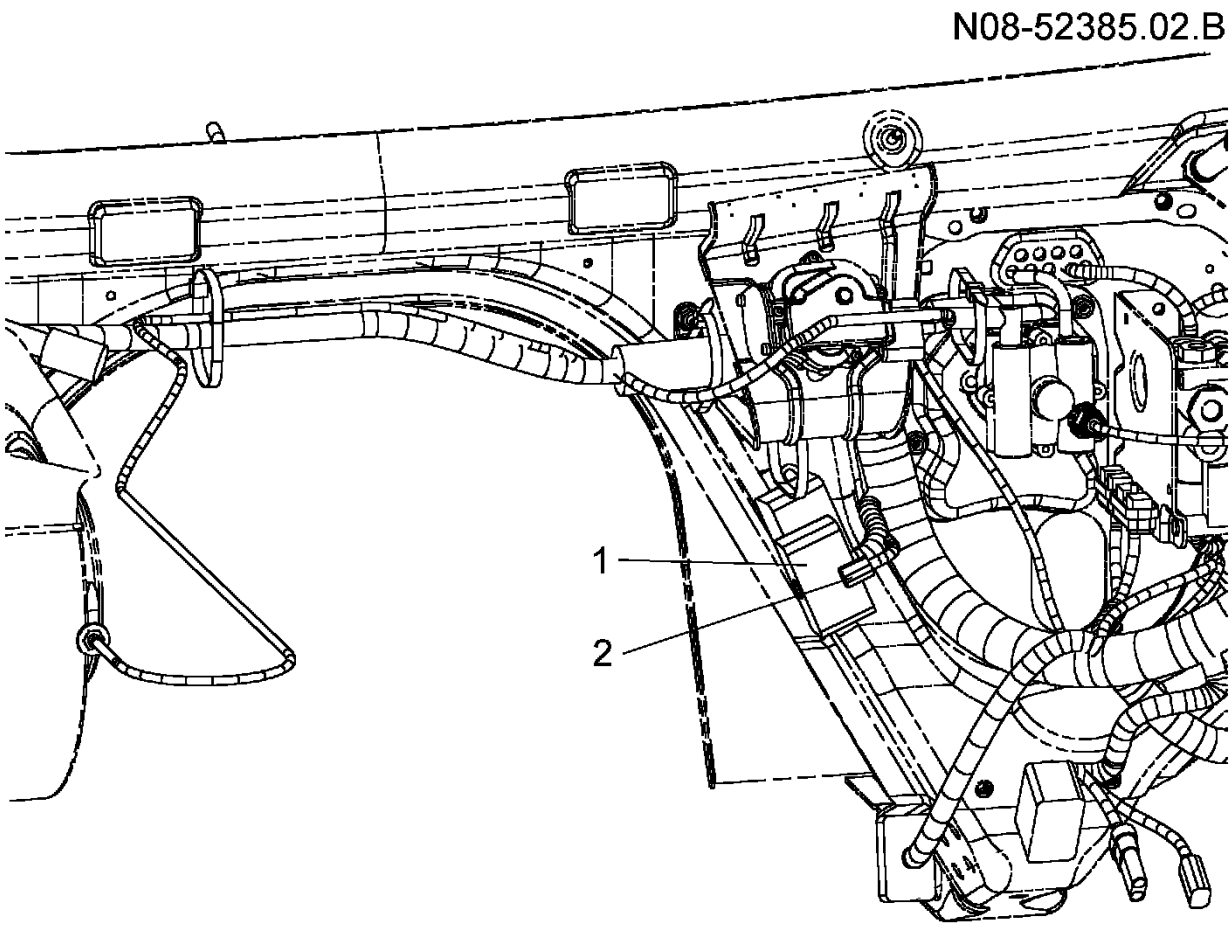

Figure 196 Engine Connector Locations

1. ENGINE/DASH CONNECTOR (4103)
2. ECM POWER/STARTER CONNECTOR (4105)

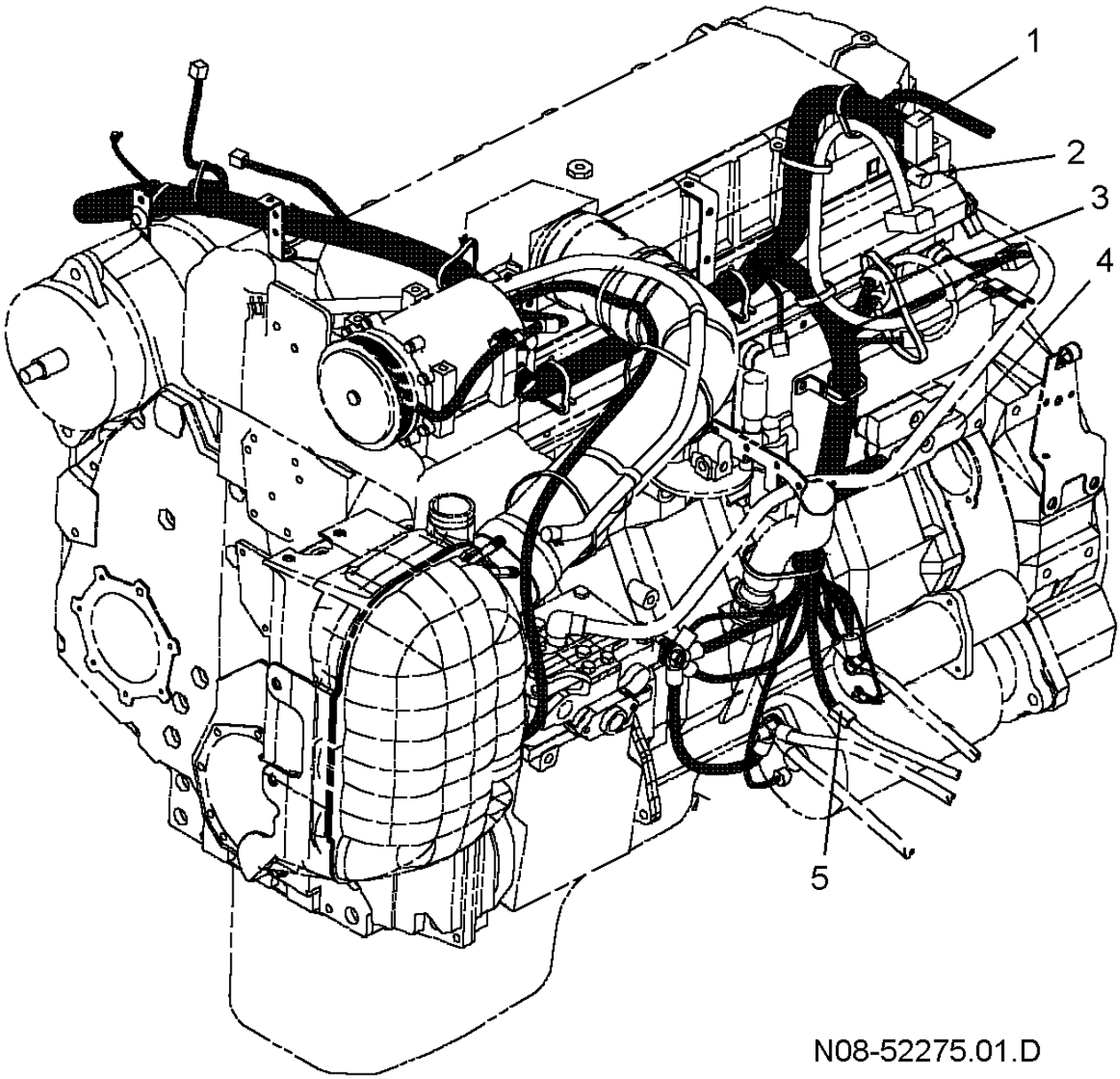

Figure 197 Engine ECM Location

1. ENGINE/DASH CONNECTOR (4103)
2. ECM POWER/STARTER (4105)
3. DRIVETRAIN 1939 DATALINK “Y” CONNECTOR
4. ECM CONNECTOR (6007)
5. ENGINE MODULE POWER AND GROUND (6323)

1.2. ENGINE DATA LINK CIRCUITS

Circuit Functions

The engine electronic control module communicates on the drivetrain 1939 data link and the 1708 data link.

Communication on the drivetrain 1939 data link allows the ECM to send and receive messages to the ESC, the EGC and other controllers on the vehicle. Refer to Drive Train 1939 Data Link in the Multiplexing (Data Links) section of this manual. (See DRIVETRAIN 1939 DATA LINK, page 60)

The 1708 data link is primarily used for diagnostics and programming. The 1708 data link connection is also used with the hydraulic ABS (hydraulic ABS doesn't have a J1939 interface). Refer to 1708 Data Link in the Multiplexing (Data Links) section of this manual. (See 1708 DATA LINK, page 75)

1.3. CRUISE CONTROL

Circuit Functions

Cruise control and engine speed for PTO operations are selected with the cruise switches on the steering wheel. These switches are inputs to the ESC. The ESC generates commands to the engine controller on the Drivetrain 1939 data link.

Refer to Cruise Control Circuitsin the Cab Section of this manual.

1.4. REMOTE ENGINE SPEED CONTROL MODULE (RESCM)

Circuit Functions

The I6 engine has optional feature codes that allow controlling the engine from a remote location outside the cab. This is accomplished by connecting to the discrete wiring of the engine ECM. When one of these feature codes, 012VVW (Provision for Remote Throttle Control) or 012VWY (Hydraulic Pressure Governor) is ordered, a harness pigtail with the engine control circuits is strapped to the engine harness.

Refer to Body Builder Manual CT-471 or the applicable engine manual for more details.

Component Locations

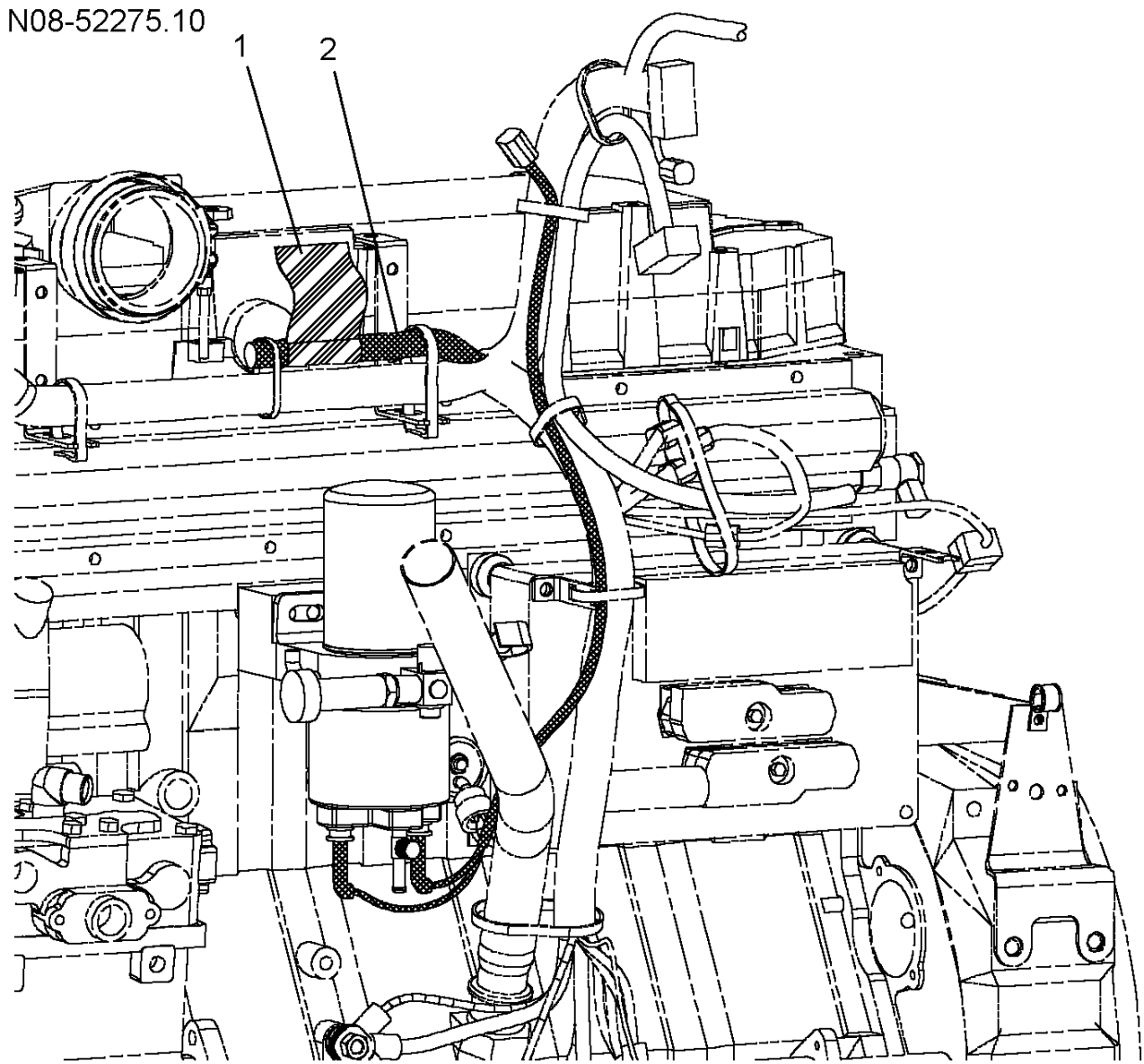

Figure 198 Engine Body Builder Location

1. BODY BUILDER PRODUCT
2. ENGINE BODY BUILDER HARNESS

2. V8–AVNT ENGINES

Discussion of the V8–AVNT Engine, in this section, is limited to the engine electronic control module (ECM) power circuits and data link connectivity. The engine controller has its own diagnostic system and uses flash codes displayed by the ENGINE warning lights. For detailed information on engine diagnostics, refer to the applicable International Engine Diagnostic Manual EGES–190.

