
Perkins 2800 Series

Model 2806C-E16

DIAGNOSTIC MANUAL

6 cylinder turbocharged diesel engine

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Diagnostic code quick reference

CID-FMI	Diagnostic code description	Troubleshooting
1-11	Injector Cylinder #1 Fault	See Test 10 on page 133
2-11	Injector Cylinder #2 Fault	See Test 10 on page 133
3-11	Injector Cylinder #3 Fault	See Test 10 on page 133
4-11	Injector Cylinder #4 Fault	See Test 10 on page 133
5-11	Injector Cylinder #5 Fault	See Test 10 on page 133
6-11	Injector Cylinder #6 Fault	See Test 10 on page 133
41-03	ECM 8 Volt DC Supply Open/Short to B+	See Test 6 on page 107
41-04	ECM 8 Volt DC Supply Short to ground	See Test 6 on page 107
91-08	PWM Speed Control Abnormal	See Test 6 on page 107
100-03	Engine Oil Pressure Sensor Open/Short to B+	See Test 3 on page 88
100-04	Engine Oil Pressure Sensor Short to ground	See Test 3 on page 88
110-03	Engine Coolant Temperature Sensor Open/Short to B+	See Test 3 on page 88
110-04	Engine Coolant Temperature Sensor Short to ground	See Test 3 on page 88
168-02	Intermittent Battery Power to the ECM	See Test 2 on page 85
172-03	Inlet Air Temperature Sensor Open/Short to B+	See Test 3 on page 88
172-04	Inlet Air Temperature Sensor Short to ground	See Test 3 on page 88
174-03	Fuel Temperature Sensor Open/Short to B+	See Test 3 on page 88
174-04	Fuel Temperature Sensor Short to ground	See Test 3 on page 88
190-02	Engine Speed Sensor Data Intermittent	See Test 8 on page 121
190-09	Engine Speed Sensor Abnormal Update	See Test 8 on page 121
190-11,190-12	Engine Speed Sensor Mechanical Fault	See Test 8 on page 121
252-11	Incorrect Engine Software	See page 23
253-02	Check Customer or System Parameters	See page 26
261-13	Engine Timing Calibration Required	See Test 9 on page 129
262-03	5 Volt Sensor Power Supply Open/Short to B+	See Test 5 on page 102
262-04	5 Volt Sensor Power Supply Short to ground	See Test 5 on page 102
268-02	Check Programmable Parameters	See page 26
273-03	Turbo Outlet Pressure Sensor Open/Short to B+	See Test 3 on page 88
273-04	Turbo Outlet Pressure Sensor Short to ground	See Test 3 on page 88
274-03	Atmospheric Pressure Sensor Open/Short to B+	See Test 3 on page 88
274-04	Atmospheric Pressure Sensor Short to ground	See Test 3 on page 88
281-03	Action Alert lamp Open/Short to B+	See Test 4 on page 97
281-04	Action Alert lamp Short to ground	See Test 4 on page 97
281-05	Action Alert Lamp Open Circuit	See Test 4 on page 97
282-03	Overspeed lamp Open/Short to B+	See Test 4 on page 97
282-04	Overspeed lamp Short to ground	See Test 4 on page 97
285-03	Coolant temperature lamp Open/Short to B+	See Test 4 on page 97
285-04	Coolant temperature lamp Short to ground	See Test 4 on page 97
286-03	Lub oil pressure lamp Open/Short to B+	See Test 4 on page 97
286-04	Lub oil pressure lamp Short to ground	See Test 4 on page 97
286-05	Lub Oil Pressure Lamp Open Circuit	See Test 4 on page 97
323-03	Shutdown lamp Open/Short to B+	See Test 4 on page 97

CID-FMI	Diagnostic code description	Troubleshooting
323-04	Shutdown lamp Short to ground	See Test 4 on page 97
323-05	Shutdown Lamp Open Circuit	See Test 4 on page 97
324-03	Warning lamp Open/Short to B+	See Test 4 on page 97
324-04	Warning lamp Short to ground	See Test 4 on page 97
324-05	Warning Lamp Open Circuit	See Test 4 on page 97
342-02	Secondary Engine Speed Sensor Data Intermittent	See Test 8 on page 121
342-11, 342-12	Secondary Engine Speed Sensor Mechanical Fault	See Test 8 on page 121
861-03	Diagnostic lamp Open/Short to B+	See Test 4 on page 97
861-04	Diagnostic lamp Short to ground	See Test 4 on page 97

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1

General information

Introduction

The 2800 Series industrial diesel engines are the latest development from Perkins Engines Company Limited, a world leader in the design and manufacture of high performance diesel engines.

Read and remember the ["Safety precautions" on page 2](#). They are given for your protection and must be applied at all times.

Danger is indicated in the text by two methods:

Warning! *This indicates that there is a possible danger to the person.*

Caution: *This indicates that there is a possible danger to the engine.*

Note: Is used where the information is important, but there is not a danger.

Ensure that all adjustments and repairs are done by personnel who have had the correct training.

Safety precautions

These safety precautions are important.

Reference must also be made to the local regulations in the country of operation.

- Only use these engines in the type of application for which they have been designed.
- Do not change the specification of the engine.
- Do not smoke when you put fuel in the tank.
- Clean away fuel which has been spilt. Material which has been contaminated by fuel must be moved to a safe place.
- Do not put fuel in the tank while the engine runs (unless it is absolutely necessary).
- Do not clean, add lubricating oil, or adjust the engine while it runs (unless you have had the correct training; even then extreme caution must be used to prevent injury).
- Do not make adjustments that you do not understand.
- Ensure that the engine does not run in a location where it can cause a concentration of toxic emissions.
- Other persons must be kept at a safe distance while the engine or equipment is in operation.
- Do not permit loose clothing or long hair near moving parts.
- Keep away from moving parts during engine operation. **Warning!** *Some moving parts cannot be seen clearly while the engine runs.*
- Do not operate the engine if a safety guard has been removed.
- Do not remove the filler cap of the cooling system while the engine is hot and while the coolant is under pressure, because dangerous hot coolant can be discharged.
- Do not use salt water or any other coolant which can cause corrosion in the closed coolant circuit.
- Do not allow sparks or fire near the batteries (especially when the batteries are on charge) because the gases from the electrolyte are highly flammable. The battery fluid is dangerous to the skin and especially to the eyes.
- Disconnect the battery terminals before a repair is made to the electrical system.
- Only one person must control the engine.
- Ensure that the engine is operated only from the control panel or from the operator's position.
- If your skin comes into contact with high-pressure fuel, obtain medical assistance immediately.
- Diesel fuel and lubricating oil (especially used lubricating oil) can damage the skin of certain persons. Protect your hands with gloves or a special solution to protect the skin.
- Do not wear clothing which is contaminated by lubricating oil. Do not put material which is contaminated with oil into the pockets.
- Discard used lubricating oil in a safe place to prevent contamination.
- The combustible material of some components of the engine (for example certain seals) can become extremely dangerous if it is burned. Never allow this burnt material to come into contact with the skin or with the eyes.
- Fuel and oil pipes **MUST** be inspected for cracks or damage before they are fitted to the engine.
- Fit only genuine Perkins parts.

2

Electronic system overview

System operation

The 2800 Series industrial diesel engines are designed for electronic control. The injection pump, fuel lines and nozzles used in mechanical engines have been replaced with an electronic unit injector in each cylinder. A solenoid on each injector controls the amount of fuel that is delivered by the injector. An Engine Control Module (ECM) sends a signal to each injector solenoid in order to provide complete control of the engine.

Electronic controls

The electronic system consists of the Engine Control Module (ECM), the engine sensors and the OEM interface. The ECM is the computer which controls the engine. The Personality Module in the ECM contains the software which controls how the ECM behaves (the Personality Module stores the operating maps that define power, rev/min, etc).

Engine governor

The electronic controls on the engine serve as the engine governor, determining when and how much fuel to deliver to the cylinders based on the actual and desired conditions at any given time.

The ECM uses one of three possible speed control inputs to determine the desired engine speed and compares this to the actual engine speed determined through the crankshaft position sensor. If the desired engine speed is greater than the actual engine speed, more fuel is injected in order to increase engine speed.

Timing considerations

Once the ECM has determined how much fuel is required, it must next determine when to inject the fuel. Injection timing is determined by the ECM after considering input from the following components:

- Coolant temperature sensor
- Intake manifold air temperature sensor
- Atmospheric pressure sensor
- Boost pressure sensor

The ECM determines where top centre on cylinder number one is located from the engine camshaft position sensor signal. The ECM decides when injection should occur relative to top centre and provides the signal to the injector at the desired time. The ECM adjusts timing for the best engine performance, fuel economy and white smoke control.

Note: Actual or desired timing cannot be viewed with an electronic service tool.

Fuel injection

The ECM controls the amount of fuel injected by varying the signals to the injectors. The injectors will pump fuel only if the injector solenoid is energized. The ECM sends a high voltage signal to energize the solenoid. By controlling the timing and duration of the high voltage signal, the ECM can control injection timing and the amount of fuel that is injected.

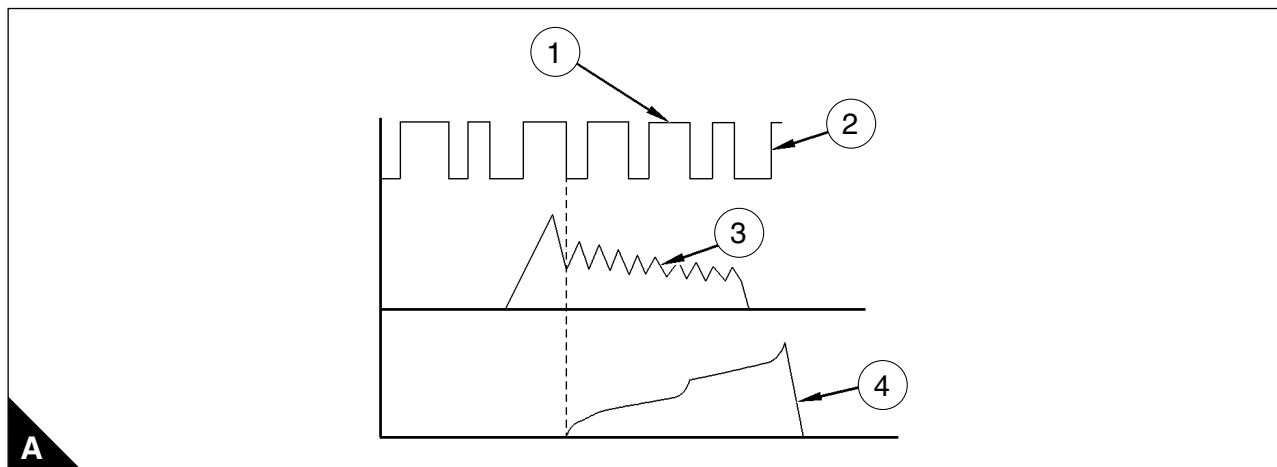
The Personality Module inside the ECM sets certain limits on the amount of fuel that can be injected. The **FRC Fuel Limit** is a limit based on boost pressure to control the air/fuel ratio for control of emissions. When the ECM senses a higher boost pressure (more air into cylinder) it increases the **FRC Fuel Limit** (allows more fuel into cylinder).

The **Rated Fuel Limit** is a limit that is based on the power rating of the engine and engine rev/min. It is similar to the rack stops and torque spring on a mechanically governed engine. It provides power and torque curves for a specific engine family and rating.

Note: All of these limits are determined at the factory in the Personality Module and cannot be changed.

Example of EUI system

- 1 TC reference
- 2 Speed/timing signal
- 3 Electrical current to the injector solenoid
- 4 Injection pressure curve



Note: Signals and timing are not to scale.

Engine monitoring

Perkins provides a factory installed engine monitoring system. The Perkins engine monitoring system monitors the following parameters:

- Engine oil pressure
- Coolant temperature
- Intake manifold air temperature
- Engine speed
- Boost pressure
- Fuel temperature

The Perkins engine monitoring system has three levels of operation, WARNING, ACTION ALERT and SHUTDOWN as described below.

Perkins engine monitoring WARNING operation

In the WARNING condition the ECM causes the Warning lamp to turn ON to indicate a problem has been detected by the Engine Monitoring System. No further ECM or engine action occurs.

Perkins engine monitoring ACTION ALERT operation

In the ACTION ALERT condition the ECM begins by activating the Action Alert lamp ON to indicate a problem has been detected by the Engine Monitoring System. This is also normally wired to cause a shutdown via the OEM control panel.

Perkins engine monitoring SHUTDOWN operation

If the fault reaches the SHUTDOWN condition the ECM activates the shutdown lamp and unless the engine is in CRITICAL OVERRIDE condition, the engine will shutdown.

Fuel temperature monitoring

The fuel temperature sensor monitors the fuel temperature, adjusting the ECM calculated fuel rate to compensate for fuel temperature changes and to adjust the fuel rate for constant power. The sensor is also used to warn the operator of excessive fuel temperature with a diagnostic event code because excessive fuel temperatures can adversely affect engine performance.

