ISC, QSC8.3, and ISL (FIS3666271)

ISC, QSC8.3, and ISL (FIS3666271)

Last Modified: 6 Apr 2011 (71-t05-278)

FIS Usage Recommendations

- To avoid Internet Explorer opening its "splash screen" each time when viewing a FIS page with popup content, start Internet Explorer before opening the FIS.
- The "Hide" / "Show" button hides the left column; the right column can be maximized after hiding the left column.
- The "Back" button will move backward through pages viewed since opening the FIS ("Alt" - "Left Arrow" is the keyboard equivalent).
- The "Forward" button goes to the previous screen after having just used the "Back" button ("Alt" - "Right Arrow").
- In case the display is corrupted, the "Refresh" button redraws the current FIS display ("Ctrl" - "R").
- Right-clicking anywhere in the left-column display offers "open all" and "close all" options for expanding or compressing the left column folders.
- The left-column search tab offers a full-text search of the FIS; the check box at the bottom selects between complete text search or page titles only.
- The "Favorites" tab in the left column permits each user to Add and Remove bookmarks to his own frequently-used pages in each CHM FIS.

CODE: 211

LAMP: None

REASON: This fault indicates that the vehicle's electronic control unit (VECU), provided by the OEM, detected an active fault in the vehicle's control system.

EFFECT: None on performance.

ACTION: Refer to the OEM for proper repair procedure. Clear inactive fault code using INSITE™ after OEM problem is corrected.

Last Modified: 22 Jan 2003

CODE: 287

LAMP: Yellow

REASON: The OEM vehicle electronic control unit (VECU) detected a fault with its accelerator pedal.

EFFECT: The engine will only idle.

ACTION: Refer to the OEM troubleshooting and repair manual. Troubleshoot the accelerator pedal connected to the OEM supplied vehicle electronic control unit (VECU).

Last Modified: 22 Jan 2003

CODE: 288

LAMP: Yellow

REASON: The OEM vehicle electronic control unit (VECU) detected a fault with its remote throttle.

EFFECT: The engine will only idle.

ACTION: Refer to the OEM troubleshooting and repair manual. Troubleshoot the remote throttle pedal connected to the OEM supplied vehicle electronic control unit (VECU).

Last Modified: 22 Jan 2003

CODE: 319

LAMP: Maintenance or none

REASON: Real-time clock lost power. Unswitched battery power to the ECM has been interrupted.

EFFECT: None on performance. Data in the ECM will not have accurate time and date information.

ACTION: Set real-time clock using RoadRelay™ (if equipped) or by using INSITE™.

Last Modified: 22 Jan 2003

CODE: 599

LAMP: Red

REASON: The dual-output feature in this customer-specialized calibration has initiated an engine shutdown based on operating conditions, engine sensor values, or OEM inputs to the ECM.

EFFECT: Engine will shut down.

ACTION: The dual-output feature is contained only in customer-specialized calibrations. The feature can be set up to shut down the engine based on operating conditions, engine sensor values, or OEM inputs to the ECM. The two OEM inputs are OEM switch input and OEM pressure input. The technician must contact Cummins Engine Company to determine the dual output feature's configuration to understand which parameters and what parameter value(s) are causing the engine to shut down.

Last Modified: 22 Jan 2003

CODE: 611

LAMP: None

REASON: The engine was shut down with the keyswitch before proper engine cooldown.

EFFECT: No action is taken by the ECM.

ACTION: Hot shutdowns damage engine components and shorten engine life. Refer to the engine operation and maintenance manual for proper cooldown techniques.

Last Modified: 22 Jan 2003

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FAULT CODE 111
Electronic Control Module (ECM) Microprocessor

Overview

CODE	REASON	EFFECT
Fault Code: 111 PID: S254 SPN: 629 FMI: 12 LAMP: Yellow SRT:	ECM internal hardware error.	Possible no effect or engine can, perhaps, run rough or **not** start.

ECM Microprocessor

Circuit Description

The ECM is a computer that is responsible for engine control, diagnostics, and user features.

Component Location

The ECM is located on the left side of the engine block, behind the fuel filter.

Shop Talk

This fault code can be caused **only** by an internal ECM problem. Repairs are **not** possible for the ECM.

Refer to Troubleshooting Fault Code t05-111

Last Modified: 16-Dec-2010

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FAULT CODE 115
Engine Speed Sensor (ESS) Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 115 PID: P190 SPN: 190 FMI: 2 LAMP: Yellow SRT:	No engine speed signal detected at pin 17 of the engine harness.	Engine power derate. Possible white smoke.

Engine Speed Sensor (ESS) Circuit

Circuit Description

The engine speed sensor provides engine speed information to the electronic control module (ECM). The sensor **must** be powered by +5 VDC to operate. The sensor generates its signals by sensing the movement of target teeth cut into a steel ring fastened to the back side of the cam gear. This ring has 71 teeth and a gap where the 72nd tooth would be placed. This missing tooth indicates that cylinder 1 (and 6) is at top dead center.

Component Location

The engine speed sensor is located on the back side of the gear housing, between the fuel injection pump and the air compressor.

Refer to Troubleshooting Fault Code t05-115

Last Modified: 16-Dec-2010

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FAULT CODE 121
Engine Position Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 121 PID: P190 SPN: 190 FMI: 2 LAMP: Yellow SRT:	No engine position signal detected at pin 9 of the engine harness.	No engine speed and position backup for main speed/position sensor.

Engine Position Sensor Circuit

Circuit Description

The engine position sensor provides engine position information to the electronic control module (ECM). The sensor **must** be powered by +5-VDC to operate. The sensor generates a signal by sensing the movement of target teeth cut into a steel ring fastened to the back side of the cam gear. This ring has 71 teeth and a gap where the 72nd tooth would be placed. This missing tooth indicates that cylinder 1 (and 6) is at top dead center.

Component Location

The engine position sensor is located on the backside of the gear housing, between the fuel injection pump and the air compressor.

Refer to Troubleshooting Fault Code t05-121

Last Modified: 16-Dec-2010

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FAULT CODE 122
Intake Manifold Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 122 PID: P102 SPN: 102 FMI: 3 LAMP: Yellow SRT:	High voltage detected at the boost pressure sensor signal pin-45 of the engine harness.	Engine will derate to no-boost fueling.

Intake Manifold Pressure Sensor Circuit

Circuit Description

The intake manifold pressure sensor monitors intake manifold pressure and passes information to the electronic control module (ECM) through the sensor harness. If the intake manifold pressure becomes too high, it will cause a derate condition.

Component Location

The intake manifold pressure sensor is located on the rear of the intake air manifold in the second port on the side of the head to the right of the fuel filter.

Shop Talk

- Determine if engine is being overfueled.
- Confirm that the correct intake manifold pressure sensor part number is being used.
- Confirm that the correct turbocharger is being used.
- If it is suspected that cold intake air is the cause of the high intake manifold pressure, test the engine with warm intake air.
- Check for high restriction in the intake air manifold due to a shutdown device in the manifold (if the vehicle is equipped with one). Do **not** remove this device. If the engine is operated in a flammable atmosphere, the device is an essential safety feature.

Refer to Troubleshooting Fault Code t05-122

Last Modified: 16-Dec-2010

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FAULT CODE 123
Intake Manifold Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 123 PID: P102 SPN: 102 FMI: 4 LAMP: Yellow SRT:	Low voltage detected at the boost pressure sensor signal pin 45 of the engine harness.	Engine will derate to no-boost fueling.

Intake Manifold Pressure Sensor Circuit

Circuit Description

The intake manifold pressure sensor monitors intake manifold pressure and passes information to the electronic control module (ECM) through the sensor harness. If the intake manifold pressure becomes too high, it will cause a derate condition.

Component Location

The intake manifold pressure sensor is located on the rear of the intake air manifold in the second port on the side of the head to the right of the fuel filter.

Shop Talk

- Determine if engine is being overfueled.
- Confirm that the correct intake manifold pressure sensor part number is being used.
- Confirm that the correct turbocharger is being used.
- If it is suspected that cold intake air is the cause of the high intake manifold pressure, test the engine with warm intake air.
- Check for high restriction in the intake air manifold due to a shutdown device in the manifold (if the vehicle is equipped with one). Do **not** remove this device. If the engine is operated in a flammable atmosphere, the device is an essential safety feature.

Refer to Troubleshooting Fault Code t05-123

Last Modified: 16-Dec-2010

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FAULT CODE 124
Intake Manifold Pressure - Engine Protection

Overview

CODE	REASON	EFFECT
Fault Code: 124 PID: P102 SPN: 102 FMI: 0 LAMP: Yellow SRT:	Intake manifold pressure signal indicates intake manifold pressure has exceeded the maximum limit for the given engine rating.	Engine will derate to no-boost fueling.

Intake Manifold Pressure Sensor Circuit

Circuit Description

The intake manifold pressure sensor is used by the electronic control module (ECM) to monitor the engine intake manifold pressure. The ECM monitors the voltage on the signal pin 45 and converts this to a pressure value. The intake manifold pressure value is used by the ECM for the engine protection system.

Component Location

The intake manifold pressure sensor is located on the rear of the intake manifold in the second port on the side of the head to the right of the fuel filter.

Shop Talk

Possible causes:

- Malfunctioning turbocharger wastegate. 010-050 in the ISC Troubleshooting and Repair Manual, Bulletin No. 3666245.
- Wastegate tampering. 010-100 in the ISC Troubleshooting and Repair Manual, Bulletin No. 3666245.
- Wrong turbocharger tampering. 010-101 through 010-107 in the ISC Troubleshooting and Repair Manual, Bulletin No. 3666245.

Refer to Troubleshooting Fault Code t05-124

Last Modified: 16-Dec-2010

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FAULT CODE 131 or 132
Accelerator Position Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 131 or 132 PID: P091 SPN: 091 FMI: 3 or 4 LAMP: Yellow SRT:	FC 131: High voltage detected at accelerator position signal pin 30 of the OEM harness. FC 132: Low voltage detected at accelerator position signal pin 30 of the OEM harness.	Engine idles when idle validation switch indicates idle and operates at a default set speed when idle validation switch indicates off-idle.

Accelerator Position Sensor Circuit

Circuit Description

The accelerator position sensor is attached to the accelerator pedal. The accelerator position sensor sends a signal to the electronic control module (ECM) when the driver pushes on the accelerator pedal. The accelerator position circuit contains three wires: a +5-VDC supply wire (pin 29), a return ground (pin 19), and a signal wire (pin 30).

Note: The connector pin letters shown for the accelerator pedal wiring in these troubleshooting steps are examples of representative sensors. The connector pin assignments can vary with equipment manufacturer, but the base troubleshooting logic will still apply.

Component Location

The accelerator position sensor is located on the accelerator pedal.

Shop Talk

If all wiring and sensor checks look in good order, then replace the accelerator position sensor and the idle validation switch circuit wires between the accelerator pedal and the ECM with new wires. Run the wires through, or around, the bulkhead without using the bulkhead connector. Test the truck with the test wires in place. If the fault goes away, replace the OEM harness. Seal the openings in the bulkhead around the connector and wires to prevent toxic and noxious fumes from entering the operator area.

Note: The three wires in the accelerator position sensor circuit **must** be twisted together. Depending on ground location, IVS can, perhaps, **only** be two wires.

Refer to Troubleshooting Fault Code t05-131

Last Modified: 16-Dec-2010

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FAULT CODE 131 or 132
Accelerator Position Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 131 or 132 PID: P091 SPN: 091 FMI: 3 or 4 LAMP: Yellow SRT:	Fault Code 131: High voltage detected at accelerator position signal pin 30 of the OEM harness. Fault Code 132: Low voltage detected at accelerator position signal pin 30 of the OEM harness.	Engine idles when idle validation switch indicates idle and operates at a default set speed when idle validation switch indicates off-idle.

Accelerator Position Sensor Circuit

Circuit Description

The accelerator position sensor is attached to the accelerator pedal. The accelerator position sensor sends a signal to the electronic control module (ECM) when the driver pushes on the accelerator pedal. The accelerator position circuit contains three wires: a +5-VDC supply wire (pin 29), a return ground (pin 19), and a signal wire (pin 30).

Note: The connector pin letters shown for the accelerator pedal wiring in these troubleshooting steps are examples of representative sensors. The connector pin assignments can vary with equipment manufacturer, but the base troubleshooting logic will still apply.

Component Location

The accelerator position sensor is located on the accelerator pedal.

Shop Talk

If all wiring and sensor checks look in good order, then replace the accelerator position sensor and the idle validation switch circuit wires between the accelerator pedal and the ECM with new wires. Run the wires through, or around, the bulkhead without using the bulkhead connector. Test the truck with the test wires in place. If the fault goes away, replace the OEM harness. Seal the openings in the bulkhead around the connector and wires to prevent toxic and noxious fumes from entering the operator area.

Note: The three wires in the accelerator position sensor circuit **must** be twisted together. Depending on ground location, idle validation switch can, perhaps, **only** be two wires.

Refer to Troubleshooting Fault Code t05-132

Last Modified: 16-Dec-2010

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FAULT CODE 133
Remote Throttle Position Sensor

Overview

CODE	REASON	EFFECT
Fault Code: 133 PID: P029 SPN: 29 FMI: 3 LAMP: Red SRT:	High voltage detected at the remote throttle position signal circuit.	Engine will **not** respond to remote throttle input.

Remote Throttle Position Sensor Circuit

Circuit Description

The remote throttle pedal provides the driver's throttle command to the electronic control module (ECM) through the OEM harness and the original equipment manufacturer's (OEM) interface harness. The ECM uses this signal to determine the fueling command.

Component Location

The remote throttle pedal location varies with each OEM. Refer to the OEM manual.

Shop Talk

The throttle position sensor is a potentiometer. The resistance specifications of the throttle position sensor is as follows:

- Between supply and return = 2000 to 3000 ohms
- Between supply and signal: Released = 1500 to 3000 ohms; depressed = 200 to 1500 ohms

Note: If the throttle or throttle position sensor is changed or after a calibration download cycle the throttle pedal (keyswitch in the ON position) through its complete travel three times. This procedure calibrates the new throttle with the ECM.

- The remote throttle enable switch **must** be turned on for the remote throttle to operate and the feature **must** be enabled with INSITE™.
- Possible causes of this fault code include an open circuit in the return wire, short circuit to +5 VDC or 12 VDC, defective remote throttle position sensor, or a failed ECM power supply.

Refer to Troubleshooting Fault Code t05-133

Last Modified: 16-Dec-2010

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FAULT CODE 134
Remote Throttle Position Sensor

Overview

CODE	REASON	EFFECT
Fault Code: 134 PID: P029 SPN: 29 FMI: 4 LAMP: Red SRT:	Low voltage detected at the remote throttle position signal circuit.	Engine will **not** respond to remote throttle input.

Remote Throttle Position Sensor Circuit

Circuit Description

The remote throttle pedal provides the driver's throttle command to the electronic control module (ECM) through the original equipment manufacturer's (OEM) harness and the OEM interface harness. The ECM uses this signal to determine the fueling command.

Component Location

The remote throttle pedal location varies with each OEM. Refer to the OEM manual.

Shop Talk

The remote throttle position sensor is a potentiometer. The resistance specifications of the throttle position sensor are as follows:

- Between supply and return = 2000 to 3000 ohms
- Between supply and signal: Released = 1500 to 3000 ohms; depressed = 200 to 1500 ohms

Note: If the remote throttle position sensor is changed, or after a calibration download, cycle the throttle pedal (keyswitch in the ON position) through its complete travel three times. This procedure calibrates the new remote throttle with the ECM.

- The remote throttle enable switch **must** be turned on for the remote throttle to operate and the feature **must** be enabled with INSITE™.
- Possible causes of this fault code include an open circuit in the supply wire, short circuit to ground in the supply or signal wires, defective remote throttle position sensor, or a failed ECM power supply.

Refer to Troubleshooting Fault Code t05-134

Last Modified: 16-Dec-2010

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FAULT CODE 135 (SN)
Oil Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 135 PID: P100 SPN: 100 FMI: 3 LAMP: Yellow SRT:	High voltage detected at oil pressure sensor signal pin 33 of the engine harness.	Default value used for oil pressure. No engine protection for oil pressure.

Oil Pressure Sensor Circuit

Circuit Description

The oil pressure sensor is used by the electronic control module (ECM) to monitor the lubricating oil pressure. The ECM monitors the voltage on the signal pin and converts this to a pressure value. The oil pressure value is used by the ECM for the engine protection system.

Component Location

The oil pressure sensor is located on the engine block, below and to the right of the ECM.

Shop Talk

- If Fault Code 143 or 415 is **not** present, the problem is **not** related to the engine lubrication system.
- INSITE™ can be used to monitor the oil pressure signal voltage going into the ECM.

Refer to Troubleshooting Fault Code t05-135

Last Modified: 16-Dec-2010

FAULT CODE 141
Fault Code Path Selection

Do you have an Oil Pressure Sensor?	Go to 71-fc141sn
Do you have an Oil Pressure Switch?	Go to 71-fc141sw

Last Modified: 27-Jan-2004

:

FAULT CODE 141 (SN)
Oil Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 141 PID: P100 SPN: 100 FMI: 4 LAMP: Yellow SRT:	High voltage detected at oil pressure sensor signal pin 33 of the engine harness.	Default value used for oil pressure. No engine protection for oil pressure.

Oil Pressure Sensor Circuit

Circuit Description

The oil pressure sensor is used by the electronic control module (ECM) to monitor the lubricating oil pressure. The ECM monitors the voltage on the signal pin and converts this to a pressure value. The oil pressure value is used by the ECM for the engine protection system.

Component Location

The oil pressure sensor is located on the engine block, below and to the right of the ECM.

Shop Talk

- If Fault Code 143 or 415 is **not** present, the problem is **not** related to the engine lubrication system.
- INSITE™ can be used to monitor the oil pressure signal voltage going into the ECM.

Refer to Troubleshooting Fault Code t05-141sn

Last Modified: 16-Dec-2010

:

FAULT CODE 141 (SW)
Oil Pressure Switch Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 141 PID: P100 SPN: 100 FMI: 4 LAMP: Yellow SRT:	Low voltage detected on pin 47 of the engine harness.	Default value used for oil pressure. No engine protection for oil pressure.

Oil Pressure Switch Circuit

Circuit Description

The oil pressure switch is used by the electronic control module (ECM) to monitor the lubricating oil pressure.

Component Location

The oil pressure switch is located on the engine block, below and to the right of the ECM.

Shop Talk

- If Fault Code 143 or 415 is **not** present, the problem is **not** related to the engine lubrication system.
- INSITE™ can be used to monitor the oil pressure signal voltage going into the ECM.
- If an oil pressure switch is installed, INSITE™ will read a constant value of 379 kPa [55 psi] ±2 kPa [±0.3 psi] if the ECM is reading a signal from the oil pressue switch.
- The switch is a single wire device which requires engine block ground for operation.
- Engine Protection will activate, if enabled, if the lubricating oil pressure drops below 41 kPa [6 psi] with the engine running.

Refer to Troubleshooting Fault Code t05-141sw

Last Modified: 16-Dec-2010

FAULT CODE 143
Fault Code Path Selection

Do you have an Oil Pressure Sensor?	Go to 71-fc143sn
Do you have an Oil Pressure Switch?	Go to 71-fc143sw

Last Modified: 27-Jan-2004

:

FAULT CODE 143 (SN)
Oil Pressure - Engine Protection

Overview

CODE	REASON	EFFECT
Fault Code: 143 PID: P100 SPN: 100 FMI: 1 LAMP: Yellow SRT:	Oil pressure signal indicates oil pressure below the low engine protection limit.	Power and/or speed derate and possible engine shutdown if engine protection shutdown feature enabled.

Oil Pressure Sensor Circuit

Circuit Description

The oil pressure sensor is used by the electronic control module (ECM) to monitor the lubricating oil pressure. The ECM monitors the voltage on the signal pin and converts this to a pressure value. The oil pressure value is used by the ECM for the engine protection system.

Component Location

The oil pressure sensor is located on the engine block, below and to the right of the ECM.

Shop Talk

- Confirm that the oil pressure sensor supply voltage is between (+) 4.5 and 5.25 VDC at the sensor.
- Verify, with the driver, the engine speed at which the fault occurs. If the engine is being operated at too low of a speed under load, the oil pressure can drop below the engine protection limits.
- Connect a manual gauge to monitor engine oil pressure and compare to the value in INSITE™.

Refer to Troubleshooting Fault Code t05-143sn

Last Modified: 16-Dec-2010

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FAULT CODE 143 (SW)
Oil Pressure - Engine Protection With An Oil Pressure Switch

Overview

CODE	REASON	EFFECT
Fault Code: 143 PID: P100 SPN: 100 FMI: 1 LAMP: Yellow SRT:	Oil pressure signal indicates oil pressure below the low engine protection limit.	Power and/or speed derate and possible engine shutdown if engine protection shutdown feature enabled.

Oil Pressure Sensor Circuit

Circuit Description

The oil pressure switch is used by the electronic control module (ECM) to detect the presence of lubricating oil pressure.

Component Location

The oil pressure switch is located on the engine block, below and to the right of the ECM.

Shop Talk

- Confirm that the oil pressure sensor supply voltage is between (+) 4.5 and 5.25 VDC at the sensor.
- Verify, with the driver, the engine speed at which the fault occurs. If the engine is being operated at too low of a speed under load, the oil pressure can drop below the engine protection limits.
- Connect a manual gauge to monitor the actual oil pressure of the engine.
- The fault will trigger if lubricating oil pressure drops below 41 kPa [6 psi] for 5 seconds while the engine is running.
- Engines in the field can have had a jumper harness kit installed which connect the oil pressure switch to pin K in the 23-pin OEM connector or cavity 8 in the Ford OEM connector.

Refer to Troubleshooting Fault Code t05-143sw

Last Modified: 16-Dec-2010

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FAULT CODE 144 or 145
Coolant Temperature Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 144 or 145 PID: P110 SPN: 110 FMI: 3 or 4 LAMP: Yellow SRT:	FC 144: High voltage detected at the coolant temperature signal pin 23 of the engine harness. FC 145: Low voltage detected at the coolant temperature signal pin 23 of the engine harness.	Default value used for engine coolant temperature. No engine protection for coolant temperature.

Coolant Temperature Sensor Circuit

Circuit Description

The coolant temperature sensor is used by the electronic control module (ECM) to monitor the temperature of the engine coolant. The coolant temperature is used by the ECM for the engine protection system, timing, and fueling control.

Component Location

The coolant temperature sensor is located below the thermostat housing.

Shop Talk

The resistance of the sensor varies with the temperature. Use a multimeter and INSITE™ to read the fuel temperature. Compare the resistance value measured with the following table to verify that the sensor is functioning properly.

Temperature (°C)	Temperature [°F]	Resistance (ohms)
0	32	30k to 36k
25	77	9k to 11k
50	122	3k to 4k
75	167	1350 to 1500
100	212	600 to 675

Refer to Troubleshooting Fault Code t05-144

Last Modified: 16-Dec-2010

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FAULT CODE 144 or 145
Coolant Temperature Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 144 or 145 PID: P110 SPN: 110 FMI: 3 or 4 LAMP: Yellow SRT:	FC 144: High voltage detected at the coolant temperature signal pin 23 of the engine harness. FC 145: Low voltage detected at the coolant temperature signal pin 23 of the engine harness.	Default value used for engine coolant temperature. No engine protection for coolant temperature.

Coolant Temperature Sensor Circuit

Circuit Description

The coolant temperature sensor is used by the electronic control module (ECM) to monitor the temperature of the engine coolant. The coolant temperature is used by the ECM for the engine protection system, timing, and fueling control.

Component Location

The coolant temperature sensor is located below the thermostat housing.

Shop Talk

The resistance of the sensor varies with the temperature. Use a multimeter and INSITE™ to read the fuel temperature. Compare the resistance value measured with the following table to verify that the sensor is functioning properly.

Temperature (°C)	Temperature [°F]	Resistance (ohms)
0	32	30k to 36k
25	77	9k to 11k
50	122	3k to 4k
75	167	1350 to 1500
100	212	600 to 675

Refer to Troubleshooting Fault Code t05-145

Last Modified: 16-Dec-2010

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FAULT CODE 146
Coolant Temperature - Engine Protection

Overview

CODE	REASON	EFFECT
Fault Code: 146 PID: P110 SPN: 110 FMI: 0 LAMP: Yellow SRT:	Coolant temperature signal indicates coolant temperature has exceeded the engine protection limit.	Power derate and possible engine shutdown, if engine protection shutdown feature is enabled.

Coolant Temperature Sensor Circuit

Circuit Description

The coolant temperature sensor (CTS) is used by the electronic control module (ECM) to monitor the temperature of the engine coolant. The coolant temperature is used by the ECM for the engine protection system, and the timing and fueling control.

Component Location

The coolant temperature sensor is located below the thermostat housing.

Shop Talk

Make sure the airflow through the radiator is **not** obstructed.

Refer to Troubleshooting Fault Code t05-146

Last Modified: 16-Dec-2010

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FAULT CODE 147
Frequency Throttle Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 147 PID: P091 SPN: 091 FMI: 8 LAMP: Red SRT:	A frequency below a calibrated value has been detected at frequency throttle signal pin 4 of the engine harness.	Engine will **not** respond to changes in frequency throttle. The engine will go to low idle.

Frequency Throttle Circuit

Circuit Description

The throttle pedal provides the driver's throttle command to the electronic control module (ECM) through the original equipment manufacturer (OEM) harness and the 23-pin connector to the engine harness. The ECM uses this signal to determine the fueling command.

Component Location

The throttle pedal location varies with each OEM. Refer to the OEM manual.

Shop Talk

The frequency throttle can either be used in conjunction with a voltage throttle or by itself.

Refer to Troubleshooting Fault Code t05-147

Last Modified: 16-Dec-2010

:

FAULT CODE 148
Frequency Throttle Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 148 PID: P091 SPN: 091 FMI: 8 LAMP: Red SRT:	A frequency above a calibrated value has been detected at the frequency throttle signal pin 4 of the engine harness.	Engine will **not** respond to changes in the frequency throttle. Engine will go to low idle.

Frequency Throttle Circuit

Circuit Description

The throttle pedal provides the driver's throttle command to the electronic control module (ECM) through the original equipment manufacturer's (OEM) harness and the 23-pin connector to the engine harness. The ECM uses this signal to determine the fueling command.

Component Location

The throttle pedal location varies with each OEM. Refer to the OEM manual.

Shop Talk

The frequency throttle can either be used in conjunction with a voltage throttle or by itself.

Refer to Troubleshooting Fault Code t05-148

Last Modified: 16-Dec-2010

:

FAULT CODE 151
Coolant Temperature - Engine Protection

Overview

CODE	REASON	EFFECT
Fault Code: 151 PID: P110 SPN: 110 FMI: 0 LAMP: Red SRT:	Coolant temperature signal indicates coolant temperature has exceeded the engine protection limit.	Speed derate and possible engine shutdown if engine protection shutdown feature is enabled.

Coolant Temperature Sensor Circuit

Circuit Description

The coolant temperature sensor (CTS) is used by the electronic control module (ECM) to monitor the temperature of the engine coolant. The coolant temperature is used by the ECM for the engine protection system, and the timing and fueling control.

Component Location

The coolant temperature sensor (CTS) is located below the thermostat housing.

Shop Talk

Make sure the airflow through the radiator is **not** obstructed.

Refer to Troubleshooting Fault Code t05-151

Last Modified: 16-Dec-2010

:

FAULT CODE 153 or 154
Intake Manifold Air Temperature Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 153 or 154 PID: P105 SPN: 105 FMI: 3 or 4 LAMP: Yellow SRT:	FC 153: High voltage detected at intake manifold air temperature signal pin 34 of the engine harness. FC 154: Low voltage detected at intake manifold air temperature signal pin 34 of the engine harness.	Default value used for intake manifold air temperature. No engine protection for intake manifold air temperature.

Intake Manifold Air Temperature Sensor Circuit

Circuit Description

The intake manifold air temperature sensor is used by the electronic control module (ECM) to monitor the temperature of the engine intake air. The intake manifold air temperature signal is used by the ECM for the engine protection system, injection timing, and fueling control.

Component Location

The intake manifold air temperature sensor is located on the side of the intake manifold near the middle of the cylinder head.

Shop Talk

The resistance of the sensor varies with the temperature. Use a multimeter and read the air temperature using INSITE™. Compare the resistance value measured with the following table to verify the sensor is functioning properly.

Temperature (°C)	Temperature [°F]	Resistance (ohms)
0	32	30k to 36k
25	77	9k to 11k
50	122	3k to 4k
75	167	1350 to 1500
100	212	600 to 675

Refer to Troubleshooting Fault Code t05-153

Last Modified: 16-Dec-2010

:

FAULT CODE 153 or 154
Intake Manifold Air Temperature Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 153 or 154 PID: P105 SPN: 105 FMI: 3 or 4 LAMP: Yellow SRT:	FC 153: High voltage detected at intake manifold air temperature signal pin 34 of the engine harness. FC 154: Low voltage detected at intake manifold air temperature signal pin 34 of the engine harness.	Default value used for intake manifold air temperature. No engine protection for intake manifold air temperature.

Intake Manifold Air Temperature Sensor Circuit

Circuit Description

The intake manifold air temperature sensor is used by the electronic control module (ECM) to monitor the temperature of the engine intake air. The intake manifold air temperature signal is used by the ECM for the engine protection system, injection timing, and fueling control.

Component Location

The intake manifold air temperature sensor is located on the side of the intake manifold near the middle of the cylinder head.

Shop Talk

The resistance of the sensor varies with the temperature. Use a multimeter and read the air temperature using INSITE™. Compare the resistance value measured with the following table to verify the sensor is functioning properly.

Temperature (°C)	Temperature [°F]	Resistance (ohms)
0	32	30k to 36k
25	77	9k to 11k
50	122	3k to 4k
75	167	1350 to 1500
100	212	600 to 675

Refer to Troubleshooting Fault Code t05-154

Last Modified: 16-Dec-2010

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FAULT CODE 184
Primary and Secondary Electronic Control Modules (ECM) Identification Error

Overview

CODE	REASON	EFFECT
Fault Code: 184 PID: S233 SPN: 609 FMI: 2 (J1587), 2 (J1939) LAMP: Yellow SRT:	Error detected in the control synchronization of multiple engines.	Multiple unit synchronization will be disabled. Engine will **only** idle.

Primary/Secondary ECM Identification Error

Circuit Description

The QSL9 control system synchronizes two ECMs, one primary and one secondary.

Component Location

The ECMs are located on the left side of the engine block, behind the fuel filter.

Shop Talk

Identification between primary and secondary modules is done at key-on through the harness. Pins 47 and 48 of each engine harness provide the determination of primary or secondary. Reference the following table for primary/secondary identification:

ECM Identification	Pin 47	Pin 48
Primary	Grounded	Open
Secondary	Open	Grounded

Refer to Troubleshooting Fault Code t05-184

Last Modified: 16-Dec-2010

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FAULT CODE 191
Air Conditioner Clutch Supply Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 191 PID: P050 SPN: 876 FMI: 11 LAMP: SRT:	Air conditioner clutch driver signal indicates a short to ground when commanded on.	Can **not** turn on air conditioner.

Air Conditioner Clutch Supply Circuit

Circuit Description

The air conditioner clutch solenoid is a device used by the electronic control module (ECM) to control the air conditioner, by sending a signal to open or close the fan clutch solenoid.

Component Location

Refer to an original equipment manufacturer's (OEM) diagram for the location of the air conditioner clutch solenoid.

Shop Talk

Air conditioner clutch solenoid could be malfunctioning due to a failed engine harness or a bad ground on the air conditioner clutch connector.

Refer to Troubleshooting Fault Code t05-191

Last Modified: 16-Dec-2010

:

FAULT CODE 221 or 222
Ambient Air Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 221 or 222 PID: P108 SPN: 108 FMI: 3 or 4 LAMP: Yellow SRT:	FC 221: High voltage detected at the ambient air pressure sensor signal pin 32 of the engine harness. FC 222: Low voltage detected at the ambient air pressure sensor signal pin 32 of the engine harness.	Power derate by 15 percent.

Ambient Air Pressure Sensor Circuit

Circuit Description

The ambient air pressure sensor monitors atmospheric pressure and passes information to the electronic control module (ECM) through the sensor harness.

Component Location

The ambient air pressure sensor is located below the fuel transfer pump. Refer to Procedure 100-002 (Engine Diagrams) in Section E.

Shop Talk

Monitor the ambient air pressure reading with a service tool to confirm that the pressure reading matches the actual air pressure.

Refer to Troubleshooting Fault Code t05-221

Last Modified: 16-Dec-2010

:

FAULT CODE 221 or 222
Ambient Air Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 221 or 222 PID: P108 SPN: 108 FMI: 3 or 4 LAMP: Yellow SRT:	FC 221: High voltage detected at the ambient air pressure sensor signal pin 32 of the engine harness. FC 222: Low voltage detected at the ambient air pressure sensor signal pin 32 of the engine harness.	Power derate by 15 percent.

Ambient Air Pressure Sensor Circuit

Circuit Description

The ambient air pressure sensor monitors atmospheric pressure and passes information to the electronic control module (ECM) through the sensor harness.

Component Location

The ambient air pressure sensor is located below the fuel transfer pump. Refer to Procedure 100-002 (Engine Diagrams) in Section E.

Shop Talk

Monitor the ambient air pressure reading with a service tool to confirm that the pressure reading matches the actual air pressure.

Refer to Troubleshooting Fault Code t05-222

Last Modified: 16-Dec-2010

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FAULT CODE 234
Engine Overspeed Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 234 PID: P190 SPN: 190 FMI: 0 LAMP: Red SRT:	Engine speed signal indicates engine speed has exceeded the overspeed limit.	Fuel to the injectors disabled until the engine speed falls below the overspeed limit.

Engine Overspeed Circuit

Circuit Description

The engine speed sensor provides engine speed information to the electronic control module (ECM). The sensor **must** be powered by +5 VDC to operate. The sensor generates a signal by sensing the movement of target teeth cut into a steel ring fastened to the backside of the camshaft gear. This ring has 71 teeth and a gap where the 72nd tooth would be placed. This missing tooth indicates that cylinder 1 (and 6) is at top dead center.

Component Location

The engine speed sensor is located on the back side of the gear housing, between the Cummins accumulator pump system (CAPS) fuel pump and the air compressor.

Refer to Troubleshooting Fault Code t05-234

Last Modified: 16-Dec-2010

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FAULT CODE 235
Engine Coolant Level - Engine Protection

Overview

CODE	REASON	EFFECT
Fault Code: 235 PID: P111 SPN: 111 FMI: 1 LAMP: Maintenance SRT:	Coolant level signal at pin 27 and pin 37 of the engine harness indicates coolant level is low.	Power and/or speed derates and possible engine shutdown if engine protection shutdown feature is enabled.

Engine Coolant Level - Engine Protection

Circuit Description

The coolant level sensor monitors the coolant level within the coolant system and passes information to the electronic control module (ECM) through the engine harness. Because this sensor is complex, do **not** use a multimeter to check it. If the radiator coolant level drops below a certain level, a progressive power and/or speed derate will occur. Engine can, perhaps, shut down if the engine protection shutdown feature is enabled.

Component Location

The coolant level sensor is located in the radiator top tank or surge tank.

Shop Talk

This is an OEM-supplied component and can vary in location.

- If a shorting plug is used in the coolant level circuit, verify that it is wired correctly.
- Inspect the wiring harness between the Weather-Pack four-way connector and the coolant level sensor for damage.
- Make sure the coolant level sensor is located in the middle of the tank rather than off to one side where the coolant level can change when the vehicle turns a corner.
- Make sure the correct ECM code is in the ECM. Calibrating the ECM with the incorrect DO option can cause Fault Code 235 to be active since some OEMs use a coolant level sensor that requires a special calibration. Refer to OEM service manual.

Refer to Troubleshooting Fault Code t05-235

Last Modified: 16-Dec-2010

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FAULT CODE 241
Vehicle Speed Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 241 PID: P084 SPN: 084 FMI: 2 LAMP: Yellow SRT:	Vehicle speed signal on pins 8 and 18 of the original equipment manufacturer's (OEM) harness has been lost.	Engine speed limited to "Max. Engine Speed without Vehicle Speed Sensor" parameter value. Cruise control, gear-down protection, and road speed governor will **not** work. Trip information data that are based on mileage will be incorrect.

Vehicle Speed Sensor Circuit

Circuit Description

The vehicle speed sensor (VSS) uses two separate coils of wire (some applications use a single coil sensor) to count gear teeth as they pass in front of the sensor. One coil is used by the electronic control module (ECM) to sense vehicle speed. The other coil is sometimes used by the OEM to send a vehicle speed signal to the speedometer.

Component Location

The VSS is most commonly installed in the rear of the transmission.

Shop Talk

- Disconnect the vehicle speed sensor connector that connects to the OEM speedometer, or trip recorder, and move the truck. If the fault goes inactive, there is probably electrical noise being fed into the vehicle speed sensor circuit from the OEM device.
- Verify the vehicle speed sensor wires in the OEM harness are twisted-pairs.

Refer to Troubleshooting Fault Code t05-241

Last Modified: 16-Dec-2010

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FAULT CODE 242
Vehicle Speed Sensor (VSS) Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 242 PID: P084 SPN: 084 FMI: 10 LAMP: Yellow SRT:	Invalid or inappropriate vehicle speed signal detected on pins 8 and 18 of the OEM harness indicating an intermittent connection or possible tampering.	Engine speed limited to "Maximum Engine Speed without Vehicle Speed Sensor" for the duration of the invalid signal.

Vehicle Speed Sensor Circuit

Circuit Description

The vehicle speed sensor (VSS) uses two separate coils of wire (some applications use a single coil sensor) to count gear teeth as they pass in front of the sensor. One coil is used by the electronic control module (ECM) to sense vehicle speed. The other coil is sometimes used by the OEM to send a vehicle speed signal to the speedometer.

Component Location

The VSS is most commonly installed in the rear of the transmission.

Shop Talk

- Verify that the feature settings for "VSS Antitampering (Fault Code 242), "Application Type," and "Automatic Transmission" are set correctly. If any of these are set incorrectly, Fault Code 242 could occur erroneously.

NOTE: Driving techniques, such as driving for extended periods of time in lower gears, could log Fault Code 242.

- Fault Code 242 can be logged if the driver attempts to defeat the road speed governor by repeatedly cycling the keyswitch.
- Interview the driver to discover what occurred when the fault code was logged. Explain the driver actions that can cause Fault Code 242 to be logged.
- When deactivating the fault, verify that the vehicle is stopped and the engine is shut down.
- Verify that the keyswitch has been cycled and has remained in the ON position for 30 seconds after the invalid signal has been corrected. This fault will remain active until the keyswitch is cycled and the ECM sees zero vehicle speed and zero engine speed for 30 seconds.

Refer to Troubleshooting Fault Code t05-242

Last Modified: 16-Dec-2010

FAULT CODE 243
Fault Code Path Selection

Do you have an ISC engine?	Go to 71-fc243isc
Do you have an ISL engine?	Go to 71-fc243isl

Last Modified: 18-Mar-2003

:

FAULT CODE 243 (ISC)
Engine Brake Supply Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 243 PID: P121 SPN: 513 FMI: 4 LAMP: SRT:	Error detected in engine brake relay enable circuit at pin 42 of the engine harness.	Engine brake will **not** work.

Engine Brake Relay Supply Circuit

Circuit Description

The electronic control module (ECM) enables the engine brake by sending a signal to the engine brake under certain conditions.

Component Location

Refer to the original equipment manufacturer's (OEM) diagram for the location of the engine brake.

Refer to Troubleshooting Fault Code t05-243isc

Last Modified: 16-Dec-2010

:

FAULT CODE 243 (ISL)
Engine Brake Supply Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 243 PID: P121 SPN: 513 FMI: 4 LAMP: SRT:	Error detected in engine brake relay enable circuit at pin 42 of the engine harness.	Engine brake will **not** work.

Engine Brake Relay Supply Circuit

Circuit Description

The electronic control module (ECM) enables the engine brake by sending a signal to the engine brake under certain conditions.

Component Location

Refer to the original equipment manufacturer's (OEM) diagram for the location of the engine brake.

Shop Talk

The OEM could possibly have installed an engine brake level selector switch. This switch would allow the operator to choose the level of braking.

Refer to Troubleshooting Fault Code t05-243isl

Last Modified: 16-Dec-2010

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FAULT CODE 245
Engine Fan Clutch Supply Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 245 PID: S533 SPN: 641 FMI: 4 LAMP: SRT:	Error detected in fan clutch relay enable circuit at pin 41 of the engine harness.	Electronic control module (ECM) can **not** control the engine cooling fan. Fan will remain either on or off.

Engine Fan Clutch Supply Circuit

Circuit Description

The fan clutch solenoid is a device used by the ECM to control the engine fan by sending a signal to open or close the fan clutch solenoid.

Component Location

Refer to an original equipment manufacturer's (OEM) diagram for the location of the fan clutch solenoid.

Shop Talk

Fan clutch solenoid could be malfunctioning due to a failed engine harness or a bad ground on the fan clutch connector.

Refer to Troubleshooting Fault Code t05-245

Last Modified: 16-Dec-2010

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FAULT CODE 263 or 265
Fuel Temperature Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 263 or 265 PID: P174 SPN: 174 FMI: 3 or 4 LAMP: Yellow SRT:	FC 263: High voltage detected at the fuel temperature signal pin 35 of the engine harness. FC 265: Low voltage detected at the fuel temperature signal pin 35 of the engine harness.	Default value used for engine fuel temperature. Possible low power and no engine protection for fuel temperature.

Fuel Temperature Sensor Circuit

Circuit Description

The fuel pressure/temperature sensor is used by the electronic control module (ECM) to monitor the fuel temperature in the accumulator. The ECM monitors the voltage on the signal pin, and converts this to a temperature value.

Component Location

The fuel pressure/temperature sensor is located on the rear of the Cummins accumulator pump system (CAPS).

Shop Talk

The resistance of the sensor varies with the temperature. Use a multimeter and INSITE™ to read the fuel temperature. Compare the resistance value measured with the following table to verify that the sensor is functioning properly.

Temperature (°C)	Temperature [°F]	Resistance (ohms)
0	32	30k to 36k
25	77	9k to 11k
50	122	3k to 4k
75	167	1350 to 1500
100	212	600 to 675

Refer to Troubleshooting Fault Code t05-263

Last Modified: 16-Dec-2010

:

FAULT CODE 263 or 265
Fuel Temperature Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 263 or 265 PID: P174 SPN: 174 FMI: 3 or 4 LAMP: Yellow SRT:	FC 263: High voltage detected at the fuel temperature signal pin 35 of the engine harness. FC 265: Low voltage detected at the fuel temperature signal pin 35 of the engine harness.	Default value used for engine fuel temperature. Possible low power and no engine protection for fuel temperature.

Fuel Temperature Sensor Circuit

Circuit Description

The fuel pressure/temperature sensor is used by the electronic control module (ECM) to monitor the fuel temperature in the accumulator. The ECM monitors the voltage on the signal pin, and converts this to a temperature value.

Component Location

The fuel pressure/temperature sensor is located on the rear of the Cummins accumulator pump system (CAPS).

Shop Talk

The resistance of the sensor varies with the temperature. Use a multimeter and INSITE™ to read the fuel temperature. Compare the resistance value measured with the following table to verify that the sensor is functioning properly.

Temperature (°C)	Temperature [°F]	Resistance (ohms)
0	32	30k to 36k
25	77	9k to 11k
50	122	3k to 4k
75	167	1350 to 1500
100	212	600 to 675

Refer to Troubleshooting Fault Code t05-265

Last Modified: 16-Dec-2010

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FAULT CODE 268
Fuel Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 268 PID: P094 SPN: 94 FMI: 2 LAMP: Yellow SRT:	Indicates that the sensor is significantly offset or biased with respect to actual pressure at ambient conditions.	Engine slow to start; engine could run rough

Fuel Pressure Sensor Circuit

Circuit Description

The fuel pressure sensor contains supply, signal, and return pins. The electronic control module (ECM) provides 5 VDC to the fuel pressure sensor for a supply voltage. The ECM supplies a shared ground from the fuel pressure sensor circuit. The signal voltage is variable depending on the pressure that is being generated inside the fuel pump's accumulator.

This 5 VDC power supply is a shared supply. Other sensors on this circuit are the engine speed sensor, engine position sensor, oil pressure sensor, intake manifold pressure sensor and ambient air pressure sensor.