2.1. ENGINE CONTROL MODULE (ECM) POWER AND GROUND

Circuit Functions

Diagnostics

A problem with power to the ECM will be apparent when the vehicle will not crank and the “CHECK ELEC SYS” warning lamp in the gauge cluster is constantly on.

The problem could be attributed to open or shorted wiring between the ECM and related power circuits, a blown fuse, a failed relay or a failure inside the ECM.

Several diagnostic trouble codes (DTC’s) will be logged when there is no communication on the drivetrain 1939 data link between the ECM and the ESC or the EGC.

An electronic service tool, running the "INTUNE" diagnostic software, can be used to view diagnostic trouble codes. Refer to the “INTUNE” software manual

Table 133 Engine Electronic Control Module Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify “CHECK ELEC SYS” warning lamp is on and ECM is inoperative.	Visually check “CHECK ELEC SYS” warning lamp and attempt to start vehicle.	Engine cranks.	Go to Drivetrain 1939 Data Link(See DRIVETRAIN 1939 DATA LINK, page 60)	Go to Fault Detection Management.(See Fault Detection Management, page 411)

Fault Detection Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A fault in the ECM power circuits will be apparent when the engine will not start and there is no communication between the ECM and the ESC or EGC. Problems in the ECM power circuits could be attributed to a blown fuse, a short or an open circuit.

Refer to ECM Power Circuits.

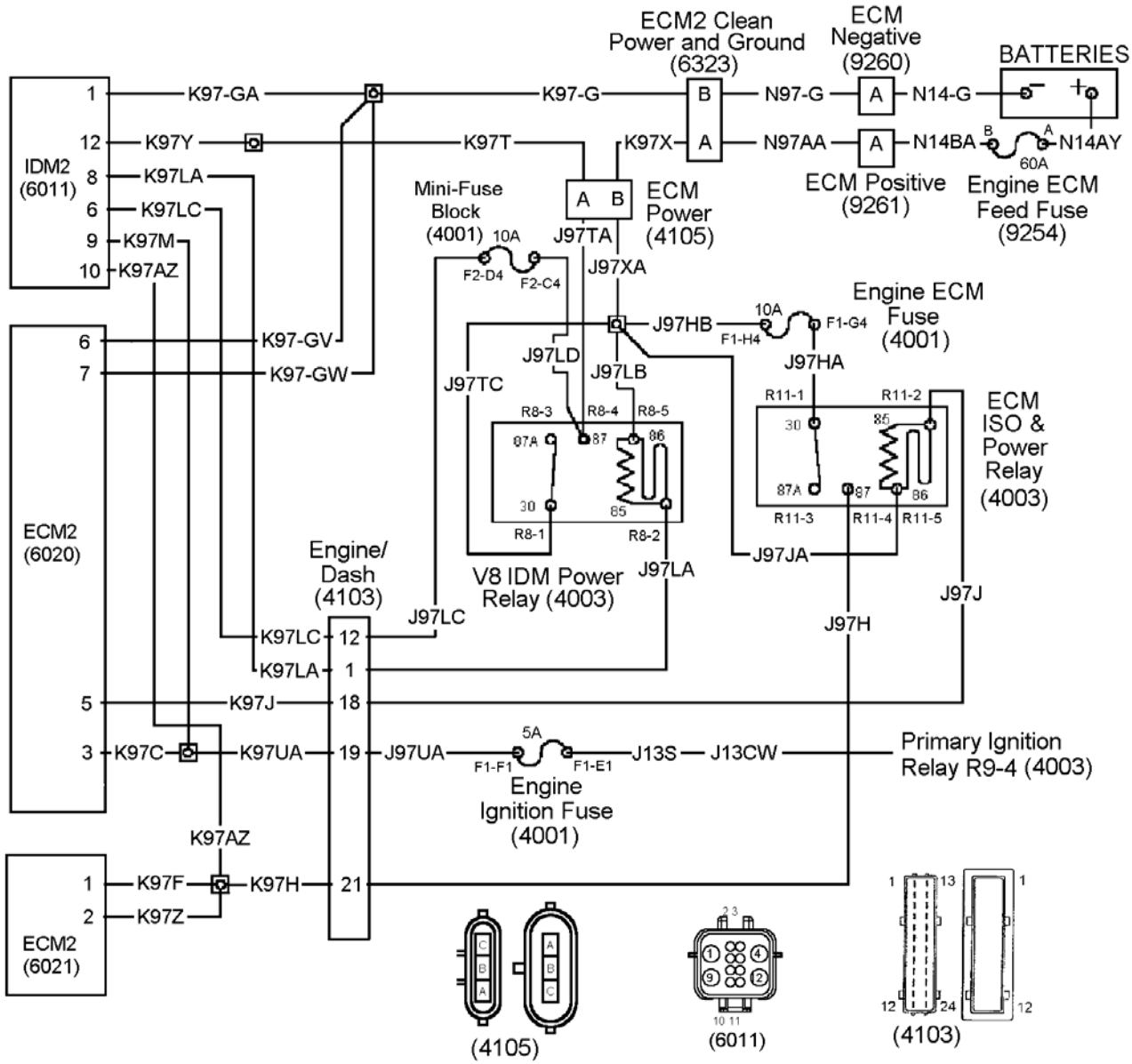

Figure 199 ECM Power Circuits

(4001) MINI FUSE BLOCK
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4003) (R8) V8 IDM POWER AND (R11) ECM ISO & POWER RELAYS
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4103) ENGINE/DASH CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(4105) ECM POWER/STARTER SOLENOID CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(6011) IDM2, (6020) ECM2 AND (6021) ECM2 ENGINE ECM CONNECTORS
LOCATED ON ENGINE ECM
(6323) ENGINE MODULE POWER AND GROUND
LOCATED NEAR START MOTOR
(9254) ENGINE ECM FEED FUSE CONNECTOR
LOCATED IN BATTERY COMPARTMENT
(9260) BATTERY ECM NEGATIVE CONNECTOR
LOCATED IN BATTERY COMPARTMENT
(9261) BATTERY ECM POSITIVE CONNECTOR
LOCATED IN BATTERY COMPARTMENT

Table 134 ECM Power Circuit Tests

Diagnostic Trouble Codes	
639 14 4 240	Engine speed not communicated to the ESC
1705 14 150 2 (EGC Version 8.7)	Engine Controller not communicating with the EGC Loss of communication in excess of 10 seconds Bad drivetrain J1939 data link.
2023 14 150 2 or 2023 14 250 2 (EGC Version 9.3 and later)	Engine Controller not communicating with the primary EGC (150) or secondary EGC (250) Loss of communication in excess of 10 seconds Bad drivetrain J1939 data link.

Due to the inaccessibility of ECM connectors (6011), (6020) and (6021) voltage checks will be performed at other connector locations.

ECM Power & Ground Connector (6323) Voltage Checks

Check with (6323) disconnected.

Test Points	Spec.	Comments
(6323) harness to battery connector, cavity A to ground	12 ± 1.5 volts	Positive battery feed to ECM If voltage is missing, check for blown fuse (9254) and short or open in circuit N97AA. A blown fuse could be the result of a short in any circuits between (6011) and the fuse.

Table 134 ECM Power Circuit Tests (cont.)

(6323) harness to battery connector, cavity A to cavity B	12 ± 1.5 volts	Negative battery feed to ECM If voltage is missing, check for open in circuit N97–G.
Due to the inaccessibility of ECM connector (6011), (6020) and (6021) voltage checks will be performed at other connector locations. **Engine/Dash Connector (4103) Voltage Checks** Check with (6323) connected, ignition on, and (4103) disconnected.		
Test Points	Spec.	Comments
(4103) Harness to dash connector, pin 19 to ground	12 ± 1.5 volts	Ignition feed to ECM If voltage is missing, check for blown fuse and short or open in circuit J97UA.
(4103) Harness to dash connector, pin 18 to ground	12 ± 1.5 volts	Battery voltage through ECM power relay coil R11. If voltage is missing check for open relay coil, open circuits or short to ground.
(4103) Harness to dash connector, pin 1 to ground	12 ± 1.5 volts	Battery voltage through IDM power relay coil R8. If voltage is missing check for open relay coil, open circuits or short to ground.
(4103) Harness to dash connector, pin 12 to ground	12 ± 1.5 volts	IDM2 feed from mini-fuse block (4001). If voltage is missing, check for blown fuse and short or open in circuit J97LC, J97LD.
Due to the inaccessibility of ECM connector (6011), (6020) and (6021) voltage checks will be performed at other connector locations. **ECM Power/Starter Solenoid Connector (4105) Voltage Checks** Check with (4103) connected, ignition on, and (4105) disconnected.		
Test Points	Spec.	Comments
(4105) Harness to dash connector, pin B to ground	12 ± 1.5 volts	Battery feed to IDM2 and ECM power relays R8 and R11. Check for defective Power relay R8 or R11(4003).
IDM Power Relay R8 and ECM Power Relay R11 (4003) Voltage Checks Check with relays removed, ignition key on and engine off. Bench check relay and replace if it has failed. **NOTE – Always check connectors for damage and pushed–out terminals.**		
Test Points	Spec.	Comments

Table 134 ECM Power Circuit Tests (cont.)

Power relays R8 and R11 (4003) socket cavity 1 (relay 30) to ground.	12 ± 1.5 volts	If voltage is missing, check for open or shorts in circuits between relay socket and fuse.
Power relays R8 and R11 (4003) socket cavity 2 (relay 85) to ground.	12 ± 1.5 volts	Voltage to relay coil from ESC. If voltage is missing, check for open or shorts in circuits between ECM and relay socket. Also insure proper voltage out of ECM connector (6011).
Power relays R8 and R11 (4003) socket cavity 2 (relay 85) to cavity 5 (relay 86).	12 ± 1.5 volts	Check ground to relay coil through ECM connector (6011). If voltage is missing, check for open in circuits between ground and relay socket. If all voltages are good and the ECM is still not functioning, check for open circuits or shorts to ground at connector (6011). ECM may have failed. Refer to the Engine Diagnostic Manual EGES–190.

Extended Description

When the key is switched to the ignition position, the primary ignition relay R9 in the engine compartment should energize and apply voltage through the 5 amp minifuse to ECM connector (6011) pin 9. The ECM will then apply a ground to energize the ECM power relay R11. The contacts of the relay will apply battery voltage from engine ECM 60 amp fuse (9254) to IDM2 and ECM2 connectors (6011), (6020) and (6021).

Ground for the ECM is supplied from the negative terminal of the battery to ECM ECM connector (6011) pin 1 and (6011) pins 6 and 7.