Self diagnostics

The electronic system has the ability to diagnose problems. When a problem is detected, a diagnostic code is generated and stored in permanent memory (logged) in the ECM. The diagnostic lamp is also activated.

When diagnostic codes occur, the diagnostic codes are referred to as **Active** diagnostic codes. They indicate that a problem of some kind currently exists.

Diagnostic codes that are stored in memory are called **Logged** diagnostic codes. Since the problem may have been temporary, or may have been repaired since the problem was logged, logged codes do not necessarily mean that something needs to be repaired. They are instead meant to be an indication of probable causes for intermittent problems.

Diagnostic codes that identify operating conditions outside the normal operating range are called **Events**. Event codes are not typically an indication of an electronic system problem.

Note: Some of the diagnostic codes require passwords to clear.

Effect of diagnostic codes on engine performance

The discussion on engine monitoring mentions that the diagnostic lamp activates when a specific condition exists. When the ECM detects an engine problem, it generates an active diagnostic code and also logs the diagnostic code in order to indicate when, and if appropriate, how many times the problem occurred. There are two types of diagnostic codes, **Fault codes** and **Event codes**.

Diagnostic fault codes

These are provided in order to indicate that an electrical or electronic problem has been detected by the ECM. In some cases the engine performance can be affected when the condition causing the code exists. More frequently, however, no difference in the engine performance can be detected.

Diagnostic event codes

Diagnostic event codes are used to indicate that some operational problem has been detected in the engine by the ECM. This usually does not indicate an electronic malfunction.

The ECM also provides an ECM clock with date/time to date and time stamp the following critical event codes:

- 362-3 Engine overspeed Shutdown
- 360-3 Low oil pressure Shutdown
- 361-3 High coolant temperature Shutdown

For a listing all of the **CID-FMI Diagnostic codes**, along with the page number where details regarding the cause, performance effect, and troubleshooting of the code can be located, refer to ["Quick reference for ECM diagnostic codes" on page 76](#).

Current totals stored in the ECM

The ECM maintains engine total data for the following parameters:

Total time

The total time is the engine's operating hours. This does not include operating time when the ECM is powered ON but the engine is not running.

Programmable parameters

Certain parameters affecting engine operation may be changed with electronic service tools. The parameters are stored in the ECM, and are protected from unauthorized changes by passwords. These parameters are either System Configuration Parameters or Customer Parameters.

System configuration parameters

These are set at the factory and affect emissions or power ratings within an engine family. Factory passwords must be obtained and used to change the system configuration parameters.

Customer parameters

These are variable and can be used to tailor the engine to customer requirements within the limits set by the factory and Perkins engine monitoring operation. Customer passwords may be required to change customer parameters.

Caution: *Some of the parameters may affect engine operation. Without adequate training, these parameters may lead to power or performance complaints even when the engine is performing to specification.*

Refer to ["Programming parameters" on page 26](#) for further information.

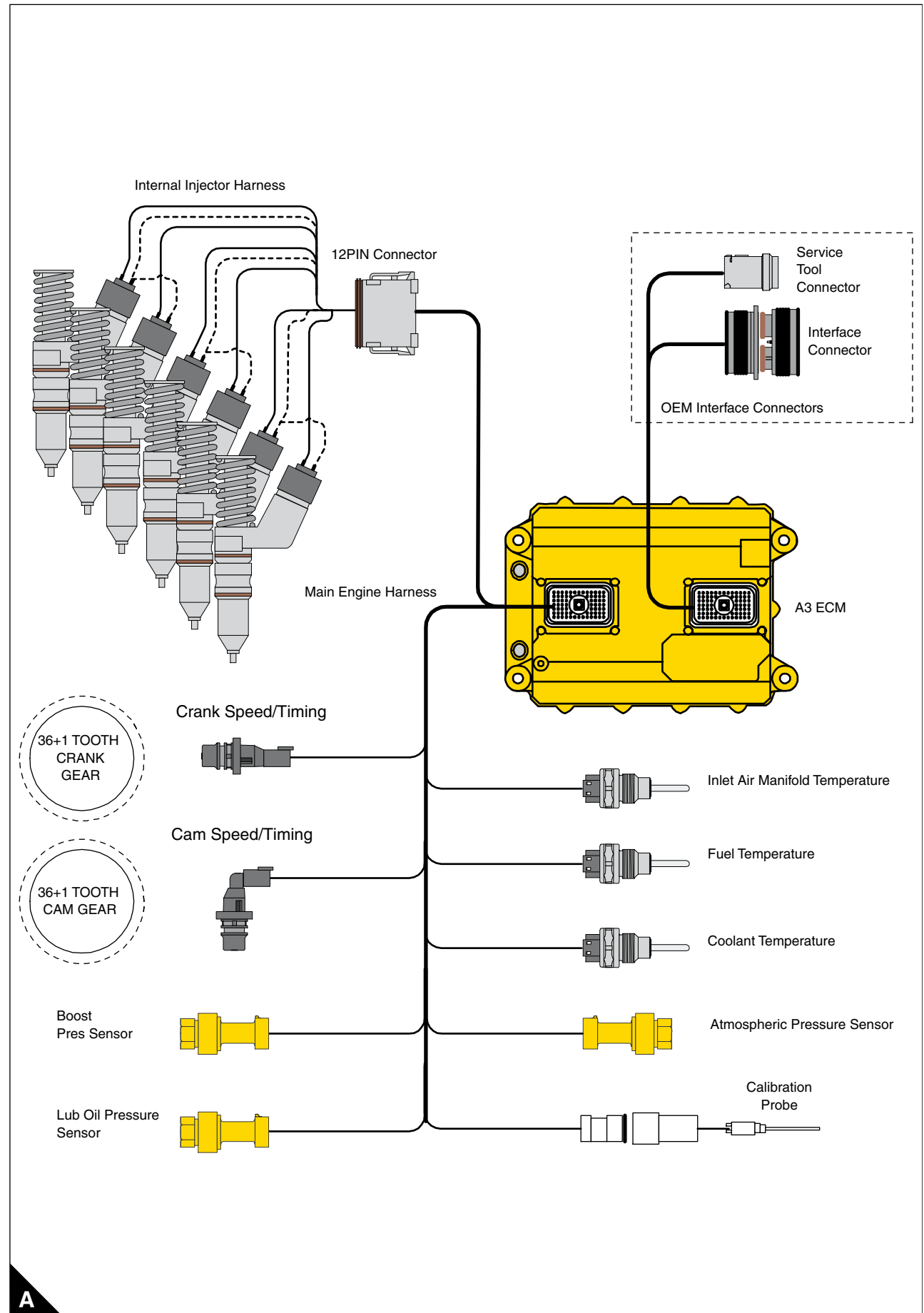
Passwords

System configuration parameters are protected by **Factory passwords**. Factory passwords are calculated on a computer system that is available only to Perkins dealers.

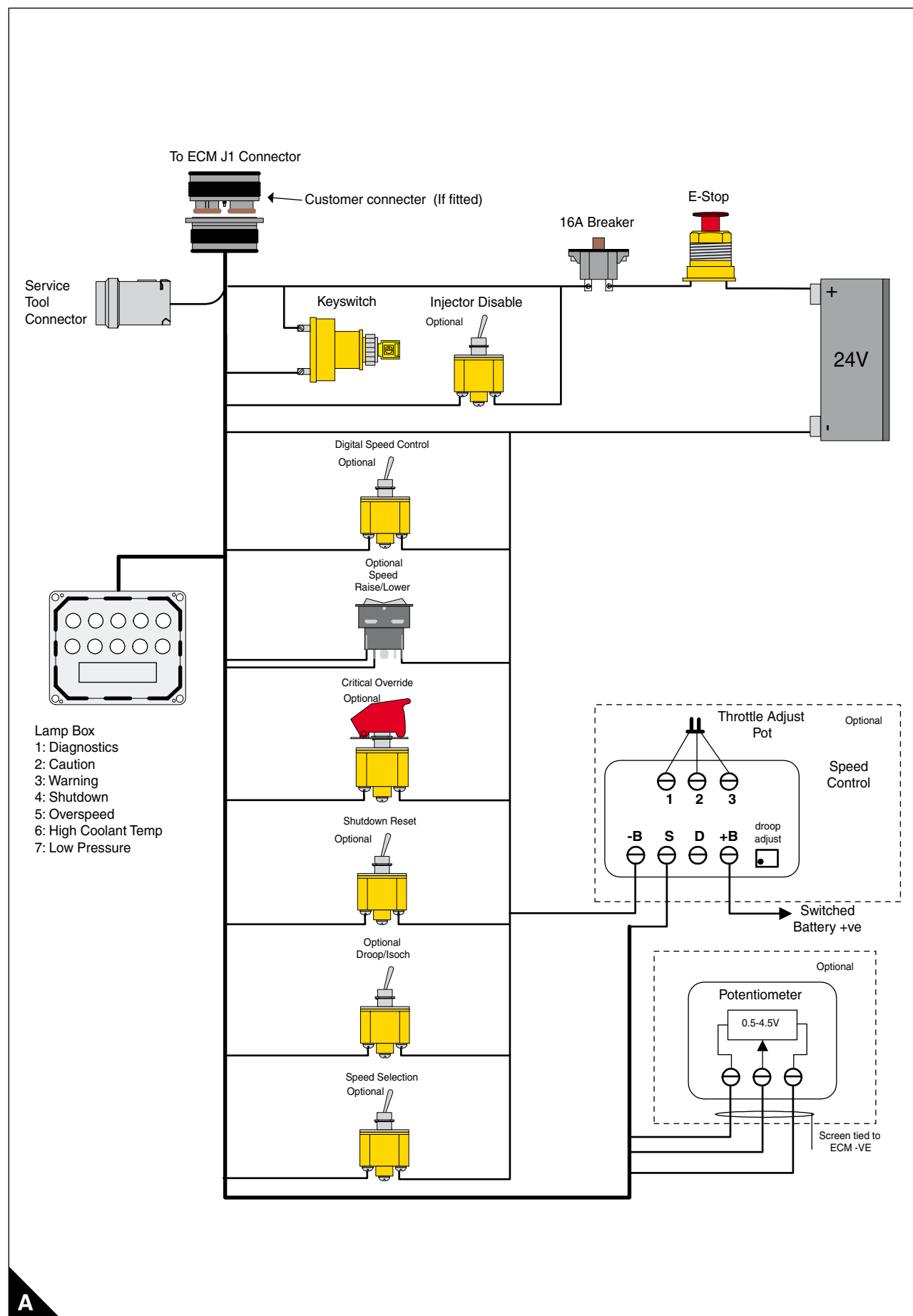
Customer parameters can be protected by **Customer passwords**. The customer passwords are programmed by the customer. Factory passwords can be used to change customer passwords if they are lost.

Refer to ["System configuration parameters" on page 26](#) for further information when passwords are needed and how to obtain them.