The shared ground for the fuel pressure sensor also connects to the injection control valve identifier, temperature sensor, intake manifold air temperature sensor, engine position sensor, oil pressure sensor, intake manifold pressure sensor, and ambient air pressure sensor.

Component Location

The fuel pressure sensor is located on the top rear of the fuel pump. The pressure sensor can be identified by its mounting location, rear center of CAPS Accumulator module.

Shop Talk

This fault can be set due to:

- ECM calibration is **not** updated, therefore logging the incorrect fault code. ECM calibrations before December 2000 contained **only** Fault Code 268 for fuel pressure sensor faults. At that time Fault Code 268 was a fault for sensor bias high or low, erratic pressure, and stuck in range. To assist with troubleshooting, this fault code was split into two separate fault codes, Fault Code 268 and Fault Code 456. Fault Code 268 is fuel pressure sensor biased high or low and can **only** log while keyswitch is in the ON position and the engine is off. Fault Code 456, on the other hand, is fuel pressure stuck in range, or erratic pressure, and can **only** log while the engine is running
- Faulty fuel pressure sensor wiring (pig tail harness), sensor connections (pin fretting), or engine harness issues (shorts) which can cause a faulty pressure signal
- Internal sensor failures
- Poor ECM grounds.

Refer to Troubleshooting Fault Code t05-268

Last Modified: 16-Dec-2010

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FAULT CODE 271 or 272
Front Pumping Valve Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 271 or 272 PID: S151 SPN: 1347 FMI: 5 or 6 LAMP: Yellow SRT:	FC 271: Low or no current detected at the front pumping valve pin 21 of the engine harness. FC 272: High current detected at the front pumping valve pin 21 of the engine harness.	Engine power will derate.

Front Pumping Valve Circuit

Circuit Description

The pumping control valve of Cummins accumulator pump system (CAPS) regulates the quantity of fuel that is pumped into the accumulator. The electronic control module (ECM) commands the valve to close based on several different parameters including fuel pressure, engine load, and throttle position.

Component Location

The pumping control valves are located on the fuel pump on the top of the accumulator.

Refer to Troubleshooting Fault Code t05-271

Last Modified: 16-Dec-2010

:

FAULT CODE 271 or 272
Front Pumping Valve Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 271 or 272 PID: S151 SPN: 1347 FMI: 5 or 6 LAMP: Yellow SRT:	FC 271: Low or no current detected at the front pumping valve pin 21 of the engine harness. FC 272: High current detected at the front pumping valve pin 21 of the engine harness.	Engine power will derate.

Front Pumping Valve Circuit

Circuit Description

The pumping control valve of Cummins accumulator pump system (CAPS) regulates the quantity of fuel that is pumped into the accumulator. The electronic control module (ECM) commands the valve to close based on several different parameters including fuel pressure, engine load, and throttle position.

Component Location

The pumping control valves are located on the fuel pump on the top of the accumulator.

Refer to Troubleshooting Fault Code t05-272

Last Modified: 16-Dec-2010

:

FAULT CODE 273 or 274
Rear Pumping Valve Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 273 or 274 PID: S152 SPN: 1348 FMI: 5 or 6 LAMP: Yellow SRT:	FC 273: Low or no current detected at the rear pumping valve pin 15 of the engine harness. FC 274: High current detected at the rear pumping valve pin 15 of the engine harness.	Engine power will derate.

Rear Pumping Valve Circuit

Circuit Description

The pumping control valve of Cummins accumulator pump system (CAPS) regulates the quantity of fuel that is pumped into the accumulator. The electronic control module (ECM) commands the valve to close based on several different parameters including fuel pressure, engine load, and throttle position.

Component Location

The pumping control valves are located on the fuel pump on the top of the accumulator.

Refer to Troubleshooting Fault Code t05-273

Last Modified: 16-Dec-2010

:

FAULT CODE 273 or 274
Rear Pumping Valve Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 273 or 274 PID: S152 SPN: 1348 FMI: 5 or 6 LAMP: Yellow SRT:	FC 273: Low or no current detected at the rear pumping valve pin 15 of the engine harness. FC 274: High current detected at the rear pumping valve pin 15 of the engine harness.	Engine power will derate.

Rear Pumping Valve Circuit

Circuit Description

The pumping control valve of Cummins accumulator pump system (CAPS) regulates the quantity of fuel that is pumped into the accumulator. The electronic control module (ECM) commands the valve to close based on several different parameters including fuel pressure, engine load, and throttle position.

Component Location

The pumping control valves are located on the fuel pump on the top of the accumulator.

Refer to Troubleshooting Fault Code t05-274

Last Modified: 16-Dec-2010

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FAULT CODE 275
Front Pumping Element

Overview

CODE	REASON	EFFECT
Fault Code: 275 PID: S151 SPN: 1347 FMI: 7 LAMP: Yellow SRT:	Front Pumping Element. The electronic control module (ECM) has detected a malfunction in the front pumping element.	Derate in power output of the engine.

Front Pumping Element

Circuit Description

The front pumping element in the Cummins® accumulator pump system (CAPS) consists of the front barrel and plunger, front pumping control valve, and the front check valve in the accumulator. These components are part of the accumulator module. The pumping element is responsible for pumping fuel into the accumulator and maintaining the desired pressure in the accumulator.

Component Location

The front pumping element is part of the CAPS fuel pump in the accumulator module.

Shop Talk

- A plugged fuel filter can cause both Fault Code 275 and Fault Code 328 to be logged intermittently.
- If Fault Code 275 and Fault Code 328 are both present, check fuel filter restriction.
- A damaged engine harness can also cause this fault code to be active.
- If Fault Code 271 or Fault Code 272 is active, troubleshoot it first.

Refer to Troubleshooting Fault Code t05-275

Last Modified: 16-Dec-2010

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FAULT CODE 276
Injection Control Valve Stator Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 276 PID: S018 SPN: 633 FMI: 5 LAMP: Yellow SRT:	High current detected on injection control valve stator return pin 7.	Engine power derate. Engine possibly dies.

Injection Control Valve Stator Circuit

Circuit Description

The injection control valve regulates both the quantity of fuel that is injected into each cylinder and the timing of the injection event. The injection control valve stator is the electronic solenoid that actuates the injection control valve. The electronic control module (ECM) commands the stator to actuate the injection control valve to open based on several different parameters, including fuel pressure, engine speed, and throttle position.

Component Location

The injection control valve is located on the fuel injection pump on the top of the distributor. The injection control valve stator is mounted onto the front side of the injection control valve with four capscrews.

Shop Talk

This fault code can be caused by a faulty stator, improper or poor grounds, and internal damage to the injection control valve. Inspect the snapshot data to see if the battery voltage dropped below 9-VDC when the fault code logged. In addition to these possible causes, a malfunctioning transient suppressor can also cause Fault Code 276 to become active, and is often accompanied with an engine no-start condition. If these symptoms occur, replace the transient suppressor.

Refer to Troubleshooting Fault Code t05-276

Last Modified: 16-Dec-2010

:

FAULT CODE 277
Injection Control Valve Stator Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 277 PID: S018 SPN: 633 FMI: 7 LAMP: Yellow SRT:	Engine ECM has detected a malfunction in the injection control valve.	Engine power derate. Engine possibly dies.

Injection Control Valve Stator Circuit

Circuit Description

The injection control valve regulates both the quantity of fuel that is injected into each cylinder and the timing of the injection event. The injection control valve stator is the electronic solenoid that actuates the injection control valve. The electronic control module (ECM) commands the stator to actuate the injection control valve to open based on several different parameters, including fuel pressure, engine speed, and throttle position.

Component Location

The injection control valve is located on the fuel injection pump on the top of the distributor. The injection control valve stator is mounted onto the front side of the injection control valve with four capscrews.

Shop Talk

This fault code can be caused by a faulty stator, improper or poor grounds, and internal damage to the injection control valve. Inspect the snapshot data to see if the battery voltage dropped below 9-VDC when the fault code logged. In addition to these possible causes, a malfunctioning transient suppressor can also cause Fault Code 277 to become active, and is often accompanied with an engine no-start condition. If these symptoms occur, replace the transient suppressor.

Refer to Troubleshooting Fault Code t05-277

Last Modified: 16-Dec-2010

:

FAULT CODE 278
Lift Pump Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 278 PID: P073 SPN: 073 FMI: 11 LAMP: Yellow SRT:	Error detected in lift pump circuit at pins 11 and 22 of the engine harness.	Possible low power, engine may stall, rough operation, or difficult start.

Lift Pump Circuit

Circuit Description

The ECM enables the lift pump by sending a signal directly to the lift pump. The ECM cycles the lift pump on for 30 seconds after turning on the keyswitch.

Component Location

The lift pump is mounted to the engine block on the intake side, toward the rear of the engine.

Shop Talk

This fault code is set by an internal timer expiring within the engine control system code if the lift pump does **not** complete its pre-charge of the fuel system. In hard-to-diagnose cases, it can be useful to disconnect the OEM harness and run dedicated battery power and ground.

Refer to Troubleshooting Fault Code t05-278

Last Modified: 16-Dec-2010

:

FAULT CODE 279
Injection Control Valve Stator Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 279 PID: S018 SPN: 633 FMI: 6 LAMP: Yellow SRT:	Low or no current detected on injection control valve stator return pin 7.	Engine power derate.

Injection Control Valve Stator Circuit

Circuit Description

The injection control valve regulates both the quantity of fuel that is injected into each cylinder and the timing of the injection event. The injection control valve stator is the electronic solenoid that actuates the injection control valve. The electronic control module (ECM) commands the stator to actuate the injection control valve to open based on several different parameters, including fuel pressure, engine speed, and throttle position.

Component Location

The injection control valve is located on the fuel injection pump on the top of the distributor. The injection control valve stator is mounted onto the front side of the injection control valve via four capscrews.

Shop Talk

This fault code is primarily caused by an open circuit in the injection control valve stator circuit.

Refer to Troubleshooting Fault Code t05-279

Last Modified: 16-Dec-2010

:

FAULT CODE 281 or 282
Pumping Element

Overview

CODE	REASON	EFFECT
Fault Code: 281 or 282 PID: S151 or S152 SPN: 1347 or 1348 FMI: 7 LAMP: Yellow SRT:	FC 281: Engine ECM has detected a failure in the front pumping element. FC 282: Engine ECM has detected a failure in the rear pumping element.	Possible no effect or engine power derate.

Pumping Element

Circuit Description

These faults are due to a failure internal to the Cummins accumulator pump system (CAPS). The pump **must** be sent to Cummins ReCon® for repairs. Blowshut is a condition that results when the fuel being moved, as the pumping plunger travels upwards, causes the PCV to close before the electronic control module (ECM) commands the PCV to close.

Component Location

The pumping element is part of the CAPS fuel injection pump.

Shop Talk

Overspeed of the engine could cause this fault.

Refer to Troubleshooting Fault Code t05-281

Last Modified: 16-Dec-2010

:

FAULT CODE 281 or 282
Pumping Element

Overview

CODE	REASON	EFFECT
Fault Code: 281 or 282 PID: S151 or S152 SPN: 1347 or 1348 FMI: 7 LAMP: Yellow SRT:	FC 281: Engine ECM has detected a failure in the front pumping element. FC 282: Engine ECM has detected a failure in the rear pumping element.	Possible no effect or engine power derate.

Pumping Element

Circuit Description

These faults are due to a failure internal to the Cummins accumulator pump system (CAPS). The pump **must** be sent to Cummins ReCon® for repairs. Blowshut is a condition that results when the fuel being moved, as the pumping plunger travels upwards, causes the PCV to close before the electronic control module (ECM) commands the PCV to close.

Component Location

The pumping element is part of the CAPS fuel injection pump.

Shop Talk

Overspeed of the engine could cause this fault.

Refer to Troubleshooting Fault Code t05-282

Last Modified: 16-Dec-2010

:

FAULT CODE 283 or 284
Engine Speed Sensor

Overview

CODE	REASON	EFFECT
Fault Code: 283 or 284 PID: P190 SPN: 190 FMI: 3 or 4 LAMP: Yellow SRT:	FC 283: High voltage detected at main engine speed sensor voltage supply pin 8 of the engine harness. FC 284: Low voltage detected at main engine speed sensor voltage supply pin 8 of the engine harness.	The electronic control module (ECM) will use the engine speed sensor signal as a backup. Possible white smoke.

Engine Speed Sensor

Circuit Description

The engine speed sensor provides engine speed and position information to the electronic control module (ECM). The sensor **must** be powered by +5 VDC to operate. The sensor generates its signals by sensing the movement of target teeth cut into a steel ring fastened to the backside of the camshaft gear. This ring has 71 teeth and a gap where the 72nd tooth would be placed. This missing tooth indicates that cylinder 1 (and 6) is at top dead center.

Component Location

The engine speed sensor is located on the backside of the gear housing, between the fuel injection pump and the air compressor.

Refer to Troubleshooting Fault Code t05-283

Last Modified: 16-Dec-2010

:

FAULT CODE 283 or 284
Engine Speed Sensor

Overview

CODE	REASON	EFFECT
Fault Code: 283 or 284 PID: P190 SPN: 190 FMI: 3 or 4 LAMP: Yellow SRT:	FC 283: High voltage detected at main engine speed sensor voltage supply pin 8 of the engine harness. FC 284: Low voltage detected at main engine speed sensor voltage supply pin 8 of the engine harness.	The electronic control module (ECM) will use the engine speed sensor signal as a backup. Possible white smoke.

Engine Speed Sensor

Circuit Description

The engine speed sensor provides engine speed and position information to the electronic control module (ECM). The sensor **must** be powered by +5 VDC to operate. The sensor generates its signals by sensing the movement of target teeth cut into a steel ring fastened to the backside of the camshaft gear. This ring has 71 teeth and a gap where the 72nd tooth would be placed. This missing tooth indicates that cylinder 1 (and 6) is at top dead center.

Component Location

The engine speed sensor is located on the backside of the gear housing, between the fuel injection pump and the air compressor.

Refer to Troubleshooting Fault Code t05-284

Last Modified: 16-Dec-2010

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FAULT CODE 285
J1939 Datalink Multiplexing

Overview

CODE	REASON	EFFECT
Fault Code: 285 PID: S231 SPN: 639 FMI: 9 LAMP: Yellow SRT:	The ECM expected information from a multiplexed device but did **not** receive it soon enough, or did **not** receive it at all.	At least one multiplexed device will **not** operate properly.

J1939 Datalink Multiplexing Circuit

Circuit Description

Inputs, such as throttle pedals, switches, and sensors, can be communicated to the ECM over the J1939 datalink. Messages sent from the vehicle electronic control units (VECUs) are received by the ECM and used for controlling the engine. Both the ECM and VECU **must** be properly configured so that each device's information is transmitted by the VECU and received by the ECM.

Component Location

The ECM is located on the intake side of the engine, about mid-engine. The J1939 datalink wiring and VECU(s) vary by OEM options.

Shop Talk

This fault occurs when the ECM is set up to receive information about a multiplexed device from a VECU over the J1939 datalink and does **not** receive a message with that information. This fault can also be caused if the ECM does **not** receive the information fast enough to control the engine properly. This condition can be caused by the J1939 datalink having an electrical problem, a lack of terminating plugs on the J1939 datalink backbone, the ECM **not** being set up to receive information, a multiplexed device that truly is **not** multiplexed, or a VECU **not** being correctly set up to transmit information on one of its multiplexed devices.

Refer to Troubleshooting Fault Code t05-285

Last Modified: 16-Dec-2010

:

FAULT CODE 286
J1939 Datalink Multiplexing

Overview

CODE	REASON	EFFECT
Fault Code: 286 PID: S231 SPN: 639 FMI: 13 LAMP: Yellow SRT:	The ECM expected information from a multiplexed device but **only** received a portion of the necessary information.	At least one multiplexed device will **not** operate properly.

J1939 Datalink Multiplexing Circuit

Circuit Description

Inputs, such as throttle pedals, switches, and sensors, can be communicated to the ECM over the J1939 datalink. Messages sent from the vehicle electronic control units (VECUs) are received by the ECM and used for controlling the engine. Both the ECM and VECU **must** be properly configured so that each device's information is transmitted by the VECU and received by the ECM.

Component Location

The ECM is located on the intake side of the engine, about mid-engine. The J1939 datalink wiring and VECU(s) vary by OEM options.

Shop Talk

This fault occurs when the ECM is set up to receive information from several multiplexed switches from VECU(s) and **only** receives some of the switches. It indicates the ECM is set up to receive too many switches or the VECU(s) is set up to transmit too few switches.

Refer to Troubleshooting Fault Code t05-286

Last Modified: 16-Dec-2010

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FAULT CODE 296
OEM Pressure - Engine Protection

Overview

CODE	REASON	EFFECT
Fault Code: 296 PID: P223 SPN: 1387 FMI: 14 (J1587), 14 (J1939) LAMP: Red SRT:	OEM pressure signal at pin 48 of the OEM harness indicates pressure outside the engine protection limit.	Speed derate and possible engine shutdown if engine protection shutdown feature is enabled.

OEM Pressure Sensor Circuit

Circuit Description

The OEM pressure sensor is used by the electronic control module (ECM) to monitor an OEM-specific pressure sensor. The ECM monitors the voltage on signal pin 48 and converts this to a pressure value. The OEM pressure value is used by the ECM for the engine/vehicle protection system.

Component Location

The OEM pressure sensor is located in different locations depending on the OEM and equipment model. Refer to the OEM manual.

Shop Talk

Verify with the driver the engine operating condition when the fault occurs. Depending on the engine speed and load, the OEM pressure can fall below or exceed the engine protection limits. The sensor can be used to detect fluid pressure that is too low or too high. Refer to the OEM manual for more information.

Refer to Troubleshooting Fault Code t05-296

Last Modified: 16-Dec-2010

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FAULT CODE 297
OEM Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 297 PID: P223 SPN: 1084 FMI: 3 LAMP: Yellow SRT:	High voltage detected at the original equipment manufacturer's (OEM) pressure sensor signal.	Default value used for OEM pressure.

OEM Pressure Sensor Circuit

Circuit Description

The OEM sensor signal is used by the electronic control module (ECM) to monitor the OEM pressure. The OEM pressure is used by the ECM in one of two ways:

A sensor that has failed high can be caused by an open circuit in the signal or return wire, voltage shorts in the signal or return wire, or a faulty sensor.

1. The ECM can shut down the engine based on an OEM pressure input value exceeding or falling below a customer-specified value.

2. The ECM can control a device (dual output driver A and driver B) based on the value of the OEM pressure.

Component Location

The location varies with the OEM. Refer to the OEM manual.

Shop Talk

The sensor voltage signal is the responsibility of the OEM. Refer to the OEM manual for specifications.

Refer to Troubleshooting Fault Code t05-297

Last Modified: 16-Dec-2010

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FAULT CODE 298
OEM Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 298 PID: P223 SPN: 1084 FMI: 4 LAMP: Yellow SRT:	Low voltage detected at the original equipment manufacturer's (OEM) pressure sensor signal.	Default value used for OEM pressure.

OEM Pressure Sensor Circuit

Circuit Description

The OEM sensor signal is used by the electronic control module (ECM) to monitor the OEM pressure. The OEM pressure is used by the ECM in one of two ways:

A sensor that has failed low can be caused by shorts to ground on the signal wire or an internally grounded (faulty) sensor.

1. The ECM can shut down the engine based on an OEM pressure input value exceeding or falling below a customer-specified value.

2. The ECM can control a device (dual-output driver A and driver B) based on the value of the OEM pressure.

Component Location

The location varies with the OEM. Refer to the OEM manual.

Shop Talk

The resistance of all pressure sensors varies with the pressure. Refer to the OEM troubleshooting and repair manual for specifications.

Refer to Troubleshooting Fault Code t05-298

Last Modified: 16-Dec-2010

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FAULT CODE 328
Rear Pumping Element

Overview

CODE	REASON	EFFECT
Fault Code: 328 PID: S152 SPN: 1348 FMI: 7 LAMP: Yellow SRT:	The electronic control module (ECM) has detected a malfunction in the rear pumping element.	Derate in power output of the engine.

Rear Pumping Element

Circuit Description

The rear pumping element consists of the rear barrel and plunger, rear pumping control valve, and rear check valve in the accumulator. These components are part of the accumulator module. The pumping element is responsible for pumping fuel into the accumulator and maintaining the desired pressure in the accumulator.

Component Location

The rear pumping element is part of the Cummins® accumulator pump system (CAPS) fuel pump in the accumulator module.

Shop Talk

- A plugged fuel filter can cause both Fault Code 275 and Fault Code 328 to be logged intermittently.
- If Fault Code 275 and Fault Code 328 are both present, check fuel filter restriction.
- A damaged engine harness could also cause this fault code to be active.
- If Fault Code 273 or Fault Code 274 is active, troubleshoot it first.

Refer to Troubleshooting Fault Code t05-328

Last Modified: 16-Dec-2010

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FAULT CODE 329
Fuel Injection Pump

Overview

CODE	REASON	EFFECT
Fault Code: 329 PID: S233 SPN: 1077 FMI: 12 LAMP: None SRT:	Engine ECM has detected an overpumping malfunction in the Cummins accumulator pump system (CAPS) pump.	Low power; possible engine shutdown.

CAPS Injection Pump

Circuit Description

The ECM monitors several variables, including accumulator pressure, valve close angle, and injection control valve open-time, to determine if the pump has malfunctioned.

Component Location

The CAPS fuel injection pump is located on the intake side of the engine.

Shop Talk

Fault Code 329 can result due to one or more of the following:

- Other fault codes that are caused by bad grounds. Make sure to troubleshoot other fault codes before following the 329 fault code troubleshooting tree.
- High fuel inlet restrictions and/or air in the fuel can set the fault code.
- Fuel that does **not** meet Fuels for Cummins Engines, Bulletin 3379001, criteria, specifically density and viscosity, has also been know to set fault code 329.
- High fuel inlet temperatures can also set fault code 329. Fuel temperatures at the inlet to the gear pump should **not** exceed 60°C [140°F] on ISC and 71°C [160°F] on ISL engines (**Not** the INSITE electronic service tool temperature reading).
- This fault code could also be caused by a fuel leak in the sealing plate between the injection control valve and the distributor. The injection control valve module should be replaced if a fuel leak in the sealing plate has been identified. Refer to Procedure 005-078 in the ISC Bulletin 4021418
- Fault Code 329 can be caused by broken internal injection control valve components and/or by poor lubricity fuel which scuffed the internal components of the injection control valve.

Refer to Troubleshooting Fault Code t05-329

Last Modified: 16-Dec-2010

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FAULT CODE 349
Auxiliary Speed or Auxiliary Pressure Input Error

Overview

CODE	REASON	EFFECT
Fault Code: 349 PID: P191 SPN: 191 FMI: 0 LAMP: Yellow SRT:	The auxiliary speed or auxiliary pressure indicates the frequency is above a calibrated threshold value.	Engine will go to idle and lose ability to control the speed of the auxiliary device.

Auxiliary Speed and Pressure Input Circuit

Circuit Description

The auxiliary governor's input is either a frequency signal from an auxiliary speed sensor or a pressure signal from an OEM pressure sensor. It is sent to the electronic control module (ECM) and is used to control the engine speed.

Component Location

The auxiliary speed sensor or pressure sensor location is dependent on the original equipment manufacturer's (OEM) application. Refer to OEM manual for component location.

Shop Talk

The auxiliary speed governor controls engine speed based on a measured auxiliary speed or pressure. The auxiliary speed governor feature **must** be enabled using INSITE™ and configured properly in the OEM-specific calibration for speed or pressure.

Refer to Troubleshooting Fault Code t05-349

Last Modified: 16-Dec-2010

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FAULT CODE 352 or 386
Sensor Supply Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 352 or 386 PID: S232 SPN: 620 FMI: 4 or 3 LAMP: Yellow SRT:	FC 352: Low voltage detected at engine position sensor +5-VDC supply, pin 10 of the engine harness. FC 386: High voltage detected at engine position sensor +5-VDC supply, pin 10 of the engine harness.	Default value used for sensors connected to this +5-VDC supply. Engine will derate to no-boost fueling and loss of engine protection for oil pressure, intake manifold pressure, ambient air pressure, and fuel pressure.

Sensor Supply Circuit

Circuit Description

The engine position sensor (EPS), the intake manifold pressure sensor, the oil pressure sensor, the ambient air pressure sensor, and the fuel temperature sensor are powered by the same +5-VDC source and the same return in the electronic control module (ECM). This supply is also used to operate the intake manifold air temperature and coolant temperature sensors.

Component Location

The +5-VDC sensor supply circuit is located in the engine harness. See Section E of this manual the Troubleshooting and Repair Manual, ISC Fuel Systems ISC Series Engines, Bulletin 3666271 for the sensor locations.

Shop Talk

The faults could also cause high- or low-voltage faults on the coolant temperature and intake manifold air temperature sensors.

Refer to Troubleshooting Fault Code t05-352

Last Modified: 16-Dec-2010

:

FAULT CODE 381 or 382
Intake Air Heater Relay Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 381 or 382 PID: S237 SPN: 626 FMI: 2 LAMP: Yellow SRT:	FC 381: Error detected in the cold-start air relay 1 enable circuit at pin 41 of the original equipment manufacturer (OEM) harness. FC 382: Error detected in the cold-start air relay 2 enable circuit at pin 31 of the OEM harness.	Intake air heater can **not** be energized by the electronic control module (ECM). Possible white smoke and/or hard starting in cold ambient conditions.

Intake Air Heater Relay Circuit

Circuit Description

The intake air heater improves starting and white smoke control in cold ambient conditions. The ECM controls relays that switch power to the air heater. There are two heating coils in the heater that are individually controlled by the ECM.

Component Location

The intake air heater is located under the air inlet coverplate on the intake manifold. The location of the heater relays will vary with OEM.

Refer to Troubleshooting Fault Code t05-381

Last Modified: 16-Dec-2010

:

FAULT CODE 381 or 382
Intake Air Heater Relay Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 381 or 382 PID: S237 SPN: 626 FMI: 2 LAMP: Yellow SRT:	FC 381: Error detected in the cold-start air relay 1 enable circuit at pin 41 of the original equipment manufacturer (OEM) harness. FC 382: Error detected in the cold-start air relay 2 enable circuit at pin 31 of the OEM harness.	Intake air heater can **not** be energized by the electronic control module (ECM). Possible white smoke and/or hard starting in cold ambient conditions.

Intake Air Heater Relay Circuit

Circuit Description

The intake air heater improves starting and white smoke control in cold ambient conditions. The ECM controls relays that switch power to the air heater. There are two heating coils in the heater that are individually controlled by the ECM.

Component Location

The intake air heater is located under the air inlet coverplate on the intake manifold. The location of the heater relays will vary with OEM.

Refer to Troubleshooting Fault Code t05-382

Last Modified: 16-Dec-2010

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FAULT CODE 385 or 444
Remote Accelerator Control Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 385 or 444 PID: S232 SPN: 620 FMI: 3 or 1 LAMP: Yellow SRT:	FC 385: High voltage detected at remote accelerator position sensor supply pin 10 of the original equipment manufacturer (OEM) harness. FC 444: Low voltage detected at remote accelerator position sensor supply pin 10 of the OEM harness.	Sensors connected to this +5-VDC supply will **not** function.

Remote Accelerator Control Circuit

Circuit Description

The remote accelerator control assembly contains the remote accelerator position sensor. This sensor sends the accelerator percentage requested by the operator to the electronic control module (ECM). Remote accelerator is used by the ECM to determine fueling. In order for the remote accelerator position sensor to function properly, it is necessary that a good +5-VDC supply voltage be available.

Note: The connector pin letters shown for the accelerator pedal wiring in these troubleshooting steps are examples of representative sensors. The connector pin assignments can vary with equipment manufacturer, but the base troubleshooting logic will still apply.

Component Location

The remote accelerator position sensor is located on the remote accelerator control assembly somewhere outside the cab.

Refer to Troubleshooting Fault Code t05-385

Last Modified: 16-Dec-2010

:

FAULT CODE 387 or 443
Accelerator Position Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 387 or 443 PID: P091 or S232 SPN: 091 or 620 FMI: 3 or 1 LAMP: Yellow SRT:	FC 387: High voltage detected at accelerator position sensor supply pin 29 of the original equipment manufacturer's (OEM) harness. FC 443: Low voltage detected at accelerator position sensor supply pin 29 of the OEM harness.	Engine idles when accelerator idle validation switch indicates idle and ramps up to a default set speed when idle validation switch indicates off-idle.

Accelerator Position Sensor Circuit

Circuit Description

The accelerator pedal assembly with accelerator position sensor relays the accelerator percentage requested by the operator to the electronic control module (ECM). Percent accelerator is used by the ECM to determine fueling. In order for the accelerator position sensor to function properly, it is necessary that a good +5-VDC supply voltage be available.

Component Location

The accelerator position sensor is located on the accelerator pedal inside the vehicle cab.

Refer to Troubleshooting Fault Code t05-387

Last Modified: 16-Dec-2010

FAULT CODE 415
Fault Code Path Selection

Do you have an Oil Pressure Sensor?	Go to 71-fc415sn
Do you have an Oil Pressure Switch?	Go to 71-fc415sw

Last Modified: 27-Jan-2004

:

FAULT CODE 415 (SN)
Oil Pressure - Engine Protection

Overview

CODE	REASON	EFFECT
Fault Code: 415 PID: P100 SPN: 100 FMI: 1 LAMP: Red SRT:	Oil pressure signal indicates oil pressure below the very low engine protection limit.	Power and/or speed derate and possible engine protection shutdown if feature is enabled.

Oil Pressure Sensor Circuit

Circuit Description

The oil pressure sensor is used by the electronic control module (ECM) to monitor the lubricating oil pressure. The ECM monitors the voltage on the signal pin and converts this to a pressure value. The oil pressure value is used by the ECM for the engine protection system.

Component Location

The oil pressure sensor is located on the engine block below the ECM.

Shop Talk

Verify, with the driver, the engine speed at which the fault occurs. If the engine is being operated at too low of a speed, the oil pressure can drop below the engine protection limits.

Possible causes:

- Low oil level
- Low operation speeds
- Oil dilution
- Oil filters change

Refer to Troubleshooting Fault Code t05-415sn

Last Modified: 16-Dec-2010

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FAULT CODE 415 (SW)
Oil Pressure - Engine Protection With An Oil Pressure Switch

Overview

CODE	REASON	EFFECT
Fault Code: 415 PID: P100 SPN: 100 FMI: 1 LAMP: Red SRT:	Oil pressure signal indicates oil pressure below the very low engine protection limit.	Power and/or speed derate and possible engine protection shutdown if feature is enabled.

Oil Pressure Sensor Circuit

Circuit Description

The oil pressure switch is used by the electronic control module (ECM) to detect the presence of lubricating oil pressure.

Component Location

The oil pressure switch is located on the engine block below the ECM.

Shop Talk

- Verify, with the driver, the engine speed at which the fault occurs. If the engine is being operated at too low of a speed, the oil pressure can drop below the engine protection limits.
- Connect a manual gauge to monitor actual oil pressure of the engine.
- Engines in the field can have had a jumper harness kit installed which connects the oil pressure switch to pin K in the 23-pin OEM connector or cavity 8 in the Ford OEM connector.
- The fault will trigger if lubricating oil pressure drops below 41 kPa [6 psi] for 30 seconds. Engine Protection Shutdown will be activated after an additional 30 seconds if the feature is enabled in the ECM.

Refer to Troubleshooting Fault Code t05-415sw

Last Modified: 16-Dec-2010

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FAULT CODE 418
Water-In-Fuel (WIF) Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 418 PID: P097 SPN: 097 FMI: 0 LAMP: WIF SRT:	Water-in-fuel signal indicates the water in the fuel filter needs to be drained.	Excessive water in the fuel can lead to severe fuel system damage.

WIF Sensor Circuit

Circuit Description

The WIF sensor is attached to the fuel filter. The WIF sensor sends a signal to the electronic control module (ECM) when a set volume of water has accumulated in the fuel filter. The WIF circuit contain two wires: A return ground (pin 20), and a signal wire (pin 40).

Component Location

The WIF sensor is installed in the bottom of the fuel filter, which is located on the side of the cylinder head approximately midengine.

Refer to Troubleshooting Fault Code t05-418

Last Modified: 16-Dec-2010

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FAULT CODE 422
Coolant Level Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 422 PID: P111 SPN: 111 FMI: 2 LAMP: Yellow SRT:	Voltage detected simultaneously on both the coolant level high and low signal pins 27 and 37 of the engine harness or no voltage detected on either pin.	No engine protection for coolant level.

Coolant Level Sensor Circuit

Circuit Description

The coolant level sensor monitors the coolant level within the coolant system and passes information to the electronic control module (ECM) through the engine harness. This sensor is very complex. Do **not** use a multimeter to check the coolant level sensor. If the radiator coolant level drops below a certain level, a progressive power derate with increasing time after alert will occur.

Component Location

The coolant level sensor is located in the radiator top tank or surge tank.

Shop Talk

This is an OEM-supplied component and will vary in sensor location.

- If a shorting plug is used in the coolant level circuit, verify that it is wired correctly.
- Inspect the wiring harness between the Weather-Pack four-way connector and the coolant level sensor for damage.
- Make sure the coolant level sensor is located in the middle of the tank rather than off to one side where the coolant level can change when the vehicle makes a turn.
- Make sure the correct ECM code is in the ECM. Calibrating the ECM with the incorrect DO option can cause Fault Code 422 to be active since some OEMs use a coolant level sensor that requires a special calibration. Refer to the OEM service manual.

Refer to Troubleshooting Fault Code t05-422

Last Modified: 16-Dec-2010

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FAULT CODE 429
Water-In-Fuel (WIF) Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 429 PID: P097 SPN: 097 FMI: 4 LAMP: Yellow SRT:	Low voltage detected at WIF signal pin 40 of the original equipment manufacturer (OEM) harness.	No water-in-fuel detection.

WIF Sensor Circuit

Circuit Description

The WIF sensor is attached to the fuel filter. The WIF sensor sends a signal to the electronic control module (ECM) when a set volume of water has accumulated in the fuel filter. The WIF circuit contain two wires: A return ground (pin 20), and a signal wire (pin 40).

Component Location

The WIF sensor is installed in the bottom of the fuel filter and is located on the side of the cylinder head approximately midengine.

Shop Talk

The WIF sensor uses the same internal ECM power supply as sensors on engine harness. If Fault Code 352 is also active, use its troubleshooting logic and tree.

Refer to Troubleshooting Fault Code t05-429

Last Modified: 16-Dec-2010

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FAULT CODE 431 or 551
Idle Validation Switch (IVS) Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 431 or 551 PID: P091 SPN: 091 FMI: 2 or 4 LAMP: Yellow SRT:	FC 431: Idle validation signals on pins 25 and 26 of the OEM harness indicate no voltage simultaneously detected on both pins or no voltage detected on either pin. FC 551: Idle validation signals on pins 25 and 26 of the OEM harness indicate voltage detected simultaneously on both pins.	FC 431: No effect on performance but loss of idle validation. FC 551: Engine will **only** idle.

Idle Validation Switch Circuit

Circuit Description

The idle validation switch (IVS) is used by the electronic control module (ECM) to indicate when the accelerator pedal is released (on-idle) or depressed (off-idle). The switch is adjusted by the accelerator pedal manufacturers to switch from on-idle to off-idle at the correct accelerator pedal position.

Component Location

The IVS is located on the accelerator pedal assembly.

Shop Talk

This fault code is usually caused by a loose connection, uncalibrated accelerator pedal, or miswired IVS.

A bad ground on pin A of the IVS can also cause this fault.

Refer to Troubleshooting Fault Code t05-431

Last Modified: 16-Dec-2010

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FAULT CODE 432
Accelerator Pedal Circuit (ISS)

Overview

CODE	REASON	EFFECT
Fault Code: 432 PID: P091 SPN: 091 FMI: 13 LAMP: Yellow SRT:	No voltage detected at pin 26 of the original equipment manufacturer's (OEM) harness indicates the accelerator is at the idle position when the accelerator position signal at pin 30 of the OEM harness indicates the accelerator is **not** at the idle position or idle validation signal at pin 26 of the OEM harness indicates the accelerator is **not** at the idle position when the accelerator position signal pin 30 of the OEM harness indicates the accelerator is at the idle position.	No effect on engine.

Accelerator Pedal Circuit

Circuit Description

The accelerator pedal assembly relays the accelerator percentage requested by the operator to the electronic control module (ECM). Percent accelerator is used to determine fueling. The accelerator position sensor and the idle validation switch on the accelerator pedal are adjusted at the factory to provide the correct output signals.

Note: The connector pin letters shown for the accelerator pedal wiring in these troubleshooting steps are examples of representative sensors. The connector pin assignments can vary with equipment manufacturer, but the base troubleshooting logic will still apply.

Component Location

The accelerator position sensor and the idle validation switch are located on the accelerator pedal in the cab.

Shop Talk

Confirm that the idle validation switch (IVS) is properly calibrated. Refer to the accelerator pedal manufacturer's instructions for adjustment information.

Note: The three wires in the accelerator position sensor circuit **must** be twisted together. Depending on ground location, IVS can, perhaps, **only** have two wires.

Refer to Troubleshooting Fault Code t05-432

Last Modified: 16-Dec-2010

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FAULT CODE 433
Intake Manifold Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 433 PID: S102 FMI: 2 LAMP: Yellow SRT:	Boost pressure signal indicates boost pressure is high when other engine parameters (i.e., speed and load) indicate boost pressure can be low, or boost pressure is low when other engine parameters indicate it can be high.	Possible overfueling during acceleration. Increase in black smoke.

Intake Manifold Pressure Sensor Circuit

Circuit Description

The intake manifold pressure sensor monitors intake manifold pressure and passes information to the electronic control module (ECM) through the engine harness. If intake manifold pressure becomes too high, it will cause a derate condition.

Component Location

The intake manifold pressure sensor is located in the rear of the intake manifold, in the second port on the side of the cylinder head to the right of the fuel filter.

Shop Talk

The ECM checks for this fault **only** at idle speed. If the intake manifold pressure shows too high of a value at this time, the ECM will log a fault code.

Refer to Troubleshooting Fault Code t05-433

Last Modified: 16-Dec-2010

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FAULT CODE 434
Unswitched Battery Supply Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 434 PID: S251 SPN: 627 FMI: 2 LAMP: Yellow SRT:	Supply voltage to the electronic control module (ECM) fell below (+) 6.2 VDC for a fraction of a second, or the electronic control module (ECM) was **not** allowed to power down correctly (retain unswitched battery voltage for 30 seconds after key turned off).	None on performance. Fault information, trip information data, and maintenance monitor data can be inaccurate.

Unswitched Battery Supply Circuit

Circuit Description

The ECM receives constant voltage from the batteries through the unswitched battery wires that are connected directly to the positive (+) battery post. There are three in-line 7.5-amp fuses and two 10-amp fuses in the unswitched battery wires to protect the engine harness from overheating. The ECM receives switched battery input through the vehicle keyswitch wire when the vehicle keyswitch is turned on.

Component Location

The ECM is connected to the battery by the engine harness. This direct link provides a constant power supply for the ECM. The location of the battery will vary with the equipment manufacturer. Refer to the equipment manufacturer repair manual.

Shop Talk

If the ECM unswitched battery supply is taken from the starter, check for low voltage during cranking. Low voltage during cranking can cause the ECM power supply to drop below specifications and log Fault Code 434.

Refer to Troubleshooting Fault Code t05-434

Last Modified: 16-Dec-2010

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FAULT CODE 441
Unswitched Battery Supply Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 441 PID: P168 SPN: 168 FMI: 1 LAMP: Yellow SRT:	Voltage detected at electronic control module (ECM) power supply pins 38, 39, 40, and 50 of the engine harness indicates ECM supply voltage fell below (+) 6 VDC.	Engine could possibly **not** start.

Unswitched Battery Supply Circuit

Circuit Description

The ECM receives unswitched battery input through the engine harness. There are three in-line 7.5-amp fuses and two 10-amp fuses in the unswitched battery wire of the engine harness to protect it from overheating.

Component Location

The ECM is connected to the battery by the engine harness. This direct link provides a constant power supply for the ECM. The location of the battery will vary with the equipment manufacturer. Refer to the equipment manufacturer's repair manual for the battery location.

Shop Talk

Make sure the ECM unswitched battery supply is coming directly from the battery and **not** the starter.

Refer to Troubleshooting Fault Code t05-441

Last Modified: 16-Dec-2010

:

FAULT CODE 442
Unswitched Battery Supply Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 442 PID: P168 SPN: 168 FMI: 0 LAMP: Yellow SRT:	Voltage detected at electronic control module (ECM) power supply pins 38, 39, 40, and 50 of the engine harness indicates ECM supply voltage is above the maximum system voltage level.	Possible ECM damage.

Unswitched Battery Supply Circuit

Circuit Description

The ECM receives unswitched battery input through the engine harness. There is two in-line 10-amp fuses and three 7.5-amp fuses in the unswitched battery wire to protect the engine harness from overheating. The battery return wires are connected directly to the negative (-) battery post.

Component Location

The ECM is connected to the battery by the engine harness. This direct link provides a constant power supply for the ECM. The location of the battery will vary with the OEM. Refer to the OEM manual for battery location.

Shop Talk

Disconnect all aftermarket devices from the battery supply circuit. Make sure the proper size fuses are being used (10-amp fuse or 7.5-amp fuse).

Refer to Troubleshooting Fault Code t05-442

Last Modified: 16-Dec-2010

:

FAULT CODE 387 or 443
Accelerator Position Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 387 or 443 PID: P091 or S232 SPN: 091 or 620 FMI: 3 or 1 LAMP: Yellow SRT:	FC 387: High voltage detected at accelerator position sensor supply pin 29 of the original equipment manufacturer's (OEM) harness. FC 443: Low voltage detected at accelerator position sensor supply pin 29 of the OEM harness.	Engine idles when accelerator idle validation switch indicates idle and ramps up to a default set speed when idle validation switch indicates off-idle.

Accelerator Position Sensor Circuit

Circuit Description

The accelerator pedal assembly with accelerator position sensor relays the accelerator percentage requested by the operator to the electronic control module (ECM). Percent accelerator is used by the ECM to determine fueling. In order for the accelerator position sensor to function properly, it is necessary that a good +5-VDC supply voltage be available.

Component Location

The accelerator position sensor is located on the accelerator pedal inside the vehicle cab.

Refer to Troubleshooting Fault Code t05-443

Last Modified: 16-Dec-2010

:

FAULT CODE 385 or 444
Remote Accelerator Control Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 385 or 444 PID: S232 SPN: 620 FMI: 3 or 1 LAMP: Yellow SRT:	FC 385: High voltage detected at remote accelerator position sensor supply pin 10 of the original equipment manufacturer (OEM) harness. FC 444: Low voltage detected at remote accelerator position sensor supply pin 10 of the OEM harness.	Sensors connected to this +5-VDC supply will **not** function.

Remote Accelerator Control Circuit

Circuit Description

The remote accelerator control assembly contains the remote accelerator position sensor. This sensor sends the accelerator percentage requested by the operator to the electronic control module (ECM). Remote accelerator is used by the ECM to determine fueling. In order for the remote accelerator position sensor to function properly, it is necessary that a good +5-VDC supply voltage be available.

Note: The connector pin letters shown for the accelerator pedal wiring in these troubleshooting steps are examples of representative sensors. The connector pin assignments can vary with equipment manufacturer, but the base troubleshooting logic will still apply.

Component Location

The remote accelerator position sensor is located on the remote accelerator control assembly somewhere outside the cab.

Refer to Troubleshooting Fault Code t05-444

Last Modified: 16-Dec-2010

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FAULT CODE 449
Fuel Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 449 PID: P094 SPN: 094 FMI: 0 LAMP: Yellow SRT:	Fuel pressure signal indicates that fuel pressure has exceeded the maximum limit for the given engine rating.	Power and/or speed derate; engine can, perhaps, die.

Fuel Pressure Sensor Circuit

Circuit Description

The fuel pressure/temperature sensor is used by the electronic control module (ECM) to monitor the fuel temperature in the accumulator. The ECM monitors the voltage on the signal pin and converts this to a pressure value.

Component Location

The fuel pressure/temperature sensor is located on the rear of the accumulator.

Shop Talk

A missing weather seal on the 4-pin fuel pressure sensor connector can cause this fault to log intermittently.