Component Locations

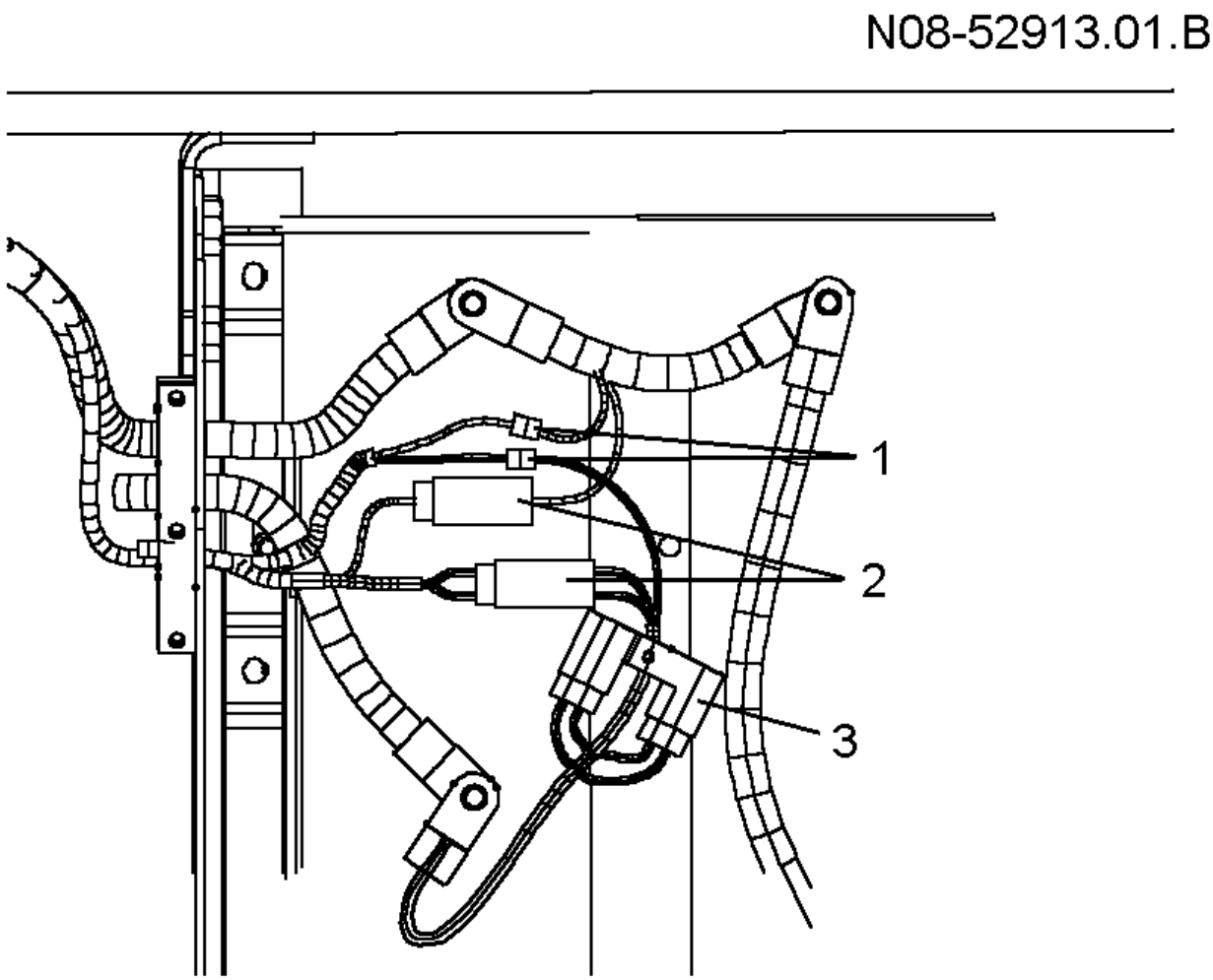

Figure 200 Engine ECM Power Battery Box Connectors (Typical)

1. 2–WAY RADIO CIRCUITS, N14HC TO POSITIVE AND N14–GD TO NEGATIVE TERMINALS ON THE BATTERY.
2. ENGINE ECM CLEAN POWER FEED.
3. 60 AMP FUSE FOR V8.

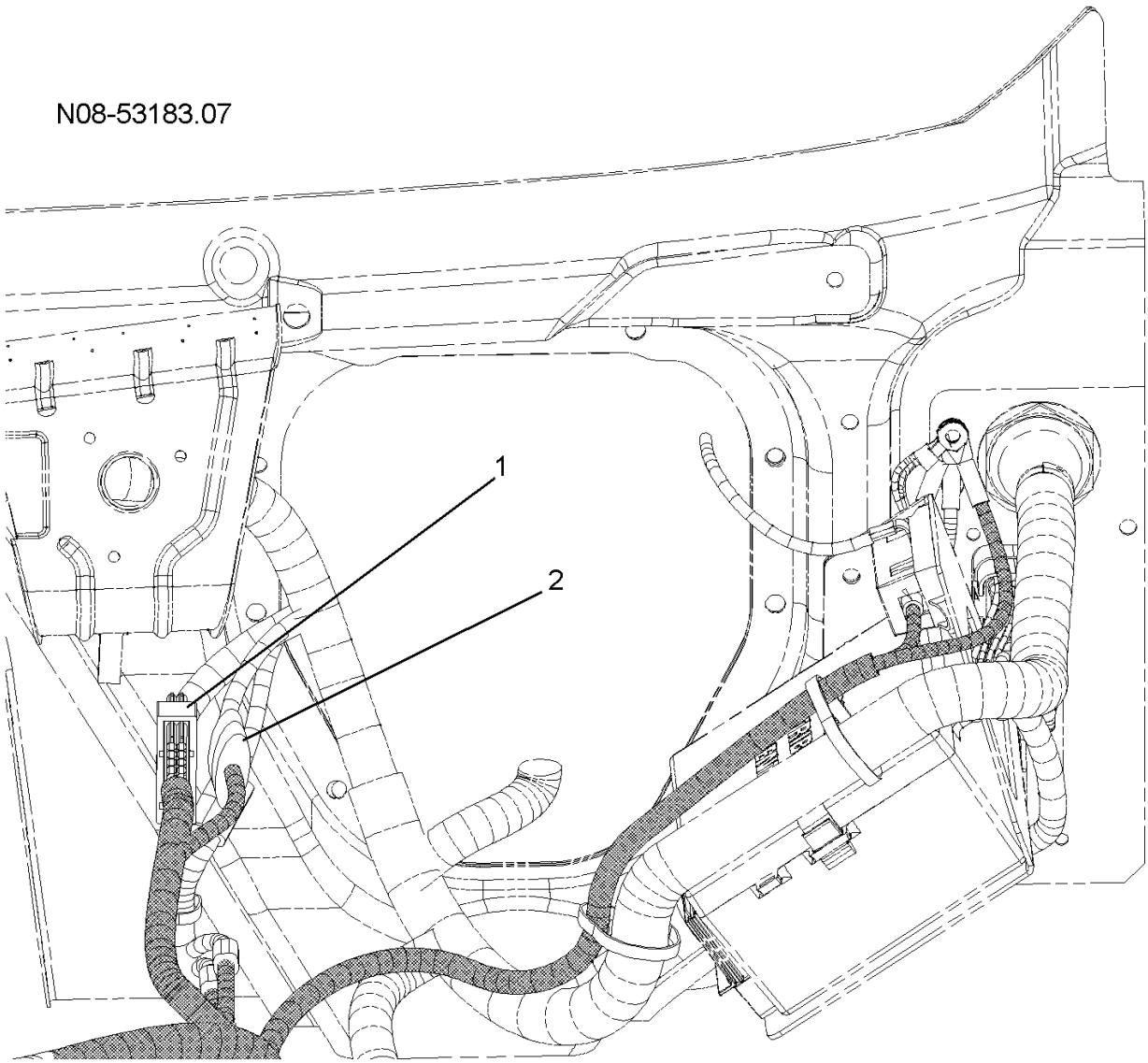

Figure 201 Engine Connector Locations

1. ENGINE/DASH CONNECTOR (4103)
2. ECM POWER/STARTER (4105)

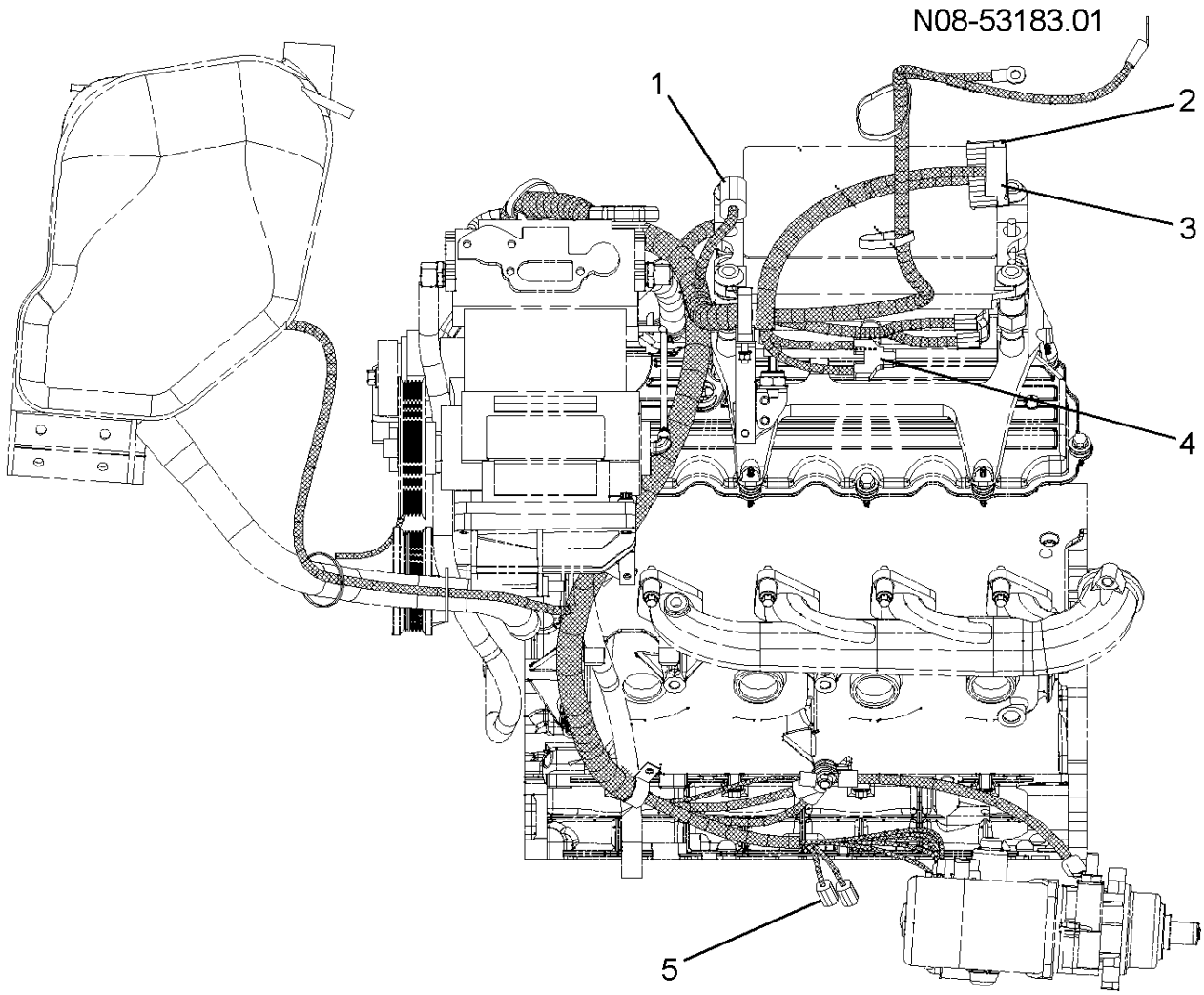

Figure 202 Engine ECM Location

1. IDM ECM CONNECTOR (6011), (6020) AND (6021)
2. ENGINE/DASH CONNECTOR (4103)
3. ECM POWER/STARTER (4105)
4. DRIVETRAIN 1939 DATALINK “Y” CONNECTOR
5. ENGINE MODULE POWER AND GROUND (6323)

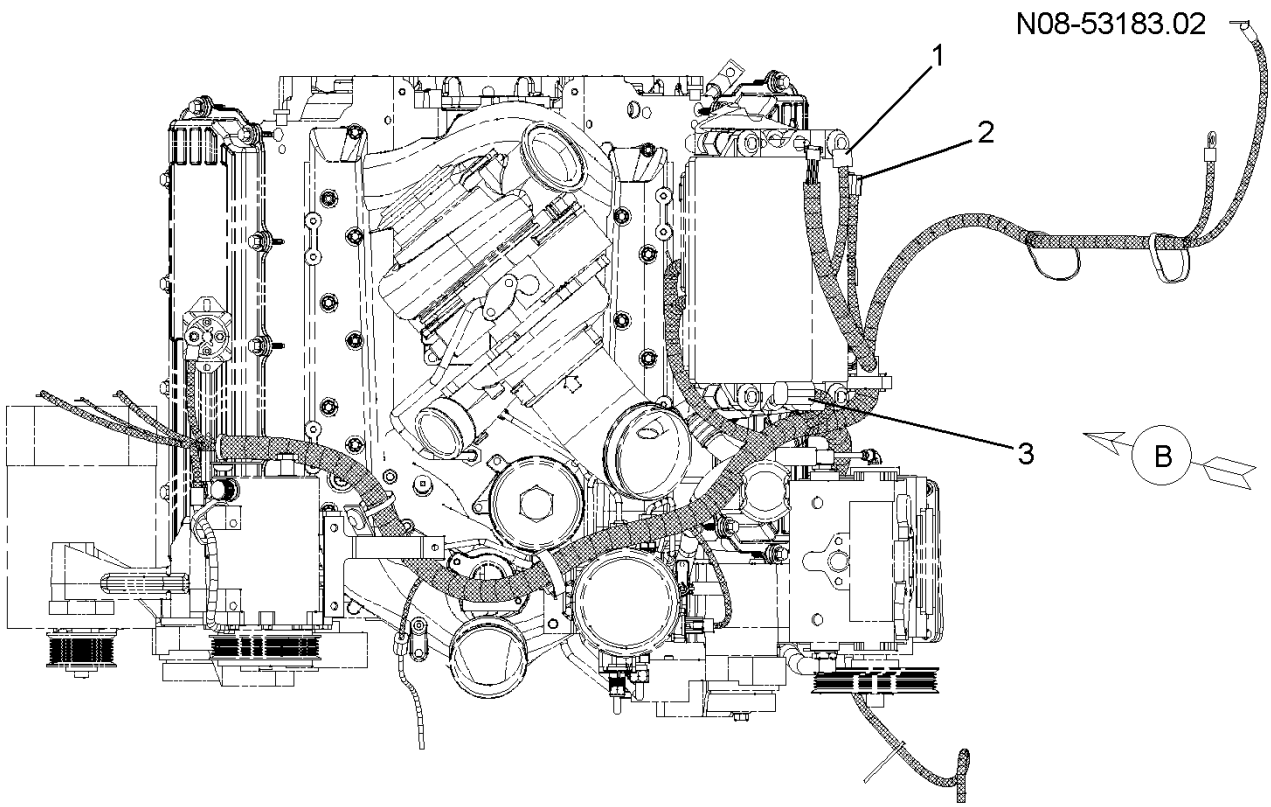

Figure 203 Engine ECM Location

1. ENGINE/DASH CONNECTOR (4103)
2. ECM POWER/STARTER (4105)
3. ECM CONNECTOR (6011), (6020) AND (6021)

2.2. ENGINE DATA LINK CIRCUITS

Circuit Functions

The engine electronic control module communicates on the drivetrain 1939 data link and the 1708 data link.