Engine component diagram

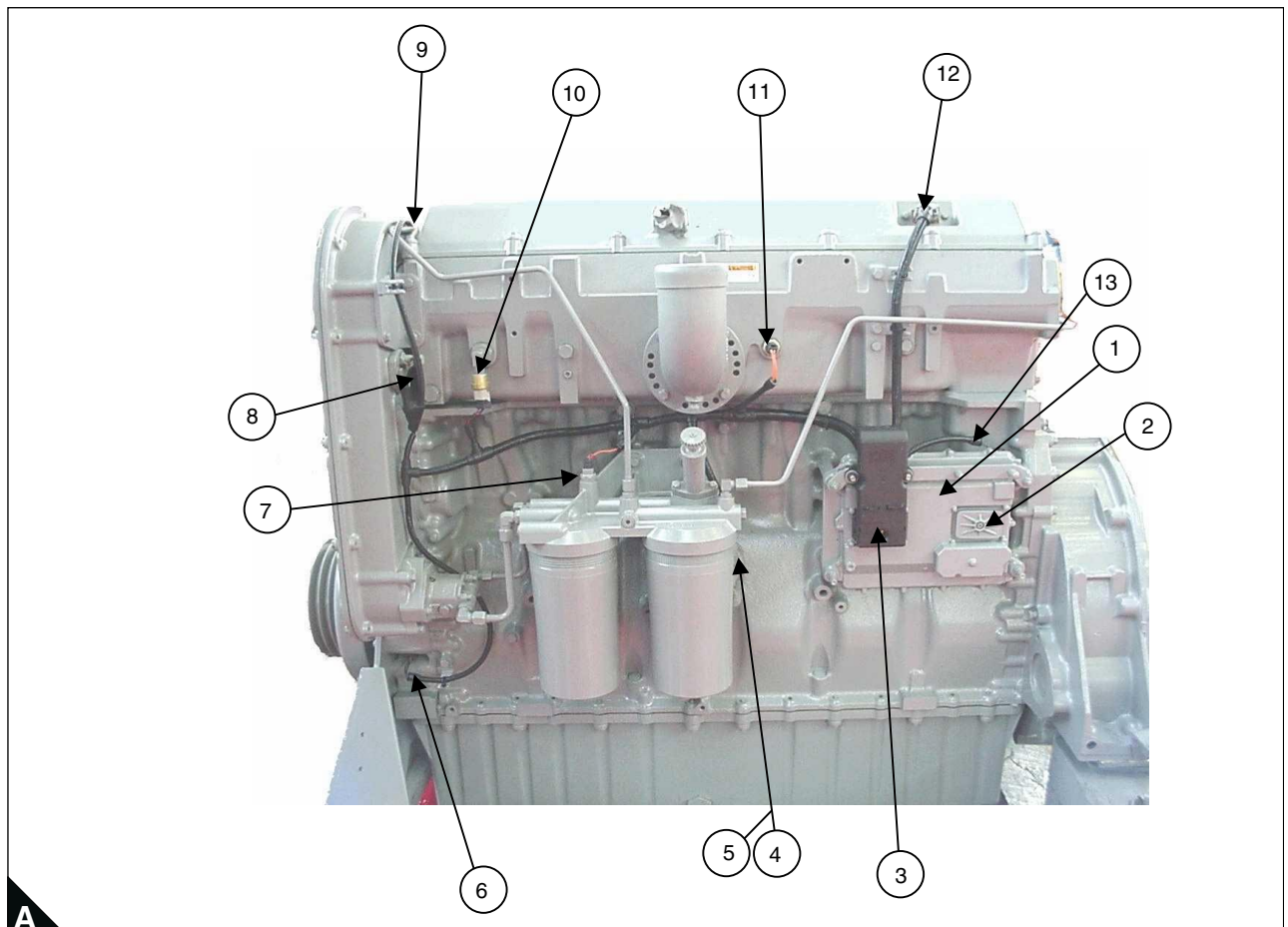


OEM connection diagram

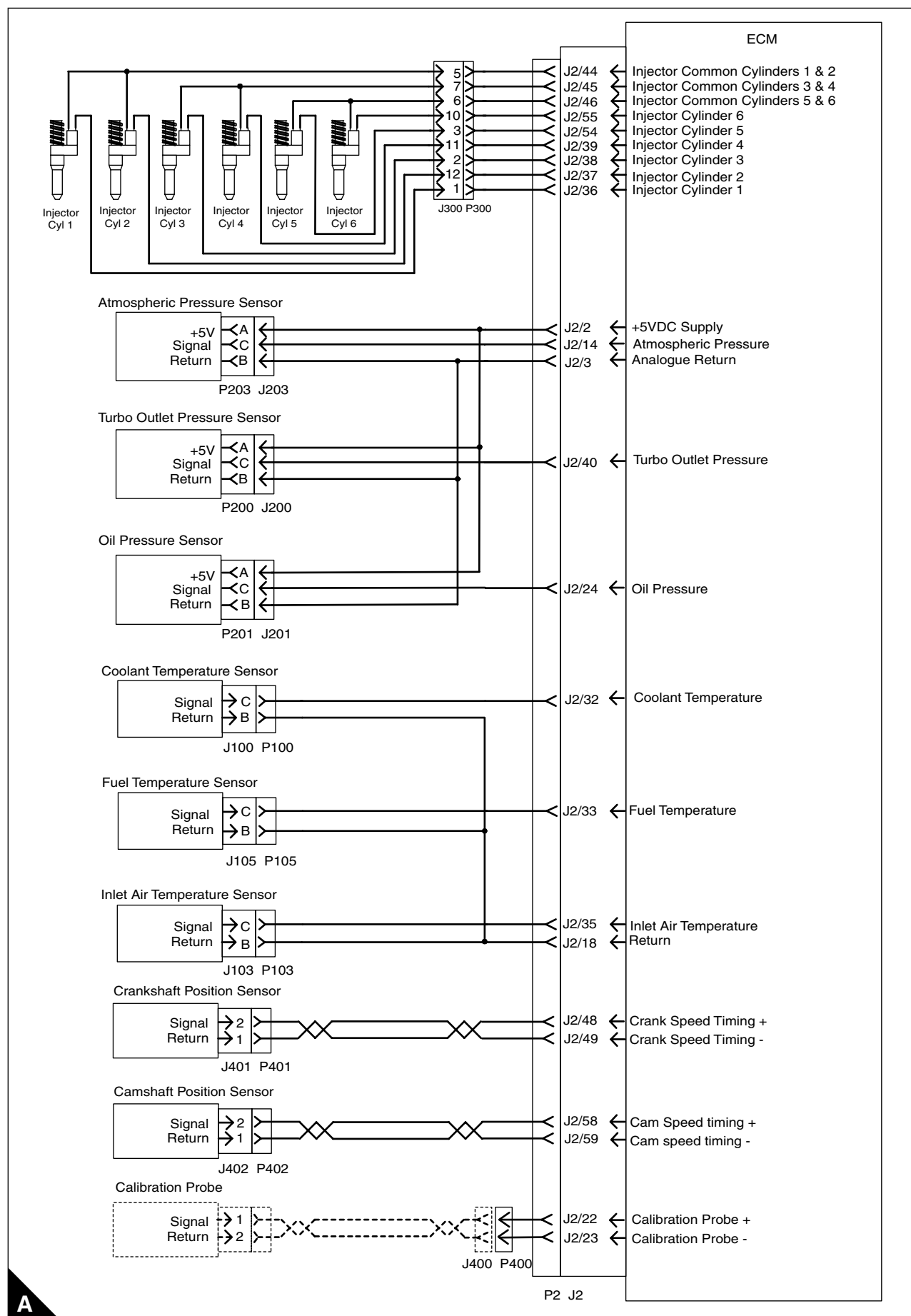


Sensor and connector location diagram**Key**

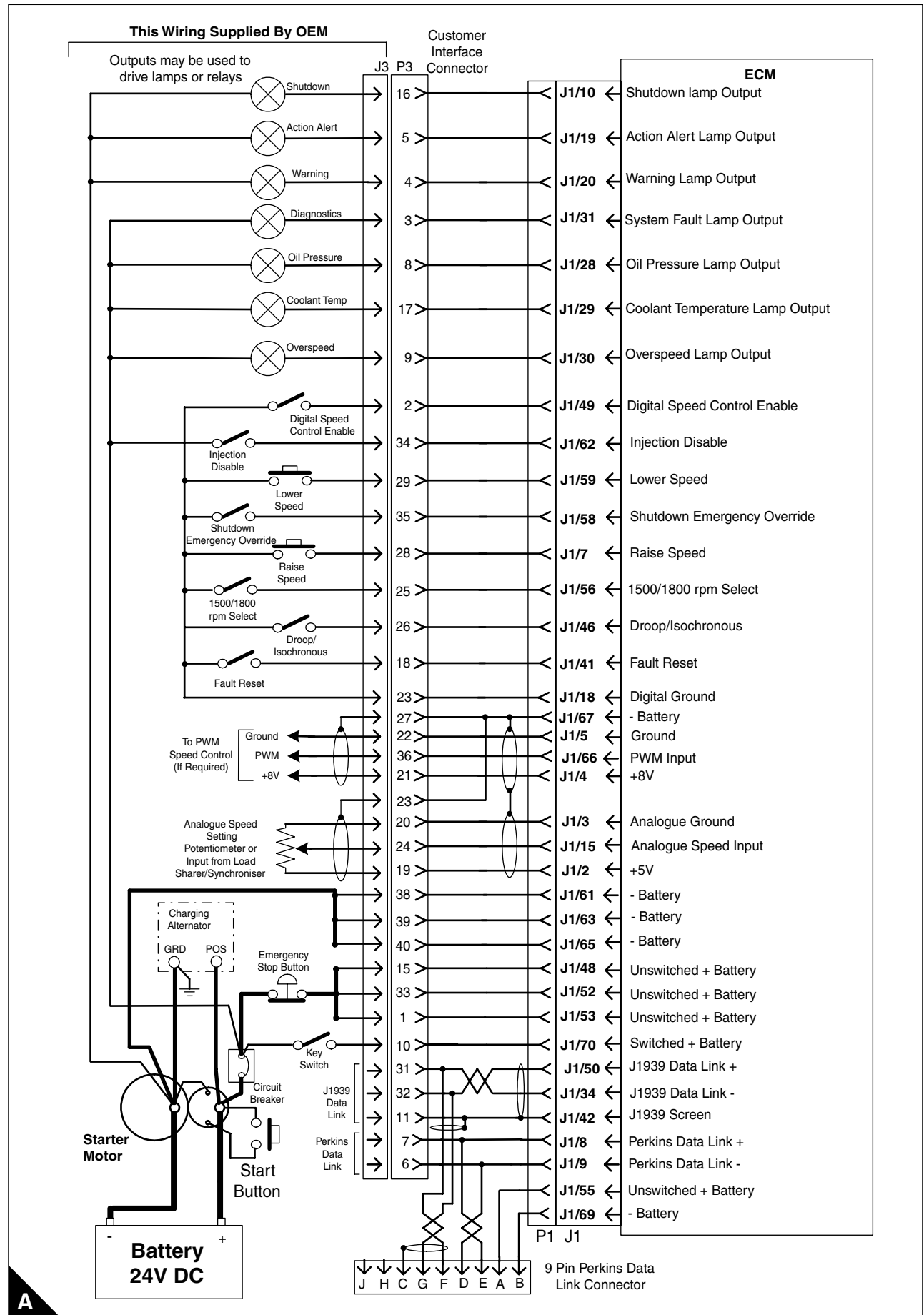
- 1 Electronic Control Module (ECM)
- 2 J1/P1 Machine connector
- 3 J2/P2 Engine connector
- 4 Atmospheric pressure sensor
- 5 Oil pressure sensor
- 6 Crankshaft position sensor
- 7 Fuel temperature sensor
- 8 Camshaft position sensor
- 9 Coolant temperature sensor
- 10 Boost pressure sensor
- 11 Intake manifold air temperature sensor
- 12 Electronic unit injector connector
- 13 Timing calibration pickup connector



Engine wiring diagram



Machine wiring diagram (all options)



Electrical connectors and functions

Connector	Function
J1/P1	ECM connector (70-Pin OEM harness)
J2/P2	ECM connector (70-Pin Engine harness)
J3/P3	Machine wiring connector (40-Pin connector) - optional
J100/P100	Engine coolant temperature sensor (2-pin connector)
J103/P103	Engine inlet air temperature sensor (2-pin connector)
J105/P105	Engine fuel temperature sensor (2-pin connector)
J200/P200	Engine turbo outlet pressure sensor (3-pin connector)
J201/P201	Engine oil pressure sensor (3-pin connector)
J203/P203	Engine atmospheric pressure sensor connector (3-pin connector)
J300/P300	Injector solenoid harness (12-pin connector)
J400/P400	Engine timing calibration probe (2-pin connector)
J401/P401	Crankshaft position sensor (2-pin connector)
J402/P402	Camshaft position sensor (2-pin connector)

Service tools and diagnostics

The Perkins TIPSS-EST service tools are designed to help the service technician analyze and locate faults or problems within the system. They are required to perform calibrations and to read or change engine parameters.

Perkins TIPSS-EST is a software program that runs on a personal computer and requires a communication adapter to translate information from the Perkins Data Link to the computer RS232 port.

Perkins TIPSS-EST can be used to display the following information:

- Programmable parameter settings
- Active and logged diagnostic codes
- Logged events
- Engine rating history
- Histograms
- Custom data
- ECM date/time clock

Perkins TIPSS-EST can also be used to perform the following functions:

- Diagnostic tests
- Sensor calibrations
- Flash programming
- Parameter programming
- Copy configuration (ECM replacement)
- Data logging
- Real time graphing

There are several adapter cables, breakout T cables, etc that are used in order to access measurements of signals. A heavy duty multimeter is suitable in order to make the necessary measurements. A multimeter that has the ability to measure duty cycle may also be required. Other special tools include those needed to measure pressure and temperature.