Overspeed of the engine can cause this fault.

Refer to Troubleshooting Fault Code t05-449

Last Modified: 16-Dec-2010

:

FAULT CODE 451 or 452
Fuel Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 451 or 452 PID: P094 SPN: 94 FMI: 3 or 4 LAMP: Yellow SRT:	FC 451: High voltage detected at fuel pressure sensor signal pin 46 of the engine harness. FC 452: Low voltage detected at fuel pressure sensor signal pin 46 of the engine harness.	Power and/or speed derate; engine can, perhaps, run rough.

Fuel Pressure Sensor Circuit

Circuit Description

The fuel pressure/temperature sensor is used by the electronic control module (ECM) to monitor the fuel temperature in the accumulator. The ECM monitors the voltage on the signal pin and converts this to a pressure value.

Component Location

The fuel pressure/temperature sensor is located on the rear of the accumulator.

Shop Talk

Damaged connector at the fuel pressure sensor or a missing weather seal could cause these faults to go active.

Refer to Troubleshooting Fault Code t05-451

Last Modified: 16-Dec-2010

:

FAULT CODE 451 or 452
Fuel Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 451 or 452 PID: P094 SPN: 94 FMI: 3 or 4 LAMP: Yellow SRT:	FC 451: High voltage detected at fuel pressure sensor signal pin 46 of the engine harness. FC 452: Low voltage detected at fuel pressure sensor signal pin 46 of the engine harness.	Power and/or speed derate; engine can, perhaps, run rough.

Fuel Pressure Sensor Circuit

Circuit Description

The fuel pressure/temperature sensor is used by the electronic control module (ECM) to monitor the fuel temperature in the accumulator. The ECM monitors the voltage on the signal pin and converts this to a pressure value.

Component Location

The fuel pressure/temperature sensor is located on the rear of the accumulator.

Shop Talk

Damaged connector at the fuel pressure sensor or a missing weather seal could cause these faults to go active.

Refer to Troubleshooting Fault Code t05-452

Last Modified: 16-Dec-2010

:

FAULT CODE 456
Fuel Pressure Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 456 PID: P094 SPN: 94 FMI: 10 LAMP: Yellow SRT:	Fuel pressure sensor stuck in range while engine is operating or fuel pressure sensor reading erratic in range.	Engine power derate; engine can run rough or die.

Cummins Accumulator Pump System (CAPS) Injection Pump

Circuit Description

The fuel pressure sensor contains supply, signal, and return pins. The electronic control module (ECM) provides 5 VDC to the fuel pressure sensor for a supply voltage. The ECM supplies a shared ground from the fuel pressure sensor circuit. The signal voltage is variable depending on the pressure that is being generated inside the fuel pump accumulator.

This 5 VDC power supply is a shared supply. Other sensors on this circuit include the engine speed sensor, engine position sensor, oil pressure sensor, intake manifold pressure sensor, and ambient air pressure sensor.

The shared ground for the fuel pressure sensor also connects to the injection control valve identifier, temperature sensor, intake manifold air temperature sensor, engine position sensor, oil pressure sensor, intake manifold pressure sensor, and ambient air pressure sensor.

Component Location

The fuel pressure sensor is located on the top rear of the fuel pump. The pressure sensor can be identified by its mounting location, rear center of the CAPS accumulator module.

Shop Talk

This fault can be set due to:

- Faulty fuel pressure sensor wiring (pig tail harness), sensor connections (pin fretting), or engine harness issues (shorts) which can cause the pressure signal to erratically spike up or down
- Excessive fuel inlet restriction
- Internal sensor failures.

Refer to Troubleshooting Fault Code t05-456

Last Modified: 16-Dec-2010

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FAULT CODE 488
Intake Manifold Air Temperature Sensor - Engine Protection Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 488 PID: P105 SPN: 105 FMI: 0 LAMP: Yellow SRT:	Intake manifold air temperature signal indicates the intake manifold air temperature is approaching the engine protection limit.	Power derate.

Intake Manifold Air Temperature Sensor Circuit

Circuit Description

The intake manifold air temperature sensor is used by the electronic control module (ECM) to monitor the temperature of the engine intake air. The intake air temperature is used by the ECM for the engine protection system, and the timing and fueling control.

Component Location

The intake manifold temperature sensor is located on the side of the intake manifold, toward the rear of the cylinder head.

Shop Talk

This is a warning fault code. If the intake manifold air temperature continues to rise, Fault Code 155 will become active and shut down the engine.

- Possible causes:- clogged, dirty, inadequate capacity air cleaner element.- intake restriction. 010-059 in the Troubleshooting and Repair Manual, ISC Engines, Bulletin No. 3666245.

Refer to Troubleshooting Fault Code t05-488

Last Modified: 16-Dec-2010

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FAULT CODE 489
Auxiliary Speed or Auxiliary Pressure Input Error

Overview

CODE	REASON	EFFECT
Fault Code: 489 PID: P191 SPN: 191 FMI: 0 LAMP: Yellow SRT:	The auxiliary speed or auxiliary pressure indicates the frequency is below a calibrated threshold value.	Engine will go to idle and lose ability to control the speed of the auxiliary device.

Auxiliary Speed and Pressure Input Circuit

Circuit Description

The auxiliary governor's input is either a frequency signal from an auxiliary speed sensor or a pressure signal from an OEM pressure sensor. It is sent to the electronic control module (ECM) and is used to control the engine speed.

Component Location

The auxiliary speed sensor or pressure sensor location is dependent on the original equipment manufacturer's (OEM) application. Refer to OEM manual for component location.

Shop Talk

The auxiliary speed governor controls engine speed based on a measured auxiliary speed or pressure. The auxiliary speed governor feature **must** be enabled using INSITE™ and configured properly in the OEM-specific calibration for speed or pressure.

Refer to Troubleshooting Fault Code t05-489

Last Modified: 16-Dec-2010

:

FAULT CODE 493
Injection Control Valve Identifier Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 493 PID: S018 SPN: 1076 FMI: 13 LAMP: None SRT:	The electronic control module (ECM) detected a failure in the injection control valve identifier circuit.	A 5-percent engine power derate.

Injection Control Valve Identifier Circuit

Circuit Description

The injection control valve identifier optimizes the quantity of fuel that is injected into each cylinder during an injection event. The identifier is matched with each individual injection control valve at the factory to maximize the performance of the CAPS pump.

Component Location

The injection control valve identifier is shrink-wrapped to the injection control valve pigtail, which is located on the CAPS fuel injection pump on the top of the distributor.

Shop Talk

A shrink-wrap sleeve is installed over the injection control valve pigtail and the injection control valve identifier. Tampering could possibly be suspected if the shrink-wrap or identifier is removed.

Refer to Troubleshooting Fault Code t05-493

Last Modified: 16-Dec-2010

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FAULT CODE 497
Multiple Unit Synchronization Switch Error

Overview

CODE	REASON	EFFECT
Fault Code: 497 PID: S114 SPN: 1377 FMI: 2 (J1587), 2 (J1939) LAMP: Yellow SRT:	Error detected in the multiple unit synchronization control switch input, pins 24 and 38 of the OEM harness.	Multiple unit synchronization feature will be disabled.

Multiple Unit Synchronization Switch Circuit

Circuit Description

The multiple unit synchronization uses a complimentary switch to provide two opposite signals into the ECM.

Component Location

The multiple unit synchronization switch is cab mounted. Refer to OEM manual for specific location.

Shop Talk

When the multiple unit synchronization switch is in the ON position, pin 24 **must** be grounded, and pin 38 **must** be open. When the multiple unit synchronization switch is in the OFF position, pin 24 **must** be open, and pin 38 **must** be grounded.

Refer to Troubleshooting Fault Code t05-497

Last Modified: 16-Dec-2010

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FAULT CODE 515 or 516
Coolant Level Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 515 or 516 PID: P091 SPN: 091 FMI: 3 or 4 LAMP: Yellow SRT:	FC 515: High voltage detected at the auxiliary +5-VDC sensor supply voltage pin 49 of the engine harness. FC 516: Low voltage detected at the auxiliary +5-VDC sensor supply voltage pin 49 of the engine harness.	No engine protection for coolant level.

Coolant Level Sensor Circuit

Circuit Description

The coolant level sensor monitors the coolant level within the coolant system and passes information to the electronic control module (ECM) through the engine harness.

Component Location

The coolant level sensor is located in the radiator top tank or surge tank.

Shop Talk

This is an OEM-supplied component and will vary in sensor location.

- If a shorting plug is used in the coolant level circuit, verify that it is wired correctly.
- Inspect the wiring harness between the Weather-Pack four-way connector and the coolant level sensor for damage.
- Make sure the coolant level sensor is located in the middle of the tank rather than off to one side where the coolant level can change when the vehicle makes a turn.

Refer to Troubleshooting Fault Code t05-515

Last Modified: 16-Dec-2010

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FAULT CODE 515 or 516
Coolant Level Sensor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 515 or 516 PID: P091 SPN: 091 FMI: 3 or 4 LAMP: Yellow SRT:	FC 515: High voltage detected at the auxiliary +5-VDC sensor supply voltage pin 49 of the engine harness. FC 516: Low voltage detected at the auxiliary +5-VDC sensor supply voltage pin 49 of the engine harness.	No engine protection for coolant level.

Coolant Level Sensor Circuit

Circuit Description

The coolant level sensor monitors the coolant level within the coolant system and passes information to the electronic control module (ECM) through the engine harness.

Component Location

The coolant level sensor is located in the radiator top tank or surge tank.

Shop Talk

This is an OEM-supplied component and will vary in sensor location.

- If a shorting plug is used in the coolant level circuit, verify that it is wired correctly.
- Inspect the wiring harness between the Weather-Pack four-way connector and the coolant level sensor for damage.
- Make sure the coolant level sensor is located in the middle of the tank rather than off to one side where the coolant level can change when the vehicle makes a turn.

Refer to Troubleshooting Fault Code t05-516

Last Modified: 16-Dec-2010

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FAULT CODE 524
Switched Droop Selection Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 524 PID: P113 FMI: 2 LAMP: Yellow SRT:	Error detected on the high-speed governor droop selection switch.	Droop setting defaults to switch position 1 (or normal) preprogrammed droop governor values.

Switched Droop Selection Circuit

Circuit Description

The switched droop circuit allows the operator to select from up to three preprogrammed droop governor values using a two- or three-position switch, depending on which the original equipment manufacturer (OEM) has provided.

Component Location

The location of the droop switch circuit varies with each OEM and equipment model. Refer to the OEM manual.

Shop Talk

The switch can be monitored for proper operation on INSITE™. If the switch is changing state correctly on the service tool, then the problem does **not** lie in the switch circuit. The three-position switch has three states:

- Position 1 - open
- Position 2 - closed
- Position 3 - 1500 ohm resistance

The two-position switch has two states:

- Position 1 - open
- Position 2 - closed

Refer to Troubleshooting Fault Code t05-524

Last Modified: 16-Dec-2010

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FAULT CODE 527
Dual Output Driver A

Overview

CODE	REASON	EFFECT
Fault Code: 527 PID: P154 SPN: 702 FMI: 3 LAMP: Yellow SRT:	A problem was detected with the dual output-driver A circuit.	The device controlled by the driver A output circuit will **not** function properly.

Dual-Output Driver A

Circuit Description

The dual-output driver A will control engine and vehicle functions by controlling original manufacturer's (OEM) devices based on up to 12 selected engine parameters and two selected OEM parameters (OEM switch input and OEM pressure input). The solenoid output will control functions such as a fan clutch, air cleaner restriction indicator, or an oil filter differential pressure indicator.

Component Location

The OEM device is dependent upon the OEM.

Refer to Troubleshooting Fault Code t05-527

Last Modified: 16-Dec-2010

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FAULT CODE 528
Alternate (Switched) Torque Curve Switch Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 528 PID: P093 SPN: 093 FMI: 2 LAMP: Yellow SRT:	Error detected on the torque curve selection switch.	Torque curve setting defaults to the preprogrammed torque curve.

Alternate Torque Signal Circuit

Circuit Description

The torque curve switch circuit allows the operator to select from up to three preprogrammed torque curves using a two- or three-position switch, depending on which the original equipment manufacturer (OEM) has provided.

Component Location

The location of the torque curve switch circuit varies with each OEM and equipment model. Refer to the OEM manual.

Shop Talk

The switch can be monitored for proper operation in INSITE™. If the switch is changing state correctly on the service tool, then the problem does **not** lie in the switch circuit. The three position-switch has three states:

- Position 1 - open
- Position 2 - closed
- Position 3 - 1500-ohm resistance

The two position-switch has two states:

- Position 1 - open
- Position 2 - closed

Refer to Troubleshooting Fault Code t05-528

Last Modified: 16-Dec-2010

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FAULT CODE 529
Dual Output Driver B

Overview

CODE	REASON	EFFECT
Fault Code: 529 PID: S051 SPN: 703 FMI: 3 LAMP: Yellow SRT:	Error detected in the dual-output driver B circuit.	The device being controlled by the driver B output signal will **not** function properly.

Dual-Output Driver B

Circuit Description

The dual-output driver B will control engine and vehicle functions by controlling original equipment manufacturer's (OEM) devices based on up to 12 selected engine parameters and two selected OEM inputs (the OEM switch and the OEM pressure). The OEM device output will control functions such as a fan clutch, air cleaner restriction indicator, or an oil filter differential pressure indicator.

Component Location

The location of the OEM device is dependent upon the OEM.

Refer to Troubleshooting Fault Code t05-529

Last Modified: 16-Dec-2010

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FAULT CODE 539
Transient Suppressor Circuit

Overview

CODE	REASON	EFFECT
Fault Code: 539 PID: P018 SPN: 633 FMI: 11 LAMP: Yellow SRT:	Open circuit detected at the transient suppressor in the injection control valve circuit in the engine harness.	Possible white smoke and rough running.

Injection Control Valve Circuit

Circuit Description

The transient suppressor absorbs the extra current created when the injection control valve closes after an injection event. Without the transient suppressor, high voltage would be transmitted back into the ECM and damage the pump driver circuits.

Component Location

The transient suppressor extends from the trunk of the engine harness and is mounted with a p-clip to the engine block. It is a small copper colored cylinder with a red and a black wire extending from one end. It is located just below where the injection lines connect to the fuel pump. The injection control valve is located at the rear of the fuel injection pump, on the top of the distributor, and below the accumulator.

Shop Talk

When the transient suppressor is working normally, it will generate heat. Caution **must** be taken when working with it, as it can be hot. The heat generated in the transient suppressor is dependent on the speed of the engine.

Refer to Troubleshooting Fault Code t05-539

Last Modified: 16-Dec-2010

FAULT CODE 551
Fault Code Path Selection

Do you have an ISS throttle pedal?	Go to 71-fc551iss
Do you have an NISS throttle pedal?	Go to 71-fc551niss
Do you have an SSS throttle pedal?	Go to 71-fc551sss

Last Modified: 20-Dec-2007

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FAULT CODE 551 (ISS)
Accelerator Pedal or Lever Idle Validation Circuit - Voltage Below Normal or Shorted to Low Source

Overview

CODE	REASON	EFFECT
Fault Code: 551 PID: S230 SPN: 558 FMI: 4/4 LAMP: Amber SRT:	Accelerator Pedal or Lever Idle Validation Circuit - Voltage Below Normal or Shorted to Low Source. No voltage detected simultaneously on both the idle validation and off-idle and on-idle switches.	Automotive: Engine will **only** idle. Marine: Severe derate in engine speed. Limp home capability **only**.

Accelerator Pedal or Lever Idle Validation Circuit

Circuit Description

The idle validation switch is used by the electronic control module (ECM) to indicate when the accelerator pedal or lever is released (on-idle) or depressed (off-idle). The switch is adjusted by the accelerator pedal or lever manufacturers to switch from on-idle to off-idle at the correct accelerator pedal or lever position. The switch return is a shared return with other OEM cab switches.

Component Location

The integrated sensor switch (ISS) is located on the accelerator pedal or lever assembly.

Shop Talk

- This fault code is usually caused by a short circuit to ground in the harness, an uncalibrated accelerator pedal or lever assembly, or a miswired idle validation switch.
- When installing a new accelerator pedal or lever assembly, it **must** be calibrated before operating the engine. To calibrate, turn the keyswitch to the ON position, and fully depress and release the pedal or lever 3 times.

Refer to Troubleshooting Fault Code t05-551iss

Last Modified: 16-Dec-2010

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FAULT CODE 551 (NISS)
Accelerator Pedal or Lever Idle Validation Circuit - Voltage Below Normal or Shorted to Low Source

Overview

CODE	REASON	EFFECT
Fault Code: 551 PID: S230 SPN: 558 FMI: 4/4 LAMP: Amber SRT:	Accelerator Pedal or Lever Idle Validation Circuit - Voltage Below Normal or Shorted to Low Source. No voltage detected simultaneously on both the idle validation off-idle and on-idle circuits.	Automotive: Engine will **only** idle. Marine: Severe derate in engine speed. Limp home capability **only**.

Accelerator Pedal or Lever Idle Validation Circuit

Circuit Description

The idle validation switch is used by the electronic control module (ECM) to indicate when the accelerator pedal or lever is released (on-idle) or depressed (off-idle). The switch is adjusted by the accelerator pedal or lever manufacturers to switch from on-idle to off-idle at the correct accelerator pedal or lever position. The switch return is a shared return with other OEM cab switches.

Component Location

The nonintegrated sensor switch (NISS) is located on the accelerator pedal or lever assembly.

Shop Talk

- This fault code is usually caused by a short circuit to ground in the harness, an uncalibrated accelerator pedal or lever assembly, or a miswired idle validation switch.
- When installing a new accelerator pedal or lever assembly, it **must** be calibrated before operating the engine. To calibrate, turn the keyswitch to the ON position and fully depress and release the pedal or lever 3 times.

Refer to Troubleshooting Fault Code t05-551niss

Last Modified: 16-Dec-2010

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FAULT CODE 551 (SSS)
Accelerator Pedal or Lever Idle Validation Circuit - Voltage Below Normal or Shorted to Low Source

Overview

CODE	REASON	EFFECT
Fault Code: 551 PID: S230 SPN: 558 FMI: 4/4 LAMP: Amber SRT:	Accelerator Pedal or Lever Idle Validation Circuit - Voltage Below Normal or Shorted to Low Source. No voltage detected simultaneously on both the idle validation off-idle and on-idle circuits.	Automotive: Engine will **only** idle. Marine: Severe derate in engine speed. Limp home capability **only**.

Accelerator Pedal or Lever Idle Validation Circuit

Circuit Description

The idle validation switch is used by the electronic control module (ECM) to indicate when the accelerator pedal or lever is released (on-idle) or depressed (off-idle). The switch is adjusted by the accelerator pedal or lever manufacturers to switch from on-idle to off-idle at the correct accelerator pedal or lever position. The switch return is a shared return with other OEM cab switches.

Component Location

The solid state sensor switch (SSS) is located on the accelerator pedal or lever assembly.

Shop Talk

- This fault code is usually caused by a short circuit to ground in the harness, an uncalibrated accelerator pedal or lever assembly, or a miswired idle validation switch.
- When installing a new accelerator pedal or lever assembly, it **must** be calibrated before operating the engine. To calibrate, turn the keyswitch to the ON position, and fully depress and release the pedal or lever 3 times.

Refer to Troubleshooting Fault Code t05-551sss

Last Modified: 16-Dec-2010

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FAULT CODE 768
Output Device Driver (Transmission Shift Modulator)

Overview

CODE	REASON	EFFECT
Fault Code: 768 PID: S009 SPN: 923 FMI: 11 LAMP: Yellow SRT:	Error detected in the output device driver (transmission shift modulation signal) signal pin 21 on the original equipment manufacturer's (OEM) harness.	Can **not** control the transmission.

Output Device Driver Circuit

Circuit Description

The output device driver is a device used by the electronic control module (ECM) to control the transmission shift modulation signal.

Component Location

Refer to an OEM diagram for the location of the transmission shift modulator.

Shop Talk

The output device driver could be malfunctioning due to a failed engine harness, a bad ground on the transmission shift modulator connector, or a bad transmission shift modulator.

Refer to Troubleshooting Fault Code t05-768

Last Modified: 16-Dec-2010

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FAULT CODE 779
OEM Input - Engine Protection

Overview

CODE	REASON	EFFECT
Fault Code: 779 PID: S051 SPN: 703 FMI: 11 LAMP: Yellow SRT:	OEM input signal indicates OEM value has exceeded the engine protection limit.	Speed derate and possible engine shutdown if engine protection shutdown feature is enabled.

OEM Input Sensor Circuit

Circuit Description

The OEM device input to engine protection allows vehicle OEMs to wire up a device, such as a hydraulic oil temperature limit switch, transmission temperature limit switch, etc., to the ECM. The ECM will monitor values from this device the same as other engine protection inputs, such as coolant level, etc. If a threshold value is exceeded, engine speed derate will occur and possible engine shutdown.

Component Location

The location of the OEM device is dependent upon the OEM.

Refer to Troubleshooting Fault Code t05-779

Last Modified: 16-Dec-2010

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FAULT CODE 2194
OEM Pressure - Engine Protection

Overview

CODE	REASON	EFFECT
Fault Code: 2194 PID: P223 SPN: 1387 FMI: 11 (J1587), 11 (J1939) LAMP: Yellow SRT:	OEM pressure signal at pin 48 of the OEM harness indicates pressure outside the engine protection limit.	Power derate and possible engine shutdown if engine protection shutdown feature is enabled.

OEM Pressure Sensor Circuit

Circuit Description

The OEM pressure sensor is used by the electronic control module (ECM) to monitor an OEM-specific pressure sensor. The ECM monitors the voltage on signal pin 48 and converts this to a pressure value. The OEM pressure value is used by the ECM for the engine/vehicle protection system.

Component Location

The OEM pressure sensor is located in different locations depending on the OEM and equipment model. Refer to the OEM manual.

Shop Talk

Verify with the driver the engine operating condition when the fault occurs. Depending on the engine speed and load, the OEM pressure can fall below or exceed the engine protection limits. The sensor can be used to detect fluid pressure that is too low or too high. Refer to the OEM manual for more information.

Refer to Troubleshooting Fault Code t05-2194

Last Modified: 16-Dec-2010

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FAULT CODE 2195
OEM Switch - Engine Protection

Overview

CODE	REASON	EFFECT
Fault Code: 2195 PID: S051 SPN: 703 FMI: 14 (J1587), 14 (J1939) LAMP: Red SRT:	OEM switch signal at pin 16 of the engine harness indicates engine protection condition.	Speed derate and possible engine shutdown if engine protection shutdown feature is enabled.

OEM Switch Circuit

Circuit Description

The OEM switch is used by the electronic control module (ECM) to monitor an OEM-specific switch. The ECM monitors the signal on pin 16 for the engine/vehicle protection system.

Component Location

The OEM switch is located in different locations, depending on the OEM and equipment model. Refer to the OEM manual.

Shop Talk

Verify with the driver the engine operating condition when the fault occurs. Depending on the engine speed and load, the OEM switch can detect a condition that falls below or exceeds the engine protection limit. Refer to the OEM manual for more information.

Refer to Troubleshooting Fault Code t05-2195

Last Modified: 16-Dec-2010

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Troubleshooting Procedures and Techniques (t00-001)

General Information

A thorough analysis of the customer's complaint is the key to successful troubleshooting. The more information known about a complaint, the faster and easier the problem can be solved.

The Troubleshooting Symptom Charts are organized so that a problem can be located and corrected by doing the easiest and most logical things first. Complete all steps in the sequence shown from top to bottom.

It is **not** possible to include all the solutions to problems that can occur; however, these charts are designed to stimulate a thought process that will lead to the cause and correction of the problem.

Follow these basic troubleshooting steps:

- Get all the facts concerning the complaint
- Analyze the problem thoroughly
- Relate the symptoms to the basic engine systems and components
- Consider any recent maintenance or repair action that can relate to the complaint
- Double-check before beginning any disassembly
- Solve the problem by using the symptom charts and doing the easiest things first
- Determine the cause of the problem and make a thorough repair
- After repairs have been made, operate the engine to make sure the cause of the complaint has been corrected

Last Modified: 17-Nov-2010

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Troubleshooting Symptoms Charts
(t00-002)

General Information

Use the charts on the following pages of this section to aid in diagnosing specific engine symptoms. Read each row of blocks from top to bottom. Follow through the chart to identify the corrective action.

WARNING

Troubleshooting presents the risk of equipment damage, personal injury or death.
Troubleshooting must be performed by trained, experienced technicians.

Last Modified: 03-Apr-2002

Engine Speed Surges in PTO or Cruise Control

This is symptom tree t068

Cause	Correction
Engine speed also surges at idle	Refer to the Engine Speed Surges at Low or High Idle symptom tree.
Engine speed surges while in the normal operating range and **not** in PTO or cruise control	Refer to the Engine Speed Surges Under Load or in Operating Range symptom tree.
Electronic fault codes active or high counts of inactive fault codes	Refer to Section TF for fault code troubleshooting.
Electronic control module (ECM) calibration is malfunctioning	Verify the ECM calibration is correct. Check the calibration revision history for applicable fixes to the calibration stored in the ECM. Refer to the calibration history spreadsheet Click here to see ecm_calibration_rev_history.xls on QuickServe® Online or the INCAL™ CD-ROM. Compare the calibration stored in the ECM with the engine rating and the Control Parts List (CPL), Bulletin 4021326 or 4021327. If necessary, recalibrate the ECM. Refer to Procedure 019-032.
Fuel filter is plugged	Measure the fuel pressure before and after the fuel filter. Refer to Procedure 006-015 in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.
Vehicle speed sensor (VSS) or circuit is malfunctioning	Use an electronic service tool to monitor the vehicle speed while the vehicle is **not** moving. Refer to the appropriate electronic service tool manual. If the monitor shows speed, check the sensor and circuit. Refer to Procedures 019-090, 019-091, and 019-093.

Moisture in the wiring harness connectors	Dry the connectors with Cummins electronic cleaner, Part Number 3824510.

Last Modified: 15-Dec-2003

View Related Topic

Engine Fan Does Not Operate or Operates Erratically

This is symptom tree t046

Cause	Correction
Programmable parameters or selected features are **not** correct	Check the programmable parameters and the selected features with an electronic service tool. Set the parameters and features again if necessary. Refer to Procedure 019-078.
Manual fan ON/OFF switch and circuit is malfunctioning	Check the manual fan ON/OFF switch and circuit. Refer to Manual Fan ON/OFF Switch, Resistance Check, and Short Circuit to Ground Check in Procedure 019-045.
Air conditioner pressure switch is malfunctioning	Check the air conditioner pressure switch. Refer to OEM service manual.
Fan clutch actuator or circuit is malfunctioning	Check the fan clutch actuator circuit. Refer to Procedure 019-045.
Engine electrical ground is malfunctioning	Check engine ground to chassis and chassis ground to battery negative (-) post. Refer to the OEM service manual and Procedure 013-009 Battery Cables and Connections in the C-Series Troubleshooting and Repair Manual, Bulletin 3666003.

Last Modified: 15-May-2007

Engine Will Not Shut Off

This is symptom tree t081

Cause	Correction
Electronic fault codes active or high counts of inactive fault codes	Refer to Section TF for the fault code troubleshooting.
Keyswitch circuit is malfunctioning	Check the vehicle, equipment, or vessel keyswitch circuit. Refer to Procedure 019-064.
Engine is running on fumes drawn into the air intake	Check the air intake ducts. Locate and isolate the source of the fumes. Repair as necessary. Refer to the OEM service manual.
Turbocharger oil seal is leaking	Check the turbocharger compressor and turbine seals. *Refer to Procedure 010-033 in the Troubleshooting and Repair Manual ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.*
Fuel injection pump is malfunctioning	Perform ICV solenoid click test. Refer to Procedure 005-229 in the Troubleshooting and Repair Manual ISC , QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.
Electronic control module (ECM) is malfunctioning	Replace the ECM. Refer to Procedure 019-031.

Fuel injection pump is malfunctioning	Replace the fuel injection pump. Refer to Procedure 005-016 in the Troubleshooting and Repair Manual ISC , QSC8.3, ISL, and QSL9 Series Engines,Engines, Bulletin 4021418.

Last Modified: 15-Dec-2003

Fault Code Warning Lamps Stay On (No Apparent Reason)

This is symptom tree t083

Cause	Correction
Diagnostic shorting plug is installed	Remove the diagnostic shorting plug.
Diagnostic switch is in the ON position	Turn off the diagnostic switch.
Diagnostic switch or circuit is malfunctioning	Check the diagnostic switch and circuit. Refer to Procedure 019-027 and 019-028.
Electronic fault codes active or high counts of inactive fault codes	Refer to Section TF for fault code troubleshooting.
Fault code warning lamp circuit is malfunctioning	Check the fault code warning lamp circuit. Refer to Procedure 019-047.

Last Modified: 15-Dec-2003

Fault Code Warning Lamps Do Not Illuminate

This is symptom tree t084

Cause	Correction
Keyswitch is in the OFF position	Turn the keyswitch to the ON position.
Fault code warning lamps are burned out	Check the warning lamps for voltage. Replace the bulbs if necessary. Refer to Procedure 019-046.
Battery voltage supply to the electronic control module (ECM) is low, interrupted, or open	Check the battery connections, the fuses, and the unswitched battery supply circuit. Refer to Procedures 019-198, 019-087, and Procedure 013-009 in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.
Fault code warning lamp circuit is malfunctioning	Check the fault code warning lamp circuit. Refer to Procedure 019-047.
Idle shutdown or PTO shutdown features are activated	Check the time limit on idle and PTO shutdowns with an electronic service tool. Refer to the appropriate electronic service tool manual.
Keyswitch circuit is malfunctioning	Check the vehicle, equipment, or vessel keyswitch circuit. Refer to Procedure 019-064.

Last Modified: 15-Dec-2003

Fuel Consumption Excessive

This is symptom tree t087

Cause	Correction
Interview the operator to verify the complaint	Refer to Fuel Consumption General Information and Customer Complaint Form. Follow the instructions on the form before continuing with this tree.
Engine duty cycle has changed	Verify the engine duty cycle with an electronic service tool. Refer to the appropriate electronic service tool manual.
Operator technique is **not** correct	Explain correct engine operation to the operator. Refer to the Operation and Maintenance Manual, ISC Engine, Bulletin 3666262.
Hubometer or odometer is miscalibrated	Check the hubometer and odometer calibrations. Calibrate or replace the hubometer or odometer, if necessary. Calculate fuel consumption with new mileage figures.
Electronic fault codes active or high counts of inactive fault codes	Refer to Section TF for fault code troubleshooting.
Programmable parameters or selected features are **not** correct	Check the programmable parameters and the selected features with an electronic service tool. Set the parameters and features again if necessary. Refer to Procedure 019-078 or the appropriate electronic service tool manual.

Engine idle or PTO time is excessive	Check the idle or PTO time with INSITE.™ Low oil and coolant temperatures can be caused by long idle time (greater than 10 minutes).
Electronic control module (ECM) calibration is malfunctioning	Verify the ECM calibration is correct. Check the calibration revision history for applicable fixes to the calibration stored in the ECM. Refer to the calibration history spreadsheet Click here to see ecm_calibration_rev_history.xls on QuickServe® Online or the INCAL™ CD-ROM. Compare the calibration stored in the ECM with the engine rating and Control Parts List (CPL), Bulletin 4021326 or 4021327. If necessary, recalibrate the ECM. Refer to Procedure 019-032 and the appropriate electronic service tool manual.
Intake manifold pressure (boost) sensor or circuit is malfunctioning	Check the boost sensor and circuit. Refer to Procedure 019-061.
Vehicle speed sensor (VSS) or circuit is malfunctioning	Use an electronic service tool to monitor the vehicle speed while the vehicle is **not** moving. Refer to the appropriate electronic service tool manual. If the monitor shows speed, check the sensor and circuit. Refer to Procedures 019-090, 019-091, and 019-093.
Vehicle speed sensor (VSS) tampering has occurred	Check the vehicle speed sensor and circuit for tampering. Check for Fault Code 242. Repair the circuit as necessary. Refer to Procedures 019-090, 019-091, and 019-093.
Fuel leak	Check the fuel lines, fuel connections, and fuel filters for leaks. Check the fuel lines to the supply tanks. Refer to Procedure 006-024 in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Engines, Bulletin 4021418.
	Inspect the air intake and exhaust systems for air leaks.

Air intake or exhaust leaks	*Refer to Procedure 010-024 in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Engines, Bulletin 4021418.*
Air intake system restriction is above specification	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to Procedure 010-031 in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Engines, Bulletin 4021418.
Drivetrain is **not** correctly matched to the engine	Check for correct gearing and drivetrain components. Refer to the OEM service manual.
Vehicle parasitics are excessive	Check the vehicle brakes for dragging, transmission malfunction, cooling fan operation cycle time, and engine-driven units. Refer to the OEM service manual.
Fuel grade is **not** correct for the application or the fuel quality is poor	Operate the engine from a tank of high-quality fuel. Refer to Fuel Recommendations and Specifations in the Operation and Maintenance Manual, ISC Engine, Bulletin 3666262.
Injector is malfunctioning	Perform the automated cylinder performance test. Replace injectors as necessary. Refer to Procedure 006-026 or 014-008 in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Engines, Bulletin 4021418.
Equipment and environmental factors are affecting fuel consumption	Consider ambient temperatures, wind, tire size, axle alignment, routes, and use of aerodynamic aids when evaluating fuel consumption.

Lubricating oil level is above specification	Check the oil level. Verify the dipstick calibration and oil pan capacity. Fill the system to the specified level. Refer to Procedures 007-009 or 007-037 in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Engines, Bulletin 4021418.
Exhaust system restriction is **not** within specification	Check the exhaust system for restrictions. *Refer to Procedure 011-009 in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Engines, Bulletin 4021418.*
Overhead adjustments are **not** correct	Measure and adjust the overhead settings. Refer to Procedure 003-004 in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Engines, Bulletin 4021418.
Fuel injection pump is malfunctioning	Check CAPS accumulator pressure. Refer to Procedure 005-085 in the Troubleshooting and Repair Manual ISC, QSC8.3, ISL, and QSL9 Series Engines, Engines, Bulletin 4021418.
Fuel injection pump is malfunctioning	Replace the fuel injection pump. Refer to Procedure 005-016 in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Engines, Bulletin 4021418.
Internal engine damage	Analyze the oil and inspect the filters to locate an area of probable damage. Refer to an Authorized Cummins Repair Facility.

Last Modified: 15-Dec-2003

Fuel in Coolant

This is symptom tree t091

Cause	Correction
Cylinder head is cracked or porous	Remove intake and exhaust manifolds. Check for evidence of coolant leak. If necessary, operate engine at low idle. Pressure-test the cylinder head. Refer to Procedure 002-004 in the Troubleshooting and Repair Manual ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.
Bulk coolant supply is contaminated	Check the bulk coolant supply. Drain the coolant and replace with noncontaminated coolant. Replace the coolant filters. *Refer to Procedure 008-018 in the Troubleshooting and Repair Manual ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.*

Last Modified: 17-Mar-2004

View Related Topic

Fuel in the Lubricating Oil

This is symptom tree t092

Cause	Correction
Engine idle time is excessive	Low oil and coolant temperatures can be caused by long idle time (greater than 10 minutes). Shut off the engine rather than idle for long periods. If idle time is necessary, raise the idle speed.
Injector o-rings are damaged or missing	Remove and check the injectors. Replace the injector o-rings. Refer to Procedure 006-026 (Injector) in Section 6 of the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.
Injector is malfunctioning	Perform the automated cylinder performance test. Replace injectors as necessary. Refer to Procedure 006-026 (Injector) in Section 6 of the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418. Also, refer to Procedure 014-008 (Engine Testing, In Chassis) in Section 14 of the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.
Fuel injection pump is malfunctioning	Replace the accumulator module. Refer to Procedure 005-085 (Fuel Pump Accumulator Module) in the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.
Fuel injection pump is malfunctioning	Inspect the cam housing for cracks and damage. Refer to Procedure 005-088 (Fuel Pump Cam Housing Module) in Section 5 of the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.
Fuel injection pump is malfunctioning	Inspect the injection pump gear pump module oil seal. Replace gear pump module if there are signs or leakage. Refer to Procedure 005-025 (Fuel Pump Gear Pump) in Section 5 of the Troubleshooting and Repair Manual, ISC,

	QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.
Cylinder head is cracked or porous	Remove the intake and the exhaust manifolds. Check for evidence of coolant leak. If necessary, operate the engine at low idle. Pressure-test the cylinder head. Refer to Procedure 002-004 (Cylinder Head) in Section 2 of the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.
Bulk oil supply is contaminated	Check the bulk oil supply. Drain the oil and replace with noncontaminated oil. Replace the oil filters. *Refer to Procedure 007-037 (Lubricating Oil System) in Section 7 of the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418. Also, refer to Procedure 007-013 (Lubricating Oil Filter, Spin-On) in Section 7 of the Troubleshooting and Repair Manual, ISC, QSC8.3, ISL, and QSL9 Series Engines, Bulletin 4021418.*
Internal engine damage	Analyze the oil and inspect the filters to locate an area of probable damage. Refer to an Authorized Cummins® Repair Facility.

Last Modified: 31-May-2007

Low Idle Adjust Switch Does Not Work

This is symptom tree t099

Cause	Correction
Electronic fault codes active or high counts of inactive fault codes	Refer to Section TF for fault code troubleshooting.
Engine idle speed is set at either the minimum or the maximum allowable value	The idle adjust switch will **not** adjust the idle speed outside the allowable range. Refer to the Operation and Maintanance Manual, ISC Engine, Bulletin 3666262.
Low-idle adjust switch and circuit is malfunctioning	Check the idle adjust switch and circuit. Refer to Procedures 019-052 and 019-053.
Low-idle adjust switch feature is **not** enabled	Check the low-idle adjust switch feature with an electronic service tool. Refer to the appropriate electronic service tool manual.

Last Modified: 15-Dec-2003

PTO or Cruise Control Does Not Operate

This is symptom tree t112

Cause	Correction
Electronic fault codes active or high counts of inactive fault codes	Refer to Section TF for fault code troubleshooting.
Programmable parameters or selected features are **not** correct	Check the programmable parameters and the selected features with an electronic service tool. Set the parameters and features again if necessary. Refer to the appropriate electronic service tool manual.
Cruise control/PTO on/off switch or circuit is malfunctioning	Check the cruise control/PTO on/off switch and the circuit. Refer to Procedures 019-021 and 019-022.
Cruise control/PTO selector switch or circuit is malfunctioning	Check the cruise control/PTO selector switch and circuit. Refer to Procedures 019-023 and 019-024.
Clutch switch or circuit is malfunctioning	Check the clutch switch adjustment, switch, and circuit. *Refer to Procedures 019-009*.
Vehicle brake switch or circuit is malfunctioning	Check the vehicle brake switch and circuit. Refer to Procedures 019-088 and 019-089.

Vehicle speed sensor (VSS) or circuit is malfunctioning	Use an electronic service tool to monitor the vehicle speed while the vehicle is **not** moving. Refer to the appropriate electronic service tool manual. If the monitor shows speed, check the sensor and circuit. Refer to Procedures 019-090, 019-091, and 019-093.
J1939 control devices are interfering with the engine controls	Alternately disconnect all other J1939 control devices from the datalink circuit until communication or functionality is restored. Refer to the OEM service manual to locate and repair J1939 control devices.
Electronic control module (ECM) calibration is malfunctioning	Verify the ECM calibration is correct. Check the calibration revision history for applicable fixes to the calibration stored in the ECM. Refer to the calibration history spreadsheet Click here to see ecm_calibration_rev_history.xls on QuickServe® Online or the INCAL™ CD-ROM. Compare the calibration stored in the ECM with the engine rating and the Control Parts List (CPL), Bulletin 4021326 or 4021327. If necessary, recalibrate the ECM. Refer to Procedure 019-032 and the appropriate electronic service tool manual.

Last Modified: 15-Dec-2003

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View Related Topic

ECM - No Communication Troubleshooting Tree

Symptoms

- No communication and engine will **not** start
- No communication and engine will start
- No communication related INSITE™ electronic service tool errors
- Communication with some ECMs but **not** all ECMs on a multi-module engine.

How To Use This Tree

This troubleshooting procedure can be used to troubleshoot J1939 and J1587 data link communication issues between the electronic service tool and the ECM. There are four procedures that can be used to support this troubleshooting tree:

- Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, in the appropriate electronic control system troubleshooting and repair manual.
- Procedure 019-165 (Data Link Circuit, SAE J1939) in Section 19 in the appropriate electronic control system troubleshooting and repair manual.
- Procedure 019-166 (Data Link Circuit, SAE J1587) in Section 19 in the appropriate electronic control system troubleshooting and repair manual.

The troubleshooting steps in this procedure build upon information obtained in previous steps. The troubleshooting steps **must** be performed in the sequence specified in the troubleshooting procedure.

This troubleshooting procedure supports several engine families, therefore some instructions are stated in a general manner. Apply the requested procedures and actions to the specific engine family with the support of engine specific documentation that can be found in the Troubleshooting and Repair manuals for the specific engine family.

Shop Talk

Three basic principles were used to define and sequence the troubleshooting steps that are listed in this tree.

- Verify high level system operation prior to troubleshooting individual components of the system. The purpose for this is to learn from the behavior of the system in order to direct the next steps for troubleshooting.
- Use the Bench Top Harness to separate the ECM from the vehicle so the ECM can be isolated from vehicle issues that could be causing no communication.
- Use a second vehicle or a second ECM to isolate high level system issues before troubleshooting individual components of the system.

Troubleshooting Steps

STEPS		SPECIFICATIONS
STEP 1.	INSITE™ electronic service tool error code check	
	STEP 1A. Check for INSITE™ electronic service tool error code 5023.	Is INSITE™ electronic service tool error code 5023 present?
	STEP 1B. INSITE™ electronic service tool error code 5080 or 5081 check.	Is INSITE™ electronic service tool error code 5080 or 5081 present?
	STEP 1C. INSITE™ electronic service tool other error code checks.	Are any INSITE™ electronic service tool error codes present other than 5023, 5080, or 5081?
	STEP 1D. ECM password check	Does INSITE™ electronic service tool indicate the ECM is password protected?
STEP 2.	Initial data link adapter and INSITE™ electronic service tool check	
	STEP 2A. Initial data link adapter check	Are the communication lights on the data link adapter flashing?
	STEP 2B. data link adapter reset check	Does the ECM communicate?
	STEP 2C. Initial INSITE™ electronic service tool check	Does the ECM communicate?
	STEP 2D. data link adapter verification check	Is an Inline or Inline I being use to communicate with the ECM?
	STEP 2E. data link adapter firmware check	Is firmware version compatible with ECM?

STEP 3.	Bench communication setup checks	
	STEP 3A. Bench setup availability check	Is a bench setup available?
	STEP 3A-1. Engine start check	
	STEP 3B. Initial bench setup communication check	Does the ECM communicated using bench setup?
	STEP 3B-1. Engine start check	
	STEP 3C. Second vehicle or second ECM availability check for bench setup	Is second vehicle or second ECM available to connect to the bench setup?
	STEP 3D. Initial bench setup functionality check	Does the second ECM communicate using bench setup?
	STEP 3E. Troubleshoot bench setup	Does bench setup check OK?
	STEP 3F. data link adapter replacement check	Does bench setup communicate with the second ECM using a replacement data link adapter?
STEP 4.	ECM power up circuit check	
	STEP 4A. Engine configuration check	Is the engine equipped with a fuel shutoff valve?
	STEP 4A-1. Check fuel shutoff valve voltage	
	STEP 4A-2. Coolant temperature sensor signal voltage check	
	STEP 4B. ECM keyswitch voltage check	Is the keyswitch voltage within 1-VDC or vehicle system voltage?
	STEP 4C. Check the ECM power and ground	Is the ECM battery supply voltage equal to the battery voltage?
STEP 5.	Initial electronic tool check	
	STEP 5A. Bench setup previously used for troubleshooting check	In Step 3 checks, was bench setup used to successfully communicate with the ECM?
	STEP 5B. Second vehicle availability check for electronic tool	Is a second vehicle available to connect to the electronic tool?
	STEP 5C. Initial electronic tool functionality check	Does the second ECM communicate using electronic tool?
STEP 6.	data link adapter power check	
	STEP 6A. data link adapter determination check	Is an Inline I data link adapter being used to communicate with INSITE™ electronic service tool?
	STEP 6B. Check data link adapter power	Is the data link adapter power light on?
	STEP 6C. Determination if communication is being attempted at OEM dash connector	Is the communication being attempted at the OEM data link dash connector?
	STEP 6D. OEM data link dash connector voltage check	Is the voltage equal to or greater than 9-VDC?
	STEP 6E. Check voltage at data link adapter auxiliary power supply	Is the voltage equal to or greater than 9-VDC?
	STEP 6F. Check voltage at vehicle battery	Is the voltage equal or greater than 11-VDC?
	STEP 6G. Computer serial port voltage check	Is a minimum of 5 VDC available?
STEP 7.	data link circuit check	
	STEP 7A. Check J1939 or J1587 circuits	Does the circuit check OK?
STEP 8.	Initial electronic tool check	
	STEP 8A. Second vehicle availability check for electronic tool	Is a second vehicle available to connect to the electronic tool?
	STEP 8B. Initial electronic tool functionality check	Does the second ECM communicate using the electronic tool?
STEP 9.	Detailed electronic tool check	
	STEP 9A. Troubleshoot electronic tool hardware	Does the electronic tool hardware check OK?
STEP 10.	Serial cable and computer check	
	STEP 10A. Troubleshoot serial cable and computer	Do the serial cable and computer check OK?
STEP 11.	ROM boot ECM	

STEP 11A. ROM boot tool availability check	Is the ROM boot tool available?
STEP 11B. ROM boot ECM	Does the ECM communicate?