Communication on the drivetrain 1939 data link allows the ECM to send and receive messages to the ESC, the EGC and other controllers on the vehicle. Refer to Drive Train 1939 Data Link in the Multiplexing (Data Links) section of this manual. (See DRIVETRAIN 1939 DATA LINK, page 60)

The 1708 data link is primarily used for diagnostics and programming. The 1708 data link connection is also used with the hydraulic ABS (hydraulic ABS doesn't have a J1939 interface). Refer to 1708 Data Link in the Multiplexing (Data Links) section of this manual. (See 1708 DATA LINK, page 75)

2.3. CRUISE CONTROL

Circuit Functions

Cruise control and engine speed for PTO operations are selected with the cruise switches on the steering wheel. These switches are inputs to the ESC. The ESC generates commands to the engine controller on the Drivetrain 1939 data link.

Refer to Cruise Control Circuits in the Cab Section of this manual.

2.4. REMOTE ENGINE SPEED CONTROL MODULE (RESCM)

Circuit Functions

The V8 engine has an optional feature code that allows the engine to be controlled a remote location outside of the cab. This is accomplished by using a remote engine speed control module (RESCM).

The remote engine speed control is an interface for body builders to use for remote operation of the engine. The RESCM interfaces to the ESC on the Body Data Link via J1939 proprietary messages. In most cases the information simply needs to pass through the ESC to the ECM. But, because of the proprietary nature of the communication between the RESCM and the ESC, some data conversion will be necessary.

The RESCM provides 4 switch functions, a speedometer, a tachometer, two warning lights and a remote accelerator. The RESCM is also capable of providing pressure governor features covered by the Pressure Governor ESC feature.

More specifically the RESCM includes:

- A variable PTO enable switch (digital)
- A preset PTO enable switch (digital)
- A Set / Coast speed switch (duplicates the in-cab control)
- A Resume / Accel speed switch (duplicates the in-cab control)
- An amber warn engine lamp (digital)
- A red stop engine lamp (digital)
- A speedometer (data link to electronic signal output)
- A tachometer (data link to electronic signal output)
- A remote accelerator (analog input)

NOTE – The Body Builder provides the actual hardware that is connected to the RESCM unit.

If communications should happen to be lost between the RESCM and the ESC, the sensor inputs normally received from the RESCM will be sent to the engine as unavailable and switch inputs will be sent to the engine as off.

Refer to Body Builder Manual CT-471 or the applicable engine manual for more details.

Component Locations

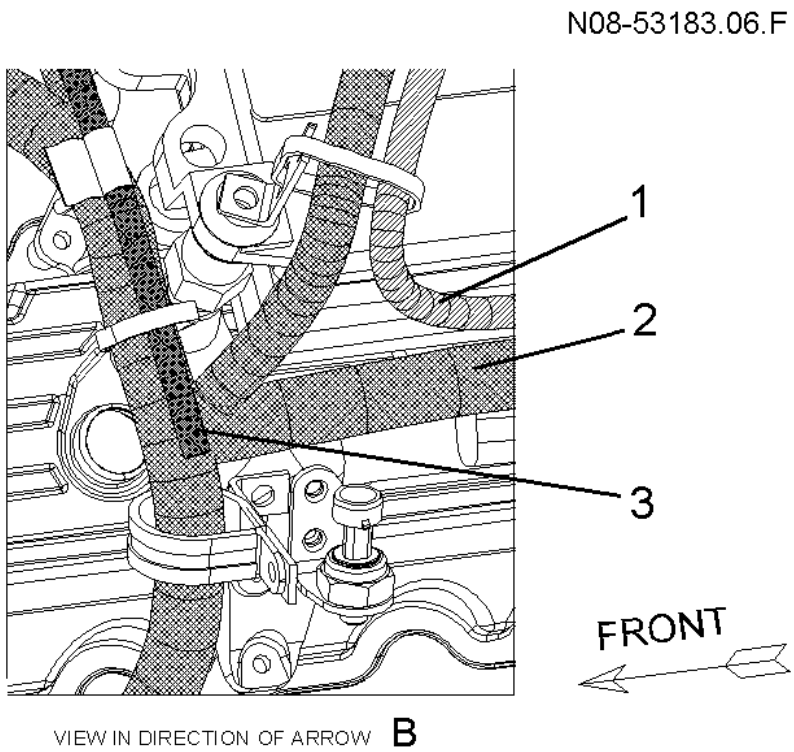

Figure 204 RESCM Location

1. TRANSMISSION HARNESS
2. ENGINE HARNESS
3. BODY BUILDER CIRCUIT

3. CUMMINS ISM ENGINES

Discussion of the Cummins ISM Engine, in this section, is limited to the engine electronic control module (ECM) power circuits and data link connectivity. The engine controller has its own diagnostic system and uses flash codes displayed by the ENGINE warning lights. For detailed information on Cummins engine diagnostics, refer to the appropriate Cummins Manual.

3.1. ENGINE CONTROL MODULE (ECM) POWER AND GROUND

Circuit Functions

Diagnostics

A problem with power to the ECM will be apparent when the vehicle will not crank and the “CHECK ELEC SYS” warning lamp in the gauge cluster is constantly on.

The problem could be attributed to open or shorted wiring between the ECM and related power circuits, a blown fuse, a failed relay or a failure inside the ECM.

Several diagnostic trouble codes (DTC’s) will be logged when there is no communication on the drivetrain 1939 data link between the ECM and the ESC or the EGC.

An electronic service tool, running the "INTUNE" diagnostic software, can be used to view diagnostic trouble codes. Refer to the “INTUNE” software manual

Table 135 Engine Electronic Control Module Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify “CHECK ELEC SYS” warning lamp is on and ECM is inoperative.	Visually check “CHECK ELEC SYS” warning lamp and attempt to start vehicle.	Engine cranks.	Go to Drivetrain 1939 Data Link(See DRIVETRAIN 1939 DATA LINK, page 60)	Go to Fault Detection Management.(See Fault Detection Management, page 422)

Fault Detection Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A fault in the ECM power circuits will be apparent when the engine will not start and there is no communication between the ECM and the ESC or EGC. Problems in the ECM power circuits could be attributed to a blown fuse, a short or an open circuit.

Refer to ECM Power Circuits.

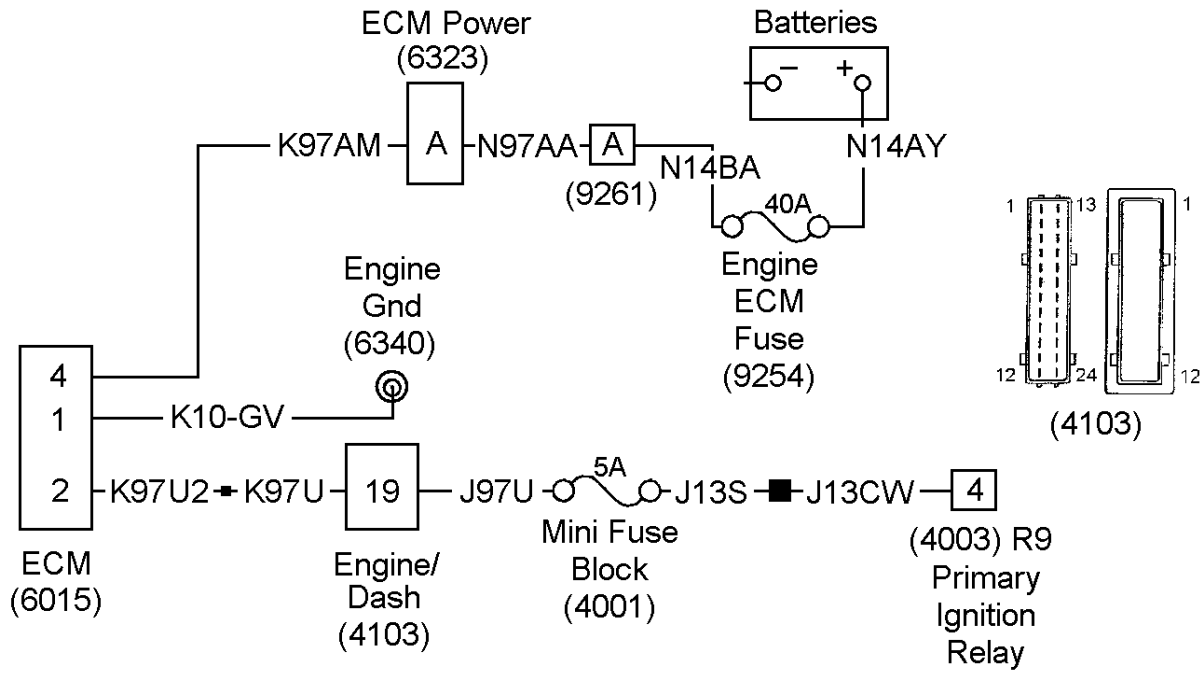

Figure 205 ECM Power Circuits

(4001) MINI FUSE BLOCK
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4003) (R9) PRIMARY IGNITION RELAY
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4103) ENGINE/DASH CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(6015) ENGINE ECM CONNECTOR
LOCATED ON ENGINE ECM
(6323) ENGINE MODULE POWER AND GROUND
LOCATED NEAR START MOTOR
(9254) ENGINE ECM FEED FUSE CONNECTOR
LOCATED IN BATTERY COMPARTMENT
(9261) BATTERY ECM POSITIVE CONNECTOR
LOCATED IN BATTERY COMPARTMENT