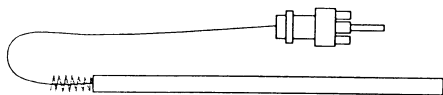
Required service tools

Part No.	Description
-	IBM PC Compatible: Minimum - Pentium 100 MHz processor or greater, 32 Mb RAM, 200 Mb of available hard disk space, VGA monitor or display, CD-ROM, 3.5 in 1.44 Mb diskette drive, Windows 95 or greater, Windows NT, Windows 2000, RS232 port with 16550AF UART, Built in pointing device or mouse. Recommended - Pentium 200 MHz processor, 64 Mb RAM, 1Gb of available hard disk space, Super VGA monitor or display, 12X CD-ROM, 3.5 in 1.44 Mb diskette drive, Windows 95 or greater, Windows NT, Windows 2000, RS232 port with 16550AF UART, Built in pointing device or mouse
-	Single user license for TIPSS All engine data subscription
27610164	Communication adapter II group (Communication adapter II, harness cables, software program, users manual and storage case)
27610165	Communication adapter
27610167	Communication adapter software
27610169	RS232 cable (connects communication adapter to PC)
27610168	Connector cable (connects communication adapter to diagnostic connector)
-	Terminal removal tool (14 AWG wire) used for removing pin and socket terminals
-	Terminal removal tool (16 and 18 AWG wire) used for removing pin and socket terminals
-	Heavy duty digital multimeter Digital multimeter capable of reading duty cycle
-	Service tool bypass harness
-	70-terminal "AMP" breakout T
-	Engine timing probe
-	Timing probe adapter
-	Deutsch "DT" timing probe cable
-	Slotted socket for removing coolant temperature sensor
-	Voltage test lamp

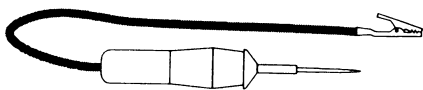
Optional service tools

Part No.	Description
27610181	Harness repair tool kit (includes crimping tool)
27610182	Harness repair tool kit top-up
-	3-Pin "DT" breakout T (breakout T harness is inserted in series between a harness jack and plug to permit voltage measurement on an operating system)
-	3-Pin "HD" breakout T (for remote mounted throttle sensor only)
-	Signal reading probes
-	Extraction pump used to pull a vacuum for atmospheric pressure test
-	Suction tube attachment to 1U-5718
-	Bottle assembly attachment to 1U-5718
-	Turning tool permits turning engine by hand
-	Pressure group used to measure oil pressure
-	Temperature adapter group
-	3-terminal Packard breakout T
-	3-Pin "DT" harness bypass T (used to bypass the harness signal lines for engine pressure sensors)

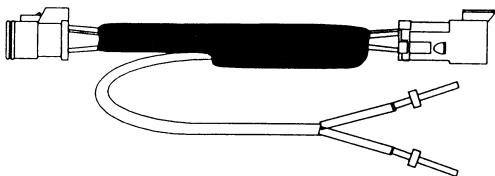
Service tool illustrations



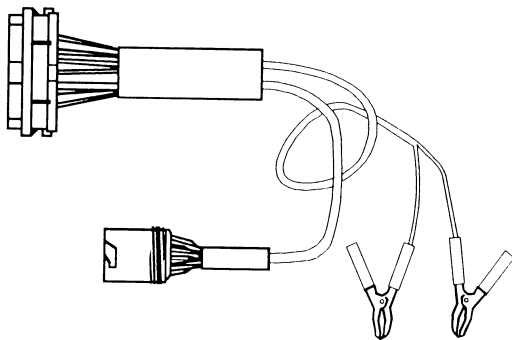
Engine Timing Probe



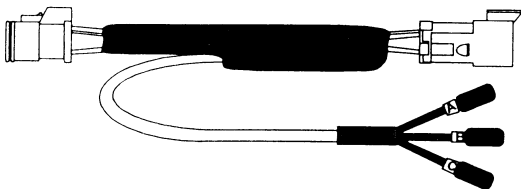
Voltage Test Lamp 5P-7277



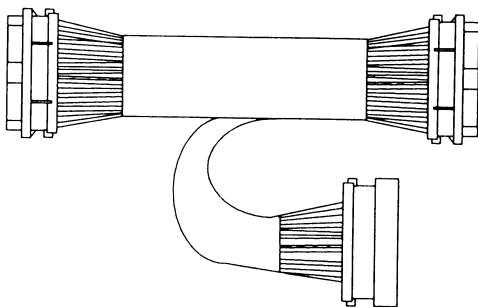
125-3662 Engine Sensor Harness Bypass



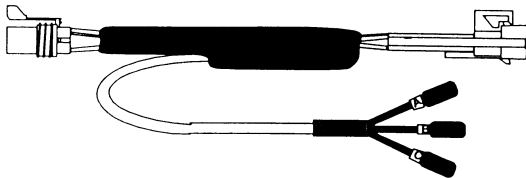
167-9225 Service Tool Bypass Harness



7X-6370 3-Pin DT Breakout T



140-2266 70-Terminal Breakout T



124-5643 3-Terminal Packard Breakout T

3

Programming parameters

Connecting the TIPSS-EST

The communications adapter is powered by 24 volts DC from the engine battery. This permits operation beside the engine to allow use during engine operation.

Use the following procedures to connect the service tool to the engine.

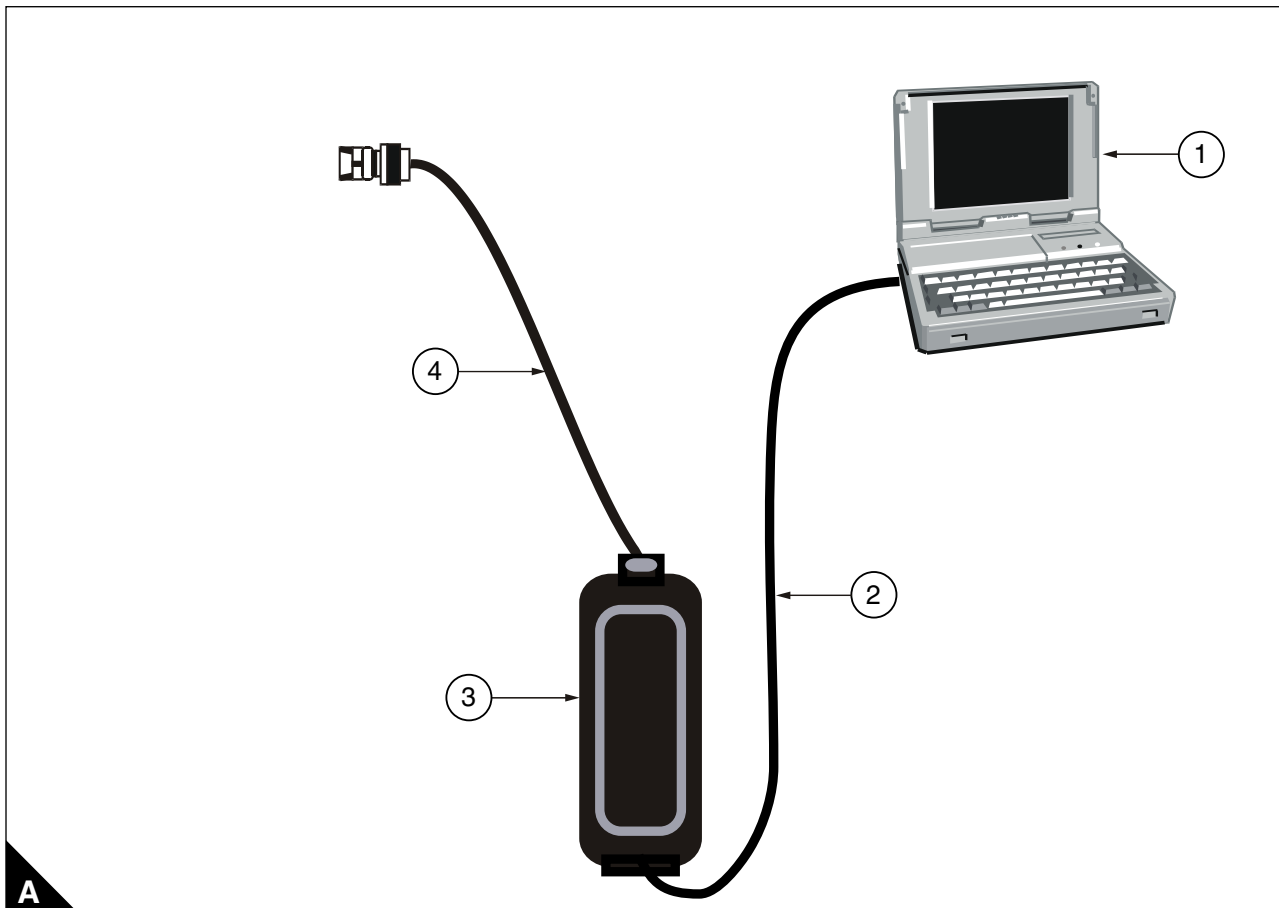
- 1 Turn the key switch to the OFF position
- 2 The PC (with the TIPSS-EST software installed) should be connected to the engine system through the diagnostics connector.
- 3 Connect the opposite end of the service tool harness cable to the communication adapter. Refer ["Connecting TIPSS-EST using a TIPSS communication adapter" on page 18](#).
- 4 Connect the communication adapter to the PC using the appropriate cable.
- 5 Turn the key switch to the ON position in order to begin testing. The service tool will operate while the engine is running or with the engine OFF and the key switch ON. If the tool does not communicate with the ECM disconnect and reconnect the diagnostics connector cable. Check the communication. If the problem is still present refer to [Test 7: Perkins Data Link circuit test on page 114](#).

Notes:

- The service tool may restart during engine cranking due to a voltage dip on the battery line.
- The TIPSS-EST must be configured to communicate with the specific type of communication adapter used. Go to the 'Preferences' menu that is located under 'Settings' in order to select the appropriate communication adapter.

Connecting TIPSS-EST using a TIPSS communication adapter

- ① PC with TIPSS-EST installed
- ② 27610169 PC to communication adapter cable
- ③ 27610165 communication adapter
- ④ 27610168 service tool harness cable



Passwords

Factory passwords

Factory passwords are required to perform each of the following five functions:

1 Program a new ECM

When an ECM is replaced the system configuration parameters must be programmed into the new ECM. A new ECM will allow these parameters to be programmed **once** without factory passwords. After the initial programming these parameters are protected by factory passwords.

2 Rerate to another engine family

This requires changing the Personality Module code, which is protected by factory passwords.

3 Read customer passwords

If the owner loses his customer passwords, he will not be able to program customer parameters. By using factory passwords, one can read customer passwords, then use those customer passwords to program customer parameters.

4 Clear certain diagnostic codes

Critical event codes require the use of factory passwords in order to clear the code once it is logged. Diagnostic code 252-11 (Incorrect Engine Software) also requires factory passwords. This diagnostic code should be cleared **only** if you are certain that the Personality Module is for the specific engine.

Caution: *Operating the engine with a Personality Module not designed for that engine will result in engine damage. Be sure the Personality Module is correct for your engine.*

Certain other codes require customer passwords. The majority of logged codes do not require passwords to be cleared. To obtain factory passwords, proceed as if you already have the password. At some point, if the factory passwords are actually needed, TIPSS-EST will request the factory passwords and display the information required to obtain the passwords.

Customer passwords

If customer passwords have been entered, they are then required to change ANY customer parameter.

TIPSS-EST can be used to change customer parameters. To obtain customer passwords, contact the supplier of the equipment. If the owner has lost the passwords, customer passwords may be read by using TIPSS-EST (factory passwords are required in order to read customer passwords) by using the following procedure.

1 In TIPSS-EST access "View Passwords" under the "Utilities" menu.

2 When the Factory Password screen appears, record the information listed.

3 Obtain the factory passwords. The information recorded above must be provided, and generates a permanent record at Perkins of the access.

4 From the Factory Password screen, enter the factory passwords.

5 When the View Customer Passwords screen appears, record the customer passwords. The customer passwords may then be used to change customer parameters.

Programming a new ECM

The Engine Control Module or ECM is the brain of the system. When a problem occurs, it is easy to assume that the ECM is responsible. This is usually the wrong conclusion.

Most failures occur at the wiring and connectors or at a sensor input/output. Follow the troubleshooting procedures, and do not replace an ECM on speculation.

However, when your troubleshooting indicates that a failure has in fact occurred in the ECM, the following procedure outlines the steps required to replace a faulty ECM.

Note: If an ECM replacement is required, the ECM parameters, injector trim codes, and timing calibration can be transferred from the suspect ECM to the replacement ECM. Timing calibration will NOT be necessary. This feature requires TIPSS-EST and is only possible if the suspect ECM can communicate with the TIPSS-EST.

Replacing the ECM using TIPSS-EST ECM replacement feature

1 Ensure that the ECM is the problem by first temporarily connecting a test ECM. Hang the test ECM on the side of the engine. Flash program the identical Personality Module that was used in the suspect ECM into the test ECM. Use the TIPSS-EST ECM Replacement feature to copy the parameter configuration of the suspect ECM into the test ECM. Ensure that the parameters in the test ECM are programmed the same as the parameters in the suspect one.

2 If the test ECM repairs the problem, reconnect the suspect ECM. Verify that the problem returns when the suspect ECM is reconnected.

3 Select the ECM Replacement feature under the Service/Copy Configuration menu and load the parameters from the failed ECM.

4 Temporarily connect the new ECM by connecting both ECM connectors. Do not mount the ECM on the engine yet.

5 Flash program the Personality Module into the new ECM if the Personality Module is not already installed.

Note: The new ECM may be shipped with a blank Personality Module, or may have been pre-flashed at the factory.

6 Use the TIPSS-EST ECM Replacement feature to program the new ECM

7 Enter Rating Number parameter into the new ECM

8 Check for active codes. Program any required parameters that have not been programmed.

Note: On initial power-up of a new ECM, the Rating Number parameter must be programmed to avoid a 253-02 Check Customer Or System Parameters diagnostic code.