Guided Step 1 - INSITE™ electronic service tool error code check

Guided Step 1A - INSITE™ electronic service tool error code 5023 check

Conditions

- Connect INSITE™ electronic service tool.
- Turn keyswitch ON.

Action

Check for INSITE™ electronic service tool error code 5023.

- Use INSITE™ electronic service tool to read the error codes.

Is INSITE™ electronic service tool error code 5023 present?	Is INSITE™ electronic service tool error code 5023 present?
YES	**NO**
No Repair	**No Repair**
Go to 2A	**Go to 1B**

Guided Step 1B - INSITE™ electronic service tool error code 5080 or 5081 check

Conditions

- Connect INSITE™ electronic service tool.
- Turn keyswitch ON.

Action

Check for INSITE™ error code 5080 or 5081.

- Use INSITE™ electronic service tool to read the error codes.

Is INSITE™ electronic service tool error code 5080 or 5081 present?	Is INSITE™ electronic service tool error code 5080 or 5081 present?
YES	**NO**
Perform the ECM calibration download	**No Repair**
Repair complete	**Go to 1C**

Guided Step 1C - INSITE™ electronic service tool other error code checks.

Conditions

- Connect Is INSITE™ electronic service tool.
- Turn keyswitch ON.

Action Are any INSITE™ electronic service tool error codes present other than 5023, 5080, or 5081? • Use INSITE™ electronic service tool to read the error codes.	
Are any INSITE™ electronic service tool error codes present other than 5023, 5080, or 5081?	Are any INSITE™ electronic service tool error codes present other than 5023, 5080, or 5081?
YES	**NO**
See the INSITE™ Electronic Service Tool manual for troubleshooting guidelines.	**No Repair**
Repair Complete	**Go to 1D**

Guided Step 1D - ECM password check

Conditions • Connect INSITE™ electronic service tool. • Turn keyswitch ON. **Action** Does INSITE™ electronic service tool indicate the ECM is password protected? • Use INSITE™ electronic service tool.	
Does INSITE™ electronic service tool indicate the ECM is password protected?	Does INSITE™ electronic service tool indicate the ECM is password protected?
YES	**NO**
Enter correct password If password is unavailable, contact customer to request password information. If customer can **not** supply password information, see the INSITE™ electronic service tool manual for password removal information. Normal warranty guidelines will apply if ECM password removal is required.	**No Repair**
Repair complete	**Go to 2A**

Guided Step 2 - Initial data link adapter and INSITE™ electronic service tool check

Guided Step 2A - Initial data link adapter check

Conditions • data link adapter connected to OEM data link connector in vehicle. • INSITE™ electronic service tool computer **must not** be connected. • Note: If connected to the 3 pin engine data link connector the communication lights will **not** blink, continue to Step 2B.

Action Turn keyswitch on.	
Are the communication lights on the data link adapter flashing? • J1708 light for Inline • J1708 or J1939 for Inline II, Inline 4, and Inline 5.	Are the communication lights on the data link adapter flashing? • J1708 light for Inline • J1708 or J1939 for Inline II, Inline 4, and Inline 5.
YES	**NO**
No Repair	**No Repair**
Go to 2C	**Go to 2B**

Guided Step 2B - data link adapter reset check

Conditions INSITE™ electronic service tool connected to vehicle. **Action** Data link adapter reset check • Disconnect power from the data link adapter. • Leave disconnected for 30 seconds • Connect power again to the Inline adapter • Turn keyswitch ON.	
Does the ECM communicate?	Does the ECM communicate?
YES	**NO**
No Repair	**No Repair**
Repair complete	**Go to 3A**

Guided Step 2C - Initial INSITE™ electronic service tool check

Conditions • INSITE™ electronic service tool connected to vehicle • Turn keyswitch ON. **Action** Reboot INSITE™ electronic service tool PC. • Launch INSITE™ electronic service tool • Check for communication.	
Does the ECM communicate?	Does the ECM communicate?
YES	**NO**
No Repair	**No Repair**
Repair complete	**Go to 2D**

Guided Step 2D - data link adapter verification check

Conditions None **Action** Verify if an Inline or Inline I data link adapter is being used to communicate with ECM. Reference Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, for General Information - data link Adapters, in the appropriate electronic control system troubleshooting and repair manual for data link adapter identification information.	
Is an Inline or Inline I being used to communicate with the ECM?	Is an Inline or Inline I being used to communicate with the ECM?
YES	**NO**
No Repair	**No Repair**
Go to 8A	Go to 2E

Guided Step 2E - data link adapter firmware check

Conditions None **Action** Verify data link adapter firmware version is compatible with ECM. Reference Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, for General Information - data link Adapters, in the appropriate Electronic Control System Troubleshooting and Repair manual for data link adapter identification information.	
Is firmware version compatible with the ECM?	Is firmware version compatible with the ECM?
YES	**NO**
No Repair	Load correct firmware version
Go to 8A	Go to 2C

Guided Step 3 - Bench communication setup checks

Guided Step 3A - Bench setup availability check

Conditions • Bench setup available. **Action** Verify bench setup is available.	
Is a bench setup available?	Is a bench setup available?
YES	**NO**
No Repair	**No Repair**

Go to 3B	Go to 3A-1

Guided Step 3A-1 - Engine start check

Conditions • None **Action** Verify if engine will start.	
Will engine start?	Will engine start?
YES	**NO**
No Repair	**No Repair**
Go to 5A	Go to 4A

Guided Step 3B - Initial bench setup communication check.

Conditions • Use the same INSITE™ electronic service tool PC as was used for the previous checks • Bench setup connected to ECM • Bench top calibration harness keyswitch ON. **Action** Attempt to comunicate with the ECM using bench setup.	
Does the ECM communicate with bench setup?	Does the ECM communicate with bench setup?
YES	**NO**
No Repair	**No Repair**
Go to 3B-1	Go to 3C

Guided Step 3B-1 - Engine start check

Conditions • None **Action** Disconnect the bench top calibration cable from the ECM. Reconnect the ECM to the original engine or OEM wiring harness connector. Verify if the engine will start.	
Will the engine start?	Will the engine start?
YES	**NO**
No Repair	**No Repair**
Go to 5A	Go to 4A

Guided Step 3C - Second vehicle or second ECM availability check for bench setup

Conditions • Second vehicle or second ECM available for testing. **Action** Verify if a second vehicle or second ECM is available to connect to the bench setup.	
Is a second vehicle or second ECM available to connect to the bench setup?	Is a second vehicle or second ECM available to connect to the bench setup?
YES	**NO**
No Repair	**No Repair**
Go to 3D	**Go to 3E**

Guided Step 3D - Initial bench setup functionality check

Conditions • Use the same INSITE™ electronic service tool PC and bench setup tools that were originally used on the problem vehicle. • Bench setup connected to second vehicle or second ECM • Bench top calibration harness keyswitch ON. **Action** Attempt to communicate with the ECM on the second vehicle or a spare ECM using bench setup.	
Does the second ECM communicate using bench setup?	Does the second ECM communicate using bench setup?
YES	**NO**
No Repair	**No Repair**
Go to 11A	**Go to 3E**

Guided Step 3E - Troubleshoot bench setup hardware

Conditions • None **Action** Troubleshoot bench calibration cable, bench calibration harness, and serial cable. • Perform troubleshooting procedures for evaluating the bench calibration cable, bench calibration harness, and serial cable. Reference Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, for Resistance Check - Serial Cable, Benchtop Calibration Harness, Benchtop Calibration Cable, in the appropriate Electronic Control System Troubleshooting and Repair manual.	

Does bench setup check OK?	Does bench setup check OK?
YES	**NO**
No Repair	Repair or replace bench calibration cable, bench calibration harness, or serial cable.
Go to 3F	Go to 3B

Guided Step 3F - data link adapter replacement check

Conditions • None **Action** Try to communicate with the bench setup using a replacement datalink.	
Does bench setup communicate with the second ECM using a replacement data link adapter?	Does bench setup communicate with the second ECM using a replacement data link adapter?
YES	**NO**
Use replacement data link adapter.	Issue with bench setup should have been found. Troubleshoot the bench setup again.
Go to 3B	Go to 3E

Guided Step 4 - ECM power up circuit check

Guided Step 4A - Engine configuration check

Conditions • None **Action** Determine if the engine is equipped with a fuel shutoff valve	
Is the engine equipped with a fuel shutoff valve?	Is the engine equipped with a fuel shutoff valve?
YES	**NO**
No Repair	**No Repair**
Go to 4A-1	Go to 4A-2

Guided Step 4A-1 - Check fuel shutoff valve voltage

Conditions • Turn keyswitch ON. **Action** Measure the voltage from the fuel shutoff valve post to engine	

block ground. There are 12 and 24 volt systems, the fuel shutoff valve voltage needs to be within 1-VDC of the vehicle system voltage.	
Is the fuel shutoff valve voltage within 1-VDC of vehicle system voltage?	Is the fuel shutoff valve voltage within 1 VDC of vehicle system voltage?
YES	**NO**
No Repair	**No Repair**
Go to 5A	**Go to 4B**

Guided Step 4A-2 - Coolant temperature sensor signal voltage check

Conditions • Turn keyswitch ON. • Disconnect the coolant temperature sensor connector. **Action** Measure the voltage across the two pins of the coolant temperature sensor on the wiring harness connector. Reference the wiring diagram or circuit diagram for connector pin identification.	
Is the coolant temperature signal voltage greater than 4.5-VDC?	Is the coolant temperature signal voltage greater than 4.5-VDC?
YES	**NO**
No Repair	**No Repair**
Go to 5A	**Go to 4B**

Guided Step 4B - ECM keyswitch voltage check

Conditions • Turn keyswitch OFF. • Disconnect the wiring harness connector that contains the keyswitch signal from the ECM. • Turn the keyswitch ON. **Action** Measure the voltage from the keyswitch input SIGNAL wire of the wiring harness to engine block ground. Reference the wiring diagram or circuit diagram for connector pin identification.	
Is the keyswitch voltage within 1-VDC of vehicle system voltage?	Is the keyswitch voltage within 1-VDC of vehicle system voltage?
YES	**NO**
No Repair	Repair or replace the wiring harness that contains the keyswitch signal, or repair or replace the keyswitch, or check the battery connection. Reference Procedure 019-064 (Key Switch Battery Supply Circuit) in Section 19 in the appropriate troubleshooting and repair manual. See the Engine Performance Troubleshooting Tree in the appropriate troubleshooting and repair manual, if the no start

	condition is still present.
Go to 4C	Repair complete

Guided Step 4C - Check the ECM power and ground

Conditions • Turn keyswitch OFF • Disconnect from the ECM the wiring harness connector that contains the ECM battery SUPPLY (-) and SUPPLY (+) wiring. **Action** Measure the voltage from each ECM battery SUPPLY (+) pin to all battery SUPPLY (-) pins in the wiring harness connector. Reference the wiring diagram or circuit diagram for connector pin identification.	
Is the ECM battery supply voltage equal to the battery voltage?	Is the ECM battery supply voltage equal to the battery voltage?
YES	**NO**
Call for authorization. Replace the ECM. Reference Procedure 019-031 (Electronic Control Module (ECM)) in Section 19 in the appropriate troubleshooting and repair manual.	Repair or replace the wiring harness that contains the ECM battery SUPPLY (+) and battery SUPPLY (-) wiring. See the Engine Performance Troubleshooting Tree if no start condition is still present.
Repair complete	Repair complete

Guided Step 5 - Initial electronic tool check

Guided Step 5A - Bench setup previously used for troubleshooting check

Conditions • None **Action** In Step 3 checks, was bench setup used to successfully communicate with the ECM?	
In Step 3 checks, was bench setup used to successfully communicate with the ECM?	In Step 3 checks, was bench setup used to successfully communicate with the ECM?
YES	**NO**
ECM is OK, repair complete if communication is **not** required through OEM data link connector or harness. If communication is required through the OEM data link connector or harness continue to Step 6A.	**No Repair**
Go to 6A	Go to 5B

Guided Step 5B - Second vehicle availability check for electronic tool

Conditions • Second vehicle available for testing **Action** Verify a second vehicle is available to connect to the electronic tool.	
Is a second vehicle available to connect to the electronic tool?	Is a second vehicle available to connect to the electronic tool?
YES	**NO**
No Repair	**No Repair**
Go to 5C	Go to 6A

Guided Step 5C - Initial electronic tool functionality check

Conditions • Electronic tool connected to a second vehicle. • Keyswitch ON. **Action** Attempt to communicate with the ECM on the second vehicle using the same electronic tool hardware used on the problem vehicle.	
Does the second ECM communicate using electronic tool?	Does the second ECM communicate using electronic tool?
YES	**NO**
No Repair	**No Repair**
Go to 6A	Go to 9A

Guided Step 6 - data link adapter power check

Guided Step 6A - data link adapter determination check

Conditions • None **Action** Determine if an Inline I datalink adapter is being used to communicate with INSITE™ electronic service tool. Reference Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, for General Information - data link adapter, in the appropriate electronic control system troubleshooting and repair manual.	
Is an Inline I data link adapter being used to communicate with INSITE™ electronic service tool?	Is an Inline I data link adapter being used to communicate with INSITE™ electronic service tool?
YES	**NO**

No Repair	No Repair
Go to 6G	Go to 6B

Guided Step 6B - Check data link adapter power

Conditions • Do **not** use an Inline I • Electronic tool hardware connected to the vehicle. • INSITE™ electronic service tool launched • Keyswitch ON. **Action** Note: For all datalink adapters except Inline I. Attempt to communicate with INSITE™ electronic service tool and check to see if the data link adapter power light is on. Reference Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, for General Information - data link Adapter, in the appropriate electronic control system troubleshooting and repair manual.	
Is the data link adapter power light on?	Is the data link adapter power light on?
YES	NO
No Repair	**No Repair**
Go to 7A	Go to 6C

Guided Step 6C - Determination if communication is being attempted at the OEM data link dash connector

Conditions • None **Action** Check to see if communication is being attempted at the OEM datalink dash connector.	
Is communication being attempted at the OEM data link dash connector?	Is communication being attempted at the OEM data link dash connector?
YES	NO
No Repair	**No Repair**
Go to 6D	Go to 6E

Guided Step 6D - OEM data link dash connector voltage check

Conditions • Turn keyswitch ON. **Action** Measure voltage across the SUPPLY and ground pins of the OEM datalink connector.	

Reference Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, for In Cab data link Connector or 6-pin In Cab data link connector, in the appropriate Electronic Control System Troubleshooting and Repair manual for pin locations.	
Is the voltage equal to or greater than 9 VDC?	Is the voltage equal to or greater than 9 VDC?
YES	**NO**
Replace data link adapter	**No Repair**
Repair complete	**Go to 6F**

Guided Step 6E - Check voltage at data link adapter auxiliary power supply

Conditions • Turn keyswitch ON. **Action** Measure the data link adapter supply voltage at the datalink adapter harness connector. Reference Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, for 3-pin data link Cable, in the appropriate Electronic Control System Troubleshooting and Repair manual for pin locations.	
Is the voltage equal to or greater than 9-VDC?	Is the voltage equal to or greater than 9-VDC?
YES	**NO**
Replace data link adapter.	**No Repair**
Repair complete	**Go to 6F**

Guided Step 6F - Check voltage at vehicle battery

Conditions • None **Action** Measure vehicle battery voltage in all cases except if using an Inline I. If using an Inline I measure data link adapter voltage supply from computer.	
Is the voltage equal to or greater than 11-VDC?	Is the voltage equal to or greater than 11-VDC?
YES	**NO**
Repair or replace damaged wiring.	Clean the battery connections or replace the batteries.
Repair complete	**Repair complete**

Guided Step 6G - Computer serial port voltage check

Conditions	

• None **Action** Note: For Inline I only. Measure voltage across the SIGNAL ground pin and the data terminal ready pin and the SIGNAL ground pin and the request to send pin on the computer serial port. Reference Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, for Serial Cable, in the appropriate Electronic and Control System Troubleshooting and Repair manual for pin locations.	
Is a minimum of 5 VDC available?	Is a minimum of 5 VDC available?
YES	**NO**
Replace data link adapter	Contact PC administration support.
Repair complete	**Repair complete**

Guided Step 7 - data link circuit check

Guided Step 7A - Check J1939 or J1587 circuits

Conditions • None **Action** Use the following procedures to perform J1939 or J1587 circuit checks depending on the datalink circuit being used. Reference Procedure 019-165 (Data Link Circuit, SAE J1939) in Section 19 in the appropriate troubleshooting and repair manual. This procedure gives information for a complete resistance check, check for short circuit to ground, and check for short circuit from pin-to-pin. Reference Procedure 019-166 (Data Link Circuit, SAE J1587) in Section 19 in the appropriate troubleshooting and repair manual. This procedure gives information for a complete resistance check, check for short circuit to ground, check for short circuit from pin-to-pin, and voltage check. Reference Procedure 019-428 (Engine data links) in Section 19 in the appropriate troubleshooting and repair manual. Complete resistance check, check for short circuit to ground, and check for short circuit from pin-to-pin.	
Does the circuit check OK?	Does the circuit check OK?
YES	**NO**
No Repair	Repair or replace the harness with the data link problem, either the engine or OEM harness.
Go to 11A	**Repair complete**

Guided Step 8 - Initial electronic tool check

Guided Step 8A - Second vehicle availability check for electronic tool

Conditions • Second vehicle available for testing **Action** Verify if a second vehicle is available to connect to electronic tool?	
Is a second vehicle available to connect to the electronic tool?	Is a second vehicle available to connect to the electronic tool?
YES	**NO**
No Repair	**No Repair**
Go to 8B	**Go to 10A**

Guided Step 8B - Initial electronic tool functionality check

Conditions • Electronic tool connected to second vehicle **Action** Attempt to communicate with the ECM on the second vehicle using the electronic tool.	
Does the second ECM communicate using the electronic tool?	Does the second ECM communicate using the electronic tool?
YES	**NO**
No Repair	**No Repair**
Go to 11A	**Go to 10A**

Guided Step 9 - Detailed electronic tool check

Guided Step 9A - Troubleshoot electronic tool hardware

Conditions • None **Action** Perform troubleshooting procedures for evaluating electronic tool hardware: • data link adapter cable • data link adapter power supply cable • data link adapter

• Serial cable • Computer. Reference Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, in the appropriate troubleshooting and repair manual. Complete the following checks: • Initial Check - INSITE™ electronic service tool • Initial Check - data link Adapters • Resistance Check - Serial Cable • Resistance Check for data link adapter cable and data link adapter power supply cable.	
Does the electronic tool hardware check OK?	Does the electronic tool hardware check OK?
YES	**NO**
Communication issue found.	Repair or replace damaged hardware.
Go to 11A	**Repair complete**

Guided Step 10 - Serial cable and computer check

Guided Step 10A - Troubleshoot serial cable and computer

Conditions • None **Action** Perform troubleshooting procedures for evaluating the serial cable and computer. Reference Procedure 022-999 (Service Tools and Hardware - Overview) in Section F, in the appropriate troubleshooting and repair manual. Complete the following checks: • Initial Check - INSITE™ electronic service tool • Resistance Check - Serial Cable.	
Do the serial cable and computer check OK?	Do the serial cable and computer check OK?
YES	**NO**
Communication issue found	Repair or replace damaged hardware.
Go to 11A	**Repair complete**

Guided Step 11 - ROM boot ECM

Guided Step 11A - ROM boot tool availability check

Conditions	

• None **Action** Verify if ROM boot tool is available for specific ECM.	
Is the ROM boot tool available?	Is the ROM boot tool available?
YES	**NO**
No Repair	Call for pre-authorization Replace the ECM. Reference Procedure 019-031 (Electronic Control Module (ECM)) in Section 19 in the appropriate troubleshooting and repair manual.
Go to 11B	**Repair complete**

Guided Step 11B - ROM boot the ECM

Conditions • None **Action** ROM boot the ECM. Reference Procedure 019-427 (ECM ROM Boot) in Section 19 in the appropriate troubleshooting and repair manual.	
Does the ECM communicate?	Does the ECM communicate?
YES	**NO**
Calibrate the ECM again.	Call for pre-authorization Replace the ECM. Reference Procedure 019-031 (Electronic Control Module (ECM)) in Section 19 in the appropriate troubleshooting and repair manual.
Repair complete	**Repair complete**

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View Related Topic

Engine Performance Troubleshooting Tree - CM554 Electronic Control System with CAPS Fuel System

Symptoms

- Engine Acceleration or Response Poor
- Cranking Fuel Pressure is Low
- Engine Operating Fuel Pressure is Low
- Engine Decelerates Slowly
- Engine Difficult to Start or Will Not Start (Exhaust Smoke)
- Engine Difficult to Start or Will Not Start (No Exhaust Smoke)
- Engine Power Output Low
- Engine Runs Rough at Idle
- Engine Runs Rough or Misfires
- Engine Speed Surges at Low or High Idle
- Engine Speed Surges Under Load or in Operating Range
- Smoke, Black - Excessive
- Smoke, White - Excessive
- Engine Shuts Off or Dies Unexpectedly or Dies During Deceleration
- Engine Starts But Will Not Keep Running
- Engine Will Not Reach Rated Speed (RPM)
- Intake Manifold Pressure (Boost) is Below Normal

How To Use This Tree

This symptom tree can be used to troubleshoot all of the performance-based symptoms listed above. Start by performing Step 1 troubleshooting. Step 2 will ask a series of questions and will provide a list of troubleshooting steps to perform, depending on the symptom. Perform the list of troubleshooting in the sequence shown in the Specifications/Repair section of the tree.

Shop Talk

Driveability is a term that in general describes vehicle performance on the road. Driveability problems for an engine can be caused by several different factors. Some of the factors are engine-related and some are **not**. Before troubleshooting, it is important to determine the exact complaint and whether the engine has a real driveability problem or if it simply does **not** meet driver expectations.

Low power is a term that is used in the field to describe many different performance problems. Low power is defined as the inability of the engine to produce the power necessary to move the vehicle at a speed that can be reasonably expected under the given conditions of load, grade, wind, and so on.

Poor acceleration or response is described as the inability of the vehicle to accelerate satisfactorily from a stop or from the bottom of a grade. It can also be the lag in acceleration during an attempt to pass or overtake another vehicle at conditions less than rated speed and load. Poor acceleration or response is difficult to troubleshoot because it can be caused by several factors.

Guided Step 1 - Perform basic troubleshooting procedures.

Guided Step 1A - Check for active fault codes or high counts of inactive fault codes.

Conditions

- Turn keyswitch ON.
- Connect INSITE™ electronic service tool.

Action

Check for active fault codes.

- Use INSITE™ electronic service tool to read the fault codes.

Active fault codes or high counts of inactive fault codes?	Active fault codes or high counts of inactive fault codes?
YES	NO
No Repair	No Repair
Go to appropriate fault code troubleshooting tree	Go to 1B

Guided Step 1B - Perform basic troubleshooting checks.

Action The following items must be checked or verified before continuing: • Verify the fuel level in the tanks, regardless of what the gauge reads. • Verify there have **not** been any changes to CPL components on the engine. • Verify fuel grade is correct for the application. • Verify the engine is operating within the recommended altitude. • Verify engine oil is at the correct level. • Verify engine parasitics have **not** changed. • Verify engine duty cycle has **not** changed. • Verify engine cranking speed is greater than 150 rpm. • Verify battery voltage is adequate.	
All steps have been verified to be correct?	**All steps have been verified to be correct?**
YES	**NO**
No Repair	Correct the condition and verify complaint is no longer present after repair.
Go to 2A	Repair complete

Guided Step 2 - Determination of engine symptom.

Guided Step 2A - Low power, poor acceleration, or poor response.

Action Interview the driver and verify the complaint.	
Is the engine symptom low power, poor acceleration, or poor response?	**Is the engine symptom low power, poor acceleration, or poor response?**
YES	**NO**
Perform the troubleshooting steps in the recommended order listed below: • Step 4 - Fuel System Checks • Step 5 - Air Handling Checks • Step 6 - Electronics Checks • Step 7 - Base Engine Checks.	**No Repair**
Perform the troubleshooting steps suggested in the repair procedure	Go to 2B

Guided Step 2B - Engine misfire, engine speed surge, or engine speed unstable.

Action Interview the driver and verify the complaint.	
Is the engine symptom engine misfire, engine speed surge, or engine speed unstable?	**Is the engine symptom engine misfire, engine speed surge, or engine speed unstable?**
YES	**NO**
Perform the troubleshooting steps in the recommended order listed below: • Step 4 - Fuel System Checks • Step 5 - Air Handling Checks • Step 6 - Electronics Checks • Step 7 - Base Engine Checks.	**No Repair**
Perform the troubleshooting steps suggested in the repair procedure.	Go to 2C

Guided Step 2C - Excessive white or black smoke.

Action Interview the driver and verify the complaint.	
Is the engine symptom excessive white or black smoke?	**Is the engine symptom excessive white or black smoke?**
YES	**NO**
Perform the troubleshooting steps in the recommended order listed below: • Step 5 - Air Handling Checks • Step 4 - Fuel System Checks • Step 7 - Base Engine Checks.	**No Repair**
Perform the troubleshooting steps suggested in the repair procedure	Go to 2D

Guided Step 2D - Low intake manifold pressure.

Action Interview the driver and verify the complaint.	
Is the engine symptom low boost pressure?	**Is the engine symptom low boost pressure?**
YES	**NO**
Perform the troubleshooting steps in the recommended order listed below: • Step 5 - Air Handling Checks • Step 4 - Fuel System Checks • Step 7 - Base Engine Checks.	**No Repair**

Perform the troubleshooting steps suggested in the repair procedure	**Go to 2E**

Guided Step 2E - Engine will not start or difficult to start, or engine shuts off unexpectedly.

Action Interview the driver and verify the complaint.	
Is the symptom engine will not start or difficult to start, or engine shuts off unexpectedly?	**Is the symptom engine will not start or difficult to start, or engine shuts off unexpectedly?**
YES	**NO**
Perform the troubleshooting steps in the recommended order listed below: • Step 3 - No Start Checks • Step 4 - Fuel System Checks • Step 7 - Base Engine Checks • Step 5 - Air Handling Checks • Step 6 - Electronics Checks.	**No Repair**
Perform the troubleshooting steps suggested in the repair procedure	**Return to correct symptom tree**

Guided Step 3 - No-start troubleshooting procedures.

Guided Step 3A - Check the ECM keyswitch voltage.

Conditions • Disconnect the OEM harness from the ECM. • Turn keyswitch ON.	
Action Measure the signal voltage from the keyswitch input SIGNAL wire of the OEM harness to the engine block ground. Measure the keyswitch voltage with the keyswitch in the ON position and also with the keyswitch in the START position. Refer to the wiring diagram for connector pin identification.	
Is the keyswitch voltage equal to battery voltage?	**Is the keyswitch voltage equal to battery voltage?**
YES	**NO**
No Repair	Repair or replace the OEM power harness or keyswitch, or check the battery connections.
Go to 3B	**Repair complete**

Guided Step 3B - Check the ECM battery supply voltage.

Conditions • Turn keyswitch OFF. • Disconnect the ECM power harness from the ECM. **Action** Measure the voltage from the ECM battery supply (+) to the ECM battery supply (-) pins in the OEM harness connector. Refer to the wiring diagram for connector pin identification.	
Is the ECM battery supply voltage equal to the battery voltage?	**Is the ECM battery supply voltage equal to the battery voltage?**
YES	**NO**
No Repair	Repair or replace the ECM power harness. Check the battery connections and fuse terminals.
Go to 3C	**Repair complete**

Guided Step 3C - Verify the operation of cold weather starting aids.

Action Make sure the intake air heater and other cold starting aids are operational, if equipped. Refer to Procedure 008-011 (Coolant Heater) in Section 8, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418. Refer to Procedure 010-029 (Cold Starting Aid) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
If equipped, are cold weather starting aids operating correctly?	**If equipped, are cold weather starting aids operating correctly?**
YES	**NO**
No Repair	Repair cold weather starting aids. Refer to Procedure 010-029 (Cold Starting Aid) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Go to 3D	**Repair complete**

Guided Step 3D - Check the fuel lift pump pressure.

Conditions • Refer to Procedure 005-045 (Fuel Lift Pump) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418. **Action** Measure the fuel lift pump output pressure. Refer to Procedure 005-045 (Fuel Lift Pump) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	

At initial key-on, the lift pump will run for 30 seconds, then it will stop. Lift pump pressure can be low if fuel prime was lost. Multiple keyswitch cycles can be necessary to prime the fuel system using the electric lift pump.	
Is the fuel lift pump pressure greater than the specifications outlined in Procedure 005-045 (Fuel Lift Pump) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418?	**Is the fuel lift pump pressure greater than the specifications outlined in Procedure 005-045 (Fuel Lift Pump) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418?**
YES	**NO**
No Repair	Find and repair the cause of low lift pump pressure. Refer to Procedure 005-045 (Fuel Lift Pump) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Go to 3E	**Repair complete**

Guided Step 3E - Verify fuel pressure sensor accuracy.

Conditions • Turn keyswitch ON. • Connect INSITE™ electronic service tool. **Action** Use INSITE™ electronic service tool to monitor accumulator pressure. The engine speed **must** be zero for at least 1 minute before performing this test.	
Is the accumulator pressure value less than 34.5 bar [500 psi]?	**Is the accumulator pressure value less than 34.5 bar [500 psi]?**
YES	**NO**
No Repair	Replace the fuel pressure sensor. Refer to Service Bulletin, CAPS Fuel Pressure Sensor Kit, 4021293 or 4021294.
Go to 3F	**Repair complete**

Guided Step 3F - Check the accumulator pressure.

Conditions • Turn keyswitch ON. • Connect INSITE™ electronic service tool. **Action** Use INSITE™ electronic service tool to read accumulator pressure while cranking the engine.	
Is accumulator pressure greater than 293 bar [4250 psi] while cranking?	**Is accumulator pressure greater than 293 bar [4250 psi] while cranking?**
YES	**NO**

No Repair	No Repair
Go to 3L	Go to 3G

Guided Step 3G - Use INSITE™ electronic service tool to check the CPS crank state.

Conditions • Connect INSITE™ electronic service tool. • Turn keyswitch ON. **Action** Use INSITE™ electronic service tool to monitor CPS state while cranking the engine.	
Does CPS state read Valid Sync while cranking?	**Does CPS state read Valid Sync while cranking?**
YES	**NO**
No Repair	Troubleshoot the engine speed sensor circuit. See Fault Codes 115 and 121.
Go to 3H	Go to 3G-1

Guided Step 3G-1 - Check and adjust the speed/position sensor air gap.

Conditions • Install the sensors. **Action** Check and adjust the speed/position sensor air gap. • Check the air gap between the ESS/EPS and the camshaft ring gear. Since the EPS and ESS are mounted on the same boss, the air gap can be measured using the outside sensor bore. This measurement can usually be taken without removing the air compressor. • Bar the engine over 2 full revolutions (**clockwise** facing the front of the engine). • Use a depth micrometer and measure the distance from the face of the gear housing boss to the face of the camshaft ring gear. Record this measurement “A”. • Measure the gap in 45 degree camshaft rotation increments. If the measurements “A” varies by more than 0.051 mm [0.002 in] the tone wheel is warped, or the camshaft gear is walking. • Next measure the sensor. Use a depth micrometer to measure the distance from the bottom of the sensor mounting flange to the tip of the threaded end of the sensor. Record this as measurement “B”. The air gap can be calculated by subtracting B from A (air gap measurement equals A minus B). If the air gap is less than 0.406 mm [0.016 in] add a 0.508 mm [0.020 in] shim to sensor. • Minimum Air Gap: 0.406 mm [0.016 in] • Maximum Air Gap: 1.020 mm [0.040 in]	
Are the sensor(s) depth measurements within specification?	**Are the sensor(s) depth measurements within specification?**

YES	NO
No Repair.	Replace the engine speed/position sensor(s). Refer to Procedure 019-042 (Engine Speed Sensor (ESS)) in Section 19, ISC, QSC8.3, and ISL Electronic Control System, Troubleshooting and Repair Manual, Bulletin 3666271.
Go to 3H	**Repair Complete**

Guided Step 3H - Measure gear pump pressure.

Conditions • Connect a fuel pressure gauge to the Compuchek™ fitting on the cam housing. **Action** Measure the gear pump pressure while cranking the engine. Refer to Procedure 005-089 (Fuel Pump Gear Pump Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Is the fuel gear pump pressure greater than the specifications outlined in Procedure 005-089 (Fuel Pump Gear Pump Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418?	**Is the fuel gear pump pressure greater than the specifications outlined in Procedure 005-089 (Fuel Pump Gear Pump Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418?**
YES	**NO**
No Repair	**No Repair**
Go to 3I	**Go to 3K**

Guided Step 3I - Perform the injection control valve (ICV) click test.

Conditions • Connect INSITE™ electronic service tool. • Turn keyswitch ON. **Action** Use INSITE™ electronic service tool to perform the ICV click test. Refer to Procedure 005-078 (Injection Control Valve) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Does the injection control valve pass the click test?	**Does the injection control valve pass the click test?**
YES	**NO**
No Repair	Replace the injection control valve stator. Refer to Procedure 019-430 (Injection Control Valve Stator) in Section 19, in the Electronic Control System ISC, QSC8.3, and ISL Troubleshooting and Repair Manual, Bulletin 3666271.
Go to 3J	**Repair complete**

Guided Step 3J - Perform the pumping control valve (PCV) click test.

Conditions • Connect INSITE™ electronic service tool. • Turn keyswitch ON. **Action** Use INSITE™ electronic service tool to perform the front and rear PCV test. Refer to Procedure 005-079 (Pumping Control Valve) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Do the pumping control valves pass the click test?	**Do the pumping control valves pass the click test?**
YES	**NO**
Replace the injection control valve module. Refer to Procedure 005-086 (Fuel Pump Distributor and Injection Control Valve Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	Replace the accumulator module. Refer to Procedure 005-085 (Fuel Pump Accumulator Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Repair complete	**Repair complete**

Guided Step 3K - Check the distributor rotor timing.

Conditions • Turn keyswitch OFF. **Action** Inspect the distributor rotor timing and check for a seized rotor. Refer to Procedure 005-072 (Rotor, CAPS Fuel Injection Pump (Rotor, CAPS Fuel Injection Pump) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Distributor rotor timing is correct as outlined in Procedure 005-072 (Rotor, CAPS Fuel Injection Pump Rotor, CAPS Fuel Injection Pump) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418?	**Distributor rotor timing is correct as outlined in Procedure 005-072 (Rotor, CAPS Fuel Injection Pump-Rotor, CAPS Fuel Injection Pump) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418?**
YES	**NO**
No Repair	Replace the fuel injection pump. Refer to 005-229 (Fuel Injection Pump) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Go to 3L	**Repair complete**

Guided Step 3L - Inspect the gear pump coupling for wear.

Conditions • Turn keyswitch OFF. • Remove the gear pump module.	

Action Inspect the gear pump drive shaft coupling and shaft for wear. Refer to Procedure 005-089 (Fuel Pump Gear Pump Module) in Section 5 in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Is the gear pump drive shaft or coupling worn?	**Is the gear pump drive shaft or coupling worn?**
YES	**NO**
Replace the gear pump module. Refer to Procedure 005-089 (Fuel Pump Gear Pump Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	Replace the injection control valve. Refer to Procedure 005-086 (Fuel Pump Distributor and Injection Control Valve Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Repair complete	**Repair complete**

Guided Step 4 - Fuel system troubleshooting procedures.

Guided Step 4A - Check for fault codes.

Conditions • Turn keyswitch ON. • Connect INSITE™ electronic service tool. **Action** Use INSITE™ electronic service tool to read the fault code information. Check for active fuel system fault codes related to the complaint.	
Are fuel system fault codes active?	**Are fuel system fault codes active?**
YES	**NO**
Follow the appropriate troubleshooting tree.	**No Repair**
Repair complete	**Go to 4B**

Guided Step 4B - Check the CAPS fuel pump wiring.

Action Check the injection control valve, pressure control valve, fuel pressure sensor, and fuel temperature sensor wiring for damage, cuts, and loose connections.	
All fuel pump wiring is undamaged and is properly connected?	**All fuel pump wiring is undamaged and is properly connected?**
YES	**NO**
No Repair	Replace the malfunctioning fuel system component.
Go to 4C	**Repair complete**

Guided Step 4C - Check the transorb diode.

Conditions • Unplug the fuel pressure sensor. **Action** Unplug the fuel pressure sensor.	
Does the rough running, black smoke, or surge complaint continue?	**Does the rough running, black smoke, or surge complaint continue?**
YES	**NO**
No Repair	Replace the transorb diode. Refer to Procedure 019-184 (Transient Suppressor) in Section 19, in the Electronic Control System ISC, QSC8.3, and ISL Troubleshooting and Repair Manual, Bulletin 3666271.
Go to 4D	**Repair complete**

Guided Step 4D - Check for air in the high-pressure pump fuel supply.

Conditions • Refer to Procedure 006-003 (Air in Fuel) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418. **Action** Check for air in the fuel. Refer to Procedure 006-003 (Air in Fuel) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Is air present in the fuel supply?	**Is air present in the fuel supply?**
YES	**NO**
Locate and correct the cause of air ingestion in the fuel supply system. Sources of air ingestion include loose fuel filters, loose fuel line fittings, loose or cracked fuel tank stand-pipes, and severe restrictions in the fuel supply lines and filters.	**No Repair**
Repair complete	**Go to 4E**

Guided Step 4E - Measure the fuel inlet restriction.

Conditions • Perform this check during the complaint. **Action** Measure the fuel inlet restriction.	

Refer to Procedure 006-020 (Fuel Inlet Restriction) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Is the fuel inlet restriction less than the specifications outlined in Procedure 006-020 (Fuel Inlet Restriction) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418?	**Is the fuel inlet restriction less than the specifications outlined in Procedure 006-020 (Fuel Inlet Restriction) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418?**
YES	**NO**
No Repair	Locate the cause of the high inlet restriction. Check the OEM fuel inlet plumbing, fuel filters, and lift pump check valve.
Go to 4F	**Repair complete**

Guided Step 4F - Measure the fuel gear pump pressure.

Conditions • Connect a fuel pressure gauge to the Compuchek™ fitting on the cam housing.	
Action Measure the gear pump pressure while the engine is at the rated condition. Refer to Procedure 005-089 (Fuel Pump Gear Pump Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Is the fuel gear pump pressure greater than the specifications outlined in Procedure 005-089 (Fuel Pump Gear Pump Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418?	**Is the fuel gear pump pressure greater than the specifications outlined in Procedure 005-089 (Fuel Pump Gear Pump Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418?**
YES	**NO**
No Repair	Replace the fuel gear pump module. Refer to Procedure 005-089 (Fuel Pump Gear Pump Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Go to 4G	**Repair complete**

Guided Step 4G - Perform the injection control valve (ICV) click test.

Conditions • Connect INSITE™ electronic service tool. • Turn keyswitch ON.	
Action Use INSITE™ electronic service tool to perform the ICV click test. Refer to Procedure 005-078 (Injection Control Valve) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	

Does the injection control valve pass the click test?	Does the injection control valve pass the click test?
YES	**NO**
No Repair	Replace the injection control valve stator. Refer to Procedure 019-430 (Injection Control Valve Stator) in Section 19, in the Electronic Control System ISC, QSC8.3, and ISL Troubleshooting and Repair Manual, Bulletin 3666271.
Go to 4H	**Repair complete**

Guided Step 4H - Perform the pumping control valve (PCV) click test.

Conditions • Connect INSITE™ electronic service tool. • Turn keyswitch ON. **Action** Use INSITE™ electronic service tool to perform the front and rear PCV click test. Refer to Procedure 005-079 (Pumping Control Valve) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Do the pumping control valves pass the click test?	**Do the pumping control valves pass the click test?**
YES	**NO**
No Repair	Replace the accumulator module. Refer to Procedure 005-085 (Fuel Pump Accumulator Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Go to 4I	**Repair complete**

Guided Step 4I - Measure fuel drain line restriction.

Conditions • Refer to Procedure 006-012 (Fuel Drain Line Restriction) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418. • Perform this check during the complaint. **Action** Check the fuel drain line restriction. Refer to Procedure 006-012 (Fuel Drain Line Restriction) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Is the drain line restriction less than specification?	**Is the drain line restriction less than specification?**
YES	**NO**
No Repair	Look for causes of high drain line restriction, such as kinked or blocked fuel lines.
Go to 4J	**Repair complete**

Guided Step 4J - Perform the single cylinder cutout test.

Conditions • Turn keyswitch ON. • Engine running at low idle. • Connect INSITE™ electronic service tool. **Action** Operate the engine at loaded conditions. • Use INSITE™ electronic service tool to perform the single cylinder cutout test to disable individual injectors.	
Can the miss or excessive smoke be attributed to a single cylinder?	**Can the miss or excessive smoke be attributed to a single cylinder?**
YES	**NO**
Replace the fuel injector in the cylinder that was identified using the single cylinder cutout test. Refer to Procedure 006-026 (Injector) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	**No Repair**
Repair complete	**Go to 4K**

Guided Step 4K - Verify the fuel temperature sensor is within specification.

Conditions • Turn keyswitch to the OFF position. • Disconnect the engine harness from the fuel temperature sensor. • Install the fuel pressure/temperature sensor breakout cable, Part Number 3162982. **Action** Check the resistance of the fuel temperature sensor. • Measure the resistance from pin B to pin D of the fuel temperature sensor. Refer to Procedure 019-119 (Engine Fuel Temperature Sensor) in Section 19, in the Electronic Control System ISC, QSC8.3, and ISL Troubleshooting and Repair Manual, Bulletin 3666271.	
Is the fuel temperature sensor within specification?	**Is the fuel temperature sensor within specification?**
YES	**NO**
No Repair	Replace the fuel temperature sensor. Refer to Procedure 019-119 (Engine Fuel Temperature Sensor) in Section 19, in the Electronic Control System ISC, QSC8.3, and ISL Troubleshooting and Repair Manual, Bulletin 3666271.
Go to 4L	**Repair complete.**

Guided Step 4L - Check for excessive injector drain leakage.

Conditions • Remove the fuel injector drain banjo fitting from the back of the cylinder head. **Action** Run the engine at low idle while monitoring the amount of fuel draining from the back of the cylinder head.	
Are only a few drops of fuel per minute draining from the back of the cylinder head?	**Are only a few drops of fuel per minute draining from the back of the cylinder head?**
YES	**NO**
No Repair	A damaged connection between the high-pressure connector and an injector has been detected. Remove all high-pressure connectors and check for burrs or deformation around the tip of the injector. Refer to Procedure 006-052 (Fuel Connector (Head Mounted)) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Go to 4M	**Repair complete**

Guided Step 4M - Pop test the injectors.