Extended Description

Component Locations

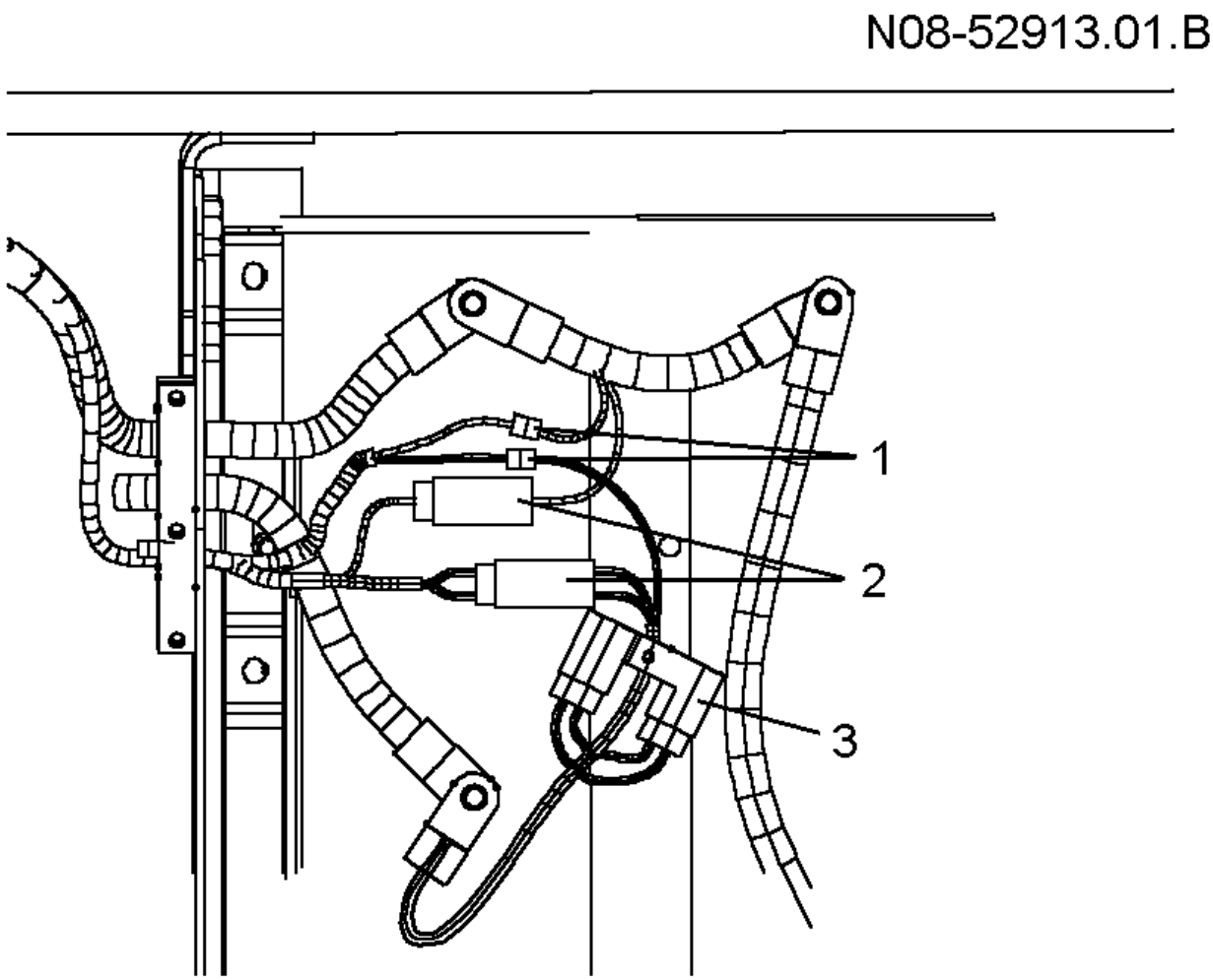

Figure 206 Engine ECM Power Battery Box Connectors (Typical)

1. 2–WAY RADIO CIRCUITS, N14HC TO POSITIVE AND N14–GD TO NEGATIVE TERMINALS ON THE BATTERY.
2. ENGINE ECM CLEAN POWER FEED.
3. ENGINE ECM FUSE

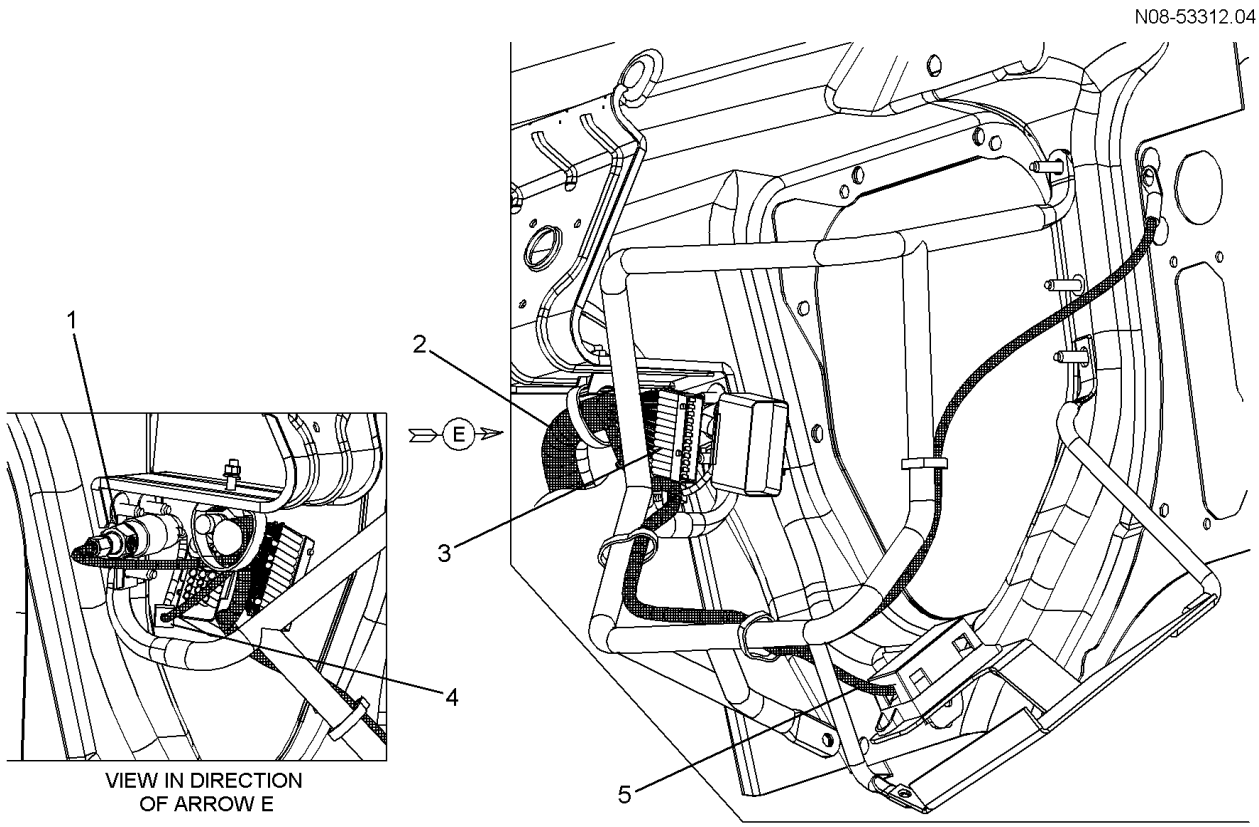

Figure 207 Engine Connector Locations

1. AIR SOLENOID
2. ENGINE HARNESS
3. ENGINE/DASH CONNECTOR (4103)
4. AIR SOLENOID CONNECTOR TO ENGINE HARNESS
5. ENGINE HARNESS CIRCUIT N14BA TO ENGINE ECM FEED FUSE (9254)

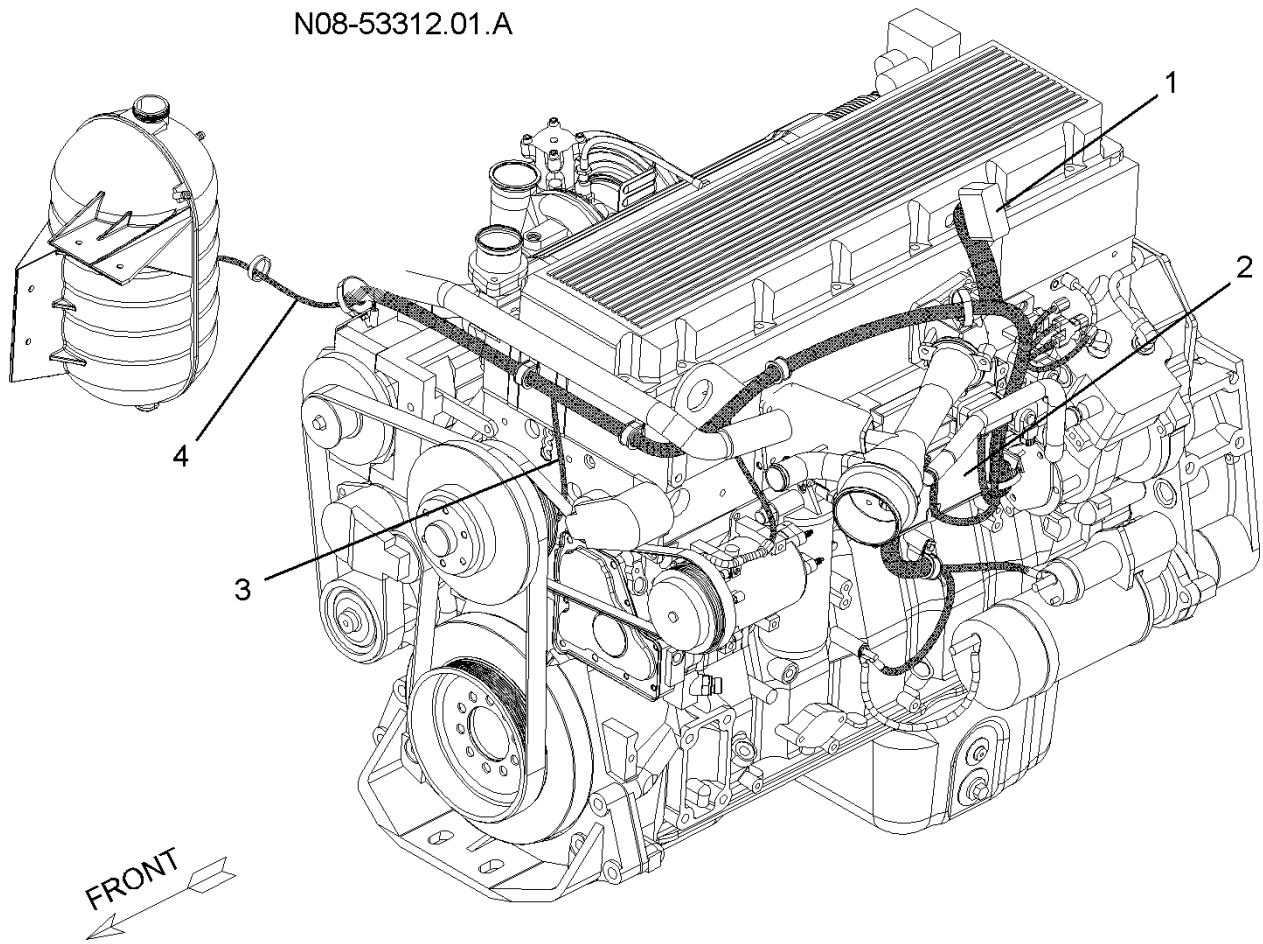

Figure 208 Engine ECM Location

1. ENGINE HARNESS CONNECTOR
2. ENGINE ECM
3. AIR LINE TO FAN DRIVE
4. COOLANT LEVEL SENSOR CIRCUITS

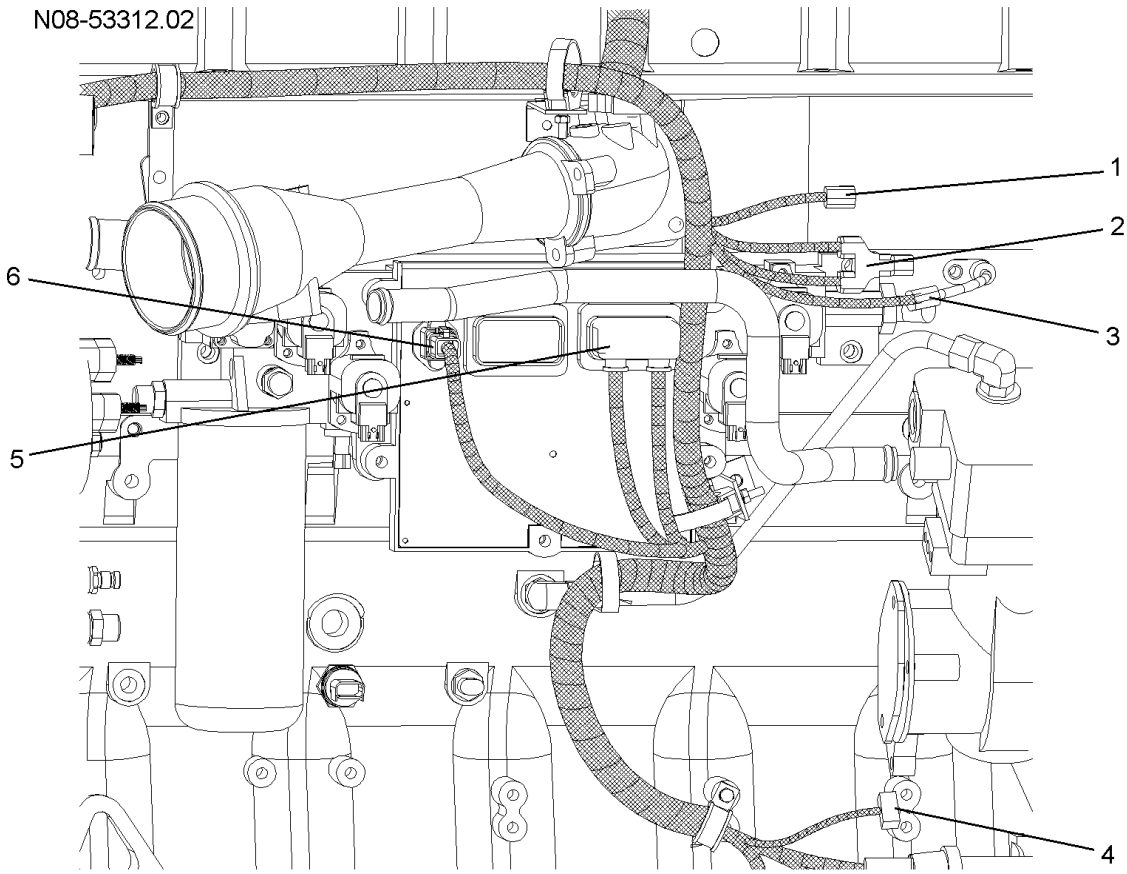

Figure 209 Engine ECM Location

1. 3–WAY ENGINE HARNESS CONNECTOR
2. DRIVETRAIN 1939 DATALINK “Y” CONNECTOR
3. ENGINE THERMOSTAT SWITCH
4. 2–WAY ECM BATTERY POWER CONNECTOR (6323)
5. ECM CONNECTOR
6. ECM CONNECTOR

3.2. ENGINE DATA LINK CIRCUITS

Circuit Functions

The engine electronic control module communicates on the drivetrain 1939 data link and the 1708 data link.