If a 261-13 Check Timing Sensor Calibration diagnostic code is not active, install the new ECM on the engine, otherwise perform a timing calibration first.

Replacing the ECM (if ECM replacement feature cannot be used)

1 Ensure that the ECM is the problem by first temporarily connecting a test ECM. Hang the test ECM on the side of the engine. Flash program the identical Personality Module that was used in the suspect ECM into the test ECM. Program any parameters that are necessary to use the ECM for the test. Program the parameters exactly the same as they are in the suspect ECM.

2 If the test ECM repairs the problem, reconnect the suspect ECM. Verify that the problem returns when the suspect ECM is reconnected.

3 Obtain customer parameters from the failed ECM

Obtain and record the customer passwords. If the customer has lost or forgotten their passwords, obtain factory passwords to get them.

Use TIPSS-EST to access customer specified parameters from the ECM that is being replaced. If the ECM does not communicate with the electronic service tool, obtain the required parameter list from the OEM.

Record the customer parameters

4 Record ECM current totals

5 Temporarily connect the new ECM by connecting both ECM connectors. Do not mount the ECM to the engine until the timing calibration has been performed.

6 Flash program the Personality Module into the new ECM if the Personality Module is not already installed.

Note: The new ECM may be shipped with a blank Personality Module, or may have been pre-flashed at the factory.

7 Obtain factory passwords if required.

The following parameters can be programmed on a new ECM without factory passwords:

- Full Load Setting (FLS)
- Full Torque Setting (FTS)
- Engine serial number

System configuration parameters must be entered before the customer specified parameters are entered

If customer parameters are entered before the system configuration parameters, the total tattletale will change. It will then be necessary to obtain another set of factory passwords in order to access system configuration parameters.

8 Record the following information from the engine information plate:

- Full Load Setting (FLS)
- Full Torque Setting (FTS)
- Engine serial number

Use TIPSS-EST to access system configuration parameters. When the Factory Specified Passwords screen appears record the following information:

- ECM serial number
- Engine serial number
- TIPSS-EST serial number
- Total tattletale
- Reason code

Leave TIPSS-EST on the Factory Specified Passwords screen and obtain the factory passwords.

9 Program the new ECM

Note: On initial powerup of a new ECM the following five parameters must be programmed to avoid a 253-02 Check Customer Or System Parameters diagnostic code:

- Full Load Setting (FLS)
- Full Torque Setting (FTS)
- Rating number
- Engine serial number
- Injector trim codes

Continued

Use TIPSS-EST to access system configuration parameters. Enter the recorded values for the following parameters:

- Full Load Setting (FLS)
- Full Torque Setting (FTS)
- Engine serial number

Use TIPSS-EST to access customer specified parameters. Enter the customer specified parameters and the original customer passwords.

Use TIPSS-EST to access current totals from the Read/Change Current Totals main menu. Using the recorded factory passwords enter the totals from the original ECM.

Use the Service\Calibrations\Timing Calibration menu to calibrate the timing. Refer to [Test 8: Engine speed/timing circuit test on page 121](#).

10 Install the new ECM on the engine.

Programming a Personality Module using flash programming

1 Connect the PC to the appropriate communication adapter and connect the communication adapter to the ECM. Refer to ["Connecting TIPSS-EST using a TIPSS communication adapter" on page 18.](#)

2 Start the WinFlash PC Program.

3 Ensure that the key switch is ON and the engine is OFF.

4 Select the part number of the engine Personality Module that needs to be programmed into the ECM and proceed with programming the Personality Module. A new ECM is shipped with a blank Personality Module.

Note: The WinFlash PC program provides the ECM, application and software part number of the selected file. Ensure that this file matches the engine before you begin to Flash the file into the ECM

PC program Personality Module messages and their meaning

A new ECM comes with a blank Personality Module (previously unprogrammed). A blank Personality Module will prompt you for all three of the following messages. The information that is contained in the ECM Status will be scrambled and meaningless if the module has not been programmed previously (this is normal).

Message: The engine ID in the flash file does not match the engine ID in the ECM

Meaning: The ECM has a Personality Module for a different engine.

Solution: Stop the transfer and access information about the ECM Status under the Electronic Control Module menu. Ensure that the file you are about to transfer matches the engine application.

Message: The application ID in the flash file does not match the application ID in the ECM

Meaning: The ECM has a Personality Module for a different application.

Solution: Stop the transfer and access information about the ECM Status under the Electronic Control Module menu. Ensure that the file you are about to transfer is for the correct Personality Module.

Message: The ID of the ECM in the flash file does not match the ID of the ECM in the ECM

Meaning: The ECM is not for use with this application.

Solution: Stop the transfer and access information about the ECM Status under the Electronic Control Module menu. Ensure that the ECM on the engine is for the correct application.

Note: If you access the ECM Status under the Engine Control Module menu, but do not program the Personality Module, complete the following procedure.

Turn the key switch to the OFF position, and then to the ON position before using TIPSS-EST. If the key switch is not cycled after reading the ECM Status, the ECM will not communicate with your service tool or will not start.

Cycling the key switch is not necessary after the Personality Module has been successfully programmed using the WinFlash program.

5 Start the engine and check for correct operation.

Program any parameters not previously in the old Personality Module if a 253-02 Check Customer or System Parameters diagnostic code is active. Read the diagnostic code from service tool Active Diagnostic Code screen in order to determine the parameter(s) requiring programming.

On initial powerup of a new ECM five parameters must be programmed to avoid a 253-02 Check Customer or System Parameters diagnostic code:

- Full Load Setting (FLS)
- Full Torque Setting (FTS)
- Rating number
- Engine serial number
- Injector trim codes

Refer to ["Programming a new ECM" on page 20.](#)

ECM date/time clock

ECM date/time stamped information

The ECM date and time can be programmed with an electronic service tool. This will display the programmed date in month/day/year format and the programmed time in hour:minute:second format. The tool has the option to program any date/time or automatically select the date/time stored in the PC real time clock.

The date and time will remain programmed in the ECM even if the Unswitched Battery connections are removed.

The ECM Date/time clock is used to stamp the following critical event codes:

- 360-3 Low oil pressure Shutdown
- 361-3 High coolant temperature Shutdown
- 362-3 Engine overspeed Shutdown

Before adjusting the ECM date/time clock

Before adjusting the ECM date/time clock, ask the owner/operator if the time stamped information should be recorded. After the time stamped information is recorded, clear this information before adjusting the ECM date/time clock. This is a very important step if the adjustment of the clock is a big adjustment. This will prevent unnecessary confusion if someone else views the information at a later date.

Determining time stamped information occurrence

When viewing time stamped information remember that the time is set to GMT, or that someone may have incorrectly or never set the clock.

Use the time currently set in the ECM to compare any ECM recorded information to the time the ECM indicates to determine how long ago the time stamped event occurred.

Caution: Do not replace an ECM because of an incorrect time.

The following example indicates the correct use of the clock.

Example use of ECM date/time stamped information

The electronic service tool indicates an Engine Overspeed occurred on NOV 19 1998 10:30:46. The electronic service tool also indicates that the current time of day in the ECM is NOV 24 1998 11:20:58.

This indicates that the problem occurred approximately one week and 50 minutes ago.

Caution: Do not compare it to the current time at your location.

If the ECM time is significantly different than your current time, for example the wrong month is programmed, make sure you have recorded the time stamped information if it is important. After recording the information, clear the code and then adjust the clock.

ECM diagnostic clock

The diagnostic clock should not be confused with the ECM date/time clock. The diagnostic clock records the actual hours the ECM has been powered (key switch ON and engine running). This information is maintained even if the unswitched battery connections are removed. The clock information is used to log diagnostic code and event code occurrences. Logged diagnostic codes and event codes display the diagnostic clock hour of the first and last occurrence and the total number of occurrences.

Note: Actual engine running hours (total time) can be obtained from the Current Totals menu of TIPSS-EST.

Injector codes

Injector codes are etched on each injector. The injector codes can be viewed/changed using TIPSS-EST by selecting the Calibrations screen under the Service menu. The Injector Codes Calibration is located under the Calibration menu. The injector code must match the code on the corresponding injector. When an injector is replaced, reprogram the new code for the new injector.

TIPSS-EST manual cylinder cutout test

The 2800 Series engines use electronic fuel injectors. These injectors are mechanically actuated and electronically energized. The cylinder cutout tests are used to confirm that the cylinders are functioning correctly.

The Manual Cylinder Cutout test allows a specific cylinder to be cut out while the fuel position is monitored for the remaining cylinders.

To perform a cylinder cutout test, connect TIPSS-EST to the diagnostic connector as described in ["Connecting the TIPSS-EST" on page 17](#). Access the Cylinder Cutout test located under the Diagnostics menu.

The Cylinder Cutout test opens with the Manual test. At the bottom of the TIPSS-EST screen there is a row of buttons that function as follows:

- **Change** toggles the highlighted cylinder between powered and not powered
- **Power All** returns all cylinders to the normal operating state
- **Start** initiates the automated Cylinder Cutout test.
- **Stop** terminates the automated test.
- **Results** displays the test results.
- **Print** allows the contents of the screen to be previewed or to be sent to a file or printer.

Programming parameters

Many programmable parameters affect engine operation. These parameters may be changed by using electronic service tools. The parameters are stored in the ECM not the Personality Module. Whilst any parameter can be read, passwords can be used to protect parameters from unauthorized changes.

Two categories contain various parameters, System Configuration Parameters and Customer Specified Parameters.

System configuration parameters can only be altered with factory passwords by using TIPSS-EST.

Customer specified parameters can be changed by using an electronic service tool (this may require customer passwords if customer passwords have been programmed). Refer to ["Passwords" on page 19](#) for more details on how to receive and use factory and customer passwords.

System configuration parameters

System configuration parameters affect critical settings for the engine. They are programmed at the factory and would normally never need to be changed through the life of the engine. A complete list of these parameters is given in the table on the following page.

Note: System Configuration Parameters must be reprogrammed if an ECM is replaced, but not if the Personality Module is replaced (unless the engine rating changes). Failure to programme these parameters will result in a 268-02 Check Programmable Parameters diagnostic code.

Proper values for these parameters are stamped on the engine information ratings plate located on the valve cover or air inlet manifold. **Factory passwords** are required to change these parameters. The following information is a description of the system configuration parameters.

Full Load Setting (FLS)

Number representing fuel system adjustment made at the factory to “fine tune” the fuel system. The correct value for this parameter is stamped on the engine information ratings plate. A new ECM requires this parameter to be programmed to avoid generating a 253-02 Check Customer or System Parameters diagnostic code.

Full Torque Setting (FTS)

Similar to Full Load Setting. This parameter must be programmed to avoid generating a 253-02 Check Customer or System Parameters diagnostic code.

Personality Module part number

This is the part number of the Personality Module flashed into the ECM.

When a Personality Module is replaced (flash programmed) this code (stored in the ECM) **must** match the one in the introduced Personality Module or the engine will only run at low idle and a 253-02 Check Customer or System Parameters diagnostic code will be generated.

When the engine is being rerated, programming this code to “0” will prompt the ECM to read and match its stored code to the Personality Module code. This code does **not** need to be programmed when a Personality Module is replaced, as long as the new module is of the same family and emission year.

Engine serial number

This should be programmed to match the engine serial number that is stamped on the engine information plate. A new ECM is delivered without the engine serial number programmed.

ECM serial number

This is a read-only parameter which displays the serial number of the ECM.

Personality Module release date

This parameter is defined by the Personality Module and is not programmable. It is used to provide the version of the software. Customer parameters software changes can be tracked by this date. The date is provided in the month and year (NOV99), where NOV is the month (November) and 99 is the year (1999).

Critical override switch install

The critical override switch, if fitted and enabled, allows the engine to continue running even if engine oil pressure or coolant temperature have reached the limits where the engine would normally be shutdown. If the engine is run in this condition, the engine warranty is void and any events occurring are stored in the ECM with time and date stamping. Implementation of this facility requires a factory password.

Total tattletail

Displays the total number of times the configuration parameters have been changed.

Configuration parameters

Configuration parameter description	R/W Security
Selected engine rating	
Rating duty selection	Customer
External speed selection switch enable	Customer
Currently defined rating	Read Only
ECM identification parameters	
Equipment ID	Customer
Engine serial number	Factory
ECM serial number	Read Only
Personality module part number	Read Only
Personality module release date	Read Only
Personality module description	Read Only
Security access parameters	
Total tattletale	Read Only
Engine/gear parameters	
Engine startup accel. rate	Customer
Droop/isochronous switch enable	Customer
Droop/isochronous selection	Customer
Engine speed droop	Customer
Critical override switch install	Factory
Remote throttle control install	Customer
Remote throttle control min speed	Customer
Remote throttle control max speed	Customer
Remote throttle control ramp rate	Customer
I/O configuration parameters	
Desired speed input configuration	Customer
System parameters	
FLS	Factory
FTS	Factory
Governor gain factor	None
Governor minimum stability factor	None
Governor maximum stability factor	None
Passwords	
Customer parameter 1	Customer
Customer parameter 2	Customer

Customer specified parameters

Customer specified parameters allow the OEM to modify engine parameters to suit the application.