Conditions • Remove the injectors. Refer to Procedure 006-026 (Injector) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418. **Action** Pop test the injectors and check for proper spray pattern. Refer to Procedure 006-026 (Injector) in Section 6, the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
The injector spray pattern is correct and the injectors pop between 275 and 300 bar [3989 and 4351 psi]?	**The injector spray pattern is correct and the injectors pop between 275 and 300 bar [3989 and 4351 psi]?**
YES	**NO**
No Repair	Replace the malfunctioning injector. Refer to Procedure 006-026 (Injector) in Section 6, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Go to 4N	**Repair complete**

Guided Step 4N - Inspect the gear pump coupling for wear.

Conditions • Turn keyswitch OFF.	

• Remove the gear pump module. **Action** Inspect the gear pump drive shaft coupling and shaft for wear.	
Is the gear pump drive shaft or coupling worn?	**Is the gear pump drive shaft or coupling worn?**
YES	**NO**
Replace the gear pump module. Refer to Procedure 005-089 (Fuel Pump Gear Pump Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	Replace the injection control valve. Refer to Procedure 005-086 (Fuel Pump Distributor and Injection Control Valve Module) in Section 5, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Repair complete	**Repair complete**

Guided Step 5 - Air handling troubleshooting procedures.

Guided Step 5A - Inspect the turbocharger blades for damage.

Conditions • Turn keyswitch OFF. • Remove the intake and exhaust pipes from the turbocharger. **Action** Inspect the compressor and turbine blades for damage or wear. Refer to Procedure 010-033 (Turbocharger) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Damage found on turbocharger blades?	**Damage found on turbocharger blades?**
YES	**NO**
Replace the turbocharger assembly. Refer to Procedure 010-033 (Turbocharger) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	**No Repair**
Repair complete	**Go to 5B**

Guided Step 5B - Check the turbocharger axial and radial clearance.

Conditions • Turn keyswitch OFF. **Action** Check the turbocharger for correct axial and radial clearance. Refer to Procedure 010-033 (Turbocharger) in Section 10,	

in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Are the turbocharger axial and radial bearing clearances within specification?	**Are the turbocharger axial and radial bearing clearance within specification?**
YES	**NO**
No Repair	Replace the turbocharger. Refer to Procedure 010-033 (Turbocharger) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Go to 5C	**Repair complete**

Guided Step 5C - Inspect the wastegate actuator rod for travel.

Conditions • Turn keyswitch OFF. • Remove the integral boost line from the wastegate actuator. **Action** Apply a regulated air supply of 138 kPa [20 psi] to the actuator and check for actuator movement.	
Does the wastegate actuator rod move?	**Does the wastegate actuator rod move?**
YES	**NO**
No Repair	**No Repair**
Repair complete	**Go to 5C-1**

Guided Step 5C-1 - Inspect the wastegate actuator rod for travel.

Conditions • Turn keyswitch OFF. • Remove the e-clip from the wastegate pin and disconnect the actuator rod. **Action** Apply a regulated air supply of 138 kPa [20 psi] to the actuator and check for actuator movement.	
Does the wastegate actuator rod move?	**Does the wastegate actuator rod move?**
YES	**NO**
Move the wastegate lever on the turbocharger back and forth to check for smooth operation. Replace the turbocharger assembly if the wastegate is seized. Refer to Procedure 010-033 (Turbocharger) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	Replace the wastegate actuator. Refer to Procedure 010-050 (Turbocharger Wastegate Actuator) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Repair complete	**Repair complete**

Guided Step 6 - Electronic feature troubleshooting procedures.

Guided Step 6A - Verify throttle pedal travel.

Conditions • Turn keyswitch ON. • Connect INSITE™ electronic service tool. **Action** Use INSITE™ electronic service tool to monitor the throttle position while fully depressing and releasing the throttle pedal.	
Does the throttle position read zero when the throttle is released and 100 percent when the throttle is depressed?	**Does the throttle position read zero when the throttle is released and 100 percent when the throttle is depressed?**
YES	**NO**
No Repair	Determine and correct the cause of the throttle pedal restriction.
Go to 6B	**Repair complete**

Guided Step 6B - Check ambient air pressure sensor accuracy (if equipped).

Conditions • Turn keyswitch ON. • Connect INSITE™ electronic service tool. **Action** Start INSITE™ Data Monitor/Logger and compare INSITE™ reading for Barometric Air Pressure to the local barometric pressure using the table below. Refer to Procedure 018-028 (Barometric Pressure at Altitude) in Section V.	
Is the reading within 50.8 mm-Hg [2 in-Hg] of local barometric pressure?	**Is the reading within 50.8 mm-Hg [2 in-Hg] of local barometric pressure?**
YES	**NO**
No Repair	Replace the barometric pressure sensor. Refer to Procedure 019-004 (Barometric Air Pressure Sensor) in Section 19. in the Electronic Control System ISC, QSC8.3, and ISL Troubleshooting and Repair Manual, Bulletin 3666271.
Go to 6C	**Repair Complete**

Guided Step 6C - Check intake manifold pressure sensor accuracy.

Conditions • Turn keyswitch ON.	

• Connect INSITE™ electronic service tool. **Action** Start INSITE™ electronic service tool Data/Monitor/Logger and read the value of intake manifold pressure.	
Is the intake manifold pressure reading less than 102 mm-Hg [4 in-Hg]?	**Is the intake manifold pressure reading less than 102 mm-Hg [4 in-Hg]?**
YES	**NO**
No Repair	Replace the intake manifold pressure sensor. Refer to Procedure 019-061 (Intake Manifold Pressure Sensor) in Section 19, in the Electronic Control System ISC, QSC8.3, and ISL Troubleshooting and Repair Manual, Bulletin 3666271.
Go to 6D	**Repair complete**

Guided Step 6D - Verify electronic feature settings are correct.

Conditions • Turn keyswitch ON. • Connect INSITE™ electronic service tool. **Action** Use INSITE™ electronic service tool to verify the following adjustable parameters are set correctly: • Maximum Vehicle Speed • Powertrain Protection • Rear Axle Ratio • Tailshaft Teeth • Tire Revolutions per Mile • Gear-Down Protection • Cruise Control Droop Settings • Cruise Control Maximum Vehicle Speed.	
Are the electronic features set correctly?	**Are the electronic features set correctly?**
YES	**NO**
No Repair	Use INSITE™ electronic service tool to correct programmable features.
Go to 2A	**Repair complete**

Guided Step 7 - Base engine troubleshooting procedures.

Guided Step 7A - Verify overhead adjustments are correct.

Conditions • Turn keyswitch OFF. • Remove the rocker lever cover. Refer to Procedure 003-011 (Rocker Lever Cover) in Section 3, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	

Action Measure the overhead settings. Refer to Procedure 003-004 (Overhead Set) in Section 3, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Are the overhead settings within the reset limits?	**Are the overhead settings within the reset limits?**
YES	**NO**
No Repair	Adjust the overhead settings. Refer to Procedure 003-004 (Overhead Set) in Section 3, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Go to 7B	**Repair complete**

Guided Step 7B - Verify engine brake adjustment (if equipped).

Conditions • Turn keyswitch OFF. • Remove the rocker lever cover. Refer to Procedure 003-011 (Rocker Lever Cover) in Section 3, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Action Verify the engine brakes are operating correctly. • Measure the engine brake settings. Refer to Procedure 020-004 (Engine Brake Assembly) in Section 20, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Are the engine brake settings within the reset limits?	**Are the engine brake settings within the reset limits?**
YES	**NO**
No Repair	Adjust the engine brake settings. Refer to Procedure 020-004 (Engine Brake Assembly) in Section 20, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.
Go to 7C	**Repair complete**

Guided Step 7C - Inspect the charge air cooler.

Conditions • Refer to Procedure 010-027 (Charge-Air Cooler) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Action Inspect the charge air cooler for cracks, holes, or other damage. Refer to Procedure 010-027 (Charge-Air Cooler) in Section	

10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Is the charge air cooler free of cracks, holes, or other damage?	**Is the charge air cooler free of cracks, holes, or other damage?**
YES	**NO**
No Repair	Repair the charge air cooler assembly.
Go to 7D	**Repair complete**

Guided Step 7D - Check air intake restriction.

Conditions • Refer to Procedure 010-031 (Air Intake Restriction) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418. **Action** Check the intake system restriction by installing a vacuum gauge into the air intake system. Refer to Procedure 010-031 (Air Intake Restriction) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Is air intake restriction greater than 635 mm-H $_2$O [25 in-H $_2$O]?	**Is air intake restriction greater than 635 mm-H $_2$O [25 in-H $_2$O]?**
YES	**NO**
Correct the cause of high intake air restriction. Check for a plugged air filter or restricted air intake piping.	**No Repair**
Repair complete	**Go to 7E**

Guided Step 7E - Check exhaust restriction.

Conditions • Refer to Procedure 011-009 (Exhaust Restriction) in Section 11, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418. **Action** Check the exhaust system back pressure by installing a pressure gauge into the exhaust system just past the turbocharger outlet. Refer to Procedure 011-009 (Exhaust Restriction) in Section 11, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Is exhaust back pressure less than 72 mm-Hg [3 in-Hg]?	**Is exhaust back pressure less than 72 mm-Hg [3 in-Hg]?**
YES	**NO**
No Repair	Inspect the exhaust system for the source of high restriction.
Go to 7F	**Repair complete**

Guided Step 7F - Check engine blowby.

Conditions • Refer to Procedure 014-005 (Engine Testing (Engine Dynamometer)) in Section 14, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418. **Action** Measure the engine blowby. Refer to Procedure 014-005 (Engine Testing (Engine Dynamometer)) in Section 14, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Are the engine blowby measurements within specification?	**Are the engine blowby measurements within specification?**
YES	**NO**
No Repair	**No Repair**
Return to Step 2 or contact a Cummins Inc. service representative for further diagnostic and troubleshooting instructions.	**Go to Step 7F-1.**

Guided Step 7F-1 - Verify turbocharger contribution to engine blowby.

Conditions • Turn keyswitch OFF. • Connect the appropriate orifice to the end of the blowby draft tube. • Remove the turbocharger oil drain line from the block and drain into a bucket. • Start the engine. **Action** Load engine to rated rpm on a chassis dynamometer. • Measure the engine blowby as outlined in Procedure 014-005 (Engine Testing (Engine Dynamometer)) in Section 14, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	
Has the total engine blowby dropped more than 30 percent of the total?	**Has the total engine blowby dropped more than 30 percent of the total?**
YES	**NO**
Replace the turbocharger assembly. Refer to Procedure 010-033 (Turbocharger) in Section 10, in the ISC, ISCe, QSC8.3, ISL and QSL9 Troubleshooting and Repair Manual, Bulletin 4021418.	The engine may need to be rebuilt. See the engine rebuild specifications.
Repair complete.	**Repair complete.**

Last Modified: 24-Sep-2008

Fuel Economy Troubleshooting Tree

Symptoms

- Fuel Consumption Excessive

How To Use This Tree

This symptom tree is to be used to troubleshoot fuel economy complaints. This tree is used along with the Fuel Consumption - Customer Complaint Form and the Driveability Low Power/Excessive Fuel - Consumption Checklist to help isolate engine, chassis, or driver issues associated with excessive fuel consumption.

Shop Talk

The Fuel Consumption - General Information section of this manual and Troubleshooting Excessive Fuel Consumption, Bulletin 3666094, should be referenced prior to any troubleshooting being performed on a customer's engine.

The cause of excessive fuel consumption is difficult to diagnose and correct because of the potential number of factors involved. Actual fuel consumption problems can be caused by any of the following factors:

- Engine factors
- Vehicle factors and specifications
- Environmental factors
- Driver technique and operating practices
- Fuel system factors
- Low power or driveability problems.

Before troubleshooting, it is important to determine the exact complaint. Is the complaint based on whether the problem is real or perceived, or does **not** meet driver expectations? The Fuel Consumption - Customer Complaint Form is a valuable list of questions that can be used to assist the service technician in determining the cause of the problem. Complete the form before troubleshooting the complaint. The following are some of the factors that **must** be considered when troubleshooting fuel consumption complaints.

- Excessive idling time: Idling the engine can use from 0.5 to 1.5 gallons per hour depending on the engine idle speed.
- Vehicle Aerodynamics: The largest single power requirement for a truck is the power needed to overcome air resistance. As a general rule, each 10 percent reduction in air resistance results in a 5 percent increase in mile per gallon.
- Rolling Resistance: Rolling resistance is the second largest consumer of power on a truck. The type of tire and tread design have a sizeable effect on fuel economy and performance. Changing from a bias ply to a low profile radial tire can reduce rolling resistance by about 36 percent.
- Environmental and Seasonal Weather Changes: There can be as much as 1 to 1.5 mile per gallon difference in fuel consumption, depending on the season and the weather conditions.
- Truck Route and Terrain: East and west routes experience almost continual crosswinds and head winds. Less fuel can be used on north and south routes where parts of the trip are **not** only warmer, but have less wind resistance.
- Driver Technique and Operating Practices: A 1 mile per hour increase in road speed equals a 0.1 mile per gallon increase in fuel consumption. This means that increasing road speed from 50 to 60 mph will result in a loss of fuel mileage of 1 mpg.
- Result of a Low Power or Driveability Problem: An operator will change driving style to compensate for a low power or driveability problem. Some things the driver is likely to do are (a) shift to a high engine rpm or (b) run on the droop curve in a lower gear instead of upshifting to drive at part-throttle conditions. These changes in driving style will increase the amount of fuel used.

Additional vehicle factors, vehicle specifications and axle alignment, can also affect fuel consumption. For additional information on troubleshooting fuel consumption complaints, refer to Troubleshooting Excessive Fuel Consumption, Bulletin 3387245.

Guided Step 1 - Verify the complaint.

Guided Step 1A - Fill the Fuel Consumption - Customer Complaint Form.

Action Fill out the Fuel Consumption - Customer Complaint Form.	
Is the problem caused by vehicle factors, environmental factors, or driver technique?	**Is the problem caused by vehicle factors, environmental factors, or driver technique?**

YES	NO
No Repair	**No Repair**
Repair complete	**Go to 1B**

Guided Step 1B - Run VE/VMS.

Action Fill out the Driveability/Low Power/Excessive Fuel Consumption - Checklist. • Use the data gathered to run VE/VMS or provide the data to the appropriate support personnel to run VE/VMS. Note: VE/VMS does **not** account for adverse ambient conditions.	
Taking into consideration the adverse effect of ambient conditions, does the VE/VMS fuel economy conflict with the customer's current fuel economy?	**Taking into consideration the adverse effect of ambient conditions, does the VE/VMS fuel economy conflict with the customer's current fuel economy?**
YES	**NO**
No Repair	Explain to the customer the effects of driving habits on fuel consumption.
Go to 2A	**Repair complete**

Guided Step 2 - Electronic checks using INSITE™ electronic service tool.

Guided Step 2A - Check for fault codes.

Conditions • Turn keyswitch ON. • Connect INSITE™ electronic service tool. **Action** Use INSITE™ electronic service tool to read the fault codes.	
Are there any active or high counts of inactive fault codes?	**Are there any active or high counts of inactive fault codes?**
YES	**NO**
No Repair	**No Repair**
Troubleshoot fault codes	**Go to 2B**

Guided Step 2B - Confirm Features and Parameters.

Conditions • Turn keyswitch ON.	

• Connect INSITE™ electronic service tool. **Action** Confirm the Programmable Features and Parameters are set correctly.	
Are the Features and Parameters set correctly?	**Are the Features and Parameters set correctly?**
YES	**NO**
No Repair	Reset the Features and Parameters to their appropriate values.
Go to 2C	**Repair complete**

Guided Step 2C - Check the ECM calibration.

Conditions • Turn keyswitch ON. • Connect INSITE™ electronic service tool. **Action** Compare the ECM code with the engine rating and CPL. • Verify the calibration is correct.	
Is the calibration correct?	**Is the calibration correct?**
YES	**NO**
No Repair	Calibrate the ECM with the correct ECM code.
Go to 2D	**Repair complete**

Guided Step 2D - Monitor vehicle speed.

Conditions • Turn keyswitch ON. • Connect INSITE™ electronic service tool. **Action** Use INSITE™ electronic service tool to monitor vehicle speed while the vehicle is not moving.	
Does vehicle speed read 0 when the vehicle is not moving?	**Does vehicle speed read 0 when the vehicle is not moving?**
YES	**NO**
No Repair	**No Repair**
Go to 3A	Go to 2D-1

Guided Step 2D-1 - Inspect the engine and chassis grounds.

Conditions • Turn keyswitch OFF. **Action** Check for loose or corroded engine, chassis, or battery ground connection. • Check the engine ground connection • Check the chassis ground connections • Check the battery terminal connections.	
Are all grounds present, properly grounded, free of corrosion, and tight?	**Are all grounds present, properly grounded, free of corrosion, and tight?**
YES	**NO**
Check the VSS and the VSS circuit. Refer to Procedure 019-091 in the Troubleshooting and Repair Manual, Electronic Control System, ISC, QSC8.3, and ISL Engines , Bulletin 3666271 or the Troubleshooting and Repair Manual, CM850 Electronic Control System, ISB, ISBe4, QSB4.5, QSB5.9, QSB6.7, ISC, QSC8.3, ISL, ISLe3 and QSL9 Engines Bulletin 4021416 or the Troubleshooting and Repair Manual, CM2150 Electronic Control System, ISB, ISC, ISL, ISLe, ISDe, and QSB3.3 Engines Bulletin 4021570.	Replace, clean, or tighten the grounds.
Repair complete	**Repair complete**

Guided Step 3 - Engine performance.

Guided Step 3A - Engine performance troubleshooting.

Action Perform the Fuel System Checks, Air Handling Checks, and Base Engine Checks in the Engine Performance Troubleshooting Tree.	
Poor fuel economy complaint still exists?	**Poor fuel economy complaint still exists?**
YES	**NO**
Perform the Fuel System Checks, Air Handling Checks, and Base Engine Checks in the Engine Performance Troubleshooting Tree.	**No Repair**
Repair complete	**Repair complete**

Last Modified: 02-Nov-2006

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Multimeter Usage
(019-359)

General Information

On most meters, the negative (-), (black) meter probe **must** be plugged into the COM position and the positive (+), (red) meter probe **must** be plugged into one of the positions marked for amperage, resistance, or voltage. Refer to the manufacturer's procedures for more detail. **NOTE: When measuring to a block ground, use a clean, unpainted metal surface to make sure a good measurement exists.**		
CAUTION To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit for this control system. Refer to the appropriate wiring repair kit for specific test leads used on this application.		
Make an open circuit at the place where the current is to be measured. Select the AC current (A ~) or DC current (A-) function on the meter. Turn on the power in the circuit being measured. Put the probes of the meter across the open circuit to measure the amperage. Read the displayed measurement.		
Select the AC voltage (V ~) or DC voltage (V-) function on the meter. Turn on the power in the circuit being measured. Touch the positive (+) probe of the multimeter to the terminal or pin that is being measured for voltage. Touch the other probe to a clean, unpainted metal surface that is connected to battery ground or to the negative (-) post of the battery. Read the displayed measurement.		
Select the resistance function on the meter. Verify that there is no power to the components being tested. Disconnect both ends of the circuit or component to be measured. Touch one probe to one end of the circuit or component terminal. Touch the other probe to the other end of the circuit or the other component terminal. Read the displayed measurement.		

It is important to know the internal resistance of the meter when measuring small resistances. To measure small resistances accurately, the internal resistance of the meter **must** be subtracted from the measured resistance.

Turn the meter ON.

Set the meter to the lowest ohm scale.

Measure the resistance of the meter by touching the test probes together and reading the resistance value (including special test leads, if they are being used).

ZERO the meter or subtract this value when taking measurements.

Select the continuity function on the meter (usually marked with a diode symbol).

Make sure there is no power to the component being measured.

Disconnect both ends of the circuit or component to be measured. Touch one probe to one end of the circuit or component terminal. Touch the other probe to the other end of the circuit or the other component terminal.

Read the displayed measurement.

The meter will beep if the resistance is less than about 150 ohms. If there is an open circuit, the meter does **not** beep.

Short circuit to ground is a condition where a connection from a circuit to ground exists when it is **not** intended.

The procedure for checking for a short circuit to ground is as follows:

- Turn keyswitch OFF.
- Disconnect the connectors that are to be tested.

When testing a sensor, **only** the sensor connection is required to be disconnected.

When testing a harness, the harness connector at the ECM and the connector at the sensor or multiple sensors should be disconnected.

Identify the pins that need to be tested.

Inspect the connector pins. 019-361.

Adjust the multimeter to measure resistance.

CAUTION

To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit for this control system.

Touch one of the multimeter probes to the correct pin to be tested.

Touch the other probe of the multimeter to a clean, unpainted surface on the engine block ground.

Read the value on the multimeter display.

The multimeter **must** read greater than 100k ohms, which is an open circuit.

If the circuit is **not** open, the wire being checked has a short circuit to ground or the engine block.

Repair or replace the component or wire.

Short circuit from pin to pin is a condition in which an electrical path exists between two pins where it is **not** intended to exist.

The procedure for checking short circuit from pin to pin is as follows:

1. Turn keyswitch OFF.
2. Disconnect the connector that are to be tested.
3. Identify the pins that are to be tested.
4. Adjust the multimeter to measure resistance.

CAUTION

To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit for this control system.

1. Touch one of the multimeter probes to the correct pin to be tested on the harness side of the connector.
2. Touch the other probe of the multimeter to all other pins on the harness side of the connector.

1. Read the value on the multimeter display.
2. The multimeter **must** read greater than 100k ohms, which is an open circuit.
3. If the circuit is **not** open, the pins being checked are electrically connected.

NOTE: Refer to the wiring diagram to verify that the wires in question are not supposed to be connected.

1. Inspect the harness connectors for moisture that can be the cause of an inappropriate electrical connection.
2. Repair or replace the harness.

Voltage check is a procedure to measure the difference in voltage potential between two points.

The procedure for checking voltage is as follows:

1. Disconnect the connectors that are to be tested.
2. Turn keyswitch ON.
3. Identify the pins that are to be tested.
4. Adjust the multimeter to AC voltage (V ˜) or DC voltage (V-).

CAUTION

To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit for this control system.

1. Touch one of the multimeter test probes to the correct lead to be tested.
2. Touch the other multimeter probe to a clean, unpainted surface

on the engine block or to the appropriate return pin.

1. Read the value on the multimeter display. Compare the measured value to the range of voltage given in the specifications.
2. If the measured value falls outside of the specified range, check the repair procedure for the electrical system that is being checked for the appropriate action.

A battery will be used as an example to check polarity of a circuit.

The terminals of a battery are marked for polarity. The multimeter displays the voltage difference of the positive (+) probe (red) to the negative (-) probe (black).

The polarity is correct when the positive (red) probe of the multimeter is on the positive (+) terminal of the battery and the negative (black) probe of the multimeter is on the negative (-) terminal of the battery.

The multimeter will display positive voltage if the polarity is correct.

If the multimeter probes are reversed, the multimeter displays negative voltage.

CAUTION

To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit for this control system.

Continuity is an electrical connection between two pins that is less than a certain resistance value. For harness wires, the specification is less than 10 ohms.

The procedure for checking continuity is as follows:

1. Turn keyswitch OFF.
2. Disconnect the harness connectors that are to be tested.
3. Adjust the multimeter to measure resistance.

CAUTION

To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit for this control system.

1. Insert test lead to the pin of the wire being tested and connect the alligator clip to the multimeter probe.
2. Insert the other test lead to the pin at the other end of the wire being tested and connect the alligator clip to the other multimeter probe.
3. Read the value on the multimeter display.

The multimeter **must** display less than 10 ohms for wire continuity.

If the multimeter displays greater than 10 ohms, the wire **must** be repaired or the harness replaced.		

Turn keyswitch OFF. Disconnect the harness from the coil. Adjust the multimeter to measure resistance.		

CAUTION To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit for this control system. Insert test lead to the coil connector pin, and connect the alligator clip to the multimeter probe. Insert the other test lead to the other coil connector pin, and connect the alligator clip to the other multimeter probe. **NOTE: For internally grounded coils, touch one multimeter lead to the coil terminal and the other multimeter lead to a clean, unpainted surface on the engine block.** Read the measured resistance on the multimeter display. Check the measured resistance against the resistance specification for the coil. **NOTE: The internal resistance of the multimeter is significant in some coil resistance checks.**		

Last Modified: 02-Dec-2009

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Resistance Measurement Using a Multimeter (019-360)

General Information

Use this procedure **only** if the harness or connector can be repaired. After performing any of the checks below, and it is necessary to repair or replace a harness or connector, refer to the table of contents in section 19 for the appropriate repair or replacement procedure. Fault code troubleshooting trees will refer to this procedure when it is necessary to measure resistance on a harness, connector, or component that the fault code applies to. Each fault code troubleshooting tree will troubleshoot a particular component and the associated circuitry such as a pressure sensor, wiring harness and connectors that connect the sensor to the ECM. When troubleshooting to determine if a short or open exists in a particular circuit, all of the associated connectors, pins, circuit names and connections that apply to this component can be viewed on the applicable wiring diagram. Use the following procedures to determine how to make the necessary resistance checks on components, connectors and circuits that apply to the fault code that referred you to this procedure.		

Resistance Check

Turn the key switch off. Disconnect the appropriate connector from the component. Adjust the multimeter to measure resistance. Use the wiring diagram to determine the pins that apply to the component you are measuring.		
CAUTION To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit. Connect the appropriate connector test leads to the connector pins and connect the alligator clips to the multimeter probe. Measure the resistance. Compare this value to the applicable fault code specification or applicable Electrical or Sensor Specification on the wiring diagram. If the value is not correct, the component is malfunctioning. Refer to the applicable fault code procedure for instructions.		

Continuity Check

Continuity is an electrical connection between two pins that is less than a certain value. For harness wires, the specification is less than 10 ohms.		
Turn the key switch to the OFF position. Disconnect the harness connectors that are to be tested. Adjust the multimeter to measure resistance.		
CAUTION To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit. Connect the appropriate connector test leads to the connector pins and connect the alligator clips to the multimeter probe. Measure the resistance.		
The multimeter **must** display less than 10 ohms for wire continuity. If the multimeter displays greater than 10 ohms, the wire **must** be repaired or the harness replaced. Refer to the applicable fault code procedure for instructions.		

Check for Short Circuit from Pin to Pin

Short circuit from pin to pin check is a condition in which an electrical connection exists between two pins where it is **not** intended to exist. Turn the key switch to the OFF position. Disconnect the harness connectors that are to be tested. Adjust the multimeter to measure resistance.		
CAUTION To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit. Connect the appropriate connector test leads to the connector pins and connect the alligator clips to the multimeter probes. Measure the resistance.		

The multimeter **must** read greater than 100k ohms, which is an open circuit. If the circuit is **not** open, the pins being checked are electrically connected. Refer to the wiring diagram to verify that the wires are intended to be connected. Inspect the harness connectors for moisture that can cause an inappropriate electrical connection. Refer to procedure 019-361. Refer to the applicable fault code procedure for instructions.		

Check for Short Circuit to Ground

Short circuit to ground is a condition where a connection from a circuit to ground exists when it is not intended. Turn the key switch to the OFF position. Disconnect the harness connectors that are to be tested.		
When testing a sensor, **only** the sensor connection is required to be disconnected. When testing a harness, the harness connector at the ECM and the connector at the sensor or multiple sensors **must** be disconnected. Identify the pins that need to be tested. Inspect the connector pins. Refer to procedure 019-361.		
CAUTION To reduce the possibility of pin and harness damage, use the appropriate test lead for the connector. Refer to the Service Tools listing or the appropriate wiring repair kit. Connect the appropriate connector test lead to a connector pin and connect the alligator clip to the multimeter probe. Touch the other multimeter probe to a clean, unpainted surface on the engine block or ground. Measure the resistance.		
The multimeter **must** read greater than 100k ohms, which is an open circuit. If the circuit is **not** open, the wire being checked has a short circuit to ground or the engine block. Refer to the applicable fault code procedure for instructions.		

Last Modified: 28-Jan-2008

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General Cleaning Instructions (204-008)

Definition of Clean

Parts **must** be free of debris that can contaminate any engine system. This does **not** necessarily mean they have to appear as new.

Sanding gasket surfaces until the factory machining marks are disturbed adds no value and is often harmful to forming a seal. It is important to maintain surface finish and flatness tolerances to form a quality sealing surface. Gaskets are designed to fill small voids in the specified surface finish.

Sanding gasket surfaces where edge-molded gaskets are used is most often unnecessary. Edge-molded gaskets are those metal carriers with sealing material bonded to the edges of the gasket to seal while the metal portion forms a metal to metal joint for stability. Any of the small amounts of sealing material that can stick to the parts are better removed with a blunt-edged scraper on the spots rather than spending time polishing the whole surface with an air sander or disc.

For those gaskets that do **not** have the edge molding, nearly all have a material that contains release agents to prevent sticking. Certainly this is **not** to say that some gaskets are **not** difficult to remove because the gasket has been in place a long time, has been overheated or the purpose of the release agent has been defeated by the application of some sealant. The object however is just to remove the gasket without damaging the surfaces of the mating parts without contaminating the engine (don't let the little bits fall where they can not be removed).

Bead blasting piston crowns until the dark stain is removed is unnecessary. All that is required is to remove the carbon build-up above the top ring and in the ring grooves. There is more information on bead blasting and piston cleaning later in this document.

Cummins Inc. does **not** recommend sanding or grinding the carbon ring at the top of cylinder liners until clean metal is visible. The liner will be ruined and any signs of a problem at the top ring reversal point (like a dust-out) will be destroyed. It is necessary to remove the carbon ring to provide for easier removal of the piston assembly. A medium bristle, high quality, steel wire wheel that is rated above the rpm of the power tool being used will be just as quick and there will be less damage. Yes, one **must** look carefully for broken wires after the piston is removed but the wires are more visible and can be attracted by a magnet.

Oil on parts that have been removed from the engine will attract dirt in the air. The dirt will adhere to the oil. If possible, leave the old oil on the part until it is ready to be cleaned, inspected and installed, and then clean it off along with any attracted dirt. If the part is cleaned then left exposed it can have to be cleaned again before installation. Make sure parts are lubricated with clean oil before installation. They do **not** need to be oiled all over but do need oil between moving parts (or a good lube system priming process conducted before cranking the engine).

Bead blasting parts to remove exterior paint is also usually unnecessary. The part will most likely be painted again so all that needs happen is remove any loose paint.

Abrasive Pads and Abrasive Paper

The keyword here is "abrasive". There is no part of an engine designed to withstand abrasion. That is they are all supposed to lock together or slide across each other. Abrasives and dirt particles will degrade both functions.

WARNING

Abrasive material must be kept out of or removed from oil passages and parts wear points. Abrasive material in oil passages can cause bearing and bushing failures that can progress to major component damage beyond reuse. This is particularly true of main and rod bearings.

Cummins Inc. does **not** recommend the use of emery cloth or sand paper on any part of an **assembled** engine or component including but **not** limited to removing the carbon ridge from cylinder liners or to clean block decks or counterbores.

Great care **must** be taken when using abrasive products to clean engine parts, particularly on partially assembled engines. Abrasive cleaning products come in many forms and sizes. All of them contain aluminum oxide particles, silicon carbide, or sand or some other similar hard material. These particles are harder than most of the parts in the engine. Since they are

harder, if they are pressed against softer material they will either damage the material or become embedded in it. These materials fall off the holding media as the product is used. If the products are used with power equipment the particles are thrown about the engine. If the particles fall between two moving parts, damage to the moving parts is likely.

If particles that are smaller than the clearance between the parts while they are at rest (engine stopped), but larger than the running clearance then damage will occur when the parts move relative to each other (engine started). While the engine is running and there is oil pressure, particles that are smaller than the bearing clearance are likely to pass between the parts without damage and be trapped in the oil filter. However, particles larger than the bearing clearance will remove material from one part and can become embedded in one of the parts. Once embedded in one part it will abrade the other part until contact is no longer being made between the two parts. If the damage sufficiently degrades the oil film, the two parts will come into contact resulting in early wear-out or failure from lack of effective lubrication.

Abrasive particles can fly about during cleaning it is **very** important to block these particles from entering the engine as much as possible. This is particularly true of lubricating oil ports and oil drilling holes, especially those located downstream of the lubricating oil filters. Plug the holes instead of trying to blow the abrasive particles and debris with compressed air because the debris is often simply blown further into the oil drilling.

All old gasket material **must** be removed from the parts gasket surfaces. However, it is **not** necessary to clean and polish the gasket surface until the machining marks are erased. Excessive sanding or buffing can damage the gasket surface. Many newer gaskets are of the edge molded type (a steel carrier with a sealing member bonded to the steel). What little sealing material that can adhere is best removed with a blunt-edged scraper or putty knife. Cleaning gasket surfaces where an edge-molded gasket is used with abrasive pads or paper is usually a waste of time.

WARNING

Excessive sanding or grinding the carbon ring from the top of the cylinder liners can damage the liner beyond reuse. The surface finish will be damaged and abrasive particles can be forced into the liner material which can cause early cylinder wear-out or piston ring failures.

Tape off or plug all openings to any component interior before using abrasive pads or wire brushes. If really necessary because of time to use a power tool with abrasive pads, tape the oil drillings closed or use plug and clean as much of the surface as possible with the tool but clean around the oil hole/opening by hand so as to prevent contamination of the drilling. Then remove the tape or plug and clean the remaining area carefully and without the tool. DO NOT use compressed air to blow the debris out of oil drilling on an assembled engine! More likely than **not**, the debris can be blown further into the drilling. Using compressed air is fine if both ends of the drilling are open but that is rarely the case when dealing with an assembled engine.

Gasket Surfaces

The object of cleaning gasket surfaces is to remove any gasket material, not refinish the gasket surface of the part.

Cummins Inc. does **not** recommend any specific brand of liquid gasket remover. If a liquid gasket remover is used, check the directions to make sure the material being cleaned will **not** be harmed.

Air powered gasket scrapers can save time but care must be taken to **not** damage the surface. The angled part of the scraper must be against the gasket surface to prevent the blade from digging into the surface. Using air powered gasket scrapers on parts made of soft materials takes skill and care to prevent damage.

Do **not** scrape or brush across the gasket surface if at all possible.

Solvent and Acid Cleaning

Several solvent and acid-type cleaners can be used to clean the disassembled engine parts (other than pistons. See Below). Experience has shown that the best results can be obtained using a cleaner that can be heated to 90° to 95° Celsius (180° to 200° Fahrenheit). Kerosene emulsion based cleaners have different temperature specifications, see below. A cleaning tank that provides a constant mixing and filtering of the cleaning solution will give the best results. Cummins Inc. does not recommend any specific cleaners. Always follow the cleaner manufacturer's instructions. Remove all the gasket material, o-rings, and the deposits of sludge, carbon, etc., with a wire brush or scraper before putting the parts in a cleaning tank. Be careful not to damage any gasket surfaces. When possible, steam clean the parts before putting them in the cleaning tank.

WARNING

When using solvents, acids, or alkaline materials for cleaning, follow the manufacturers recommendations for use. Wear goggles and protective clothing to reduce the possibility of personal injury.

Experience has shown that kerosene emulsion based cleaners perform the best to clean pistons. These cleaners should **not** be heated to temperature in excess of 77°C (170°F). The solution begins to break down at temperatures in excess of 82°C (180°F) and will be less effective.

Do **not** use solutions composed mainly of chlorinated hydrocarbons with cresols, phenols and/or cresylic components. They often do **not** do a good job of removing deposits from the ring groove and are costly to dispose of properly.

Solutions with a pH above approximately 9.5 will cause aluminum to turn black; therefore do **not** use high alkaline solutions.

Chemicals with a pH above 7.0 are considered alkaline and those below 7.0 are acidic. As you move further away from the neutral 7.0, the chemicals become highly alkaline or highly acidic.

Remove all the gasket material, o-rings, and the deposits of sludge, carbon, etc., with a wire brush or scraper before putting the parts in a cleaning tank. Be careful to **not** damage any gasket surfaces. When possible use hot high pressure water or steam clean the parts before putting them in the cleaning tank. Removing the heaviest dirt before placing in the tank will allow the cleaner to work more effectively and the cleaning agent will last longer.

Rinse all the parts in hot water after cleaning. Dry completely with compressed air. Blow the rinse water from all the capscrew holes and the oil drillings.

If the parts are **not** to be used immediately after cleaning, dip them in a suitable rust proofing compound. The rust proofing compound **must** be removed from the parts before assembly or installation on the engine.

Steam Cleaning

Steam cleaning can be used to remove all types of dirt that can contaminate the cleaning tank. It is a good method for cleaning the oil drillings and coolant passages

WARNING

When using a steam cleaner, wear safety glasses or a face shield, as well as protective clothing. Hot steam can cause serious personal injury.

Do **not** steam clean the following components:

- Electrical Components
- Wiring Harnesses
- Injectors
- Fuel Pump
- Belts and Hoses
- Bearings (ball or taper roller)
- Electronic Control Module (ECM)
- ECM Connectors
- Dosing Control Unit
- NOx Sensor.

Plastic Bead Cleaning

Cummins Inc. does **not** recommend the use of glass bead blast or walnut shell media on **any** engine part. Cummins Inc. recommends using **only** plastic bead media, Part Number 3822735 or equivalent on any engine part. **Never** use sand as a blast media to clean engine parts. Glass and walnut shell media when **not** used to the media manufacturer's recommendations can cause excess dust and can embed in engine parts that can result in premature failure of components through abrasive wear.

Plastic bead cleaning can be used on many engine components to remove carbon deposits. The cleaning process is controlled by the use of plastic beads, the operating pressure and cleaning time.

CAUTION

Do not use bead blasting cleaning methods on aluminum pistons skirts or the pin bores in any piston, piston skirt or piston crown. Small particles of the media will embed in the aluminum or other soft metal and result in premature wear of the cylinder liner, piston rings, pins and pin bores. Valves, turbocharger shafts, etc., can also be damaged. Follow the cleaning directions listed in the procedures.

CAUTION

Do not contaminate wash tanks and tank type solvent cleaners with the foreign material and plastic beads. Remove the foreign material and plastic beads with compressed air, hot high pressure water or steam before placing them in tanks or cleaners. The foreign material and plastic beads can contaminate the tank and any other engine parts cleaned in the tank. Contaminated parts may cause failures from abrasive wear.

Plastic bead blasting media, Part Number 3822735, can be used to clean all piston ring grooves. Do **not** sure any bead blasting media on piston pin bores or aluminum skirts.

Follow the equipment manufacturer's cleaning instructions. Make sure to adjust the air pressure in the blasting machine to the bead manufacturer's recommendations. Turning up the pressure can move material on the part and cause the plastic bead media to wear out more quickly. The following guidelines can be used to adapt to manufacturer's instructions:

0. Bead size: U.S. size Number 16 — 20 for piston cleaning with plastic bead media, Part Number 3822735
1. Operating Pressure — 270 kPa (40 psi) for piston cleaning. Pressure should not cause beads to break.
2. Steam clean or wash the parts with solvent to remove all of the foreign material and plastic beads after cleaning. Rinse with hot water. Dry with compressed air.

CAUTION

The bead blasting operation must not disturb the metal surface. If the metal surface is disturbed the engine can be damaged due to increased parts clearance or inadequate surface finish on parts that move against other parts.

When cleaning pistons, it is **not** necessary to remove all the dark stain from the piston. All that is necessary is to remove the carbon on the rim and in the ring grooves. This is best done by directing the blast across the part as opposed to straight at the part. If the machining marks are disturbed by the blasting process, then the pressure is too high or the blast is being held on one spot too long. The blast operation **must not** disturb the metal surface.

Walnut shell bead blast material is sometimes used to clean ferrous metals (iron and steel). Walnut shell blasting produces a great amount of dust particularly when the pressure if the air pressure on the blasting machine is increased above media manufacturer's recommendation. Cummins Inc. recommends **not** using walnut shell media to clean engine parts due to the risk media embedment and subsequent contamination of the engine.

Cummins Inc. now recommends glass bead media **NOT** used to clean any engine parts. Glass media is too easily embedded into the material particularly in soft materials and when air pressures greater than media manufacturer's recommend are used. The glass is an abrasive so when it is in a moving part, that part is abrading all the parts in contact with it. When higher pressures are used the media is broken and forms a dust of a very small size that floats easily in the air. This dust is very hard to control in the shop, particularly if **only** compressed air (and not hot water) is used to blow the media after it is removed from the blasting cabinet (blowing the part off inside the cabinet may remove large accumulations but never removes all the media).

Bead blasting is best used on stubborn dirt/carbon build-up that has **not** been removed by first steam/higher pressure washing then washing in a heated wash tank. This is particularly true of pistons. Steam and soak the pistons first then use the plastic bead method to safely remove the carbon remaining in the grooves (instead of running the risk of damaging the surface finish of the groove with a wire wheel or end of a broken piston ring. Make sure the parts are dry and oil free before bead blasting to prevent clogging the return on the blasting machine.

Always direct the bead blaster nozzle "across" rather than directly at the part. This allows the bead to get under the unwanted material. Keep the nozzle moving rather than hold on one place. Keeping the nozzle directed at one-place too long causes the metal to heat up and be moved around. Remember that the spray is **not** just hitting the dirt or carbon. If the machining marks on the piston groove or rim have been disturbed then there has **not** been enough movement of the nozzle and/or the air pressure is too high.

Never bead blast valve stems. Tape or use a sleeve to protect the stems during bead blasting. Direct the nozzle across the seat surface and radius rather than straight at them. The object is to remove any carbon build up and continuing to blast to

remove the stain is a waste of time.

Fuel System

When servicing any fuel system components, which can be exposed to potential contaminants, prior to disassembly, clean the fittings, mounting hardware, and the area around the component to be removed. If the surrounding areas are **not** cleaned, dirt or contaminants can be introduced into the fuel system.

The internal drillings of some injectors are extremely small and susceptible to plugging from contamination. Some fuel injection systems can operate at very high pressures. High pressure fuel can convert simple particles of dirt and rust into a highly abrasive contaminant that can damage the high pressure pumping components and fuel injectors.

Electrical contact cleaner can be used if steam cleaning tools are **not** available. Use electrical contact cleaner rather than compressed air, to wash dirt and debris away from fuel system fittings. Diesel fuel on exposed fuel system parts attracts airborne contaminants.

Choose lint free towels for fuel system work.

Cap and plug fuel lines, fittings, and ports whenever the fuel system is opened. Rust, dirt, and paint can enter the fuel system whenever a fuel line or other component is loosened or removed from the engine. In many instances, a good practice is to loosen a line or fitting to break the rust and paint loose, and then clean off the loosened material.

When removing fuel lines or fittings from a new or newly-painted engine, make sure to remove loose paint flakes/chips that can be created when a wrench contacts painted line nuts or fittings, or when quick disconnect fittings are removed.

Fuel filters are rated in microns. The word micron is the abbreviation for a micrometer, or one millionth of a meter. The micron rating is the size of the smallest particles that will be captured by the filter media. As a reference, a human hair is 0.003 mm [3/1000 in] in diameter. One micron measures 0.00004 mm [4/100,000 in]. The contaminants being filtered out are smaller than can be seen with the human eye, a magnifying glass, or a low powered microscope.

The tools used for fuel system troubleshooting and repair are to be cleaned regularly to avoid contamination. Like fuel system parts, tools that are coated with oil or fuel attract airborne contaminants. Remember the following points regarding your fuel system tools:

- Fuel system tools are to be kept as clean as possible.
- Clean and dry the tools before returning them to the tool box.
- If possible, store fuel system tools in sealed containers.
- Make sure fuel system tools are clean before use.

Last Modified: 24-Jul-2007

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General Repair Instructions
(204-007)

General Information

This engine incorporates the latest technology at the time it was manufactured; yet, it is designed to be repaired using normal repair practices performed to quality standards.