Communication on the drivetrain 1939 data link allows the ECM to send and receive messages to the ESC, the EGC and other controllers on the vehicle. Refer to Drive Train 1939 Data Link in the Multiplexing (Data Links) section of this manual. (See DRIVETRAIN 1939 DATA LINK, page 60)

The 1708 data link is primarily used for diagnostics and programming. The 1708 data link connection is also used with the hydraulic ABS (hydraulic ABS doesn’t have a J1939 interface). Refer to 1708 Data Link in the Multiplexing (Data Links) section of this manual. (See 1708 DATA LINK, page 75)

3.3. CRUISE CONTROL

Circuit Functions

Cruise control and engine speed for PTO operations are selected with the cruise switches on the steering wheel. These switches are inputs to the ESC. The ESC generates commands to the engine controller on the Drivetrain 1939 data link.

Refer to Cruise Control Circuitsin the Cab Section of this manual.

3.4. REMOTE ENGINE SPEED CONTROL MODULE (RESCM)

Circuit Functions

The I6 engine has optional feature codes that allow controlling the engine from a remote location outside the cab. This is accomplished by connecting to the discrete wiring of the engine ECM. When one of these feature codes, 012VVW (Provision for Remote Throttle Control) or 012VWY (Hydraulic Pressure Governor) is ordered, a harness pigtail with the engine control circuits is strapped to the engine harness .

Refer to Body Builder Manual CT-471 or the applicable engine manual for more details.

4. CATERPILLAR C10, C12 ENGINES

Discussion of the Caterpillar C10, C12 Engine, in this section, is limited to the engine electronic control module (ECM) power circuits and data link connectivity. The engine controller has its own diagnostic system and uses flash codes displayed by the ENGINE warning lights. For detailed information on Caterpillar engine diagnostics, refer to the appropriate Caterpillar Manual.

4.1. ENGINE CONTROL MODULE (ECM) POWER AND GROUND

Circuit Functions

Diagnostics

A problem with power to the ECM will be apparent when the vehicle will not crank and the “CHECK ELEC SYS” warning lamp in the gauge cluster is constantly on.

The problem could be attributed to open or shorted wiring between the ECM and related power circuits, a blown fuse, a failed relay or a failure inside the ECM.

Several diagnostic trouble codes (DTC’s) will be logged when there is no communication on the drivetrain 1939 data link between the ECM and the ESC or the EGC.

An electronic service tool, running the "INTUNE" diagnostic software, can be used to view diagnostic trouble codes. Refer to the “INTUNE” software manual

Table 136 Engine Electronic Control Module Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify “CHECK ELEC SYS” warning lamp is on and ECM is inoperative.	Visually check “CHECK ELEC SYS” warning lamp and attempt to start vehicle.	Engine cranks.	Go to Drivetrain 1939 Data Link(See DRIVETRAIN 1939 DATA LINK, page 60)	Go to Fault Detection Management.(See Fault Detection Management, page 429)

Fault Detection Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A fault in the ECM power circuits will be apparent when the engine will not start and there is no communication between the ECM and the ESC or EGC. Problems in the ECM power circuits could be attributed to a blown fuse, a short or an open circuit.

Refer to ECM Power Circuits.

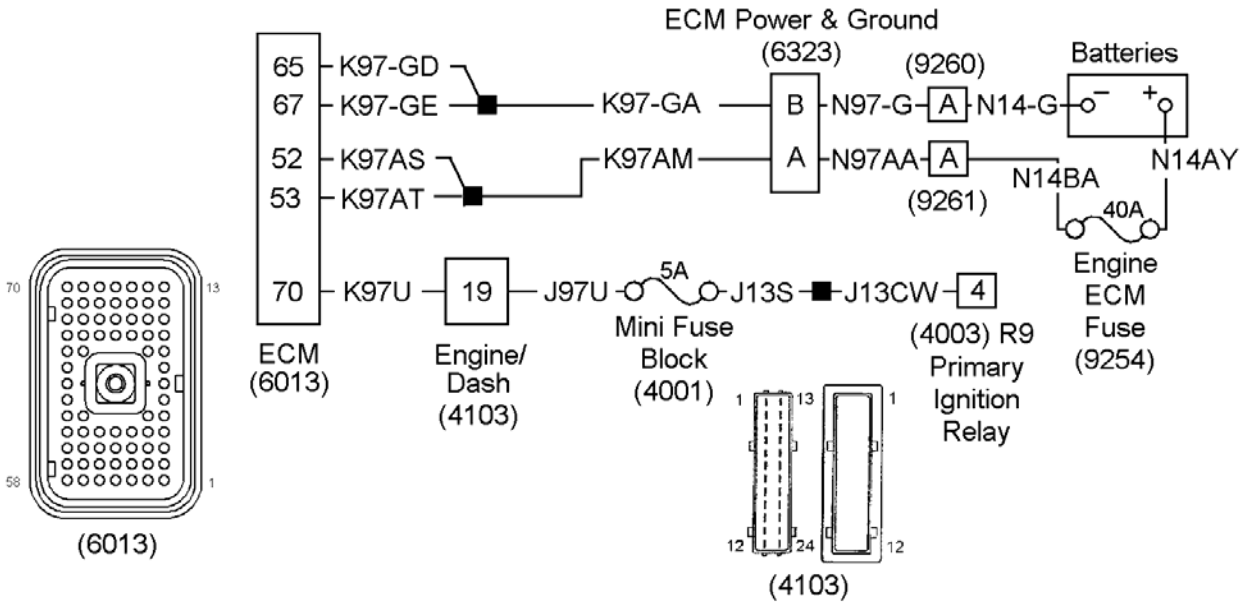

Figure 210 ECM Power Circuits

(4001) MINI FUSE BLOCK
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4003) (R11) ECM MODULE POWER RELAY
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4103) ENGINE/DASH CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(4105) ECM POWER/STARTER SOLENOID CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(6013) ENGINE ECM CONNECTOR
LOCATED ON ENGINE ECM
(6323) ENGINE MODULE POWER AND GROUND
LOCATED NEAR START MOTOR
(9254) ENGINE ECM FEED FUSE CONNECTOR
LOCATED IN BATTERY COMPARTMENT
(9260) BATTERY ECM NEGATIVE CONNECTOR
LOCATED IN BATTERY COMPARTMENT
(9261) BATTERY ECM POSITIVE CONNECTOR
LOCATED IN BATTERY COMPARTMENT

Extended Description

Component Locations

N08-53323.05.B

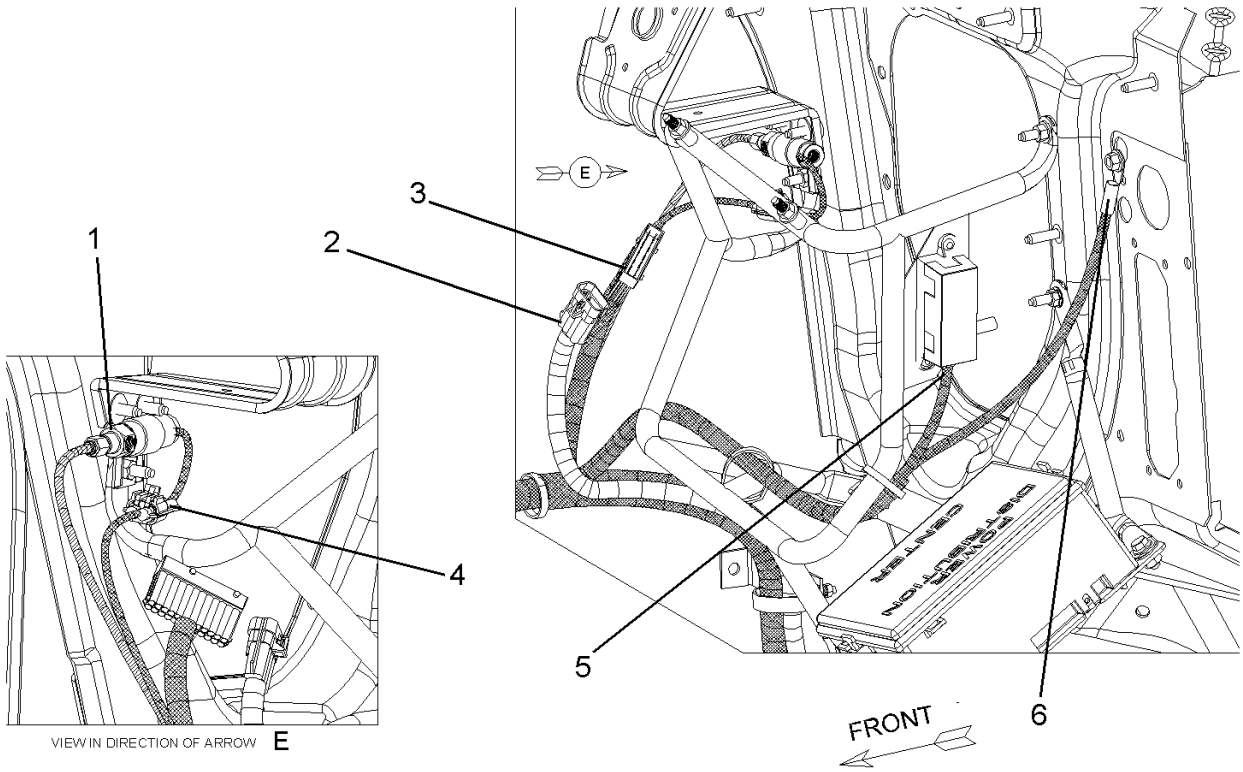

Figure 211 Engine Connector Locations

1. AIR SOLENOID
2. TRANSMISSION HARNESS
3. ENGINE/DASH CONNECTOR (4103)
4. AIR SOLENOID CONNECTOR TO ENGINE HARNESS
5. ENGINE HARNESS CIRCUIT N14BA TO ENGINE ECM FEED FUSE (9254)
6. ENGINE HARNESS CIRCUIT N14–G TO GROUND CONNECTOR (9260)