Customer parameters may be changed repeatedly as a customer changes his requirements. Customer passwords are required to change these parameters.

The following information is a brief description of the customer specified parameters.

Rating duty selection

This enables selection of the engine rating from a series of maps within the ECM. Changing the rating requires a customer password. The available ratings within the ECM will vary with engine type and specification.

External speed selection switch enable

For dual speed (1500 rev/min or 1800 rev/min) applications, where an external speed selection switch is required, this parameter enables the functionality of the speed selection switch within the software. Changing this parameter requires a customer password.

Currently defined rating

This brings up a screen detailing the rating currently selected.

Engine startup acceleration rate

Enables the acceleration rate of the engine in rev/min/s, from idle speed to rated speed, to be programmed. Control of this parameter enables any overshoot in speed on start up to be limited. Changing this parameter requires a customer password.

Droop/isochronous switch enable

Determines whether the external droop/isochronous switch is enabled or disabled. Changing this parameter requires a customer password.

Droop/isochronous selection

The engine will normally be run in isochronous mode i.e. the engine speed is the same at all loads. For certain applications where parallel operation with another generating set or with the grid is required, it is necessary for stability reasons to run in droop condition where engine speed drops with load. This parameter enables droop/isochronous running selection. Changing this parameter requires a customer password.

Engine speed droop

If droop operation is selected, this parameter allows the setting of percentage droop i.e. the percentage that the engine speed will drop with load. This parameter has no effect when the engine is running in isochronous mode. Changing this parameter requires a customer password.

Remote throttle control install

This parameter determines whether raise/lower switch input control of engine speed is installed. If remote throttle control is not installed, speed control reverts to the analogue or PWM inputs depending on which input is selected via the desired speed input configuration detailed on the following page. Changing this parameter requires a customer password.

Remote throttle control min speed

This setting determines the minimum speed range of both the raise/lower button control and the analogue control i.e. if this is set to 100 rev/min and the nominal engine speed is selected for 1500 rev/min, the minimum speed setting is 1400 rev/min. It does not affect the PWM speed control range which has fixed min/max limits. Changing this parameter requires a customer password.

Remote throttle control max speed

This setting determines the maximum speed range of both the raise/lower button control and the analogue control, i.e. if this is set to 100 rev/min and the nominal engine speed is selected for 1500 rev/min, the maximum speed setting is 1600 rev/min. It does not affect the PWM speed control range which has fixed min/max limits. Changing this parameter requires a customer password.

Remote throttle control ramp rate

This setting determines the rate of change of engine speed in rev/min/s when the raise/lower switch inputs are closed. Changing this parameter requires a customer password.

Desired speed input configuration

This parameter allows selection of the analogue or PWM external speed control if the remote throttle control is not installed. The Analogue or PWM speed control inputs are normally used with generating set load sharing and synchronising controllers. Changing this parameter requires a customer password.

Governor Gain parameters

The adjustable Governor Gain parameters are:

- Governor Gain Factor
- Governor Minimum Stability Factor
- Governor Maximum Stability

Notes:

- No engineering units associated with these numbers.
- The programmable range is wide for flexibility. The values are valid from 1- 40000. This wide programmable range may not be fully used on any system. Do not expect to use the whole range.

Gain Explanations

Governor Gain Factor

The Governor Gain Factor is multiplied to the difference between desired speed and actual speed.

- If the Governor Gain Factor value is too large, the engine speed can overshoot the desired speed. The overshoot is caused by an overcorrection or a steady state instability.
- If the Governor Gain Factor is too small, the response necessary to accelerate the engine to the desired speed must be obtained by ramping the stability terms to a higher value. This process is time consuming so, as a result, the engine speed is slow to respond.

Governor Minimum/Maximum Stability Factor

The Stability Factor terms work to eliminate a steady state speed error. There are two gain terms used for stability. If the error is greater than 20 rev/min and the error is increasing, then the Maximum Stability Gain is functioning. If the error is less than 20 rev/min, then the Minimum Stability Gain is used. This function allows the use of a high gain that would otherwise cause the engine to be unstable when the engine is operating near the desired speed.

- If either the Minimum Stability Gain or the Maximum Stability Gain is set too high, the governor will provide more fuel than is necessary to bring the error to zero. The additional fuel will cause the engine speed to overshoot and ring.
- If either the Minimum Stability Gain or the Maximum Stability Gain is set too low, the engine will take too long to arrive at a steady state speed.

Tuning Procedure

1 Turn the ECS to the OFF/RESET position. Connect TIPSS-EST and verify that Engine Overspeed Protection is enabled before beginning the tuning process. Engine Overspeed is configured on the ServiceMonitoring System screen on TIPSS-EST.

Warning! *Performing engine governor tuning without engine overspeed protection could result in serious engine damage. Ensure that this parameter is ON while performing this procedure.*

2 Start the engine. Observe, on the engine mounted genset control panel, that the engine has reached rated speed. This panel will serve as the speed reference point during this procedure.

3 Enter the Configuration Parameters screen on TIPSS-EST.

4 Determine the desired scenario to tune the engine. For example, is the engine having poor response during specific load assignments or specific load dumps ?

Continued

5 Perform the desired load change from step 4. Observe the response of the engine by viewing the engine speed on the genset mounted control panel, by looking at the system bus frequency response to the load change, or by listening to the response of the engine.

6 Use the suggestions listed under the bulleted items to determine which gains should be adjusted.

Note: Usually, the Governor Gain Factor should be somewhat lower than the Governor Minimum Stability Factor for optimum performance. The Maximum Stability Factor is typically a smaller value than the Minimum Stability Gain and Governor Gain Factor.

7 Repeat steps 5, 6, and 7 until a desired engine response can be met. Use large adjustments (10% of original gain) at first to generally tune the engine in the proper manner. As the response is closer to desired, increase the gains in smaller increments (1% of total gain).

Customer parameter 1, Customer parameter 2

These are the customer password programmable parameters that can be used to protect certain configuration parameters from unauthorised changes.

4

Troubleshooting without a diagnostic code

Introduction

This chapter is to be used for troubleshooting problems that have symptoms but do not have ACTIVE diagnostic codes. Some engine symptoms are caused by conditions or components other than the electronic control system, such as poor fuel quality or incorrectly adjusted valves.

Before using this chapter, be sure that you have gathered information about the complaint to adequately describe the symptoms, verified that the complaint is not due to normal engine operation and repaired all ACTIVE diagnostic codes. Refer to [Chapter 6, Troubleshooting with a diagnostic code](#).

The basic philosophy of troubleshooting this engine is to follow the three steps listed below **FIRST** to diagnose a malfunctioning engine:

- 1 Gather operator information. Verify that the complaint is not due to normal engine operation.
- 2 Perform a visual inspection of the engine. Check fuel and oil level, supply and/or condition. Check for visible wiring and connector problems or damaged components.
- 3 Check and repair all ACTIVE/LOGGED diagnostic codes using the troubleshooting procedures given in [Chapter 6, Troubleshooting with a diagnostic code](#).

If ALL three of these inspections reveal no problems, identify probable causes using the procedure or procedures in this chapter that best describes the symptoms. Narrow the probable causes given in the procedure by considering operator information, operating conditions, and repair history of the engine.

Operator information

- What happened, and when ?
- Under what conditions ?
- Was the engine rev/min (speed) high or low ?
- Was the engine under load ?
- Are there any customer or dealer installed systems that could cause this symptom ?
- What else occurred ?
- When did the symptoms begin (and what else happened at that time) ?

Logged diagnostic codes

- Do they correlate to probable causes ?
- Did they occur at the same time as the symptoms ?
- Are some codes logged repeatedly ?

Other symptoms

- Are they related to this symptom ?
- Do they have common probable causes ?

Finally, test each probable cause using the tests suggested by the procedure. Be sure to check connectors, especially on intermittent problems. Refer to [Test 1: Inspecting electrical connectors on page 80](#) for details.

Engine will not crank

P-401

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Battery cables/batteries
- Emergency stop switch
- Starter motor solenoid or circuit problem (in system wiring)
- Starter motor/flywheel ring gear
- Engine accessory
- Hydraulic cylinder lock
- Internal engine problem

Perform the following tests in order:

- 1 Check battery post and battery cables for loose connections and corrosion. If corroded, remove and clean cables and connections. Check the optional battery disconnect switch.
- 2 Load test batteries. If necessary, charge the batteries.
- 3 Verify that the optional emergency stop switch is not engaged.
- 4 Test starter motor solenoid operation. Check the system wiring to starter motor solenoid.
- 5 Test starter motor operation. Inspect starter motor pinion and ring gear for damage.
- 6 Verify that the timing pin was not left in the flywheel housing after setting valve clearances. Use the engine turning tool and attempt to manually turn the engine. If unable to turn the engine, remove and inspect engine accessories that can lock up the engine. Repair or replace as necessary.
- 7 Remove injectors and check for fluid in the cylinders.
- 8 Disassemble engine to inspect for internal components that may be seized, broken, bent, out of alignment, etc. Refer to the Workshop Manual.

Engine cranks but will not start

P-402

Probable root causes:

- Starting aids/fuel gel (cold temperature operation)
- Electrical connectors and wiring
- Personality Module or ECM
- Engine speed/timing signal
- Electrical connections to the unit injector solenoids
- Fuel supply
- Combustion problem

Perform the following tests in order:

1 If cold ambient conditions exist, check operation of starting aids. Check the coolant immersion heater for malfunction and replace if required. Check for presence of congealed fuel (wax). Repair as required.

2 Check for correct installation of the ECM connectors J1/P1 and J2/P2, engine speed/timing sensor connectors J401/P401 and J402/P402, and unit injector connectors J300/P300. Verify that the ECM is receiving the correct voltage.

Note: Aftermarket engine protection devices may interrupt power to the ECM and prevent communications with the electronic service tool. Check for correct installation and operation of aftermarket engine protection devices. Aftermarket devices may need to be bypassed to continue.

3 If the ECM has an unprogrammed Personality Module the engine will crank but will not start. Access ECM Status in the WinFlash PC program and follow the request to program the Personality Module. Refer to [Chapter 3, Programming parameters](#). Failure to program the Personality Module will cause the engine to not start or communicate. Cycling the key switch will allow access to the WinFlash PC program.

4 Check that none of the diagnostic lamps are illuminated. If any are, turn the key switch OFF and ON to try and clear the fault. If the diagnostic lamps cannot be cleared refer to [Chapter 6, Troubleshooting with a diagnostic code](#). Verify that the speed/timing sensors are correctly installed and that no diagnostic codes are active.

5 Verify there is not an active 252-11 Incorrect Engine Software diagnostic code. If the diagnostic code is present, refer to ["Programming a Personality Module using flash programming" on page 23](#).

6 Observe the engine speed on an electronic service tool Status screen while cranking the engine. If the electronic service tool displays 0 rev/min while cranking the engine, there is a problem in the engine speed/timing sensor circuit. Refer to [Test 8: Engine speed/timing circuit test on page 121](#).

If the engine speed is greater than 50 rev/min the engine speed/timing circuitry appears to be operating correctly. Verify that the timing reference gear is installed correctly and keyed to the camshaft by means of the locating dowel. If the gear was installed backwards or flipped over during assembly, the engine will not start.

7 Check the calibration of the timing sensor and recalibrate if required. Refer to [Test 9: Engine speed/timing calibration on page 129](#). Check for correct orientation between crankshaft and camshaft drive gears, repair as required.

8 Make sure the unit injector connectors are correctly installed. Refer to [Test 10: Injector solenoids circuit test on page 133](#) and perform the Injector Solenoid test as a quick check to confirm that the ECM can energize the unit injector solenoids. Ensure that the injection disable switch (if fitted) is ON.

9 Check for a fuel supply problem and verify fuel pressure. Refer to [P-428: Engine has a fuel supply problem on page 59](#).

10 Check for combustion problems.

Engine misfires, runs rough or is unstable

P-403

Note: If the problem is intermittent and cannot be recreated, refer to [P-406: Intermittent low power or power cutouts on page 37](#). If the problem is consistent and can be recreated, continue with this procedure.

Probable root causes:

- Cold mode operation (normal operation, if the problem occurs only after start-up)
- Battery cables, battery
- Electrical connections to the ECM
- Loss of backup engine speed/timing sensor
- Throttle position signal
- Faulty electronic unit injector circuit (individual cylinder malfunction)
- Fuel supply
- Air inlet or exhaust restrictions or air system leaks
- Internal engine problem

Note: If the problem only occurs under certain conditions (high engine speed, full load or engine operating temperature, etc), then perform the test under those operating conditions.