CAUTION

Cummins Inc. does not recommend or authorize any modifications or repairs to engines or components except for those detailed in Cummins Service Information. In particular, unauthorized repair to safety-related components can cause personal injury or death. Below is a partial listing of components classified as safety-related:

1. **Air Compressor**
2. **Air Controls**
3. **Air Shutoff Assemblies**
4. **Balance Weights**
5. **Cooling Fan**
6. **Fan Hub Assembly**
7. **Fan Mounting Bracket(s)**
8. **Fan Mounting Capscrews**
9. **Fan Hub Spindle**
10. **Flywheel**
11. **Flywheel Crankshaft Adapter**
12. **Flywheel Mounting Capscrews**
13. **Fuel Shutoff Assemblies**
14. **Fuel Supply Tubes**
15. **Lifting Brackets**
16. **Throttle Controls**
17. **Turbocharger Compressor Casing**
18. **Turbocharger Oil Drain Line(s)**
19. **Turbocharger Oil Supply Line(s)**
20. **Turbocharger Turbine Casing**
21. **Vibration Damper Mounting Capscrews**

- Follow all safety instructions noted in the procedures
- Follow the manufacturer's recommendations for cleaning solvents and other substances used during the repair of the engine. Some solvents and used engine oil have been identified by government agencies as toxic or carcinogenic. Avoid excessive breathing, ingestion and contact with such substances. **Always** use good safety practices with tools and equipment.
- Provide a clean environment and follow the cleaning instructions specified in the procedures
- The engine and its components **must** be kept clean during any repair. Contamination of the engine or components will cause premature wear.
- Perform the inspections specified in the procedures
- Replace all components or assemblies which are damaged or worn beyond the specifications
- Use genuine Cummins new or ReCon® service parts and assemblies
- The assembly instructions have been written to use again as many components and assemblies as possible. When it is necessary to replace a component or assembly, the procedure is based on the use of new Cummins or Cummins ReCon® components. All of the repair services described in this manual are available from all Cummins Distributors and most Dealer locations.
- Follow the specified disassembly and assembly procedures to reduce the possibility of damage to the components

Welding on a Vehicle with an Electronic Controlled Fuel System

CAUTION

Disconnect both the positive (+) and negative (-) battery cables from the battery before welding on the vehicle. Attach the welder ground cable no more than 0.61 meters [2 feet] from the part being welded. Do not connect the ground clamp of the welder to any of the sensors, wiring harness, the ECM or the engine. Direct welding of any electronic engine component or engine mounted component must not be attempted. Sensors, wiring harness, and ECM should be removed if nearby welding will expose these components to temperatures beyond normal operation. Additionally, all ECM connectors must be disconnected..

Last Modified: 14-Jul-2010

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General Safety Instructions (204-006)

Important Safety Notice

WARNING

Improper practices, carelessness, or ignoring the warnings can cause burns, cuts, mutilation, asphyxiation or other personal injury or death.

Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that **must** be followed to provide personal safety. Special safety precautions are included in the procedures when they apply.

- Work in an area surrounding the product that is dry, well lit, ventilated, free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist.
- **Always** wear protective glasses and protective shoes when working.
- Rotating parts can cause cuts, mutilation or strangulation.
- Do **not** wear loose-fitting or torn clothing. Remove all jewelry when working.
- Disconnect the battery (negative [-] cable first) and discharge any capacitors before beginning any repair work. Disconnect the air starting motor if equipped to prevent accidental engine starting. Put a "Do **Not** Operate" tag in the operator's compartment or on the controls.
- Use ONLY the proper engine barring techniques for manually rotating the engine. Do **not** attempt to rotate the crankshaft by pulling or prying on the fan. This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.
- If an engine has been operating and the coolant is hot, allow the engine to cool before slowly loosening the filler cap to relieve the pressure from the cooling system.
- **Always** use blocks or proper stands to support the product before performing any service work. Do **not** work on anything that is supported ONLY by lifting jacks or a hoist.
- Relieve all pressure in the air, oil, fuel, and cooling systems before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do **not** check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- To reduce the possibility of suffocation and frostbite, wear protective clothing and ONLY disconnect liquid refrigerant (Freon) lines in a well ventilated area. To protect the environment, liquid refrigerant systems **must** be properly emptied and filled using equipment that prevents the release of refrigerant gas (fluorocarbons) into the atmosphere. Federal law requires capturing and recycling refrigerant.
- To reduce the possibility of personal injury, use a hoist or get assistance when lifting components that weigh 23 kg [50 lb] or more. Make sure all lifting devices such as chains, hooks, or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. **Always** use a spreader bar when necessary. The lifting hooks **must not** be side-loaded.
- Corrosion inhibitor, a component of SCA and lubricating oil, contains alkali. Do **not** get the substance in eyes. Avoid prolonged or repeated contact with skin. Do **not** swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. IMMEDIATELY CALL A PHYSICIAN. KEEP OUT OF REACH OF CHILDREN.
- Naptha and Methyl Ethyl Ketone (MEK) are flammable materials and **must** be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. KEEP OUT OF REACH OF CHILDREN.
- To reduce the possibility of burns, be alert for hot parts on products that have just been turned off, exhaust gas flow, and hot fluids in lines, tubes, and compartments.
- **Always** use tools that are in good condition. Make sure you understand how to use the tools before performing any service work. Use ONLY genuine Cummins® or Cummins ReCon® replacement parts.
- **Always** use the same fastener part number (or equivalent) when replacing fasteners. Do **not** use a fastener of lesser quality if replacements are necessary.
- When necessary, the removal and replacement of any guards covering rotating components, drives, and/or belts should only be carried out be a trained technician. Before removing any guards the engine **must** be turned off and any starting mechanisms **must** be isolated. All fasteners **must** be replaced on re-fitting the guards.
- Do **not** perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.
- Some state and federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil.
- Do **not** connect the jumper starting or battery charging cables to any ignition or governor control wiring. This can cause electrical damage to the ignition or governor.
- **Always** torque fasteners and fuel connections to the required specifications. Overtightening or undertightening can allow leakage. This is critical to the natural gas and liquefied petroleum gas fuel and air systems.
- **Always** test for fuel leaks as instructed, as odorant can fade.

- Close the manual fuel valves prior to performing maintenance and repairs, and when storing the vehicle inside.
- Coolant is toxic. If **not** reused, dispose of in accordance with local environmental regulations.
- The catalyst reagent contains urea. Do **not** get the substance in your eyes. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. Avoid prolonged contact with skin. In case of contact, immediately wash skin with soap and water. Do **not** swallow internally. In the event the catalyst reagent is ingested, contact a physician immediately.
- The catalyst substrate contains Vanadium Pentoxide. Vanadium Pentoxide has been determined by the State of California to cause cancer. Always wear protective gloves and eye protection when handling the catalyst assembly. Do not get the catalyst material in your eyes. In Case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. Avoid prolonged contact with skin. In case of contact, immediately wash skin with soap and water.
- The Catalyst substrate contains Vanadium Pentoxide. Vanadium Pentoxide has been determined by the State of California to cause cancer. In the event the catalyst is being replaced, dispose of in accordance with local regulations.
- California Proposition 65 Warning - Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Last Modified: 25-Jan-2010

Service Tools
(022-001)

Electronic Engine Controls

Tool Number	Multimeter	
3377161	Measure electrical circuits; voltage (volts), resistance (ohms), and current (amps).	

Tool Number	Weather-Pack Terminal Removal Tool	
3822608	Used to repair Weather-Pack connectors.	

Tool Number	AMP Terminal Removal Tool	
3822759	Used to repair AMP connectors.	

Tool Number	Deutsch Terminal Removal Tool	
3822760	Used to repair Deutsch connectors.	

Tool Number	Heat Gun	
3822860	Used to repair connector wires.	

Tool Number	Wiring Repair Kit	
3162268	Contains a variety of connectors, pins, seals, terminals, test leads, and other tools used to repair connectors.	

Tool Number	Wire Crimping Pliers	
3822930	Used when repairing connector wires.	

Tool Number	Lubricant DS-ES	
3822934	Used to lubricate connector before installation.	

Tool Number	Deep Well Socket (1-1/4 inch)	
3823843	Used to remove and install sensors and actuators.	

Tool Number	Electrical Contact Cleaner	
3824510	Used to clean electrical contacts and connectors.	

Tool Number	Accelerator Position Sensor Repair Connector	
3823255	Used to troubleshoot accelerator position sensor problems.	

Tool Number	Sensor Breakout Cable	
3824775	Used to troubleshoot oil pressure sensor and engine speed and position sensor problems.	

Tool Number	Accelerator Position Sensor Breakout Cable	
3824892	Used to troubleshoot the accelerator position sensor problems.	

Tool Number	Pressure Sensor Breakout Cable	
3824776	Used to troubleshoot boost pressure sensor problems.	

Tool Number	Fuel Pressure/Temperature Sensor Brakeout Cable	
3162982	Used to troubleshoot fuel pressure/temperature sensor problems.	

Last Modified: 22-Jan-2003

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Service Tools
(022-001)

Fuel System

Tool Number	Multimeter	
3164488	Used to measure voltage, resistance, and current in electrical circuits.	

Tool Number	Pressure and Vacuum Module	
3164499	Used with multimeter, Part Number 3164488 to measure pressures and restriction in the fuel system.	

Tool Number	0.043-Inch Diagnostic Fuel Line	
3164621	Used to create rated fuel flows through the low-pressure fuel system without loading the engine.	

Tool Number	1000 cc Graduated Cylinder	
Not Applicable	Used to measure high-pressure pump drain flow (leakage).	

Tool Number	M10 Compucheck® Fitting	
3824842	Used when measuring fuel system pressure at the fuel filter head.	

Tool Number	Fuel Pump Gear Puller	
3163381	Used to pull the fuel pump gear. Includes Part Number 3900633 capscrews.	

Tool Number	QD Contact Cleaner	
3824510	Use this non-petroleum cleaner to clean electrical connections and fuel pump internal parts.	

	Fuel Pump Mounting Plate	

Tool Number 3162897	**Fuel Pump Mounting Plate** Used to hold the fuel pump in the ball joint vise during service.	

Tool Number ST 302	**Ball Joint Vise** Used with the fuel pump mounting plate for holding the fuel pump during service.	

Tool Number 3164618	**12 mm Banjo Adapter Fitting (Leakage Flow Adapter)** Used to isolate drain flow from the fuel drain lines where they connect to the fuel drain manifold. Allows fuel leakage measurement from the fuel pump, injector, or fuel rail pressure relief valve drain lines.	

Last Modified: 09-Nov-2006

Fuel System Location and Description Listing		
Component (click to view Engine Diagrams)	Fault Code Component Descriptions	Description
Accelerator Pedal Circuit (ISS)	The accelerator position sensor and the idle validation switch are located on the accelerator pedal in the cab.	The accelerator pedal assembly relays the accelerator percentage requested by the operator to the electronic control module (ECM). Percent accelerator is used to determine fueling. The accelerator position sensor and the idle validation switch on the accelerator pedal are adjusted at the factory to provide the correct output signals. Note: The connector pin letters shown for the accelerator pedal wiring in these troubleshooting steps are examples of representative sensors. The connector pin assignments can vary with equipment manufacturer, but the base troubleshooting logic will still apply.
Accelerator Pedal or Lever Idle Validation Circuit - Voltage Below Normal or Shorted to Low Source	The integrated sensor switch (ISS) is located on the accelerator pedal or lever assembly.	The idle validation switch is used by the electronic control module (ECM) to indicate when the accelerator pedal or lever is released (on-idle) or depressed (off-idle). The switch is adjusted by the accelerator pedal or lever manufacturers to switch from on-idle to off-idle at the correct accelerator pedal or lever position. The switch return is a shared return with other OEM cab switches.
Accelerator Pedal or Lever Idle Validation Circuit - Voltage Below Normal or Shorted to Low Source	The nonintegrated sensor switch (NISS) is located on the accelerator pedal or lever assembly.	The idle validation switch is used by the electronic control module (ECM) to indicate when the accelerator pedal or lever is released (on-idle) or depressed (off-idle). The switch is adjusted by the accelerator pedal or lever manufacturers to switch from on-idle to off-idle at the correct accelerator pedal or lever position. The switch return is a shared return with other OEM cab switches.
Accelerator Pedal or Lever Idle Validation Circuit - Voltage Below Normal or Shorted to Low Source	The solid state sensor switch (SSS) is located on the accelerator pedal or lever assembly.	The idle validation switch is used by the electronic control module (ECM) to indicate when the accelerator pedal or lever is released (on-idle) or depressed (off-idle). The switch is adjusted by the accelerator pedal or lever manufacturers to switch from on-idle to off-idle at the correct accelerator pedal or lever position. The switch return is a shared return with other OEM cab switches.
Accelerator Position Sensor Circuit	The accelerator position sensor is located on the accelerator pedal.	The accelerator position sensor is attached to the accelerator pedal. The accelerator position sensor sends a signal to the electronic control module (ECM) when the driver pushes on the accelerator pedal. The accelerator position circuit contains three wires: a +5-VDC supply wire (pin 29), a return ground (pin 19), and a signal wire (pin 30). Note: The connector pin letters shown for the accelerator pedal wiring in these troubleshooting steps are examples of representative sensors. The connector pin assignments can vary with equipment manufacturer, but the base troubleshooting logic will still apply.
Accelerator Position Sensor Circuit	The accelerator position sensor is located on the accelerator pedal inside the vehicle cab.	The accelerator pedal assembly with accelerator position sensor relays the accelerator percentage requested by the operator to the electronic control module (ECM). Percent accelerator is used by the ECM to determine fueling. In order for the accelerator position sensor to function properly, it is necessary that a good +5-VDC supply voltage be available.
Air Conditioner Clutch Supply Circuit		The air conditioner clutch solenoid is a device used by the electronic control module (ECM) to control the air conditioner, by sending a signal to open or close the fan clutch solenoid.
Alternate (Switched) Torque Curve Switch Circuit	The location of the torque curve switch circuit varies with each OEM and equipment model.	The torque curve switch circuit allows the operator to select from up to three preprogrammed torque curves using a two- or three-position switch, depending on which the original equipment manufacturer (OEM) has provided.

Ambient Air Pressure Sensor Circuit	The ambient air pressure sensor is located below the fuel transfer pump.	The ambient air pressure sensor monitors atmospheric pressure and passes information to the electronic control module (ECM) through the sensor harness.
Auxiliary Speed or Auxiliary Pressure Input Error	The auxiliary speed sensor or pressure sensor location is dependent on the original equipment manufacturer's (OEM) application.	The auxiliary governor's input is either a frequency signal from an auxiliary speed sensor or a pressure signal from an OEM pressure sensor. It is sent to the electronic control module (ECM) and is used to control the engine speed.
Coolant Level Sensor Circuit	The coolant level sensor is located in the radiator top tank or surge tank.	The coolant level sensor monitors the coolant level within the coolant system and passes information to the electronic control module (ECM) through the engine harness. This sensor is very complex. Do not use a multimeter to check the coolant level sensor. If the radiator coolant level drops below a certain level, a progressive power derate with increasing time after alert will occur.
Coolant Level Sensor Circuit	The coolant level sensor is located in the radiator top tank or surge tank.	The coolant level sensor monitors the coolant level within the coolant system and passes information to the electronic control module (ECM) through the engine harness.
Coolant Temperature - Engine Protection	The coolant temperature sensor is located below the thermostat housing.	The coolant temperature sensor (CTS) is used by the electronic control module (ECM) to monitor the temperature of the engine coolant. The coolant temperature is used by the ECM for the engine protection system, and the timing and fueling control.
Coolant Temperature - Engine Protection	The coolant temperature sensor (CTS) is located below the thermostat housing.	The coolant temperature sensor (CTS) is used by the electronic control module (ECM) to monitor the temperature of the engine coolant. The coolant temperature is used by the ECM for the engine protection system, and the timing and fueling control.
Coolant Temperature Sensor Circuit	The coolant temperature sensor is located below the thermostat housing.	The coolant temperature sensor is used by the electronic control module (ECM) to monitor the temperature of the engine coolant. The coolant temperature is used by the ECM for the engine protection system, timing, and fueling control.
Dual Output Driver A	The OEM device is dependent upon the OEM.	The dual-output driver A will control engine and vehicle functions by controlling original manufacturer's (OEM) devices based on up to 12 selected engine parameters and two selected OEM parameters (OEM switch input and OEM pressure input). The solenoid output will control functions such as a fan clutch, air cleaner restriction indicator, or an oil filter differential pressure indicator.
Dual Output Driver B	The location of the OEM device is dependent upon the OEM.	The dual-output driver B will control engine and vehicle functions by controlling original equipment manufacturer's (OEM) devices based on up to 12 selected engine parameters and two selected OEM inputs (the OEM switch and the OEM pressure). The OEM device output will control functions such as a fan clutch, air cleaner restriction indicator, or an oil filter differential pressure indicator.
Electronic Control Module (ECM) Microprocessor	The ECM is located on the left side of the engine block, behind the fuel filter.	The ECM is a computer that is responsible for engine control, diagnostics, and user features.
Engine Brake Supply Circuit		The electronic control module (ECM) enables the engine brake by sending a signal to the engine brake under certain conditions.
Engine Brake Supply Circuit		The electronic control module (ECM) enables the engine brake by sending a signal to the engine brake under certain conditions.
Engine Coolant Level - Engine Protection	The coolant level sensor is located in the radiator top tank or surge tank.	The coolant level sensor monitors the coolant level within the coolant system and passes information to the electronic control module (ECM) through the engine harness. Because this sensor is complex, do not use a multimeter to check it. If the radiator coolant level drops below a certain level, a progressive power and/or speed derate will occur. Engine can, perhaps, shut down if the engine protection shutdown feature is enabled.

Engine Fan Clutch Supply Circuit		The fan clutch solenoid is a device used by the ECM to control the engine fan by sending a signal to open or close the fan clutch solenoid.
Engine Overspeed Circuit	The engine speed sensor is located on the back side of the gear housing, between the Cummins accumulator pump system (CAPS) fuel pump and the air compressor.	The engine speed sensor provides engine speed information to the electronic control module (ECM). The sensor must be powered by +5 VDC to operate. The sensor generates a signal by sensing the movement of target teeth cut into a steel ring fastened to the backside of the camshaft gear. This ring has 71 teeth and a gap where the 72nd tooth would be placed. This missing tooth indicates that cylinder 1 (and 6) is at top dead center.
Engine Position Sensor Circuit	The engine position sensor is located on the backside of the gear housing, between the fuel injection pump and the air compressor.	The engine position sensor provides engine position information to the electronic control module (ECM). The sensor must be powered by +5-VDC to operate. The sensor generates a signal by sensing the movement of target teeth cut into a steel ring fastened to the back side of the cam gear. This ring has 71 teeth and a gap where the 72nd tooth would be placed. This missing tooth indicates that cylinder 1 (and 6) is at top dead center.
Engine Speed Sensor	The engine speed sensor is located on the backside of the gear housing, between the fuel injection pump and the air compressor.	The engine speed sensor provides engine speed and position information to the electronic control module (ECM). The sensor must be powered by +5 VDC to operate. The sensor generates its signals by sensing the movement of target teeth cut into a steel ring fastened to the backside of the camshaft gear. This ring has 71 teeth and a gap where the 72nd tooth would be placed. This missing tooth indicates that cylinder 1 (and 6) is at top dead center.
Engine Speed Sensor (ESS) Circuit	The engine speed sensor is located on the back side of the gear housing, between the fuel injection pump and the air compressor.	The engine speed sensor provides engine speed information to the electronic control module (ECM). The sensor must be powered by +5 VDC to operate. The sensor generates its signals by sensing the movement of target teeth cut into a steel ring fastened to the back side of the cam gear. This ring has 71 teeth and a gap where the 72nd tooth would be placed. This missing tooth indicates that cylinder 1 (and 6) is at top dead center.
Frequency Throttle Circuit	The throttle pedal location varies with each OEM.	The throttle pedal provides the driver's throttle command to the electronic control module (ECM) through the original equipment manufacturer (OEM) harness and the 23-pin connector to the engine harness. The ECM uses this signal to determine the fueling command.
Frequency Throttle Circuit	The throttle pedal location varies with each OEM.	The throttle pedal provides the driver's throttle command to the electronic control module (ECM) through the original equipment manufacturer's (OEM) harness and the 23-pin connector to the engine harness. The ECM uses this signal to determine the fueling command.
Front Pumping Element	The front pumping element is part of the CAPS fuel pump in the accumulator module.	The front pumping element in the Cummins® accumulator pump system (CAPS) consists of the front barrel and plunger, front pumping control valve, and the front check valve in the accumulator. These components are part of the accumulator module. The pumping element is responsible for pumping fuel into the accumulator and maintaining the desired pressure in the accumulator.
Front Pumping Valve Circuit	The pumping control valves are located on the fuel pump on the top of the accumulator.	The pumping control valve of Cummins accumulator pump system (CAPS) regulates the quantity of fuel that is pumped into the accumulator. The electronic control module (ECM) commands the valve to close based on several different parameters including fuel pressure, engine load, and throttle position.
Fuel Injection Pump	The CAPS fuel injection pump is located on the intake side of the engine.	The ECM monitors several variables, including accumulator pressure, valve close angle, and injection control valve open-time, to determine if the pump has malfunctioned.
		The fuel pressure sensor contains supply, signal, and return pins.

Fuel Pressure Sensor Circuit	The fuel pressure sensor is located on the top rear of the fuel pump. The pressure sensor can be identified by its mounting location, rear center of CAPS Accumulator module.	The electronic control module (ECM) provides 5 VDC to the fuel pressure sensor for a supply voltage. The ECM supplies a shared ground from the fuel pressure sensor circuit. The signal voltage is variable depending on the pressure that is being generated inside the fuel pump's accumulator. This 5 VDC power supply is a shared supply. Other sensors on this circuit are the engine speed sensor, engine position sensor, oil pressure sensor, intake manifold pressure sensor and ambient air pressure sensor. The shared ground for the fuel pressure sensor also connects to the injection control valve identifier, temperature sensor, intake manifold air temperature sensor, engine position sensor, oil pressure sensor, intake manifold pressure sensor, and ambient air pressure sensor.
Fuel Pressure Sensor Circuit	The fuel pressure/temperature sensor is located on the rear of the accumulator.	The fuel pressure/temperature sensor is used by the electronic control module (ECM) to monitor the fuel temperature in the accumulator. The ECM monitors the voltage on the signal pin and converts this to a pressure value.
Fuel Pressure Sensor Circuit	The fuel pressure sensor is located on the top rear of the fuel pump. The pressure sensor can be identified by its mounting location, rear center of the CAPS accumulator module.	The fuel pressure sensor contains supply, signal, and return pins. The electronic control module (ECM) provides 5 VDC to the fuel pressure sensor for a supply voltage. The ECM supplies a shared ground from the fuel pressure sensor circuit. The signal voltage is variable depending on the pressure that is being generated inside the fuel pump accumulator. This 5 VDC power supply is a shared supply. Other sensors on this circuit include the engine speed sensor, engine position sensor, oil pressure sensor, intake manifold pressure sensor, and ambient air pressure sensor. The shared ground for the fuel pressure sensor also connects to the injection control valve identifier, temperature sensor, intake manifold air temperature sensor, engine position sensor, oil pressure sensor, intake manifold pressure sensor, and ambient air pressure sensor.
Fuel Temperature Sensor Circuit	The fuel pressure/temperature sensor is located on the rear of the Cummins accumulator pump system (CAPS).	The fuel pressure/temperature sensor is used by the electronic control module (ECM) to monitor the fuel temperature in the accumulator. The ECM monitors the voltage on the signal pin, and converts this to a temperature value.
Idle Validation Switch (IVS) Circuit	The IVS is located on the accelerator pedal assembly.	The idle validation switch (IVS) is used by the electronic control module (ECM) to indicate when the accelerator pedal is released (on-idle) or depressed (off-idle). The switch is adjusted by the accelerator pedal manufacturers to switch from on-idle to off-idle at the correct accelerator pedal position.
Injection Control Valve Identifier Circuit	The injection control valve identifier is shrink-wrapped to the injection control valve pigtail, which is located on the CAPS fuel injection pump on the top of the distributor.	The injection control valve identifier optimizes the quantity of fuel that is injected into each cylinder during an injection event. The identifier is matched with each individual injection control valve at the factory to maximize the performance of the CAPS pump.
Injection Control Valve Stator Circuit	The injection control valve is located on the fuel injection pump on the top of the distributor. The injection control valve stator is mounted onto the front side of the injection control valve with four capscrews.	The injection control valve regulates both the quantity of fuel that is injected into each cylinder and the timing of the injection event. The injection control valve stator is the electronic solenoid that actuates the injection control valve. The electronic control module (ECM) commands the stator to actuate the injection control valve to open based on several different parameters, including fuel pressure, engine speed, and throttle position.
Injection Control Valve Stator Circuit	The injection control valve is located on the fuel injection pump on the top of the distributor. The injection control valve stator is mounted onto the front side of the injection control valve via four capscrews.	The injection control valve regulates both the quantity of fuel that is injected into each cylinder and the timing of the injection event. The injection control valve stator is the electronic solenoid that actuates the injection control valve. The electronic control module (ECM) commands the stator to actuate the injection control valve to open based on several different parameters, including fuel pressure, engine speed, and throttle position.
Intake Air Heater Relay Circuit	The intake air heater is located under the air inlet coverplate on the intake manifold. The location of the heater relays will vary with OEM.	The intake air heater improves starting and white smoke control in cold ambient conditions. The ECM controls relays that switch power to the air heater. There are two heating coils in the heater that are individually controlled by the ECM.

Intake Manifold Air Temperature Sensor - Engine Protection Circuit	The intake manifold temperature sensor is located on the side of the intake manifold, toward the rear of the cylinder head.	The intake manifold air temperature sensor is used by the electronic control module (ECM) to monitor the temperature of the engine intake air. The intake air temperature is used by the ECM for the engine protection system, and the timing and fueling control.
Intake Manifold Air Temperature Sensor Circuit	The intake manifold air temperature sensor is located on the side of the intake manifold near the middle of the cylinder head.	The intake manifold air temperature sensor is used by the electronic control module (ECM) to monitor the temperature of the engine intake air. The intake manifold air temperature signal is used by the ECM for the engine protection system, injection timing, and fueling control.
Intake Manifold Pressure - Engine Protection	The intake manifold pressure sensor is located on the rear of the intake manifold in the second port on the side of the head to the right of the fuel filter.	The intake manifold pressure sensor is used by the electronic control module (ECM) to monitor the engine intake manifold pressure. The ECM monitors the voltage on the signal pin 45 and converts this to a pressure value. The intake manifold pressure value is used by the ECM for the engine protection system.
Intake Manifold Pressure Sensor Circuit	The intake manifold pressure sensor is located on the rear of the intake air manifold in the second port on the side of the head to the right of the fuel filter.	The intake manifold pressure sensor monitors intake manifold pressure and passes information to the electronic control module (ECM) through the sensor harness. If the intake manifold pressure becomes too high, it will cause a derate condition.
Intake Manifold Pressure Sensor Circuit	The intake manifold pressure sensor is located in the rear of the intake manifold, in the second port on the side of the cylinder head to the right of the fuel filter.	The intake manifold pressure sensor monitors intake manifold pressure and passes information to the electronic control module (ECM) through the engine harness. If intake manifold pressure becomes too high, it will cause a derate condition.
J1939 Datalink Multiplexing	The ECM is located on the intake side of the engine, about mid-engine. The J1939 datalink wiring and VECU(s) vary by OEM options.	Inputs, such as throttle pedals, switches, and sensors, can be communicated to the ECM over the J1939 datalink. Messages sent from the vehicle electronic control units (VECUs) are received by the ECM and used for controlling the engine. Both the ECM and VECU must be properly configured so that each device's information is transmitted by the VECU and received by the ECM.
Lift Pump Circuit	The lift pump is mounted to the engine block on the intake side, toward the rear of the engine.	The ECM enables the lift pump by sending a signal directly to the lift pump. The ECM cycles the lift pump on for 30 seconds after turning on the keyswitch.
Multiple Unit Synchronization Switch Error	The multiple unit synchronization switch is cab mounted.	The multiple unit synchronization uses a complimentary switch to provide two opposite signals into the ECM.
OEM Input - Engine Protection	The location of the OEM device is dependent upon the OEM.	The OEM device input to engine protection allows vehicle OEMs to wire up a device, such as a hydraulic oil temperature limit switch, transmission temperature limit switch, etc., to the ECM. The ECM will monitor values from this device the same as other engine protection inputs, such as coolant level, etc. If a threshold value is exceeded, engine speed derate will occur and possible engine shutdown.
OEM Pressure - Engine Protection	The OEM pressure sensor is located in different locations depending on the OEM and equipment model.	The OEM pressure sensor is used by the electronic control module (ECM) to monitor an OEM-specific pressure sensor. The ECM monitors the voltage on signal pin 48 and converts this to a pressure value. The OEM pressure value is used by the ECM for the engine/vehicle protection system.
OEM Pressure Sensor Circuit	The location varies with the OEM.	The OEM sensor signal is used by the electronic control module (ECM) to monitor the OEM pressure. The OEM pressure is used by the ECM in one of two ways: A sensor that has failed high can be caused by an open circuit in the signal or return wire, voltage shorts in the signal or return wire, or a faulty sensor. 1. The ECM can shut down the engine based on an OEM pressure input value exceeding or falling below a customer-specified value. 2. The ECM can control a device (dual output driver A and driver B) based on the value of the OEM pressure.

OEM Pressure Sensor Circuit	The location varies with the OEM.	The OEM sensor signal is used by the electronic control module (ECM) to monitor the OEM pressure. The OEM pressure is used by the ECM in one of two ways: A sensor that has failed low can be caused by shorts to ground on the signal wire or an internally grounded (faulty) sensor. 1. The ECM can shut down the engine based on an OEM pressure input value exceeding or falling below a customer-specified value. 2. The ECM can control a device (dual-output driver A and driver B) based on the value of the OEM pressure.
OEM Switch - Engine Protection	The OEM switch is located in different locations, depending on the OEM and equipment model.	The OEM switch is used by the electronic control module (ECM) to monitor an OEM-specific switch. The ECM monitors the signal on pin 16 for the engine/vehicle protection system.
Oil Pressure - Engine Protection	The oil pressure sensor is located on the engine block, below and to the right of the ECM.	The oil pressure sensor is used by the electronic control module (ECM) to monitor the lubricating oil pressure. The ECM monitors the voltage on the signal pin and converts this to a pressure value. The oil pressure value is used by the ECM for the engine protection system.
Oil Pressure - Engine Protection	The oil pressure sensor is located on the engine block below the ECM.	The oil pressure sensor is used by the electronic control module (ECM) to monitor the lubricating oil pressure. The ECM monitors the voltage on the signal pin and converts this to a pressure value. The oil pressure value is used by the ECM for the engine protection system.
Oil Pressure - Engine Protection With An Oil Pressure Switch	The oil pressure switch is located on the engine block, below and to the right of the ECM.	The oil pressure switch is used by the electronic control module (ECM) to detect the presence of lubricating oil pressure.
Oil Pressure - Engine Protection With An Oil Pressure Switch	The oil pressure switch is located on the engine block below the ECM.	The oil pressure switch is used by the electronic control module (ECM) to detect the presence of lubricating oil pressure.
Oil Pressure Sensor Circuit	The oil pressure sensor is located on the engine block, below and to the right of the ECM.	The oil pressure sensor is used by the electronic control module (ECM) to monitor the lubricating oil pressure. The ECM monitors the voltage on the signal pin and converts this to a pressure value. The oil pressure value is used by the ECM for the engine protection system.
Oil Pressure Switch Circuit	The oil pressure switch is located on the engine block, below and to the right of the ECM.	The oil pressure switch is used by the electronic control module (ECM) to monitor the lubricating oil pressure.
Output Device Driver (Transmission Shift Modulator)		The output device driver is a device used by the electronic control module (ECM) to control the transmission shift modulation signal.
Primary and Secondary Electronic Control Modules (ECM) Identification Error	The ECMs are located on the left side of the engine block, behind the fuel filter.	The QSL9 control system synchronizes two ECMs, one primary and one secondary.
Pumping Element	The pumping element is part of the CAPS fuel injection pump.	These faults are due to a failure internal to the Cummins accumulator pump system (CAPS). The pump must be sent to Cummins ReCon® for repairs. Blowshut is a condition that results when the fuel being moved, as the pumping plunger travels upwards, causes the PCV to close before the electronic control module (ECM) commands the PCV to close.
Rear Pumping	The rear pumping element is part of the Cummins® accumulator pump	The rear pumping element consists of the rear barrel and plunger, rear pumping control valve, and rear check valve in the accumulator. These components are part of the accumulator module. The

Element	system (CAPS) fuel pump in the accumulator module.	pumping element is responsible for pumping fuel into the accumulator and maintaining the desired pressure in the accumulator.
Rear Pumping Valve Circuit	The pumping control valves are located on the fuel pump on the top of the accumulator.	The pumping control valve of Cummins accumulator pump system (CAPS) regulates the quantity of fuel that is pumped into the accumulator. The electronic control module (ECM) commands the valve to close based on several different parameters including fuel pressure, engine load, and throttle position.
Remote Accelerator Control Circuit	The remote accelerator position sensor is located on the remote accelerator control assembly somewhere outside the cab.	The remote accelerator control assembly contains the remote accelerator position sensor. This sensor sends the accelerator percentage requested by the operator to the electronic control module (ECM). Remote accelerator is used by the ECM to determine fueling. In order for the remote accelerator position sensor to function properly, it is necessary that a good +5-VDC supply voltage be available. Note: The connector pin letters shown for the accelerator pedal wiring in these troubleshooting steps are examples of representative sensors. The connector pin assignments can vary with equipment manufacturer, but the base troubleshooting logic will still apply.
Remote Throttle Position Sensor	The remote throttle pedal location varies with each OEM.	The remote throttle pedal provides the driver's throttle command to the electronic control module (ECM) through the OEM harness and the original equipment manufacturer's (OEM) interface harness. The ECM uses this signal to determine the fueling command.
Remote Throttle Position Sensor	The remote throttle pedal location varies with each OEM.	The remote throttle pedal provides the driver's throttle command to the electronic control module (ECM) through the original equipment manufacturer's (OEM) harness and the OEM interface harness. The ECM uses this signal to determine the fueling command.
Sensor Supply Circuit	The +5-VDC sensor supply circuit is located in the engine harness. See Section E of this manual the Troubleshooting and Repair Manual, ISC Fuel Systems ISC Series Engines, Bulletin 3666271 for the sensor locations.	The engine position sensor (EPS), the intake manifold pressure sensor, the oil pressure sensor, the ambient air pressure sensor, and the fuel temperature sensor are powered by the same +5-VDC source and the same return in the electronic control module (ECM). This supply is also used to operate the intake manifold air temperature and coolant temperature sensors.
Switched Droop Selection Circuit	The location of the droop switch circuit varies with each OEM and equipment model.	The switched droop circuit allows the operator to select from up to three preprogrammed droop governor values using a two- or three-position switch, depending on which the original equipment manufacturer (OEM) has provided.
Transient Suppressor Circuit	The transient suppressor extends from the trunk of the engine harness and is mounted with a p-clip to the engine block. It is a small copper colored cylinder with a red and a black wire extending from one end. It is located just below where the injection lines connect to the fuel pump. The injection control valve is located at the rear of the fuel injection pump, on the top of the distributor, and below the accumulator.	The transient suppressor absorbs the extra current created when the injection control valve closes after an injection event. Without the transient suppressor, high voltage would be transmitted back into the ECM and damage the pump driver circuits.
Unswitched Battery Supply Circuit	The ECM is connected to the battery by the engine harness. This direct link provides a constant power supply for the ECM. The location of the battery will vary with the equipment manufacturer.	The ECM receives constant voltage from the batteries through the unswitched battery wires that are connected directly to the positive (+) battery post. There are three in-line 7.5-amp fuses and two 10-amp fuses in the unswitched battery wires to protect the engine harness from overheating. The ECM receives switched battery input through the vehicle keyswitch wire when the vehicle keyswitch is turned on.
	The ECM is connected to the battery	

Unswitched Battery Supply Circuit	by the engine harness. This direct link provides a constant power supply for the ECM. The location of the battery will vary with the equipment manufacturer.	The ECM receives unswitched battery input through the engine harness. There are three in-line 7.5-amp fuses and two 10-amp fuses in the unswitched battery wire of the engine harness to protect it from overheating.
Unswitched Battery Supply Circuit	The ECM is connected to the battery by the engine harness. This direct link provides a constant power supply for the ECM. The location of the battery will vary with the OEM.	The ECM receives unswitched battery input through the engine harness. There is two in-line 10-amp fuses and three 7.5-amp fuses in the unswitched battery wire to protect the engine harness from overheating. The battery return wires are connected directly to the negative (-) battery post.
Vehicle Speed Sensor (VSS) Circuit	The VSS is most commonly installed in the rear of the transmission.	The vehicle speed sensor (VSS) uses two separate coils of wire (some applications use a single coil sensor) to count gear teeth as they pass in front of the sensor. One coil is used by the electronic control module (ECM) to sense vehicle speed. The other coil is sometimes used by the OEM to send a vehicle speed signal to the speedometer.
Vehicle Speed Sensor Circuit	The VSS is most commonly installed in the rear of the transmission.	The vehicle speed sensor (VSS) uses two separate coils of wire (some applications use a single coil sensor) to count gear teeth as they pass in front of the sensor. One coil is used by the electronic control module (ECM) to sense vehicle speed. The other coil is sometimes used by the OEM to send a vehicle speed signal to the speedometer.
Water-In-Fuel (WIF) Sensor Circuit	The WIF sensor is installed in the bottom of the fuel filter, which is located on the side of the cylinder head approximately midengine.	The WIF sensor is attached to the fuel filter. The WIF sensor sends a signal to the electronic control module (ECM) when a set volume of water has accumulated in the fuel filter. The WIF circuit contain two wires: A return ground (pin 20), and a signal wire (pin 40).
Water-In-Fuel (WIF) Sensor Circuit	The WIF sensor is installed in the bottom of the fuel filter and is located on the side of the cylinder head approximately midengine.	The WIF sensor is attached to the fuel filter. The WIF sensor sends a signal to the electronic control module (ECM) when a set volume of water has accumulated in the fuel filter. The WIF circuit contain two wires: A return ground (pin 20), and a signal wire (pin 40).

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Electronic Controlled Fuel System
(101-007)

Base Control System Description

The ISC engine control system is an electronically operated fuel control system that also provides many operator and vehicle, or equipment, features. The base functions of the control system include fueling and timing control, limiting the engine speed operating range between the low- and high-idle set points, and reducing exhaust emissions while optimizing engine performance.		
The control system uses inputs from the operator and its sensors to determine the fueling and timing required to operate at the desired engine speed. The electronic control module (ECM) is the control center of the system. It processes all of the inputs and sends commands to the fuel system, vehicle, and engine control devices.		
The ECM performs diagnostic tests on most of its circuits and will activate a fault code if a problem is detected in one of these circuits. Along with the fault code identifying the problem, a snapshot of engine operating parameters at the time of fault activation is also stored in memory. Some fault codes will cause a diagnostic lamp to activate to signal the driver.		
The ECM communicates with service tools and some other vehicle controllers (i.e., transmissions, anti-lock braking system, automatic slip reduction) through an SAE J1939 datalink. Some vehicles and equipment will have J1939 networks on them that link many of the “smart” controllers together. Vehicle control devices can temporarily command engine speed or torque to perform one of its functions (i.e., transmission shifting, anti-lock braking).		
The control system uses a number of sensors to provide information on engine operating parameters. These sensors include: 0. Coolant Temperature Sensor 1. Oil Pressure Sensor 2. CAPS Accumulator Pressure/Temperature Sensor 3. Intake Air Temperature Sensor 4. Intake Manifold Pressure Sensor 5. Engine Speed/Position Sensor 6. Water-In-Fuel Sensor 7. Front Pumping Control Valve Solenoid 8. Rear Pumping Control Valve Solenoid.		
The following inputs are provided by OEM-selected devices: 0. Accelerator Pedal Position Sensor 1. Idle Validation Switch 2. Coolant Level Sensor 3. Vehicle Speed Sensors		

4. Feature Control Switches (i.e., Cruise Control Switches). **NOTE: These inputs are application-dependent. Some applications will not use all of these inputs.**		

Engine Protection System

The ISC engines are equipped with an engine protection system. The system monitors critical engine temperatures and pressures and will log diagnostic faults when an over- or under-normal operating condition occurs. If an out-of-range condition exists, and engine derate action is to be initiated, the operator will be alerted by an in-cab WARNING lamp. The WARNING lamp will blink or flash when out-of-range conditions continue to get worse. When the red STOP lamp is illuminated, the driver **must** pull to the side of the road, when it is safe to do so, to reduce the possibility of engine damage. The engine protection system monitors the following features: • Coolant Temperature • Coolant Level (optional) • Oil Pressure • Intake Manifold Temperature • Engine Overspeed • Fuel Temperature. **NOTE: Engine power and speed will be gradually reduced, depending on the level of severity of the observed condition. The engine protection system will not shut down the engine unless the engine protection shutdown feature has been enabled.**		

Engine Protection Shutdown - This feature automatically shuts off the engine when the temperature, pressure, or coolant level sensors indicate the engine is operating over or under normal operating conditions. The red STOP lamp in the cab will flash for 30 seconds prior to shutdown to alert the driver.		

Type of Vehicle Speed Sensor - This indicates the type of vehicle speed sensor used by the ECM. The sensor is either electrical or mechanical.		

Maximum Engine Speed without Vehicle Speed Sensor (VSS) - This sets the maximum engine speed allowed when no vehicle speed is detected.		

Tire Revolutions per Mile - This is used to tell the electronic control module (ECM) how many times the tire will turn a full revolution in one mile.		

Rear Axle Ratio - This parameter is used to tell the ECM the gear ratio of the rear axle.		

Number of Transmission Tailshaft Gear Teeth -This parameter is used to tell the ECM the number of gear teeth on the transmission tailshaft.		
Vehicle Speed Sensor Anti-Tampering (Fault Code 242) - This feature gives the customer the option of disabling Fault Code 242. **NOTE: Fault Code 242 is logged when an invalid or inappropriate vehicle speed signal is detected by the ECM, indicating an intermittent connection or signal tampering. This fault code is not a guarantee that vehicle speed sensor tampering has been performed.**		
Fan Clutch Enable - The ECM can control the cooling fan based on inputs from the coolant temperature sensor and the intake manifold temperature sensor. Some applications will also provide inputs to the ECM for auxiliary device cooling, such as air conditioner pressure and power steering temperature. Your application could also include a manual switch for fan control.		
Fan Drive Selection - Enable this feature to control a variable-speed fan drive to help optimize fuel economy when a variable-speed fan is available for use. The ECM varies fan speed according to coolant temperature to maintain the temperature in the optimum operating range while minimizing the amount of load put on the engine by the fan.		
Fan-on with Exhaust Brake - This feature will enable an electric fan when the exhaust brake is engaged. This increases the total braking power by increasing the parasitic load on the engine.		
Programmable Fan Logic - Select either zero VDC = ON or 12 VDC = ON to match the fan clutch logic used in the application. A relay should be used for fans that draw more than six amps.		
Minimum Fan-on Time with Air Conditioner Pressure Switch - This feature controls the minimum amount of time that the fan will stay on when it is activated by the air conditioner pressure switch to reduce excessive fan cycling.		
Air Conditioner Pressure Switch Input - This allows for the air conditioner pressure switch input to be disabled if that input into the ECM is **not** being used. Enable this feature if the air conditioner pressure switch input into the ECM is being used to control the fan.		
Application Type - This feature selection tells the ECM what type of application this vehicle is being used for. Choose between on-highway or on/off-highway. On-highway applications are those that use top gear for the majority of its operations. On/off-highway applications are those that use gears lower than top gear for extended periods of time.		
Intake Air Heater - This feature controls the heating elements that are located in the engine's intake air stream. These elements heat the intake air when starting the engine in cold ambient conditions. Startability and white smoke control are enhanced by the use of an intake air heater. A WAIT-TO-START lamp is located on the operator controls to indicate when to crank the engine.		

The ECM checks intake manifold temperature to determine how long to energize the air heater before extinguishing the WAIT-TO-START lamp (this is for the preheat phase). Once the engine is started, the heater will be energized again for a time period determined by intake air temperature and fuel temperature (this is for the post-heat phase). To minimize cranking time in cold weather, the engine should **not** be started until the WAIT-TO-START lamp is extinguished.		
Water-in-Fuel Sensor - This sensor is located in the fuel filter housing. Once the storage space in the bottom of the filter housing fills with a certain amount of water, the sensor will signal the ECM. A water-in-fuel lamp will illuminate, at the operator controls, indicating that the water **must** be drained from the fuel filter assembly.		
Electric Lift Pump - The ECM controls the electric lift pump located in between the fuel tank and injection pump. Whenever the keyswitch is turned ON, the lift pump will be energized for 30 seconds to make sure the low-pressure fuel lines are fully primed. The electric lift pump does **not** start again unless the keyswitch is cycled.		