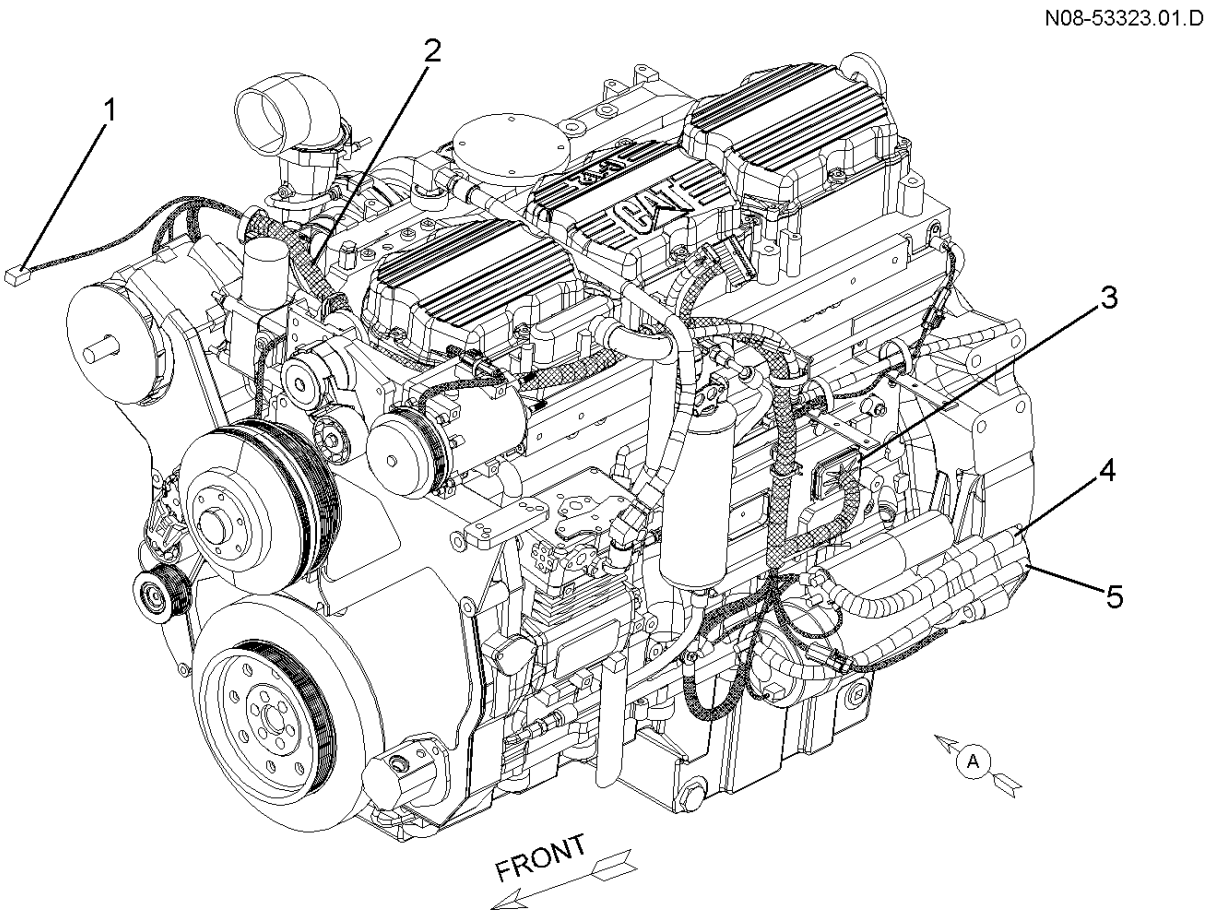

Figure 212 Engine ECM Location

1. TO SURGE TANK
2. ENGINE HARNESS
3. ENGINE ECM
4. TO BATTERY POSITIVE
5. TO BATTERY NEGATIVE

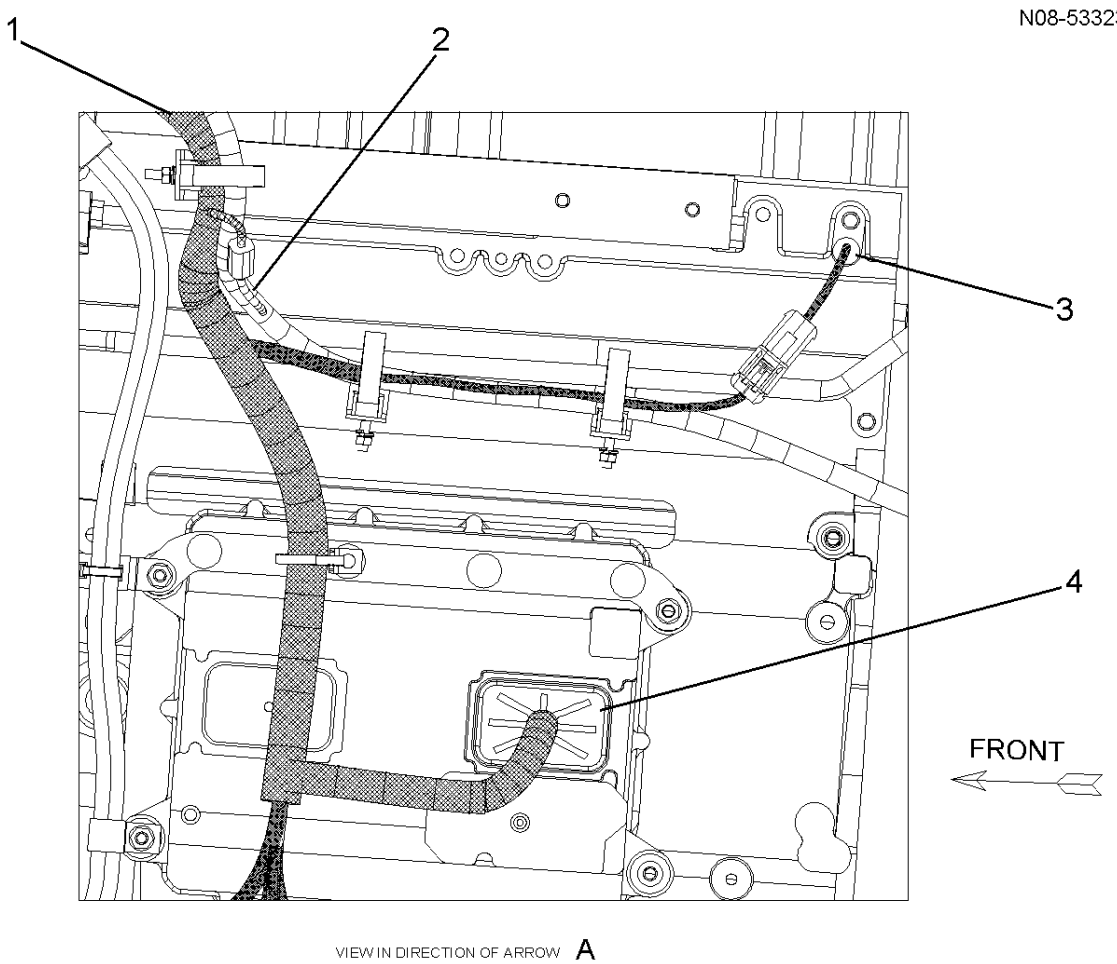

Figure 213 Engine ECM Location

1. ENGINE HARNESS
2. TRANSMISSION HARNESS
3. ENGINE ETHER START THERMOSTAT SWITCH
4. ECM CONNECTOR (6013)

4.2. ENGINE DATA LINK CIRCUITS

Circuit Functions

The engine electronic control module communicates on the drivetrain 1939 data link and the 1708 data link.

Communication on the drivetrain 1939 data link allows the ECM to send and receive messages to the ESC, the EGC and other controllers on the vehicle. Refer to Drive Train 1939 Data Link in the Multiplexing (Data Links) section of this manual. (See DRIVETRAIN 1939 DATA LINK, page 60)

The 1708 data link is primarily used for diagnostics and programming. The 1708 data link connection is also used with the hydraulic ABS (hydraulic ABS doesn't have a J1939 interface). Refer to 1708 Data Link in the Multiplexing (Data Links) section of this manual. (See 1708 DATA LINK, page 75)

4.3. CRUISE CONTROL

Circuit Functions

Cruise control and engine speed for PTO operations are selected with the cruise switches on the steering wheel. These switches are inputs to the ESC. The ESC generates commands to the engine controller on the Drivetrain 1939 data link.

Refer to Cruise Control Circuitsin the Cab Section of this manual.

4.4. REMOTE ENGINE SPEED CONTROL MODULE (RESCM)

Circuit Functions

The I6 engine has optional feature codes that allow controlling the engine from a remote location outside the cab. This is accomplished by connecting to the discrete wiring of the engine ECM. When one of these feature codes, 012VVW (Provision for Remote Throttle Control) or 012VWY (Hydraulic Pressure Governor) is ordered, a harness pigtail with the engine control circuits is strapped to the engine harness.

Refer to Body Builder Manual CT-471 or the applicable engine manual for more details.

Component Locations

5. DETROIT DIESEL ENGINES

Discussion of the Detroit Diesel Engine, in this section, is limited to the engine electronic control module (ECM) power circuits and data link connectivity. The engine controller has its own diagnostic system and uses flash codes displayed by the ENGINE warning lights. For detailed information on Caterpillar engine diagnostics, refer to the appropriate Caterpillar Manual.

5.1. ENGINE CONTROL MODULE (ECM) POWER AND GROUND

Circuit Functions

Diagnostics

A problem with power to the ECM will be apparent when the vehicle will not crank and the “CHECK ELEC SYS” warning lamp in the gauge cluster is constantly on.

The problem could be attributed to open or shorted wiring between the ECM and related power circuits, a blown fuse, a failed relay or a failure inside the ECM.

Several diagnostic trouble codes (DTC’s) will be logged when there is no communication on the drivetrain 1939 data link between the ECM and the ESC or the EGC.

An electronic service tool, running the "INTUNE" diagnostic software, can be used to view diagnostic trouble codes. Refer to the “INTUNE” software manual

Table 137 Engine Electronic Control Module Preliminary Check

STEP	KEY	ACTION	TEST POINTS	SPEC.	YES - IN SPEC.	NO - OUT OF SPEC.
1.	On	Verify “CHECK ELEC SYS” warning lamp is on and ECM is inoperative.	Visually check “CHECK ELEC SYS” warning lamp and attempt to start vehicle.	Engine cranks.	Go to Drivetrain 1939 Data Link(See DRIVETRAIN 1939 DATA LINK, page 60)	Go to Fault Detection Management.(See Fault Detection Management, page 435)

Fault Detection Management

NOTE – The testing method for troubleshooting the electrical systems portrayed in this manual is a basic voltage test. An alternative method of checking for voltage drops within a given circuit may be a quicker method of identifying an exact problem.

A fault in the ECM power circuits will be apparent when the engine will not start and there is no communication between the ECM and the ESC or EGC. Problems in the ECM power circuits could be attributed to a blown fuse, a short or an open circuit.

Refer to ECM Power Circuits.

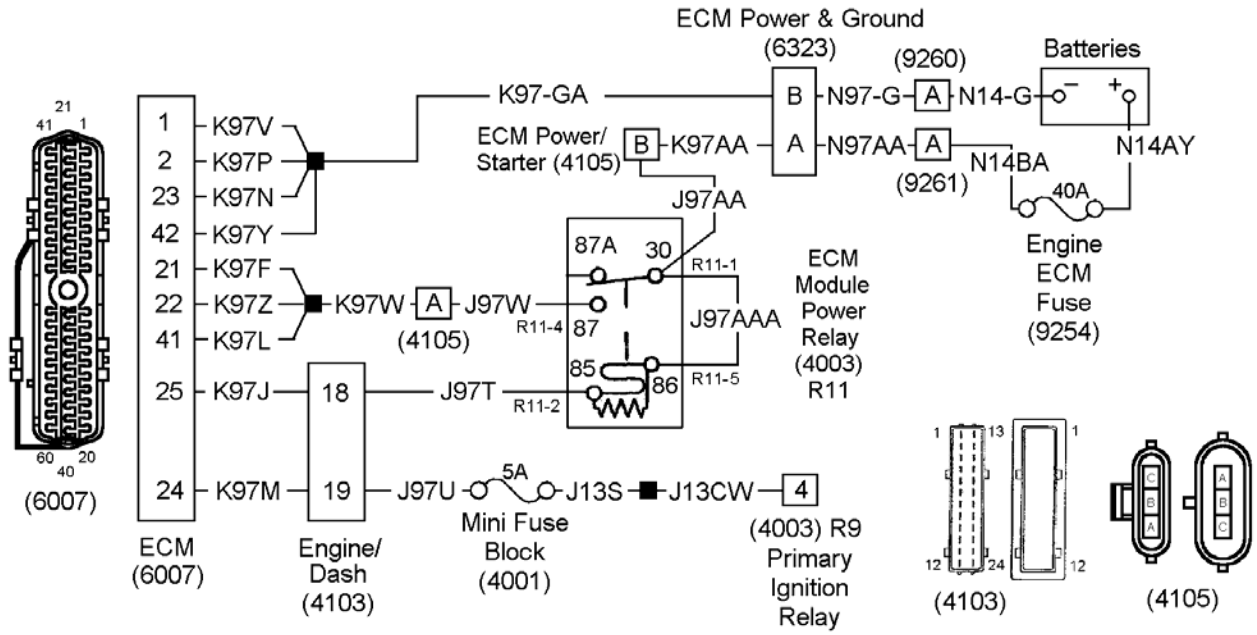

Figure 214 ECM Power Circuits

(4001) MINI FUSE BLOCK
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4003) (R11) ECM MODULE POWER RELAY
LOCATED IN ENGINE POWER DISTRIBUTION CENTER
(4103) ENGINE/DASH CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(4105) ECM POWER/STARTER SOLENOID CONNECTOR
LOCATED NEAR WIPER MOTOR BRACKET
(6007) ENGINE ECM CONNECTOR
LOCATED ON ENGINE ECM
(6323) ENGINE MODULE POWER AND GROUND
LOCATED NEAR START MOTOR
(9254) ENGINE ECM FEED FUSE CONNECTOR
LOCATED IN BATTERY COMPARTMENT
(9260) BATTERY ECM NEGATIVE CONNECTOR
LOCATED IN BATTERY COMPARTMENT
(9261) BATTERY ECM POSITIVE CONNECTOR
LOCATED IN BATTERY COMPARTMENT