Perform the following tests in order:

1 Monitor the electronic service tool Status screen to verify the engine has exited cold mode. Observe the coolant temperature reading on the electronic service tool. The engine should exit cold mode operation whenever the coolant temperature is above 17 °C (64 °F) and the engine has been running for five minutes.

2 Check battery post and battery cables for loose connections and corrosion. If corroded, remove and clean cables and connections.

3 Check the ECM connectors J1/P1 and J2/P2, customer connector, engine speed/timing sensor connectors, unit injector connectors and associated wiring for damage, abrasion or incorrect attachment. Refer to [Test 1: Inspecting electrical connectors on page 80](#).

4 Check the battery connection at the customer connector and ECM connector. Perform a pull test on the customer connector. Perform a pull test on P1 pins 48, 52, 53, 61, 63, 65 and 70. The wires should remain in the connectors during pull test. Refer to [Test 1: Inspecting electrical connectors on page 80](#).

5 Connect an electronic service tool and verify that a 190-02 Loss of Engine Speed Signal is not active. The code should not be Active. If the 190-02 Code is active check to see if a 342-02 Loss of Backup Engine Speed Sensor has been recently logged. If the electronic service tool indicates that a 342-02 has been recently logged perform a pull test on the wires to the backup engine speed/timing sensor. Refer to [Test 1: Inspecting electrical connectors on page 80](#). If a 342-02 has not been recently logged and the 190-02 code is active refer to [Test 8: Engine speed/timing circuit test on page 121](#).

6 Connect an electronic service tool to the service tool connector. Turn the key switch to the ON position, engine OFF. If a PWM speed control is fitted, verify that a 91-08 Invalid PWM Speed Control Signal diagnostic code has not been recently logged. Monitor the throttle position from low idle to full throttle.

7 Check for active or recently logged Injector Solenoid diagnostic codes. Use an electronic service tool and cut out each cylinder at low idle to isolate the misfiring cylinder(s). Refer to [Test 10: Injector solenoids circuit test on page 133](#).

8 Check for a fuel supply problem and verify fuel pressure.

9 Check air inlet and exhaust systems for restrictions and leaks. Look for a diagnostic lamp indication, or tripped restriction indicators (if fitted) associated with plugged air filters. Replace plugged air filters, or clean filters, as described in the User's Handbook, and repair any leaks found. Also refer to [Test 3: Analogue sensor open or short circuit test on page 88](#). Refer to the Workshop Manual if an internal engine problem is suspected.

Low power/poor or no response to throttle

P-404

Probable root causes:

- Customer specified parameters
- Cold mode operation (normal operation if the problem occurs only after start-up in cold weather)
- Engine is in a derated mode
- Electrical connections to the ECM
- External speed control
- Faulty electronic unit injector (individual cylinder malfunction)
- Fuel supply
- Boost pressure sensor signal
- Air inlet or exhaust system restrictions or leaks
- Incorrect adjustment of Full Load Setting or Full Torque Setting

Note: If the problem only occurs under certain conditions (high engine speed, full load or engine operating temperature, etc), then perform the test under those operating conditions.

Perform the following tests in order:

- 1** Verify that the complaint is not normal (programmed parameter) operation. Connect an electronic service tool and verify the system/customer parameters. If a 253-02 Check Customer Or System Parameters is active, ensure **ALL** the system and customer parameters are programmed. Verify that the injector codes are programmed.
- 2** Monitor the electronic service tool Status screen to verify the engine has exited cold mode. Observe the coolant temperature reading on the electronic service tool. The engine should exit cold mode operation whenever the coolant temperature is above 17 °C (64 °F) and the engine has been running for five minutes.
- 3** The engine may be derated due to altitude or other factors. Connect an electronic service tool and check for active engine derates or diagnostic codes.
- 4** Check the ECM connectors J1/P1 and J2/P2, customer connector and the relevant speed setting inputs and associated wiring for damage, abrasion or incorrect attachment. Refer to [Test 1: Inspecting electrical connectors on page 80](#).
- 5** If a PWM speed control is fitted, connect an electronic service tool to the service tool connector. Turn the key switch to the ON position, engine OFF. Verify that a 91-08 Invalid PWM Speed Control Signal diagnostic code has not been recently logged. Monitor the PWM input. The duty cycle should be between 5 and 10 percent at low load and increase at full load. If the throttle position change is erratic or out of range the problem is with the external speed control.
- 6** Verify that a 262-03 (+5 VDC Supply Above Normal) or a 262-04 (+5 VDC Supply Below Normal) diagnostic code is not present. If either of the codes are active refer to [Test 3: Analogue sensor open or short circuit test on page 88](#).
- 7** Check for a fuel supply problem and verify fuel pressure. Refer to [P-428: Engine has a fuel supply problem on page 59](#).
- 8** Check air inlet and exhaust systems for restrictions and leaks. Look for a diagnostic lamp indication, or tripped restriction indicators (if fitted) associated with plugged air filters. Replace plugged air filters, or clean filters, as described in the User's Handbook, and repair any leaks found.

Intermittent engine shutdowns

P-405

Note: Use this procedure only if the engine has shut down completely and has had to be restarted.

Probable root causes:

- Customer specified parameters
- Electrical connections to the ECM
- Faulty electronic unit injector connector
- Faulty ground level shutdown
- Engine fault

The ECM detects an engine fault, e.g. low oil pressure, etc. These fault codes may be viewed on the display modules or an electronic service tool. They are logged in memory except as noted. The ECM will attempt to limit top engine limit by not allowing the unit injectors to inject fuel.

Note: If the problem only occurs under certain conditions (high engine speed, full load or engine operating temperature, etc), then perform the test under those operating conditions.

Perform the following tests in order:

1 The engine may be shut down due to low pressure levels, or other factors. Connect an electronic service tool and check for active engine derates or diagnostic codes.

2 Check the ECM connectors J1/P1 and J2/P2, customer connector, engine speed/timing sensor connectors and the unit injector connectors and associated wiring for damage, abrasion, corrosion or incorrect attachment. Refer to [Test 1: Inspecting electrical connectors on page 80](#) for additional information.

3 Check the electronic service tool for logged 168-02 (Battery Voltage Intermittent) diagnostic code. Check the battery connection at the customer connector and the ECM connector. Refer to the electrical schematic. Perform a pull test on the customer connector. Perform a pull test on P1 pins 48, 52, 53, 61, 63, 65 and 70. The wires should remain in the connectors during the pull test. Refer to [Test 1: Inspecting electrical connectors on page 80](#).

4 If the problem occurs only after the engine is warmed up and disappears after the engine has been allowed to cool, the circuit breakers may be exceeding the trip point because of overheating. Check the circuit breakers on the engine, reset if required.

Note: Aftermarket engine protection devices may interrupt power to the ECM. Check for correct installation and operation of aftermarket engine protection devices. Aftermarket devices may need to be bypassed to continue testing.

5 Verify switch status on an electronic service tool. If the switch status is incorrect, refer to "[Machine wiring diagram \(all options\)](#)" on page 11.

6 Check for a fuel supply problem and verify fuel pressure. Refer to [P-428: Engine has a fuel supply problem on page 59](#).

Intermittent low power or power cutouts

P-406

Note: Use this procedure only if the engine DOES NOT shut down completely (the engine did not have to be restarted).

Probable root causes:

- An engine derate is occurring
- Speed setting input signal
- Faulty electrical connections
- Fuel supply

Note: If the problem only occurs under certain conditions (high engine speed, full load or engine operating temperature, etc) then perform the test under those operating conditions.

Perform the following tests in order:

1 The engine may derate due to low pressure levels or other factors. Connect an electronic service tool and check for active engine derates or diagnostic codes.

2 Check the ECM connectors J1/P1 and J2/P2, customer connector, engine speed/timing sensor connectors and the unit injector connectors and associated wiring for damage, abrasion, corrosion or incorrect attachment. Refer to [Test 1: Inspecting electrical connectors on page 80](#) for additional information.

3 Check the electronic service tool for a logged 168-02 (Battery Voltage Intermittent) diagnostic code. Check the battery connection at the customer connector and the ECM connector. Refer to the electrical schematic. Perform a pull test on the customer connector. Perform a pull test on pins 48, 52, 53, 61, 63, 65 and 70. The wires should remain in the connectors during the pull test. Refer to [Test 1: Inspecting electrical connectors on page 80](#).

4 If the problem occurs only after the engine is warmed up and disappears after the engine has been allowed to cool, the circuit breakers may be exceeding the trip point because of overheating. Check the circuit breakers on the engine, reset if required.

Note: Aftermarket engine protection devices may interrupt power to the ECM. Check for correct installation and operation of aftermarket engine protection devices. Aftermarket devices may need to be bypassed to continue testing.

5 If a PWM speed control is fitted, connect an electronic service tool to the service tool connector. Turn the key switch to the ON position, engine OFF. Verify that a 91-08 Invalid Throttle Signal diagnostic code has not been recently logged. Monitor the PWM input. The duty cycle should be between 5 and 10 percent at low load and increase with load. If the throttle position change is erratic or out of range the problem is with the external speed control.

6 Connect an electronic service tool and verify that a 190-02 Loss of Engine Speed Signal is not active. The code should not be active. If the 190-02 Code is Active check to see if a 342-02 Loss of Backup Engine Speed Sensor has been recently logged. If the electronic service tool indicates that a 342-02 has been recently logged perform a pull test on the wires to the backup engine speed/timing sensor. Refer to [Test 1: Inspecting electrical connectors on page 80](#). If a 342-02 has not been recently logged and the 190-02 code is active refer to [Test 8: Engine speed/timing circuit test on page 121](#).

7 Check for a fuel supply problem and verify fuel pressure. Refer to [P-428: Engine has a fuel supply problem on page 59](#).

Electronic service tool will not communicate with the ECM

P-407

Probable root causes:

- Personality Module or ECM problem
- Electronic service tool or communication adapter cable problem
- Perkins Data Link
- Electrical power supply to the ECM connector or wiring problem in electronic system wiring harness

Perform the following tests in order:

Note: If the engine starts but will not communicate proceed with this test. If the engine will not start, refer to [P-402: Engine cranks but will not start on page 33](#). If the engine will not crank, refer to [P-401: Engine will not crank on page 32](#). Aftermarket engine protection devices may interrupt power to the ECM and prevent communications with the electronic service tool. Check for correct installation and operation of aftermarket protection devices, they may need to be bypassed to continue.

1 In the event that the ECM on the engine is new, the engine will not start or communicate until the Personality Module is programmed. Refer to [Chapter 3, Programming parameters](#).

2 Check the ECM connectors J1/P1 and J2/P2, customer connector, service tool connectors and associated wiring for damage, abrasion, corrosion or incorrect attachment. Refer to [Test 1: Inspecting electrical connectors on page 80](#) for additional information.

3 Verify that the key switch is in the ON position and any override switches are not creating the problem. Start the engine and then connect the electronic service tool. If communication occurs when the engine is started, but not when the key switch is in the ON position, some type of system override is interrupting power to the ECM. Repair as required.

4 Verify that battery voltage is present at pin-A and Pin-B of the service tool connector (the communication adapter display will be blank if it is not receiving power).

5 Check the electronic service tool connections and wiring. Connect another electronic service tool and cable to the system to verify the fault is with the electronic service tool.

6 For the TIPSS-EST service tool only: Remove pin-D and pin-E from the service tool connector. Connect the electronic service tool to the service tool connector and retest. If the electronic service tool will not communicate with the ECM reconnect the wires and proceed to the next step. If the service tool does communicate with the ECM there is a problem in the data link wire. Repair as required.

7 Disconnect the ECM P1 connector. Install a bypass harness, connect the bypass harness directly to the electronic service tool cable and retest. Refer to [Test 7: Perkins Data Link circuit test on page 114](#). If the ECM communicates with the bypass installed, either the machine wiring or another device is causing the data link communication problem. Repair as required.

ECM will not accept factory passwords

P-408

Probable root causes:

- Error entering password
- Incorrect serial number (engine, ECM, or electronic service tool), total tattletale, or reason code used to obtain password

Perform the following tests in order:

1 Verify the correct passwords were entered. Check each character in the password for accuracy (for instance letter I vs. number 1, Z vs. 2, O vs. 0, etc). Turn the key switch to the OFF position for 30 seconds and then retry.

2 Verify the electronic service tool is on the Factory Passwords screen. Verify the engine serial number used to calculate the password is correct. Verify the total tattletale, reason code, electronic service tool serial number and ECM serial number is correct. Refer to ["Factory passwords" on page 19](#) for more details.

Excessive black smoke

P-409

Probable root causes:

- Air inlet restriction or air system leaks
- Engine speed/timing signal: injection timing or calibration, incorrect engine speed/timing wheel orientation assembly, engine speed/timing sensor calibration error after replacement
- Faulty inlet air manifold pressure sensor, atmospheric pressure sensor, or sensor calibration
- Personality Module
- Fuel supply: low supply pressure, air in low pressure fuel system, poor fuel quality
- Incorrect valve adjustment

Perform the following tests in order:

1 Connect an electronic service tool and compare atmospheric and inlet pressure readings. Check for filter restriction derates and alarms. Check air inlet and exhaust systems for restrictions and leaks. Check for a failed turbocharger. Refer to the relevant procedure in the Workshop Manual. Replace plugged air filters, or clean filters, as described in the User's Handbook, and repair any leaks found. Verify correct operation of the inlet air manifold pressure and atmospheric pressure sensors. Refer to [Test 3: Analogue sensor open or short circuit test on page 88](#).