Programmable Features

Automotive Applications

Control System Features - The electronic control system can provide many features that are integrated into the vehicle's operation. Some of these features can be adjusted or turned on or off with a service tool, but some are set at the factory and can **not** be changed. The following section describes the functionality of each feature. Whether a feature is available in a given application is calibration-dependent.		
Accelerator Interlock — When the accelerator interlock feature is active and the external accelerator inhibit switch is active, the accelerator action will be disregarded on fueling, and the engine shall run at low-idle speed or at the remote PTO speed if the remote PTO switch is activated. Because of different customer needs, each particular manufacturer will build the interaction with its brakes, transmission, and fast/slow idle selection capabilities. For example, most buses use this feature to disable the accelerator pedal and PTO operation while the bus door is open. **NOTE: This is not a customer-adjustable feature.**		
Road Speed Governor — The road speed governor limits the maximum road speed of the vehicle in top gear. The maximum vehicle speed in top gear is the maximum road speed for the vehicle. This speed **must** be greater than or equal to the maximum cruise speed if the cruise control feature is enabled.		
Smart Road Speed Governor — The smart road speed governor feature, when enabled, allows the operator to adjust the maximum vehicle speed limit by using an OEM switch, typically the cruise		

accel/resume switch. This feature can be used for city driving when reducing maximum vehicle speed can help prevent speeding tickets. To adjust the maximum vehicle speed limit, the cruise control on/off switch **must** be off and the coast/accel switch can be used to raise or lower the present limit. **NOTE: The maximum speed limit can not be adjusted above the predefined maximum vehicle speed in top gear limit.**		
Road Speed Governor Upper Droop — The road speed governor upper droop parameter allows tailoring of the torque curve before the maximum vehicle speed is reached while operating the road speed governor. Increasing the droop can increase fuel economy in hilly terrain. The setting can be between zero and three mph.		
Road Speed Governor Lower Droop - The road speed governor upper droop parameter allows tailoring of the torque curve in a downhill or no-load condition while operating the road speed governor before fueling is completely cut off. Faster downhill speed increases momentum going up the next hill and improves fuel economy in rolling terrain. The setting can be between zero and three mph.		
Cruise Control — The cruise control feature gives the driver the capability of a “foot-off” accelerator cruise operation. It is similar to an automobile cruise control.		
Maximum Cruise Control Speed — This speed is the maximum allowable cruise set speed. **NOTE: The maximum cruise control speed can not exceed the maximum vehicle speed in the top gear setting.**		
Cruise Control Governor Upper Droop — The cruise control governor upper droop parameter allows tailoring of the torque curve before the maximum vehicle speed is reached while operating in cruise control. Increasing the droop can increase fuel economy in hilly terrain. The setting can be between zero and three mph.		
Cruise Control Governor Lower Droop — The cruise control governor lower droop allows tailoring of the torque curve in a downhill or no-load condition while operating in cruise control before fueling is completely cut off. Faster downhill speed increases momentum going up the next hill and can improve fuel economy in rolling terrain. The setting can be between zero and three mph.		
Set/Accel — The set/accel parameter tells the ECM how the cab switch is configured. If it is set to yes, the cab switch will be set/accel in one position and resume/coast in the other position. If it is set to no, set/coast coast will be in one position while resume/accel will be in the other position.		
Cruise Control Set Speed Save — This feature permits the adjustable cruise control set speed to be saved through an engine shutdown and restart. This feature can be programmed using the INSITE™ electronic service tool. When this feature is enabled, the adjustable cruise control set speed established prior to shutdown can be resumed after next restart using the resume function of the cruise set/resume switch.		

Power Take-off (PTO) — The PTO feature controls the engine at a constant rpm selected by the operator. For applications needing the PTO mode, a remote-mounted switch can be used when a cab switch is **not** desirable. The cruise control switches are used for the PTO feature, also.		
PTO Maximum Speed — The PTO maximum speed parameter is the maximum engine speed that can be obtained while in the PTO mode.		
PTO Minimum Speed — The PTO minimum speed parameter is the minimum engine speed that can be obtained while in the PTO mode.		
PTO Set Point — The set point is for the PTO engine speed. This speed is obtained when the PTO on/off switch is in the ON position and the SET switch is used. **NOTE: PTO set speed can not exceed the maximum PTO speed.**		
PTO Resume Speed — This is the engine speed that will be obtained when the resume switch is used. **NOTE: PTO resume speed can not exceed the maximum PTO speed.**		
Maximum Engine Load in PTO — Some devices that are driven by the engine during PTO operation are sensitive to input torque. The maximum engine torque that can be output by the engine during PTO operation can be adjusted to protect these devices. **NOTE: This torque limit is also in effect during accelerator override of the PTO function.**		
Alternate PTO — The alternate PTO feature allows new set/resume PTO speeds to be established **only** when PTO is inactive. This is designed to protect pumping applications when high engine speed variations, while in PTO mode, could cause pump damage. The INSITE™ electronic service tool can enable or disable this feature.		
PTO Accelerator Override — Some applications require the ability to override the PTO set speed with the accelerator to increase engine speed without disengaging the PTO function. When the accelerator override in PTO feature is enabled, the engine speed can be increased above the present PTO operating speed by depressing the accelerator. Engine speed can **only** be overridden up to the maximum accelerator override in PTO speed. If the accelerator is released, the engine speed will return to the PTO set speed that was in effect before the accelerator override event.		
Brake and Clutch PTO Disable — The brake override in PTO disable feature allows the operator to exit PTO operation if the brake is activated. The clutch override in PTO disable feature allows the operator to exit PTO operation if the clutch pedal is depressed.		

Remote PTO — The remote PTO feature allows the PTO mode to be activated from a separate remote switch. Remote PTO can have up to five different set speeds, depending upon how many times the switch is toggled from OFF to ON before being left in the ON position. For example, to obtain remote PTO set speed 3, rapidly toggle the remote PTO on/off switch from OFF to ON three times, and leave it in the ON position on the last cycle.		
Remote PTO speeds one through five are the possible engine speeds when the remote PTO is enabled. The remote PTO has higher priority than the cab PTO, so it will control engine speeds in cases when both the cab and remote PTO are enabled.		
Gear-Down Protection — The gear-down protection feature limits the vehicle speed in the lower gears. The maximum vehicle speed in the lower gears is set at a lower mph than the maximum vehicle speed in the top gear. This encourages driving in the top gear for better fuel economy. The parameters' gear-down maximum vehicle speed, light engine load, and heavy engine load are associated with this feature.		
This feature allows the operator to downshift from top gear to the next lower gear under heavy load and maintain a speed higher than the gear-down speed. This allows the operator to keep the vehicle momentum up by using a lower gear to maintain a high engine speed when going uphill. As soon as the engine load drops off (e.g., going downhill) or the operator downshifts to another lower gear, the vehicle speed limit will ramp back down to the light-load gear-down speed limit. The driver will then have to upshift back into top gear to reach the maximum vehicle speed limit.		
Top Transmission Gear Ratio — The top transmission gear ratio parameter is needed for gear-down protection to work properly with double overdrive transmissions. This parameter will also be used by the trip information system to record the percentage of distance traveled in top gear.		
One Gear-Down Gear Ratio The one gear-down gear ratio parameter is used to tell the ECM the first gear down gear-ratio of the transmission.		
Gear-Down Maximum Vehicle Speed, Light Engine Load This is the maximum vehicle speed (3) for operating one gear below top gear during light engine load operations. This value can **not** exceed gear-down maximum vehicle speed, heavy engine load (2).		
Gear-Down Maximum Vehicle Speed, Heavy Engine Load This the maximum vehicle speed (2) for operating one gear below top gear during heavy engine load operations. This value can **not** exceed maximum vehicle speed in top gear (1).		
Powertrain Protection — This feature can limit engine output torque, depending upon transmission gear ratio. This feature helps protect the drivetrain when lower gears are engaged. Engine torque limits based on transmission gear ratio can be adjusted using the INSITE™ electronic service tool. This feature can also limit the maximum engine torque when a switched input to the ECM is activated. This allows the operator, or an automatic switching device, to limit engine torque under certain operating conditions, such as operation of an auxiliary		

device. This feature can also be configured to limit torque during heavy-load conditions. This allows full-torque output at light-load conditions and limits torque output when the engine is heavily loaded. An example of a torque limit table is illustrated.		
Automotive/Variable Speed (VS) Governor — The automotive/variable speed (VS) governor feature gives the owner a choice of engine governors. The automotive governor allows a larger speed variation under varying load conditions for a given accelerator position. The VS governor maintains a constant engine speed for a given accelerator position under varying load conditions.		
Low-Idle Speed — This parameter is the engine speed at which the engine will idle. This speed can be adjusted by a cab switch if the switch is installed and the low-idle adjustment feature is enabled.		
Low-Idle Adjustment — This feature allows the idle speed range to be increased or decreased in 25-rpm increments with the in-cab increment or decrement switch. There are limits on how high or low the low-idle speed can be adjusted. The allowable adjustment range for an ISC/QSC/ISL engine is 700 to 1000 rpm.		
Idle Shutdown — The feature automatically shuts off an engine after a period of engine idling when there is no activity from the driver, such as clutch, brake, or accelerator actuation. The idle shutdown system will **not** be active at coolant temperatures below 37.8°C [100°F]. After an engine has been automatically shut off, the key **must** be turned off for five seconds before attempting a restart. **NOTE: This feature will shut off the engine only. It will not remove power from other accessories powered by the keyswitch; these can cause a drain on the battery.**		
Idle Shutdown Time — Idle shutdown time is the period of engine idling time when there is no activity from the driver, such as clutch, brake, or accelerator actuation, before the engine automatically shuts off. **NOTE: This parameter will not appear if the idle shutdown feature is turned off.**		
Idle Shutdown in PTO — The idle shutdown in PTO feature automatically shuts off the engine after a period of PTO or remote PTO operation in which there is no activity from the driver, such as clutch, brake, or accelerator actuation.		
Idle Shutdown Override — The idle shutdown override feature allows the driver to override the idle shutdown by changing the position of the brake, clutch, or accelerator. After the idle shutdown feature has been overridden, this feature will **not** shut off the engine again until the vehicle has been moved.		
Duty Cycle Monitor — With this feature, the ECM tracks engine load and speed. These data are stored in the ECM, and the INSITE™ electronic service tool is used to display the data. The INSITE™ electronic service tool display shows a duty cycle “map” that shows the whole engine's operating range in terms of speed and load. This “map” is divided into 50 regions. The percent of the engine operating		

time spent in each region is shown on the display. The ECM contains duty cycle data for the whole life of the engine and for two 500-hour operating periods. The two 500-hour maps can be reset with the INSITE™ electronic service tool.		
Engine Abuse History — This feature monitors up to ten engine operating parameters, such as pressures, temperatures, switches, and engine speeds for conditions that are extreme or outside normal operating limits. This will provide comprehensive data about the life of the engine, how it has been used, how it has been maintained, and what abuse it has been subjected to.		
The collection and storage of engine operating and history data will be stored in: • Lifetime Abuse History. Data contained in the engine data files are grouped by operating category, each category having three severity levels that are assigned. These severity levels are **not** assignable with INSITE™ electronic service tool. The data stored also can **not** be reset with INSITE™electronic service tool.		
The ECM will collect and store data in a lifetime abuse history log for the following parameters: • Coolant Temperature • Intake Manifold Pressure • Oil Pressure • Engine Speed.		
On request, INSITE™ electronic service tool will display each of the following parameters along with time spent (hours of operation) over or under each of the three boundary levels and under the minimum limit or over the maximum limit. These data can be viewed with INSITE™ electronic service tool, but can **not** be reset. The boundary limits and maximum or minimum limits can **not** be altered with INSITE™ electronic service tool .		
Application Type — The application-type feature selection tells the ECM what type of application is being used in this vehicle. Choose between on-highway or on/off-highway. On-highway applications are those that use top gear for the majority of its operations. On/off-applications are those that use gears lower than top gear for the majority of its operations.		
Transmission Type — The transmission-type feature tells the ECM what type of transmission is used in the vehicle. The transmission is either manual, automatic, or fully automated. • Manual • Automatic • Fully automated.		
User-Activated Datalogger — The user-activated datalogger feature is aimed at improving troubleshooting capabilities and providing better assistance in troubleshooting intermittent problems. This is accomplished through use of an internal ECM datalogger to capture data while the problem is occurring. The INSITE™ electronic service tool is used to configure the feature for the specific type of problem that exists. Once the feature has been configured, the vehicle or machine can be put into operation.		

When the problem occurs, the ECM datalogger is activated and stores data in the ECM. These data can be analyzed using the INSITE™ electronic service tool. Once the problem has been resolved, the ECM can be reset using INSITE™ electronic service tool and the data will be cleared.

The ECM can store up to two occurrences of a specific problem. These occurrences are known as Event one and Event two. Event one is the first occurrence of a specific problem and is stored as a baseline. Additional occurrences are stored in Event two. Event two data get overwritten each time a new occurrence happens until the ECM is reset.

For example, if a high coolant temperature condition happened five times, the first occurrence would be stored in Event one and the fifth occurrence would be stored in Event two. The second, third, and fourth occurrences were stored in Event two but were overwritten each time the next event occurred.

Both Event one and Event two data are stored in a before/after manner where half the data logged is pretrigger information and the other half is logged posttrigger information. This is designed to give the user a snapshot of what was happening right up the point when the problem occurred and right after as well.

The INSITE™ electronic service tool is used to configure the feature by specifying which parameters the ECM will log, sampling rate, activation mode, and triggers one through four . The feature will need to be configured differently depending upon what type of problem is occurring. If an intermittent problem is occurring with no fault codes but the operator can determine when the problem happens, manual mode activation should be used. If a vehicle experiences fault codes intermittently or abnormal temperatures or pressures, automatic mode should be used.

Manual Activation: The INSITE™ electronic service tool is used to select manual mode, sampling rate, and which parameters to log. The list of available parameters to log will be a subset of the normal INSITE™ electronic service tool monitor parameters. The vehicle can then be sent into operation. When the operator experiences the problem, turning on the diagnostic switch will activate the ECM to start logging data. The ECM will continue to log data until that event's ECM buffer is full. After the intermittent problem stops, the diagnostic switch should be turned off. These data will be stored in Event one. The operator can keep collecting additional occurrences of the problem of which the most recent occurrence will be stored in Event two. INSITE™ electronic service tool can then be used to analyze the data.

Automatic Activation: Automatic mode allows the operator to define up to four triggers using the INSITE™ electronic service tool. When these triggers become true, the ECM will be activated to log data. Each trigger can be configured to activate the ECM by either a fault code going active/inactive or a parameter going above or below a specified value. INSITE™ electronic service tool is also used to select sampling rate and which parameters to log. When the ECM is activated, the logged data are stored in the ECM in the same manner as manual mode.

The four triggers have AND/OR logic. This means that triggers one through three are used in conjunction with each other and trigger four is used as an alternate with triggers one through 3.

In detail, this means the following:

- If **only** trigger one is used, when the condition set for trigger one is true, the ECM will be activated to log data.
- If triggers one and two are used, both conditions have to become true before the ECM is activated.

- If triggers one and two and three are used, all three conditions have to become true before the ECM is activated.
- Trigger four is the OR trigger. If trigger four is used with any combination of triggers one through 3, triggers one through three becoming true, **or** trigger four becoming true, will activate the ECM.

Real-Time Clock — The real-time clock feature provides time/date stamping of operational events, such as fault codes, audit trails, and engine protection data.

The real-time clock is contained within the ECM and will stamp events in units of year, month, day of month, hour, minute, and second. If the clock loses power, a diagnostic fault code will be triggered. Upon loss of power, the real-time clock will be initialized with the last known real time.

The INSITE™ electronic service tool can be used to enable the real-time clock feature and set the ECM clock. The auto set feature can be selected, which will automatically set the ECM clock to the present time/date of the PC.

NOTE: Once the real-time clock feature has been enabled in the ECM, it can not be disabled.

Vehicle Antitheft Protection — The antitheft feature prevents the engine from starting until a password is entered in the ECM using Cummins RoadRelay™ or the INSITE™ electronic service tool. Once deactivated, the engine can be started.

The antitheft feature will prevent the engine from starting **only** if the feature is enabled and the feature is activated. The feature can **only** be activated when the engine is idling or keyed on and **not** running. This feature has three separate functions:

- Anti-lock
- Throttle lock
- Hijack.

Anti-lock - There are two user-selectable modes of operation:

- Automatic
- Manual.

In automatic mode, the engine is **always** locked by the ECM at each engine shutdown. No password is required to activate antitheft. A password is required to deactivate antitheft. This feature will **not** lock automatically if the engine stopped because of an unintended stall.

Manual mode activation requires operator action to lock the engine. The user is prompted to activate the security by answering a yes/no question. If the user answers yes, the user **must** then key on the engine. If a PIN is required (user-selectable option), the user is prompted to enter the correct PIN to activate antitheft. If no PIN is required, the antitheft is activated by default.

There are six user passwords capable of locking or unlocking the engine. These are stored in the ECM and adjusted by INSITE™ electronic service tool.

A fault will be logged and a RED dash lamp will flash if the antitheft feature is active and an attempt to start the engine is made.

Throttle Lock - With the engine idling, the user can activate the feature

by entering the PIN. The engine will then ignore throttle input until a valid password is reentered. If the feature is activated while the engine is idling and vehicle speed is greater than zero, the engine will be shut down. The engine can also be shut off by the keyswitch. The engine will **not** restart until a valid password is entered.		
Hijack - A special hijack function will allow the engine to be temporarily unlocked. This functionality will counter a hijacking event when a hijacker forces the operator to input the password and the hijacker takes off with the vehicle. This feature is customer-selectable. When enabled, a special hijack code may be entered that will allow the vehicle to be driven for a customer-programmable amount of time, then to idle for a customer-programmable amount of time, and shut down. Once the vehicle has shut down, the special hijack code will **not** restart the engine. Once the vehicle has shut down, one of the six passwords **must** be entered to restart the engine.		
J1939 Multiplexing - The J1939 multiplexing feature gives the ability to send and receive messages over the J1939 datalink instead of hardwired connections. This is accomplished by using a vehicle electronic control unit. Inputs from switches, status parameters, and sensors can be hardwired into the vehicle electronic control unit . The vehicle electronic control unit can then broadcast the information from these switches and sensors via the J1939 datalink to the other ECMs on the vehicle system. The Cummins ECM is one of the control modules connected to the vehicle system through the J1939 datalink.		
The INSITE™ electronic service tool can be used to enable or disable this feature. When the feature is disabled, the ECM will **not** recognize any multiplexed input into the ECM, and therefore expect all switch/sensor input to the ECM by hardwire. When the feature is enabled, the ECM can be configured to receive a multiplexed signal for the following parameters: • Accelerator Interlock Switch • Air Conditioner Pressure Switch • Service Brake Switch • Clutch Switch • Cruise Control ON/OFF Switch • Cruise Control Resume Switch • Cruise Control Set Switch • PTO ON/OFF Switch • PTO Resume Switch • PTO Set Switch • Remote PTO Switch • Idle Increment/Decrement Switch • Diagnostic Switch • Torque Derate Switch • Manual Fan Switch • Engine Brake Switch • Accelerator Pedal Position • Idle Validation - On-Idle/Off-Idle • Remote Accelerator Switch • Remote Accelerator Position • Wait-to-Start Lamp Status • Water-in-Filter Lamp Status • Stop Lamp • Warning Lamp • Maintenance Lamp. This feature will be configured by the OEM. If the Cummins ECM is **not** capable of communication and a new ECM is required, a review of the customer configuration records should be used to determine how the feature should be configured in the new ECM.		
Dual Outputs - The dual-outputs feature, also known as switched outputs based on sensed inputs, allows the ECM to control one or two driver outputs based on input from up to 14 parameters.		

The feature can also be configured to shut down the engine based on customer-specified values of up to 14 of the same input parameters.

The 14 input parameters are:

0. Intake Manifold Temperature
1. Engine Speed
2. Commanded Fueling
3. Intake Manifold Pressure
4. Vehicle Speed
5. Engine Coolant Temperature
6. Engine Oil Pressure
7. PTO Status
8. OEM Switch
9. OEM Sensor
10. Throttle
11. Ambient Air Pressure
12. Remote Throttle
13. Fuel Rate.

The dual-outputs feature can be enabled or disabled by using the INSITE™ electronic service tool. The feature configuration, which defines what inputs and outputs are used, is specified by the calibration and can **not** be changed with INSITE™ electronic service tool.

The configuration can **not** be changed with the INSITE™ electronic service tool.

Industrial Applications

Control System Features - The control system can provide many features that are integrated into the vehicle's operation. Some of these features can be adjusted or turned on or off with a service tool, but some are set at the factory and can **not** be changed.

The following section describes the functionality of each feature. Whether a feature is available in a given application is calibration-dependent.

Maintenance Monitor Data — Use INSITE™ electronic service tool, the following maintenance data can be viewed or printed from the ECM:

- Percent of present interval consumed (by either time or fuel burned)
- Time since last reset
- Fuel burned since last reset
- Present maintenance monitor mode.

Alerting the Operator - The maintenance monitor will alert the operator of the need to change oil by flashing the FLUID lamp for approximately 12 seconds after keyswitch is turned on. The flashing sequence will be three quick flashes followed by a pause. This flash sequence will go through five cycles in the 12-second period. This sequence will occur every time the keyswitch is turned on until the maintenance monitor has been reset.

NOTE: The diagnostic switch must be in the OFF position for the flashing sequence to occur.

Maintenance Monitor Reset Log - The maximum threshold is entered by the user either directly using the time mode or by entering the

interval factor in the automatic mode.

The adjusted threshold is the new threshold set automatically by the maintenance monitor when the automatic mode is selected; it automatically reduces the maintenance intervals.

The “interval reset at” is the interval time and fuel recorded by the ECM at the time the maintenance monitor was reset.

The “cumulative reset at” is the total time and fuel recorded by the ECM at the time the maintenance monitor was reset.

The possible error will contain an “X” next to a row of data that can be inaccurate because of a system fault. The “X” will be triggered when a vehicle speed sensor fault or power down fault occurs. These faults can cause data either to **not** accumulate or to accumulate inaccurately.

Maintenance Monitor Reset - The maintenance monitor reset can be accomplished by clicking the reset button on the maintenance monitor screen using the INSITE™ electronic service tool or by using one of the following:

1) Procedure for applications **with** a throttle pedal.

0. Keyswitch in the ON position; diagnostic switch in the ON position; engine rpm at zero.
1. Depress the throttle pedal 100-percent; hold for more than three seconds and release.
2. Depress the throttle pedal 100-percent; twice more briefly (less than three seconds each time) and release.
3. Depress the throttle pedal 100-percent once more, and hold for three seconds or more and release.

2) Procedure for applications **without** a throttle pedal.

0. Keyswitch is in the ON position, and engine rpm is at zero.
1. Diagnostic switch is in the ON position for more than three seconds and then in the OFF position.
2. Diagnostic switch is in the ON position twice more briefly (less than three seconds each time and then in the OFF position between and after).
3. Diagnostic switch is in the ON position for more than three seconds and then in the OFF position.

NOTE: Process (one or two) must be completed within a maximum of 20 seconds after steps a and b are completed or the data will not be reset.

NOTE: The WARNING lamp will flash three quick flashes, signifying that the reset has been made.

Trip Information System -The trip information system records fuel consumption and time information for the engine during normal operation and in certain operating modes, such as intermediate-speed control and idle. These data can be displayed using the INSITE™ electronic service tool. Some data can **not** be reset and reflect the performance of the engine over its lifetime. Other data, as well as trip data, can be reset using INSITE™electronic service tool.

Duty Cycle Monitor -With this feature, the ECM tracks engine load and electronic service tool speed. These data are stored in the ECM, and the INSITE™ electronic service tool is used to display it. The INSITE™ service tool display shows a duty cycle map that allows the whole engine operating range in terms of speed and load. This map is divided into 50 regions. The percent of engine operating time spent in each region is shown on the display.

The ECM contains duty cycle data for the whole life of the engine and

for two 500-hour operating periods. The two 500-hour maps can be reset with INSITE™ electronic service tool.

Type Vehicle Speed Sensor

This feature indicates the type of vehicle speed sensor being used with the ECM.

The vehicle speed sensor can be adjusted with the INSITE™ electronic service tool.

The sensor is one of the following:

0. None
1. Magnetic
2. J1939 datalink
3. Other.

Tire Revolutions Per Mile - This feature is used to tell the ECM how many times the tire will turn a full revolution in one mile.

Tire revolutions per mile can be adjusted using the INSITE™ electronic service tool.

Rear Axle Ratio - This parameter tells the ECM the gear ratio of the rear axle.

Rear axle ratio can be adjusted with INSITE™ electronic service tool.

Number of Transmission Tailshaft Gear Teeth - This parameter tells the ECM the number of gear teeth on the transmission tailshaft.

The number of transmission tailshaft gear teeth can be adjusted with INSITE™ electronic service tool.

Road Speed Governor/Maximum Road Speed:

The road speed governor limits the maximum road speed of the vehicle in top gear.

The maximum vehicle speed in top gear is the maximum road speed for the vehicle. This speed **must** be greater than or equal to the maximum cruise speed if the cruise control feature is enabled.

The maximum road speed in top gear can be adjusted with INSITE™ electronic service tool.

NOTE: The auxiliary governor needs to be disabled to utilize the road speed governor.

WARNING

Do not use cruise control when the road is slippery, in heavy traffic, or when the weather is inclement. Loss of vehicle control can result.

Cruise Control - The cruise control feature gives the driver the capability of a “foot-off” accelerator cruise operation. It is similar to an automobile's cruise control.

The cruise control feature can be enabled or disabled with INSITE™ electronic service tool.

NOTE: Both cruise control and intermediate-speed control can

not be active at the same time.		
Maximum Cruise Control Speed - This speed is the maximum allowable cruise set speed. The maximum cruise control speed can be adjusted with INSITE™ electronic service tool . **NOTE: The maximum cruise control speed can not exceed the maximum vehicle speed in the top gear setting.**		
Intermediate-Speed Control - The intermediate speed control feature controls the engine at a constant engine rpm. Up to three intermediate speed control set speeds (one, two, three) can be selected depending upon OEM availability (four = engine speed, five = torque).		
The intermediate-speed control feature provides the ability to select an intermediate-speed control set speed by an OEM-provided switch (one = OFF, two = ON), depending upon OEM availability.		
This feature will override the throttle and control the engine speed to the intermediate-speed control setting.		
The intermediate-speed control feature provides a single droop (6) for all intermediate speeds (one, two, three). This droop is independent of all other selectable droops and is enforced during intermediate-speed control operation **only** (four = engine speed, five = torque).		
All intermediate-speed control speed settings (1) can **not** be adjusted above the maximum intermediate-speed control speed (2) or below the low-idle speed (3) (four = engine speed, five = torque).		
The intermediate-speed control set speed can be adjusted by the intermediate-speed control increment/decrement switch. Set speed changes using this switch will be saved to the ECM when the keyswitch is turned off.		
The intermediate speed control feature can be enabled or disabled by INSITE™ electronic service tool. The intermediate speed control set speeds one, two, three can be adjusted with INSITE™ electronic service tool, along with the intermediate speed control droop.		
Hybrid Governor - The hybrid governor is a selectable feature within the electronic service tool INSITE™ electronic service tool. The hybrid governor feature uses calibrated torque curves instead of the 100-percent throttle torque curve to limit fueling at partial throttle auxiliary-speed governor, and therefore achieves partial-throttle operation with the same power and torque rise characteristics of the full-throttle operation. It will allow the application to be operated in a more fuel efficient manner and the ability to drive at partial throttle.		
Auxiliary-Speed Governor - The auxiliary-speed governor is an application-specific feature that allows the engine to be governed by either an auxiliary speed or pressure signal. The feature uses a manual switch input to turn the governor operation on or off.		

The auxiliary-speed governor uses a throttle input that is scaled to the auxiliary speed governor minimum reference speed and the auxiliary-speed governor maximum reference speed. The auxiliary-speed governor reference speed (or pressure), determined by the throttle position, is the desired auxiliary-speed (or pressure). The auxiliary-speed governor algorithm will then control engine speed to match the actual auxiliary speed from the auxiliary device to the auxiliary-speed governor reference speed.		
The following adjustments can be made with INSITE™ electronic service tool: • Auxiliary speed governor minimum reference speed • Auxiliary speed governor maximum reference speed • Auxiliary speed governor number of teeth • Auxiliary speed governor high threshold • Auxiliary ramp rate.		
Alternate Droop - The alternate droop feature allows the droop characteristics to be changed for high engine governed speeds (or high-speed governor) and for the VS governor. Droop is usually expressed as a percentage. This graph illustrates the isochronous (0-percent droop) and droop (more than 0-percent droop) governor characteristics. Less governor droop provides a more responsive governor for more precise engine control. More governor droop provides smoother shifting and smoother mechanical clutch engagement.		
The alternate droop feature provides, depending on OEM availability, the ability to select up to two additional alternate droop settings by an OEM-provided switch. The type of droop switch (one position, two position, three position) can be adjusted with INSITE™ electronic service tool.		
Each alternate droop setting provides the ability to select the high-speed governor breakpoint speed and droop percent. Droop percent at minimum and maximum throttle for the VS governor is also adjustable. The breakpoint speed determines the position on the engine torque curve where the high-speed governor will start to limit engine torque output. Selection of the alternate droop feature is accomplished by using the electronic service tool INSITE™ electronic service tool.		
There are two switch variations for alternate droop: One is a two-position switch.		
The other is a three-position switch.		
Switched Torque — The switch torque feature allows the operator to switch between the 100-percent throttle torque curve one and up to two derated torque curves two and three (four = engine speed, five = torque).		
This feature improves operating efficiency in loaded (1) versus unloaded (2) conditions, as well as protecting the transmission and driveline.		

The switched torque feature provides, depending upon OEM availability, the ability to select two additional derated torque curves with an OEM-provided switch.		
This feature can be enabled or disabled by the INSITE™ electronic service tool.		
There are two switch variations for alternate torque: One is a two-position switch.		
The other is a three-position switch.		
Boost Power - The boost power feature provides the operator with enhanced torque/power for a fraction of the operating period. If the feature is enabled, boost power can be engaged by a cab-mounted switch or automatically if the automatic boost power feature is enabled. The additional power is limited by a calibrated time period, thresholds for intake manifold temperature, coolant temperature, and engine speed. **NOTE: Boost power is not available continuously.**		
The INSITE™ electronic service tool can enable or disable the boost power feature. The service tool can also monitor the cab-mounted boost power switch. If the boost power feature is enabled, the boost power can be engaged by using a cab-mounted switch. When the automatic boost power feature is enabled, it automatically switches the engine to the boost power curve based on the engine operating conditions; no manual switch is needed. The automatic boost power feature can be enabled or disabled with INSITE™ electronic service tool.		
Remote Throttle - The remote throttle feature allows the operator to control the engine from a position other than the driver's seat. This feature is selected by the operator through an OEM-mounted switch. The remote throttle feature can be enabled or disabled with INSITE™ electronic service tool. There are three modes available for the remote throttle feature. These modes can be enabled or disabled with INSITE™ electronic service tool.		
Mode one throttle (default) will override the primary throttle control (1) and control the engine speed with the remote throttle setting. **NOTE: Mode one remote throttle does not employ idle validation and is intended for stationary applications only.**		
Mode two throttle is a select minimum throttle using two different throttles. One example is equipment using a hand throttle as the		

primary throttle and a foot throttle as a decelerating remote throttle. Mode two throttle is enabled when a minimum throttle value is sensed between the primary throttle and the remote throttle. **NOTE: Mode two remote throttle does not employ idle validation.**		
Mode three throttle is a select maximum throttle using two different throttles. One example is equipment using a hand throttle as the primary throttle and a foot throttle as a decelerating remote throttle. Mode three throttle is enabled when a maximum throttle value is sensed between the primary throttle and the remote throttle. **NOTE: Mode three remote throttle does not employ idle validation.**		
Frequency Throttle — The frequency throttle feature converts a filtered throttle frequency input into a requested throttle percentage. The frequency throttle feature is applicable in industrial and marine applications where a position, electronic, or logic signal is **not** appropriate. The frequency throttle feature supports idle validation. The frequency throttle feature can be enabled or disabled with the INSITE™ electronic service tool.		
Multiple Unit Synchronization - The multiple unit synchronization feature allows two or more engines to be controlled by a single throttle signal. The ISL engine configuration available with this feature is soft-coupled marine. The multiple unit sychronization feature can be enabled or disabled with the INSITE™ electronic service tool.		
The soft-coupled marine configuration has all engines connected to a J1939 datalink.		
Pulse-Width Modulate Output — This feature allows the electronic control module to output an analog signal that is proportional to either engine speed, engine load, engine torque output, or throttle input.		
The pulse-width modulate output signal is intended to be used to control an engine or transmission that relies on an analog signal input. This signal can also be configured as an ON/OFF signal where the signal is either 12 VDC (U-battery) or open, depending upon the load.		
The pulse-width modulate output feature is adjustable with the INSITE™ electronic service tool.		
Low-Idle Speed - The low-idle speed parameter is the speed at which the engine will idle. This speed can be adjusted by a cab switch if the switch is installed and the low-idle adjust feature is enabled. Low-idle speed can also be adjusted with the INSITE™ electronic service tool.		
Low-Idle Adjustment - The low-idle adjustment feature allows the idle		

speed to be increased or decreased in 25-rpm increments with the in-cab increment or decrement switch. There are limits on how high or low the low-idle speed can be adjusted. The allowable adjustment range for an ISC/QSC engine is 700 to 1000 rpm.		
Alternate Low Idle Speed - This features allows the operator to switch between the low-idle speed setting and an alternate low idle speed setting (one = speed, two = torque).		
The alternate low-idle speed can **not** be adjusted by the idle increment/decrement switch.		
Idle Shutdown - The idle shutdown feature automatically shuts off an engine after a period of engine idling when there is no activity from the driver such as clutch, brake, or accelerator actuation. After an engine has been automatically shut off, the key **must** be turned off for five seconds before attempting a restart. The idle shutdown feature can be enabled or disabled with the INSITE™ electronic service tool. **NOTE: This feature will shut off the engine only. It will not remove power from other accessories powered by the keyswitch; these can cause a drain on the battery.**		
Idle Shutdown Time - The idle shutdown time is the period of engine idling when there is no activity from the driver, such as clutch, brake, or accelerator actuation before the engine automatically shuts off. The idle shutdown time can adjusted using INSITE™ electronic service tool . **NOTE: This parameter will not appear if the idle shutdown feature is turned off.**		
Idle Shutdown in Intermediate Speed Control - This feature automatically shuts off the engine after a period of intermediate speed control operation in which there is no activity from the driver, such as clutch, brake, or accelerator actuation.		
Idle Shutdown Override - The idle shutdown override feature allows the driver to override the idle shutdown by changing the position of the brake, clutch, or accelerator at any time during the idle shutdown warning period. The idle shutdown warning period lasts for a calibrated period prior to engine shutdown. The yellow WARNING lamp on the dash will flash during the idle shutdown warning period. After the idle shutdown feature has been overridden, this feature will **not** shut off the engine again until the vehicle has been moved.		
Manual Fan Switch Enable - The ECM can control the cooling fan based on inputs from the coolant temperature sensor and the intake manifold temperature sensor. Some applications will also provide inputs to the ECM for auxiliary device cooling, such as air conditioner pressure and power steering temperature. Your application could also include a manual switch for		

fan control. The manual fan switch feature can be enabled or disabled with the INSITE™ electronic service tool.		
Fan Type - Enable this feature to control a variable-speed fan drive to help optimize fuel economy when a variable-speed fan is available for use. The ECM varies fan speed according to coolant temperature to maintain the temperature in the optimum operating range while minimizing the amount of load put on the engine by the fan. The variable-speed fan feature can be enabled or disabled with the INSITE™ electronic service tool.		
Programmable Fan Logic - Select either zero VDC = ON or (+) 12 VDC = ON to match the fan clutch logic used in the application. A relay should be used for fans that draw more than six amps. The programmable fan logic feature can be enabled or disabled with the INSITE™ electronic service tool.		
Air Conditioner Pressure Switch Input - This allows the air conditioner pressure switch input to be disabled if that input into the ECM is **not** being used. Enable this feature if the air conditioner pressure switch input into the ECM is being used to control the fan. The air conditioner pressure switch input feature can be enabled or disabled with the INSITE™ electronic service tool. The air conditioner pressure switch is a normally closed switch.		
Fan-on with Exhaust Brake - This feature will enable an electric fan when the exhaust brake is engaged. This increases the total braking power by increasing the parasitic load on the engine. The fan-on with exhaust brake feature can be enabled or disabled with the INSITE™ electronic service tool.		
Exhaust Brake - Some vehicles are equipped with an ECM-controlled exhaust brake. This exhaust brake can be used to slow the vehicle down. The brake accomplishes this by restricting the exhaust gas flow out of the engine. Using the exhaust brake in hilly terrain or during heavily loaded decelerations can help reduce wear on the service brakes. The ECM will activate the exhaust brake when conditions require its operation.		
Several operating conditions **must** be true to activate the exhaust brake: 0. Exhaust brake switch must be in the ON position. 1. The operator's foot **must** be off the accelerator pedal (pedal at low-idle speed position). 2. Engine speed **must** be above 1000 rpm.		
If the above conditions are true in addition to several ECM interval fueling command checks, then the exhaust brake will engage and begin slowing the engine. The exhaust brake will remain on until one of the above conditions is no longer true. **NOTE: Some electronically controlled automatic transmissions will begin downshifting during exhaust brake operation. This keeps the engine speed up near rated speed where the braking effect is greatest.**		

CAUTION

The engine speed must not exceed 2900 rpm under any circumstances. When descending a steep grade, use a combination of transmission gears and engine or service brakes to control the vehicle and engine speed.

Exhaust Brake or Driveline Retarder Control - This feature tells the ECM whether an exhaust brake or a driveline retarder is being used on the vehicle. It allows the driveline retarder to operate below 1000 rpm down to idle speed, but will disengage the selected speed when the exhaust brake feature is chosen.

Engine Protection Shutdown - This feature automatically shuts off the engine whenever monitored parameters indicate the engine is operating over or under normal operating conditions.

The red STOP lamp in the cab will flash for a calibrated period prior to shutdown to alert the driver.

The engine protection system feature can be enabled or disabled with the INSITE™ electronic service tool.

Engine Warm-up Protection - This feature inhibits the throttle to keep the engine at low idle for a brief period after the engine starts to allow oil to reach all critical areas until engine components before speed is increased above low idle.

To limit the engine's speed at start-up, the following inputs are limited:

0. Throttle input
1. Intermediate-speed control switches
2. Datalink control inputs.

NOTE: The maintenance lamp is turned on while this feature is operating. Once adequate oil pressure is attained, the lamp is turned off.

The engine warm-up protection feature can be enabled or disable with the INSITE™ electronic service tool.

Engine Protection/Hot Shutdown Load Percent - If the hot shutdown monitor is enabled, the ECM will log an inactive fault when the engine is turned off while still hot by the operator or by the engine protection feature.

An engine is considered hot when the hot shutdown load percent of the engine is above the threshold set by the INSITE™ electronic service tool. The hot shutdown load percent is based on the duty cycle load factor, which is determined from engine fueling levels.

CAUTION

The maintenance monitor is designed to alert the operator of the need for a routine maintenance stop. Maintenance records must still be maintained for historical purposes.

CAUTION

The maintenance monitor uses data received from the ECM to determine the amount of fuel burned. Whenever a battery voltage fault has occurred, the maintenance monitor data can be inaccurate.

Maintenance Monitor - The maintenance monitor is an optional feature that will alert the operator when it is time to change oil and perform any other simultaneous maintenance tasks. The maintenance monitor continuously monitors the time the engine has been operating and the amount of fuel burned to determine when it is time to change oil.

NOTE: The operator must still be alert for any indications that the engine needs other service.

The maintenance monitor has three modes of operation:

- Automatic mode
- Time mode (manual).

CAUTION

The use of synthetic-base oil does not justify extended oil change intervals. Extended oil change intervals will decrease engine life due to factors such as corrosion, deposits, and wear.

The automatic mode alerts the operator when it is time to change oil based on Cummins recommended interval. It determines the maintenance interval based on coolant temperature and load factor.

When the automatic mode is selected, the SEVERE oil drain interval duty cycle is the default.

The interval factor is used only in the maintenance monitor auto mode. It is used to adjust the maintenance interval for SEVERE-, NORMAL-, or LIGHT-duty applications.

The original factory programmed value is SEVERE.

CAUTION

Refer to Lubricating Oil Drain Intervals in the operation and maintenance manual when selecting the correct oil change interval for your application. Cummins Engine Company, Inc. does not recommend exceeding these published intervals and is not responsible for damage sustained due to overextended drain intervals.

The time mode allows the customer to enter a desired time interval. The maintenance monitor will then monitor the time the engine has run and alert the operator when the interval has expired.

Maintenance Monitor Interval Alert Percentage - This feature allows the user to enter the percentage of the present interval at which the

light comes on, indicating the need for an oil change. The parameter allows the user to obtain an early warning of the need for a maintenance stop. For example, if the time mode is set to 100 hours and the interval alert percentage is set to 90-percent, the MAINTENANCE lamp will illuminate at 90 hours (90-percent of 100 hours).		
Engine Time Offset - This parameter is part of the trip information system. The value entered will be added to the total ECM time to get the total engine time. This parameter allows the time on the engine to be entered when an ECM is replaced. The engine time offset parameter can be adjusted with the INSITE™ electronic service tool.		
Real-Time Clock - The real-time clock feature provides time/date stamping of operational events, such as fault codes, audit trails, and engine protection data. The real-time clock is contained within the ECM and will stamp events in units of year, month, day of month, hour, minute, and second. If the clock loses power, a diagnostic fault code will be triggered. Upon loss of power, the real-time clock will be initialized with the last known real time.		
The INSITE™ electronic service tool can be used to enable the real-time clock feature and set the ECM clock. The autoset feature can be selected which will automatically set the ECM clock to the present time/date of the PC. **NOTE: Once real-time clock feature has been enabled in the ECM, it can not be disabled.**		
User-Activated Datalogger - The user-activated datalogger feature is aimed at improving troubleshooting capabilities and providing better assistance in troubleshooting intermittent problems. This is accomplished through the use of an internal ECM datalogger to capture data while the problem is occurring. The INSITE™ electronic service tool is used to configure the feature for the specific type of problem that exits. Once the feature has been configured, the vehicle or machine can be put into operation. When the problem occurs, the ECM datalogger is activated and stores data in the ECM. These data can be analyzed using INSITE™ electronic service tool. Once the problem has been resolved, the ECM can be reset using INSITE™ electronic service tool , and the data will be cleared.		
The ECM can store up to two occurrences of a specific problem. These occurrences are known as Event one and Event two. Event one is the first occurrence of a specific problem and is stored as a baseline. Additional occurrences are stored in Event two. Event two data gets overwritten each time a new occurrence happens until the ECM is reset. For example, if a high coolant temperature condition happened five times, the first occurrence would be stored in Event one and the fifth occurrence would be stored in Event two. The second, third, and fourth occurrences were stored in Event two but were overwritten each time the next event occurred.		
Both Event one and Event two data are stored in a before/after manner where half the data logged are pretrigger information and the other half post-trigger. This is designed to give the user a snapshot of		

what was happening right up to the point when the problem occurred and right after, as well.

The INSITE™ electronic service tool is used to configure the feature by specifying which parameters the ECM shall log, sampling rate, activation mode, and triggers one through four . The feature will need to be configured differently depending upon what type of problem is occurring. If an intermittent problem is occurring with no fault codes but the operator can determine when the problem happens, manual mode activation should be used. If a vehicle experiences fault codes intermittently or abnormal temperature or pressures, automatic mode should be used.

Manual Activation: The INSITE™ electronic service tool is used to select manual mode, sampling rate, and which parameters to log. The list of available parameters to log will be a subset of the normal INSITE™ electronic service tool monitor parameters. The vehicle can then be sent into operation. When the operator experiences the problem, turning on the diagnostic switch will activate the ECM to start logging data. The ECM will continue to log data until that event's ECM buffer is full. After the intermittent problem stops, the diagnostic switch should be turned off. These data will be stored in Event one. The operator can keep collecting additional occurrences of the problem of which the most recent occurrence will be stored in Event two. INSITE™ electronic service tool can then be used to analyze the data.