Extended Description

Component Locations

N08-53345.06

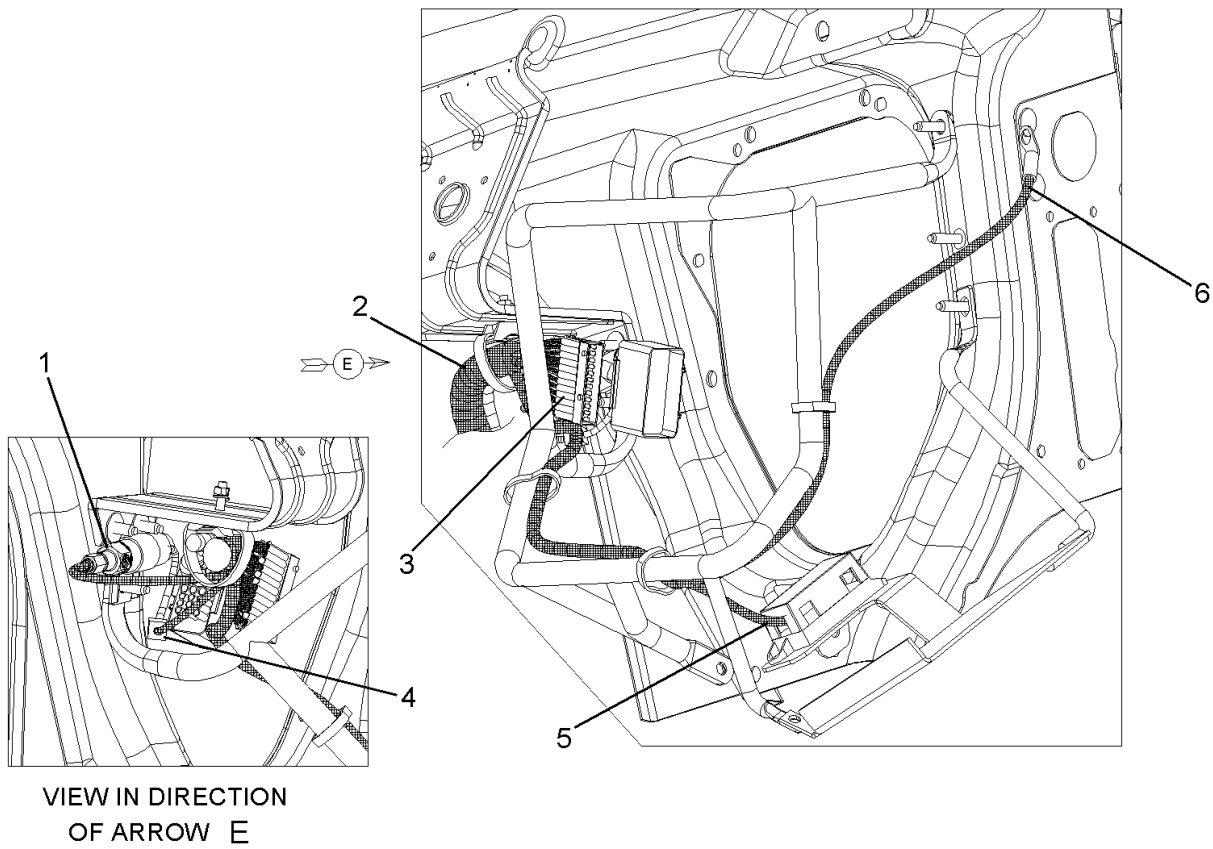

Figure 215 Engine Connector Locations

1. AIR SOLENOID
2. ENGINE HARNESS
3. ENGINE/DASH CONNECTOR (4103)
4. AIR SOLENOID CONNECTOR TO ENGINE HARNESS
5. ENGINE HARNESS CIRCUIT N14BA TO ENGINE ECM FEED FUSE (9254)
6. ENGINE HARNESS CIRCUIT N14–G TO GROUND CONNECTOR (9260)

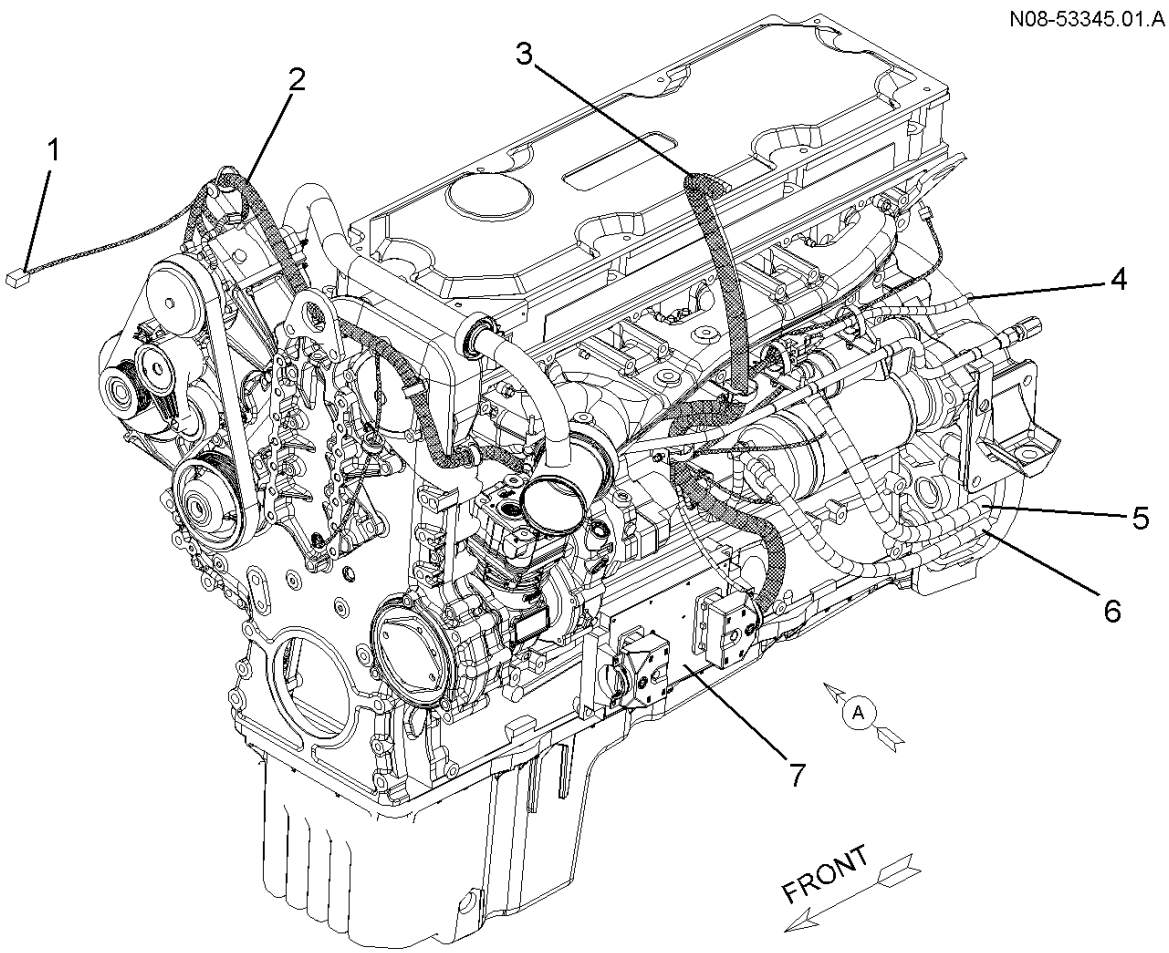

Figure 216 Engine ECM Location

1. TO SURGE TANK
2. ENGINE HARNESS
3. TO DASH HARNESS
4. TRANSMISSION HARNESS
5. TO BATTERY POSITIVE
6. TO BATTERY NEGATIVE
7. ENGINE ECM

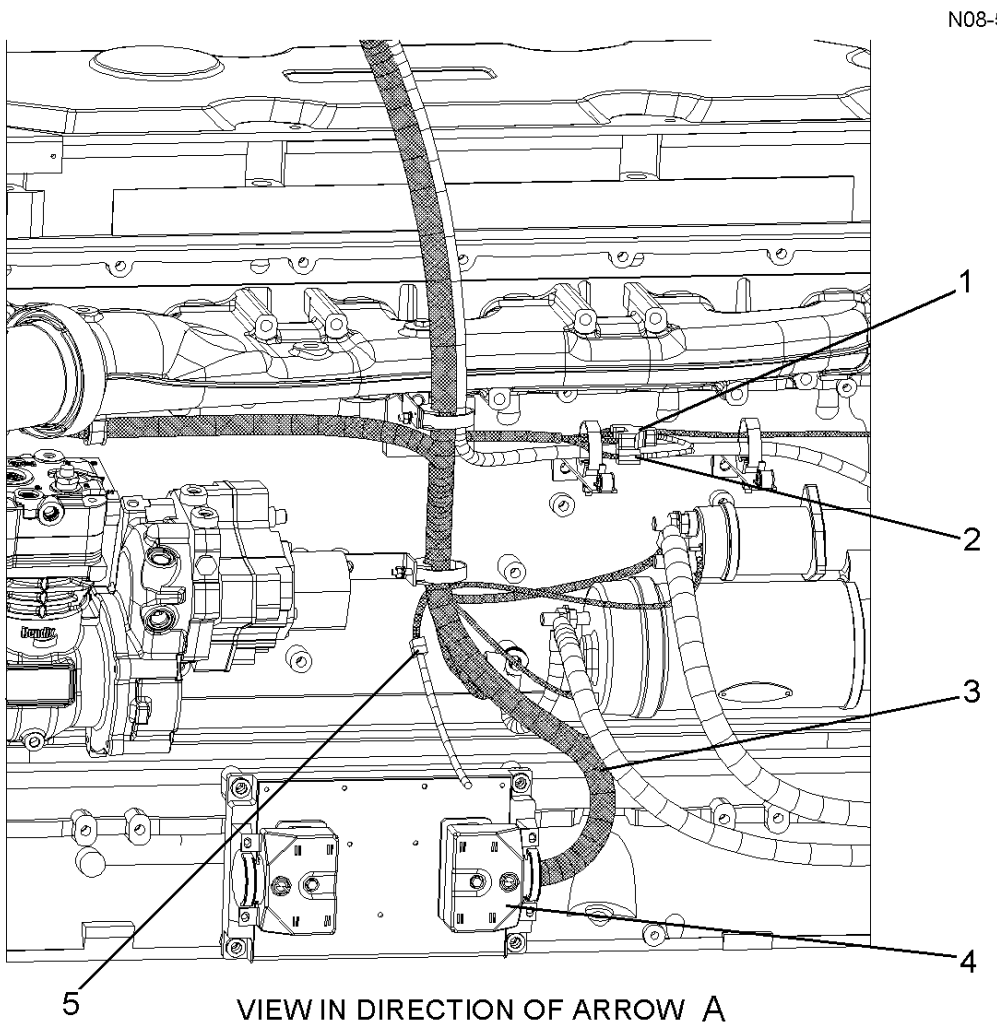

Figure 217 Engine ECM Location

1. DRIVETRAIN 1939 DATALINK “Y” CONNECTOR
2. 3–WAY ENGINE HARNESS CONNECTOR
3. ENGINE HARNESS
4. 2–WAY ECM BATTERY POWER CONNECTOR
5. ECM CONNECTOR

5.2. ENGINE DATA LINK CIRCUITS

Circuit Functions

The engine electronic control module communicates on the drivetrain 1939 data link and the 1708 data link.

Communication on the drivetrain 1939 data link allows the ECM to send and receive messages to the ESC, the EGC and other controllers on the vehicle. Refer to Drive Train 1939 Data Link in the Multiplexing (Data Links) section of this manual. (See DRIVETRAIN 1939 DATA LINK, page 60)

The 1708 data link is primarily used for diagnostics and programming. The 1708 data link connection is also used with the hydraulic ABS (hydraulic ABS doesn't have a J1939 interface). Refer to 1708 Data Link in the Multiplexing (Data Links) section of this manual. (See 1708 DATA LINK, page 75)

5.3. CRUISE CONTROL

Circuit Functions

Cruise control and engine speed for PTO operations are selected with the cruise switches on the steering wheel. These switches are inputs to the ESC. The ESC generates commands to the engine controller on the Drivetrain 1939 data link.

Refer to Cruise Control Circuits in the Cab Section of this manual.

5.4. REMOTE ENGINE SPEED CONTROL MODULE (RESCM)

Circuit Functions

The I6 engine has optional feature codes that allow controlling the engine from a remote location outside the cab. This is accomplished by connecting to the discrete wiring of the engine ECM. When one of these feature codes, 012VVW (Provision for Remote Throttle Control) or 012VWY (Hydraulic Pressure Governor) is ordered, a harness pigtail with the engine control circuits is strapped to the engine harness.

Refer to Body Builder Manual CT-471 or the applicable engine manual for more details.

Component Locations