Automatic Activation: Automatic mode allows the operator to define up to four triggers using INSITE™ electronic service tool. When these triggers become true, the ECM will be activated to log data. Each trigger can be configured to activate, the ECM by either a fault code going active/inactive or a parameter going above or below a specified value. INSITE™ electronic service tool is also used to select sampling rate and which parameters to log. When the ECM is activated the logged data is stored in the ECM in the same manner as manual mode.

The four triggers have AND/OR logic. This means that triggers one through three are used in conjunction with each other and trigger four is used as an alternate with triggers one through 3.

In detail, this means the following:

- If **only** trigger one is used, when the condition set for trigger one is true, the ECM will be activated to log data.
- If triggers one and two are used, both conditions have to become true before the ECM is activated.
- If triggers one and two and three are used, all three conditions have to become true before the ECM is activated.
- Trigger four is the OR trigger. If trigger four is used with any combination of triggers one through 3, triggers one through three becoming true **or** trigger four becoming true will activate the ECM.

Throttle-Activated Diagnostic Switch - Throttle-activated diagnostic switch is intended to eliminate the need for a dash-mounted diagnostic switch, which is used to activate the diagnostic mode to display active fault codes in a sequence of flashing lamps. The throttle-activated diagnostic switch feature eliminates the need for a dash-mounted diagnostic switch by providing a simple sequence of throttle movements that activate the diagnostic mode.

When the engine is **not** running, the keyswitch is turned on, and the feature flag is enabled, a sequence of three throttle cycles shall activate the diagnostic mode. The increment/decrement switch can be used to navigate to the next or previous fault code. In case these switches are **not** available, a throttle cycle shall also increment to the next fault.

Diagnostic Fault Codes

The ISC/QSC/ISL control system can show and record operation anomalies that present themselves as fault codes. These codes will make troubleshooting easier. The fault codes are recorded in the electronic control module (ECM). They can be read using the fault lamps in the dash or with the INSITE™ electronic service tool.

NOTE: Not all engine or QSC control system anomalies are shown as fault codes.

There are three types of system codes:

- Engine electronic control system fault codes
- Engine protection system fault codes
- Engine maintenance indicator codes.

All fault codes recorded will be either active (fault code is currently active on the engine) or inactive (fault code was active at some time, but at the moment is **not** active).

Most, but **not** all, of the electronic fault codes will light a lamp when they are active. There are three possible lamps that can be illuminated when a fault code is active:

- The WARNING or CHECK ENGINE lamp is yellow and indicates the need to repair the fault at the first available opportunity.
- The STOP or STOP ENGINE lamp is red and indicates the need to stop the engine as soon as it can be safely done. The engine should remain shut down until the fault can be repaired.
- The MAINTENANCE lamp will illuminate when an engine maintenance function needs to be performed.

Some vehicles will also have a WAIT TO START lamp and a WATER IN FUEL lamp. The WAIT TO START lamp is illuminated during the preheat time that takes place at key-on during cold-weather starting. To minimize cranking time during cold-weather starting, the engine can **not** be cranked until the WAIT TO START lamp has been extinguished.

The WATER IN FUEL lamp indicates that the engine's fuel-water separator needs to be drained. This task should be performed, as soon as possible, whenever this lamp is illuminated. Some vehicle OEMs will combine the functions of the MAINTENANCE and WATER IN FUEL lamps. In these cases, the MAINTENANCE lamp indicates a WATER IN FUEL warning, in addition to other maintenance indicators.

To check for active engine electronic system fault codes and maintenance indicator codes, turn the keyswitch to the OFF position, and move the diagnostic switch to the ON position, or connect the shorting plug into the diagnostic connector.

Turn the vehicle keyswitch to the ON position.

If no active fault codes are recorded, both WARNING and STOP lamps will illuminate and stay on.

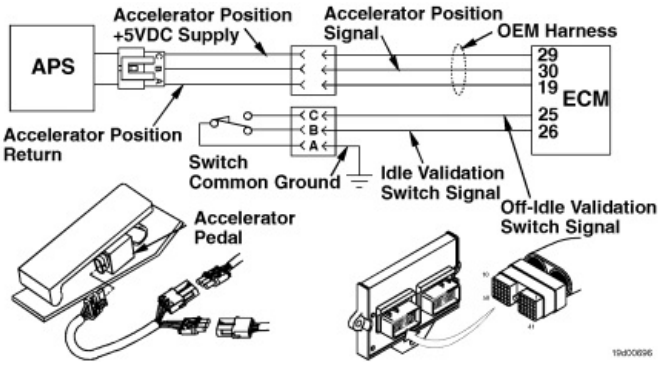
If active fault codes are recorded, both WARNING and STOP lamps will illuminate momentarily, then begin to flash the codes of the recorded faults.		

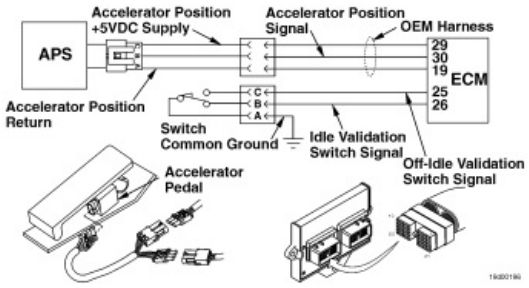
The fault code will flash in the following sequence: 0. A yellow WARNING lamp will flash. 1. There is a short 1- or 2-second pause. 2. The fault code will flash on the red STOP lamp. 3. There is a short 1- or 2-second pause between each number. When the number has finished flashing in red, a yellow WARNING lamp will appear again. The fault code will repeat the same sequence.		

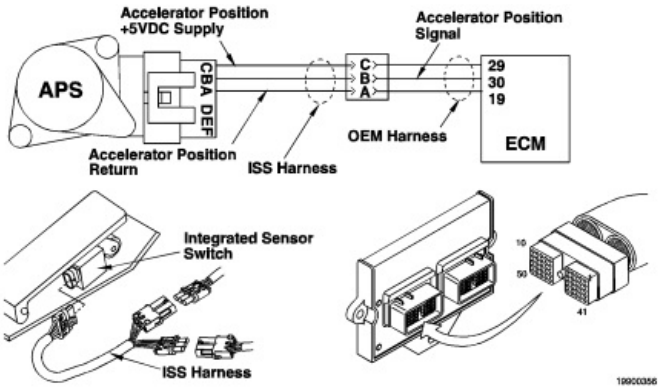
When **not** using the diagnostic system, turn OFF the Diagnostic Switch, or remove the Shorting Plug. If the Diagnostic Switch is left ON or the Shorting Plug left in, the electronic control module (ECM) will **not** log some fault codes.		

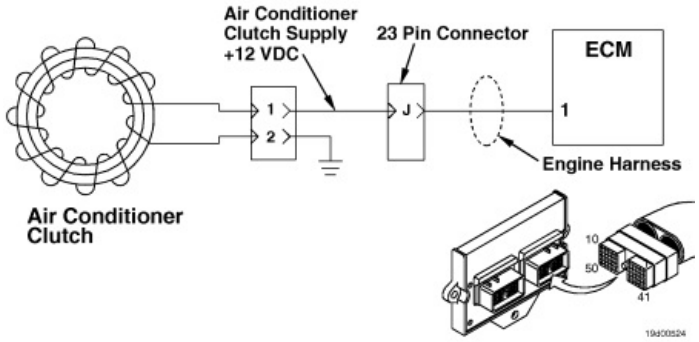
Fault Code Snapshot Data - This additional fault code information can be obtained by using the INSITE™ electronic service tool. The snapshot data records the value or state of the control system sensors and switches at the time a fault code occurred. Either set of data is stored for the first occurrence of the fault, since it was last cleared, and for the most recent occurrence. This data can be very valuable when trying to recreate or determine engine operating conditions at the time of a fault.		

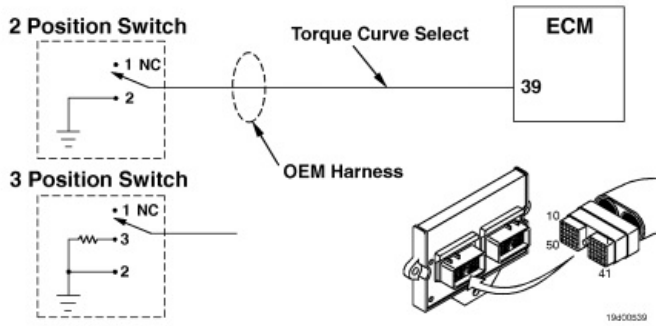
Last Modified: 12-Jan-2005

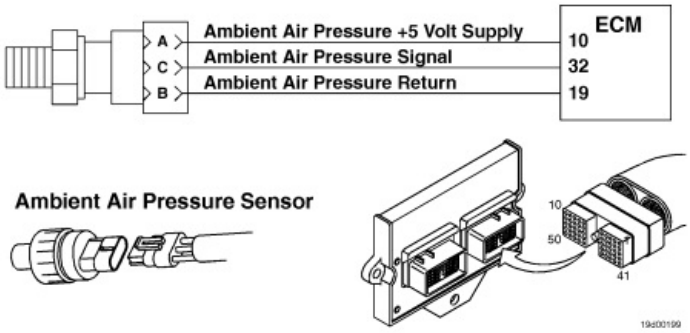

APS
Accelerator Position
+5VDC Supply
Accelerator Position
Signal
OEM Harness
29
30
19
ECM
25
26
C
B
A
Accelerator Position
Return
Switch
Common Ground
Idle Validation
Switch Signal
Off-Idle Validation
Switch Signal
Accelerator
Pedal

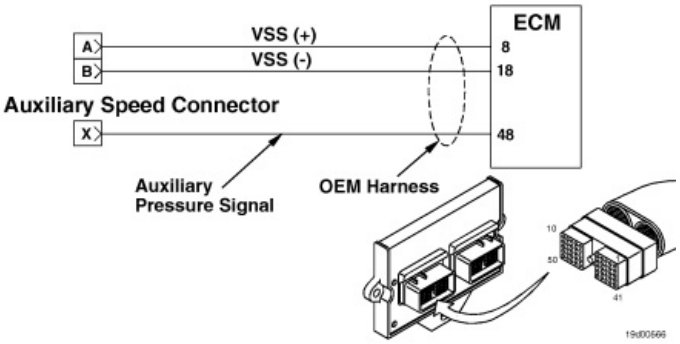

Accelerator Position
+5VDC Supply
Accelerator Position
Signal
OEM Harness
APS
29
30
19
ECM
25
26
C
B
A
Accelerator Position
Return
Switch
Common Ground
Idle Validation
Switch Signal
Off-Idle Validation
Switch Signal
Accelerator
Pedal

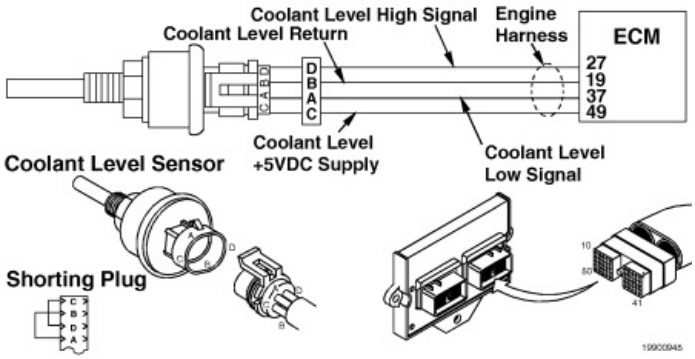

Accelerator Position
+5VDC Supply
Accelerator Position
Signal
APS
CBA DEF
C
B
A
29
30
19
ECM
OEM Harness
Accelerator Position
Return
ISS Harness
Integrated Sensor
Switch
ISS Harness
10
95
41
19900356

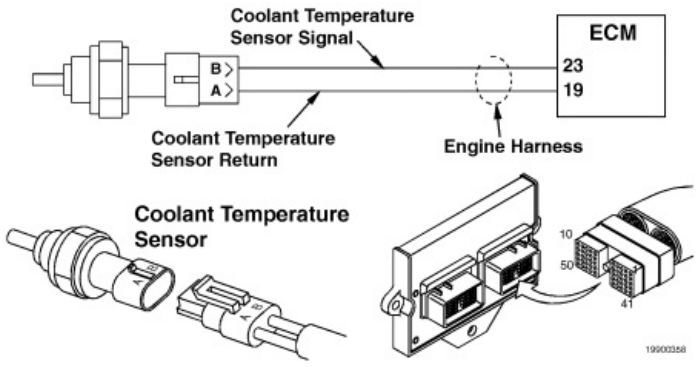

Air Conditioner
Clutch Supply
+12 VDC
23 Pin Connector
ECM
1
2
J
1
Engine Harness
Air Conditioner
Clutch
10
50
41
19d000524

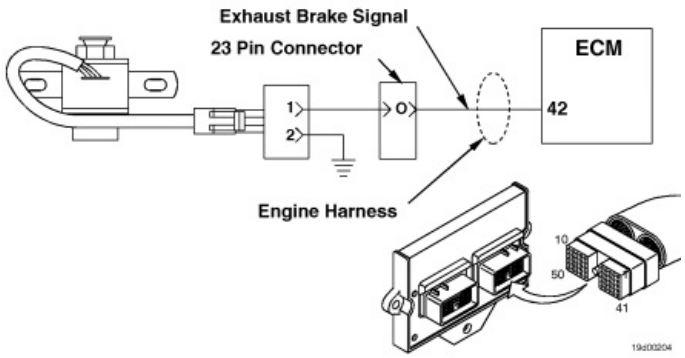

2 Position Switch
1 NC
2
Torque Curve Select
ECM
39
OEM Harness
3 Position Switch
1 NC
3
2
10
50
41
19d00539

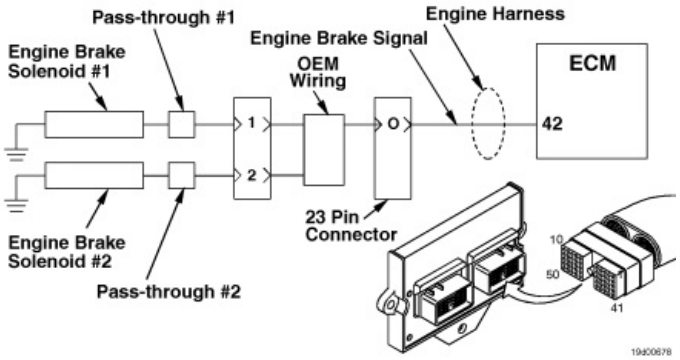

Ambient Air Pressure +5 Volt Supply
Ambient Air Pressure Signal
Ambient Air Pressure Return
A
C
B
ECM
10
32
19
Ambient Air Pressure Sensor
10
50
41
19d00199

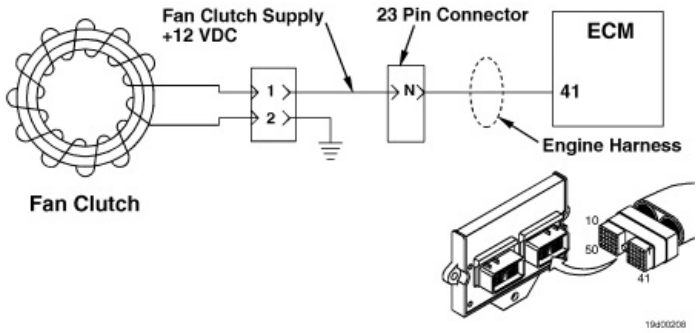

ECM
VSS (+)
VSS (-)
A
B
8
18
Auxiliary Speed Connector
X
48
Auxiliary
Pressure Signal
OEM Harness
10
50
41
19d00566

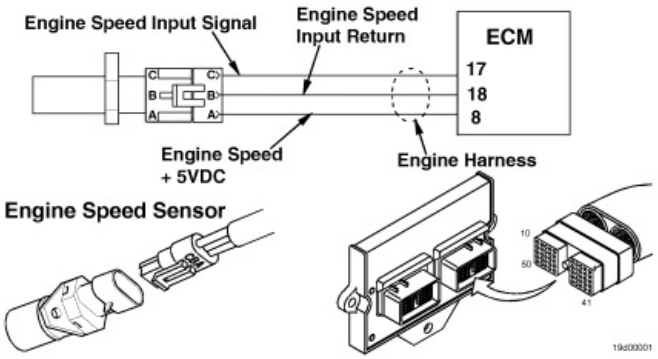

Coolant Level High Signal
Engine Harness
ECM
Coolant Level Return
D
B
A
C
27
19
37
49
Coolant Level Sensor
Coolant Level +5VDC Supply
Coolant Level Low Signal
Shorting Plug

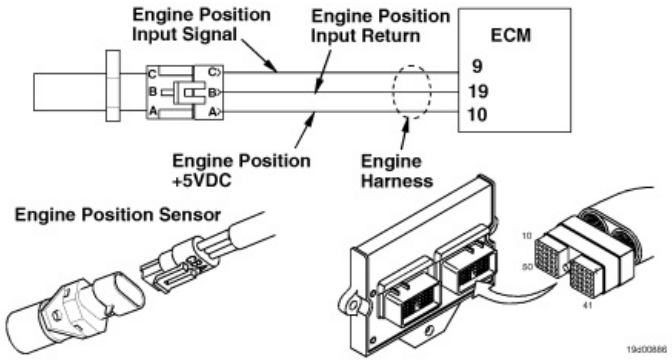

Coolant Temperature
Sensor Signal
ECM
B
A
23
19
Coolant Temperature
Sensor Return
Engine Harness
Coolant Temperature
Sensor
10
50
41
19900358

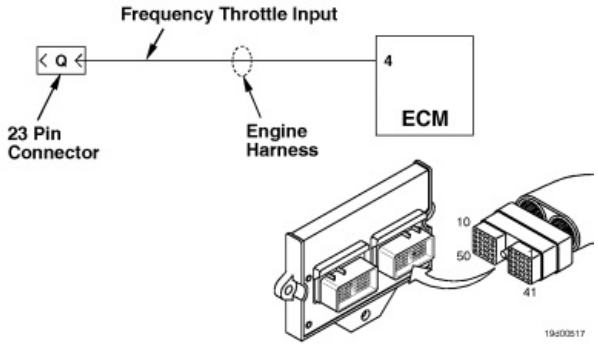

Exhaust Brake Signal
23 Pin Connector
ECM
1
2
42
Engine Harness
10
50
41
19d00204

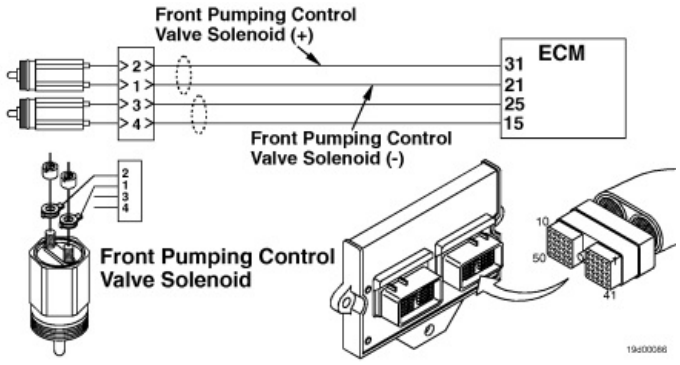

Pass-through #1
Engine Brake Solenoid #1
Engine Brake Signal
OEM Wiring
Engine Harness
ECM
1
2
O
42
23 Pin Connector
10
50
41
Engine Brake Solenoid #2
Pass-through #2
19d00878

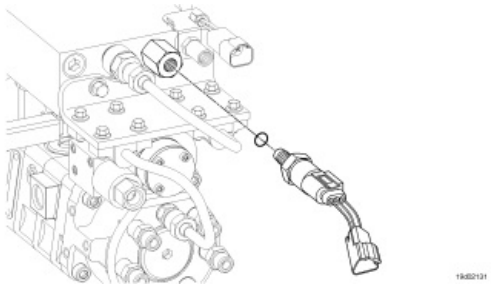

Fan Clutch Supply
+12 VDC
23 Pin Connector
ECM
1
2
N
41
Engine Harness
Fan Clutch
10
50
41
19d00208

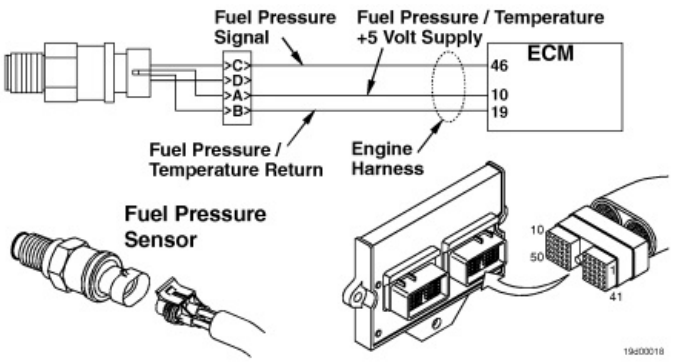

Engine Speed Input Signal
Engine Speed Input Return
ECM
17
18
8
Engine Speed + 5VDC
Engine Harness
Engine Speed Sensor
C
B
A
10
50
41
19d00001

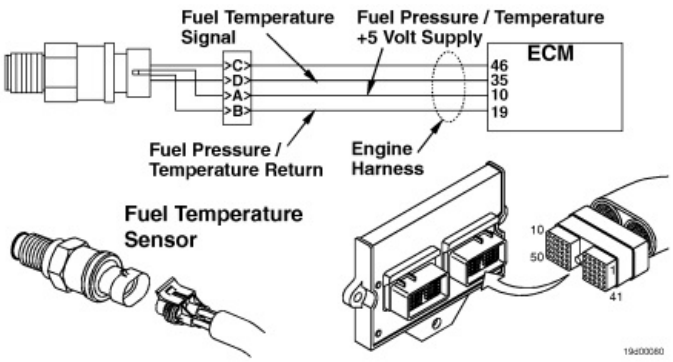

Engine Position
Input Signal
Engine Position
Input Return
ECM
9
19
10
C
B
A
Engine Position
+5VDC
Engine
Harness
Engine Position Sensor
10
50
41
19d00886

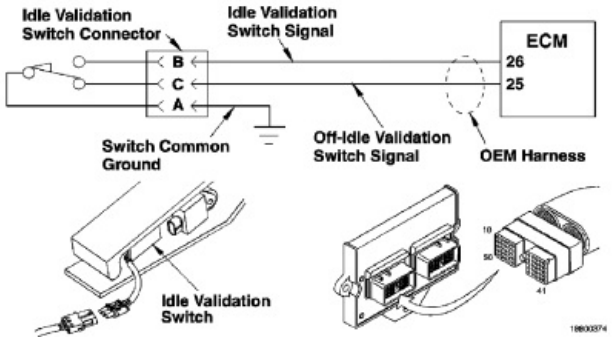

Frequency Throttle Input
Q
4
ECM
23 Pin
Connector
Engine
Harness
10
50
41
19d00517

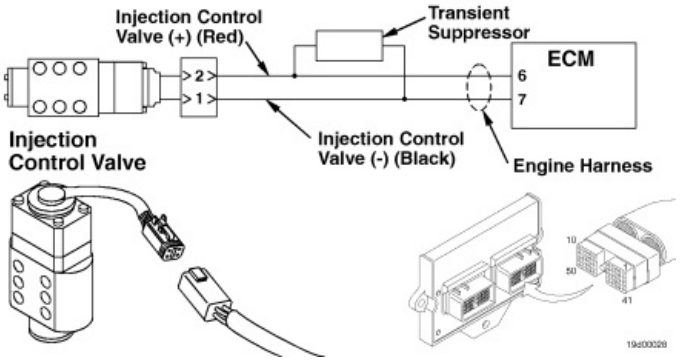

Front Pumping Control
Valve Solenoid (+)
ECM
2
1
3
4
31
21
25
15
Front Pumping Control
Valve Solenoid (-)
2
1
3
4
Front Pumping Control
Valve Solenoid
10
50
41
19d00066

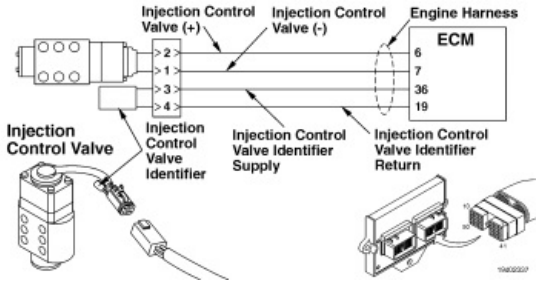


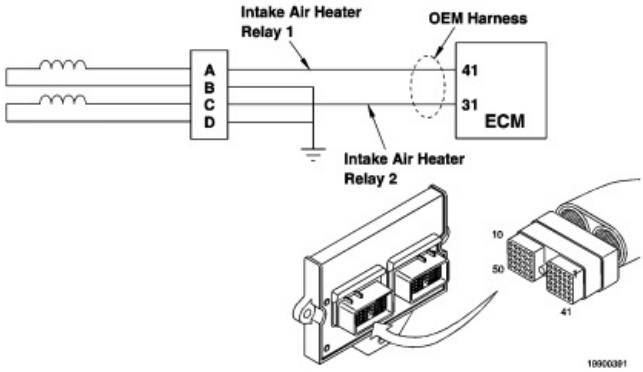

Fuel Pressure
Signal
Fuel Pressure / Temperature
+5 Volt Supply
ECM
>C<
>D<
>A<
>B<
46
10
19
Fuel Pressure /
Temperature Return
Engine
Harness
Fuel Pressure
Sensor
10
50
41
19d00018

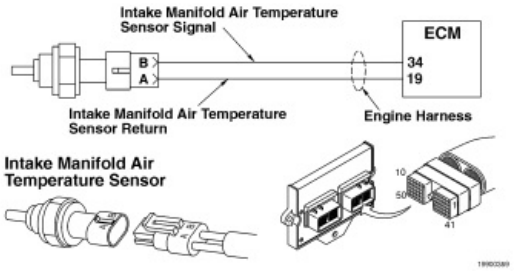

Fuel Temperature
Signal
Fuel Pressure / Temperature
+5 Volt Supply
ECM
>C<
>D<
>A<
>B<
46
35
10
19
Fuel Pressure /
Temperature Return
Engine
Harness
Fuel Temperature
Sensor
10
50
41
19d00060

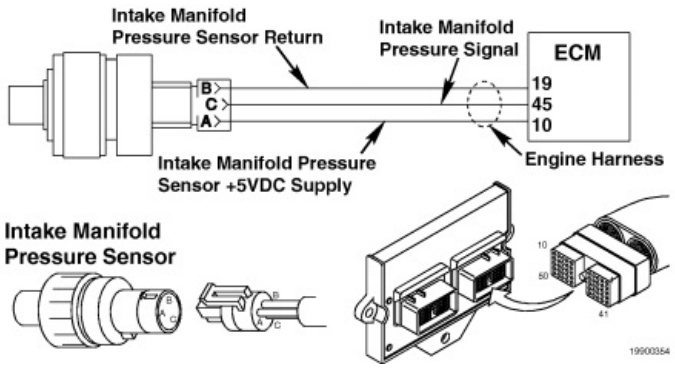

Idle Validation
Switch Connector
Idle Validation
Switch Signal
ECM
B
C
A
26
25
Switch Common
Ground
Off-Idle Validation
Switch Signal
OEM Harness
Idle Validation
Switch

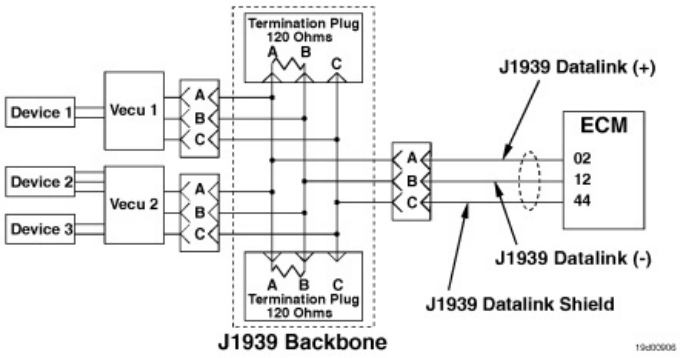

Injection Control
Valve (+) (Red)
Transient
Suppressor
ECM
2
1
6
7
Injection
Control Valve
Injection Control
Valve (-) (Black)
Engine Harness
10
50
41
19d00028

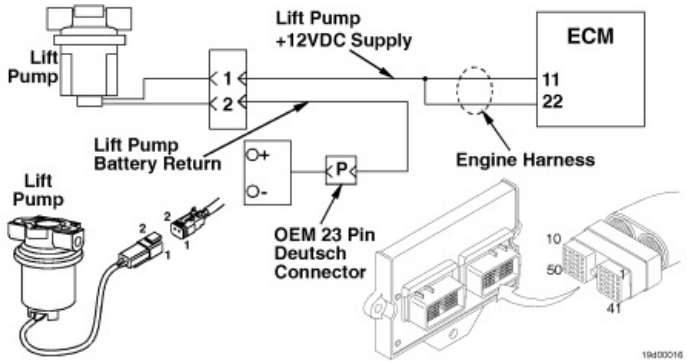

Injection Control Valve (+)
Injection Control Valve (-)
Engine Harness
ECM
2
1
3
4
6
7
36
19
Injection Control Valve
Injection Control Valve Identifier
Injection Control Valve Identifier Supply
Injection Control Valve Identifier Return

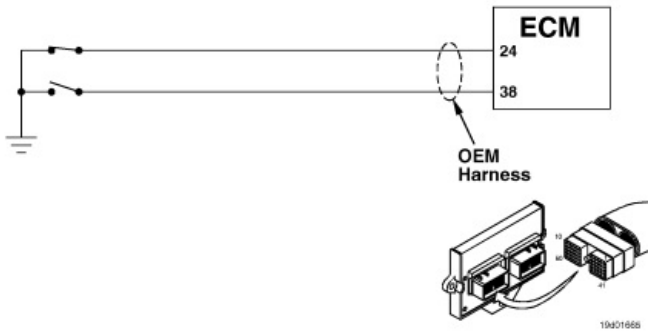

Intake Air Heater
Relay 1
OEM Harness
A
B
C
D
41
31
ECM
Intake Air Heater
Relay 2
10
50
41
10900381

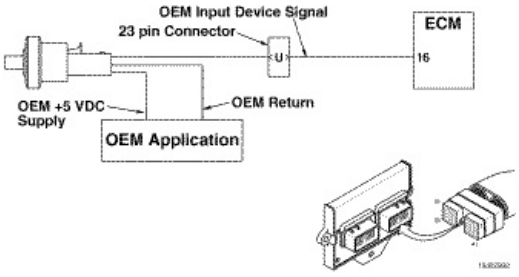

Intake Manifold Air Temperature
Sensor Signal
ECM
B
A
34
19
Intake Manifold Air Temperature
Sensor Return
Engine Harness
Intake Manifold Air
Temperature Sensor
10
50
41

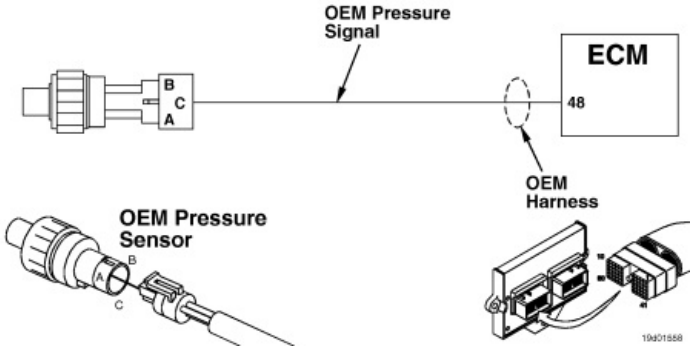

Intake Manifold
Pressure Sensor Return
Intake Manifold
Pressure Signal
ECM
B
C
A
19
45
10
Intake Manifold Pressure
Sensor +5VDC Supply
Engine Harness
Intake Manifold
Pressure Sensor
19900354

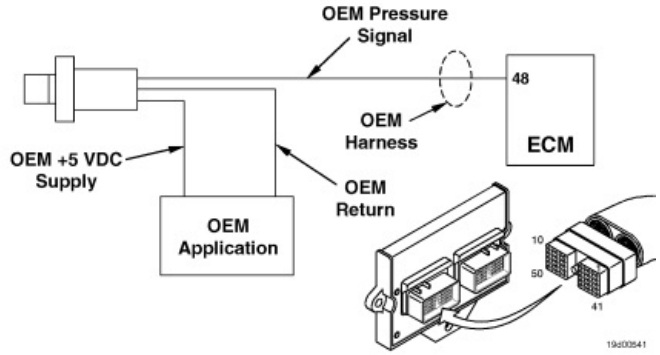

Termination Plug
120 Ohms
A B C
J1939 Datalink (+)
Device 1
Vecu 1
A
B
C
ECM
02
12
44
Device 2
Vecu 2
Device 3
J1939 Datalink (-)
J1939 Datalink Shield
Termination Plug
120 Ohms
J1939 Backbone

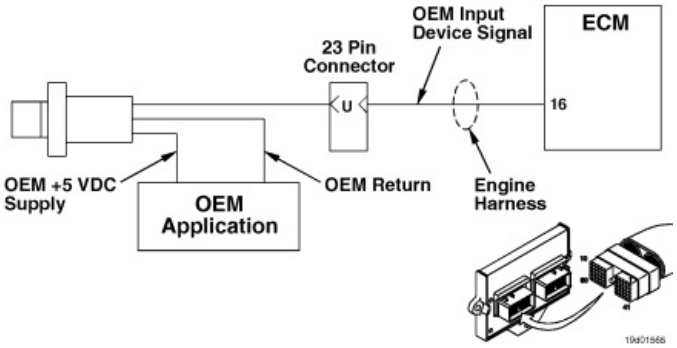

Lift Pump
Lift Pump +12VDC Supply
ECM
1
2
11
22
Lift Pump Battery Return
O+
O-
P
Engine Harness
Lift Pump
OEM 23 Pin Deutsch Connector
10
50
1
41
19d00016

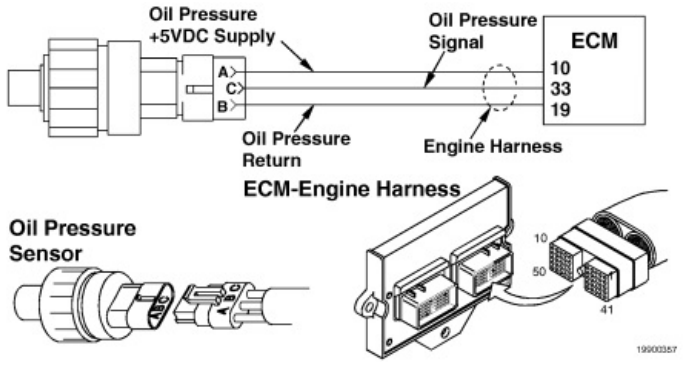

ECM
24
38
OEM
Harness
19d01668

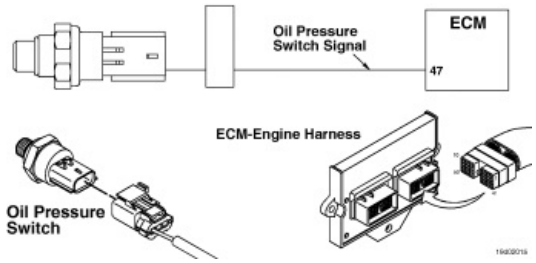

OEM Input Device Signal
23 pin Connector
ECM
U
16
OEM +5 VDC
Supply
OEM Return
OEM Application

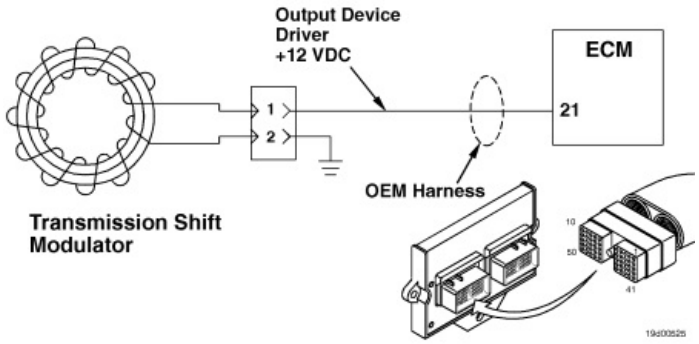

OEM Pressure
Signal
ECM
B
C
A
48
OEM
Harness
OEM Pressure
Sensor
B
A
C
19d01558

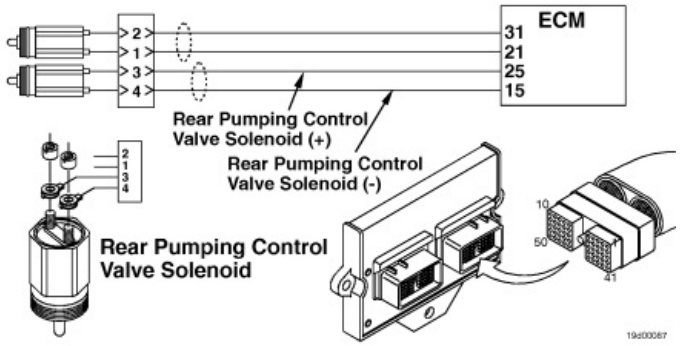

OEM Pressure
Signal
48
OEM
Harness
ECM
OEM +5 VDC
Supply
OEM
Return
OEM
Application
10
50
41
19d00541

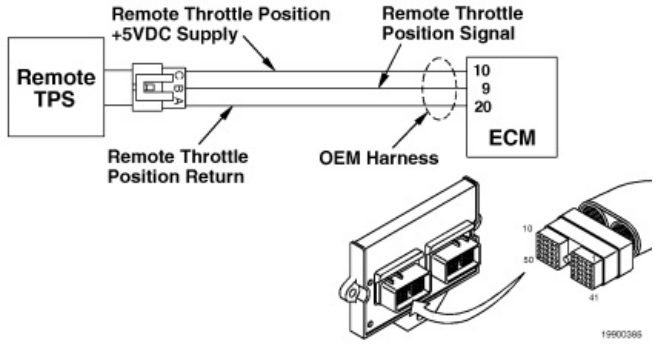

OEM Input
Device Signal
ECM
23 Pin
Connector
U
16
OEM +5 VDC
Supply
OEM
Application
OEM Return
Engine
Harness
19d01566

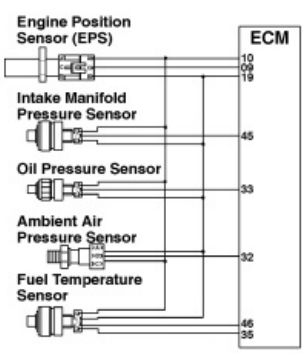

Oil Pressure
+5VDC Supply
Oil Pressure
Signal
ECM
10
33
19
A
C
B
Oil Pressure
Return
Engine Harness
ECM-Engine Harness
Oil Pressure
Sensor
10
50
41
19900357

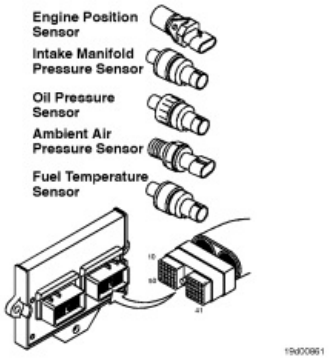

Oil Pressure
Switch Signal
ECM
47
ECM-Engine Harness
Oil Pressure
Switch

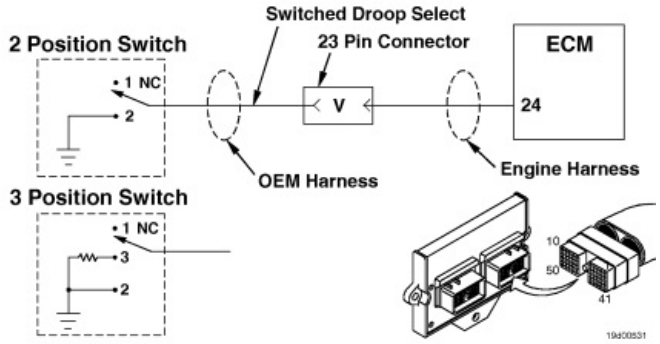

Output Device
Driver
+12 VDC
ECM
1
2
21
OEM Harness
Transmission Shift
Modulator
10
50
41
19d00525

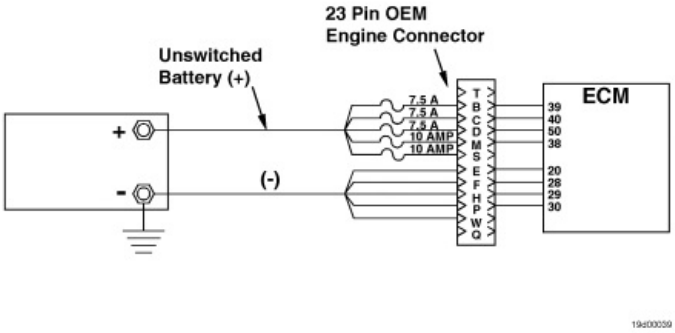

ECM
2
1
3
4
31
21
25
15
Rear Pumping Control
Valve Solenoid (+)
Rear Pumping Control
Valve Solenoid (-)
2
1
3
4
Rear Pumping Control
Valve Solenoid
10
50
41
19d00087

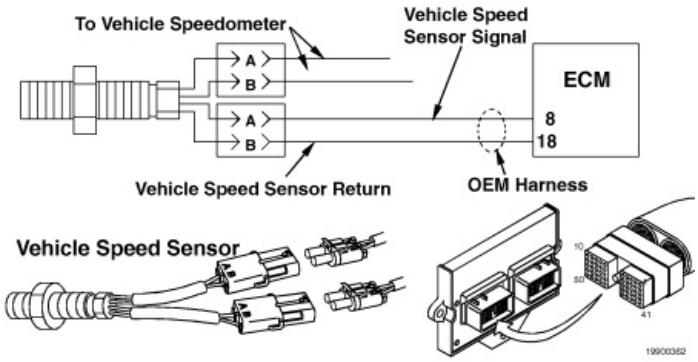

Remote Throttle Position
+5VDC Supply
Remote Throttle
Position Signal
Remote
TPS
10
9
20
ECM
Remote Throttle
Position Return
OEM Harness
10
50
41
19900386

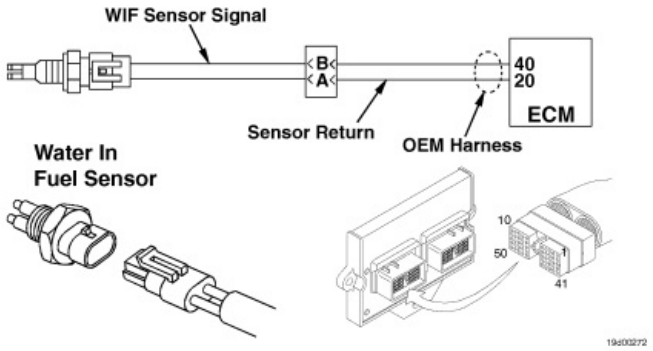

Engine Position Sensor (EPS)
ECM
10
09
19
Intake Manifold Pressure Sensor
45
Oil Pressure Sensor
33
Ambient Air Pressure Sensor
32
Fuel Temperature Sensor
46
35


Engine Position Sensor
Intake Manifold Pressure Sensor
Oil Pressure Sensor
Ambient Air Pressure Sensor
Fuel Temperature Sensor
19d00961


Switched Droop Select
23 Pin Connector
ECM
2 Position Switch
1 NC
2
V
24
OEM Harness
Engine Harness
3 Position Switch
1 NC
3
2
10
50
41
19d00531


23 Pin OEM
Engine Connector
Unswitched
Battery (+)
+
-
(-)
7.5 A
7.5 A
7.5 A
10 AMP
10 AMP
T
B
C
D
M
S
E
F
H
P
W
Q
ECM
39
40
50
38
20
28
29
30
19s000039


To Vehicle Speedometer
Vehicle Speed
Sensor Signal
ECM
A
B
A
B
8
18
Vehicle Speed Sensor Return
OEM Harness
Vehicle Speed Sensor
10
50
41
19900362


WIF Sensor Signal
B
A
40
20
ECM
Sensor Return
OEM Harness
Water In
Fuel Sensor
10
50
1
41
19s00272