2 Check calibration of the engine speed/timing sensor, recalibrate if required. Refer to [Test 9: Engine speed/timing calibration on page 129](#). Check for correct orientation between crankshaft and camshaft drive gears, repair as required. Refer to the relevant procedure in the Workshop Manual.

3 Monitor atmospheric pressure with an electronic service tool. Observe inlet air manifold pressure, fuel position, rated fuel position and FRC fuel limit while the engine is operating under full load.

**Fuel position = rated fuel position
and
FRC fuel limit > rated fuel limit**

Note: A problem with the FRC will only create black smoke problems on acceleration, not steady state operation. Check for a restriction in the atmosphere path, remove dirt and debris if required. Atmospheric pressure should range from 50 to 100 kPa (7.5 to 15 psi) depending on your area of operation. Refer to [Test 3: Analogue sensor open or short circuit test on page 88](#).

4 Check for a fuel supply problem and verify fuel pressure. Refer to [P-428: Engine has a fuel supply problem on page 59](#).

5 Check valve adjustment.

Excessive white smoke

P-410

Note: Some white smoke may be present during cold start-up conditions when the engine is operating normally.

Probable root cause:

- Faulty coolant temperature sensor
- Engine speed/timing signal: injection timing or calibration, incorrect engine speed/timing wheel orientation assembly, engine speed/timing sensor calibration error after replacement
- Personality Module
- Fuel supply
- Combustion system problem

Perform the following tests in order:

- 1** Verify cold mode is active when the engine is cold. Monitor coolant temperature status on an electronic service tool. Observe coolant temperature and ensure the reading is reasonable. If temperature reading is incorrect, refer to [Test 3: Analogue sensor open or short circuit test on page 88](#).
- 2** Check timing calibration of the engine speed/timing sensor, recalibrate if required. Refer to [Test 9: Engine speed/timing calibration on page 129](#). Check for correct orientation between crankshaft and camshaft drive gears, repair as required.
- 3** Connect an electronic service tool and verify the correct Personality Module is installed for the engine configuration and application. Refer to [Chapter 3, Programming parameters](#).
- 4** Check for a fuel supply problem and verify fuel pressure. Refer to [P-428: Engine has a fuel supply problem on page 59](#).
- 5** Excessive valve, piston, ring and/or liner wear, or low cranking speed can result in reduced compression pressure, resulting in white smoke. Coolant leakage into the cylinder or exhaust system can also produce symptoms similar to white smoke emissions from unburned fuel. Refer to the Workshop Manual.

Engine cannot reach correct rev/min

P-411

Note: If this problem occurs only under load, refer to [P-404: Low power/poor or no response to throttle on page 35](#).

Probable root causes:

- Engine is in cold mode or derated
- Personality Module
- External speed control input
- Faulty inlet boost pressure sensor, atmosphere signal or calibration
- Fuel supply
- Air inlet or exhaust restriction or air system leaks
- Air supply/low boost

Perform the following tests:

1 Connect an electronic service tool and verify the engine has exited cold mode. Check for active engine derates. Verify the programming parameters are correct. Refer to [Chapter 3, Programming parameters](#).

Note: The engine may be derated due to altitude or other factors.

2 Monitor the external speed control (if fitted) on an electronic service tool. Observe the position and verify it can reach 100 percent.

3 Check for a fuel supply problem and verify fuel pressure. Refer to [P-428: Engine has a fuel supply problem on page 59](#).

4 Check air inlet and exhaust systems for restrictions and leaks. Look for a diagnostic lamp indication, or tripped restriction indicators (if fitted) associated with plugged air filters. Replace plugged air filters, or clean filters, as described in the User's Handbook, and repair any leaks found. Also refer to [Test 3: Analogue sensor open or short circuit test on page 88](#).

Poor acceleration or response

P-412

Probable root causes:

- The engine is in cold mode or a derate mode.
- Personality Module
- External speed control input
- Incorrect inlet boost pressure sensor or atmosphere signal
- Air inlet or exhaust restriction or leaks
- Fuel supply

Perform the following tests in order:

1 Connect an electronic service tool and check for active engine derates. Verify the engine has exited cold mode operation. The engine will not respond as fast until it has warmed to operating temperature.

Note: The engine may be derated due to altitude or other factors.

2 Verify the correct Personality Module is installed. Refer to [Chapter 3, Programming parameters](#).

3 Monitor the external speed control input on an electronic service tool. Observe position and verify the reading is stable and can reach 100 percent.

4 Inspect ECM connectors J1/P1 and J2/P2, engine interface connectors, and the unit injector connectors for correct connection. Repair or replace as required. Refer to [Test 1: Inspecting electrical connectors on page 80](#). Perform the Cylinder Cutout test to check for any non-operable unit injectors, and replace only those diagnosed as faulty by the cylinder cutout check. Connect an electronic service tool and cutout each cylinder to isolate the misfiring cylinder(s). If results are inconclusive, perform the test under load or shut off half of the engine's cylinders and repeat cutout on the remaining active cylinders to locate those misfiring. If it can be isolated to a specific cylinder(s), refer to [Test 10: Injector solenoids circuit test on page 133](#).

5 Monitor atmospheric pressure with an electronic service tool. Observe boost pressure while the engine is operating under full load. Atmospheric pressure should range from 50 to 100 kPa (7.5 to 15 psi).

6 Check air inlet and exhaust systems for restrictions and leaks. Look for a warning lamp or diagnostic lamp indication, or tripped restriction indicators (if fitted) associated with plugged air filters. Replace plugged air filters, or clean filters, as described in the User's Handbook, and repair any leaks found.

7 Check for a fuel supply problem and verify fuel pressure. Refer to [P-428: Engine has a fuel supply problem on page 59](#).

Poor fuel consumption

P-413

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Incorrect engine operation
- Engine speed/timing signal: injection timing or calibration, incorrect engine speed/timing wheel orientation, engine speed/timing sensor calibration error after replacement
- Faulty electronic unit injector(s) (individual cylinder malfunction)
- Fuel supply
- Air inlet or exhaust restrictions or air system leaks

Perform the following tests in order:

- 1 Check timing calibration of engine speed/timing sensor and recalibrate if required. Refer to [Test 9: Engine speed/timing calibration on page 129](#). Check for correct orientation between crankshaft and camshaft drive gears, repair as required. Refer to the Workshop Manual.
- 2 Inspect ECM connector J2/P2 and the unit injector connector for correct connection. Refer to [Test 1: Inspecting electrical connectors on page 80](#). Connect an electronic service tool and cut out each cylinder to isolate the misfiring cylinder(s). If results are inconclusive, shut off half of the engine's cylinders and repeat cutout on remaining active cylinders to locate those that are misfiring. Refer to [Test 10: Injector solenoids circuit test on page 133](#).
- 3 Check for a fuel supply problem and verify fuel pressure. Refer to [P-428: Engine has a fuel supply problem on page 59](#).
- 4 Check air inlet and exhaust systems for restrictions and leaks. Look for a warning lamp or diagnostic lamp indication, or tripped restriction indicators (fitted) associated with plugged air filters. Replace plugged air filters, or clean filters, as described in the User's Handbook, and repair any leaks found.

Too much vibration

P-414

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Possible root causes:

- Loose or faulty vibration damper
- Engine supports are loose, wrong or are incorrectly torqued
- Equipment may not be in alignment or is out of balance
- Engine misfiring or running rough

Perform the following tests in order:

- 1 Check vibration damper for damage. Tighten bolts. If vibration damper bolt holes have damage or wear, replace with new parts. Install a new vibration damper if necessary.
- 2 Run the engine through its speed range while looking for loose or broken mounts or brackets. Tighten all mounting bolts. Install new components if necessary.
- 3 Check alignment and balance, correct if required.
- 4 Refer to [P-403: Engine misfires, runs rough or is unstable on page 34](#).

Noise coming from cylinder

P-415

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Low quality fuel
- Incorrect fuel injection timing calibration
- Faulty electronic unit injector(s)
- Incorrect valve train operation or valve train noise (clicking)
- Damage to valve spring(s) or locks
- Not enough lubrication
- Excessive valve clearance
- Damage to valve(s)
- Unit injector plunger
- Damaged camshaft lobe
- Little or no valve clearance, worn valve seat or face of valve

Perform the following tests in order:

1 Check for a fuel supply problem and verify fuel pressure. Refer to [P-428: Engine has a fuel supply problem on page 59](#).

2 Check and calibrate electronic injection timing with an electronic service tool. Refer to [Test 9: Engine speed/timing calibration on page 129](#).

3 Connect an electronic service tool and cutout each cylinder to isolate the misfiring cylinder(s). If results are inconclusive, perform test under load or shut off half of the engine's cylinders and repeat cutout on remaining active cylinders to locate those misfiring. Refer to [Test 10: Injector solenoids circuit test on page 133](#).

4 Damage to valve spring(s). Replace damaged parts. Damage to camshaft. Replace damaged parts. Clean engine valve train thoroughly. Replace damaged valve lifters. Inspect camshaft lobes for damage. Look for valves that do not move freely. Adjust using the procedure described in "Setting valve clearances" in the Workshop Manual. Refer to [P-417: Valve rotocoil or spring lock is free on page 48](#).

5 Install new parts where necessary.

Caution: Broken locks can cause the valve to fall into the cylinder. This will cause severe damage.

6 Check lubrication in valve compartment. There must be a strong flow of oil at high engine idle rev/min, but only a small flow of oil at low rev/min. Oil passages must be clean, especially those that send oil to the cylinder head.

7 Refer to [P-416: Excessive valve clearance on page 47](#). Adjust using the procedure described in "Setting valve clearances" in the Workshop Manual.

8 Replace the valve(s) and adjust using the procedure described in "Setting valve clearances" in the Workshop Manual.

9 Plunger may be stuck, repair as required with reference to the Workshop Manual.

10 Refer to the Workshop Manual

11 Reconditioning of cylinder head is required.

Excessive valve clearance

P-416

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Not enough lubrication
- Rocker arm worn at face that contacts bridge
- Bridges for valves worn/incorrect adjustment
- End of valve stem worn
- Worn cams on camshaft
- Loose or broken rocker shaft retaining bolt

Perform the following tests in order:

- 1** Check lubrication in valve compartment. There must be a strong flow of oil at high engine idle rev/min, but only a small flow at low rev/min. Oil passages must be clean.
- 2** If there is too much wear, install new parts or rocker arms. Adjust valve clearance using the procedure described in "Setting valve clearances" in the Workshop Manual.
- 3** Adjust or replace bridges as necessary. If there is too much wear, install new parts. Adjust valve clearance using the procedure described in "Setting valve clearances" in the Workshop Manual.
- 4** If there is too much wear, adjust valve clearance using the procedure described in "Setting valve clearances" in the Workshop Manual.
- 5** Clean engine valve train thoroughly. Check camshaft for wear. Check for free movement of valves or bent valve stem. Adjust using the procedure described in "Setting valve clearances" in the Workshop Manual.
- 6** Check valve clearance. Check for free movement of valves or bent valve stems. Install a new camshaft. Adjust using the procedure described in "Setting valve clearances" in the Workshop Manual.
- 7** Repair or replace rocker shaft retaining bolt as required.

Valve rotocoil or spring lock is free

P-417

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Cracked inlet valve Rotocoil
- Broken spring locks
- Broken valve spring(s)
- Broken valve

Perform the following tests in order:

- 1 Determine cause of engine overspeed that would crack the Rotocoil.
- 2 Install new parts where necessary.

Caution: Broken locks can cause the valve to fall into the cylinder, and will cause severe damage.

- 3 Install new valve spring(s).
- 4 Replace valve and other damaged parts.

Mechanical noise (knock) in engine

P-418

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Faulty accessory or driven equipment
- Damaged camshaft lobe
- Damaged gears
- Failure of bearing for connecting rod or damaged crankshaft

Perform the following tests in order:

- 1 Attempt to isolate the source of the noise. If suspected, remove and inspect engine accessories. Repair or replace as necessary. Refer to the Workshop Manual.
- 2 If noise may be coming out of the cylinder head, check for damage to camshaft or valve train components. Replace damaged parts. Clean the engine valve train thoroughly. Check for valves that do not move freely. Adjust using the procedure described in "Setting valve clearances" in the Workshop Manual. Refer to [P-415: Noise coming from cylinder on page 46](#).
- 3 Install new parts where necessary.
- 4 Inspect the connecting rod bearings and the bearing surfaces (journals) on the crankshaft. Install new parts where necessary.

Oil in cooling system

P-419

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Faulty engine oil cooler core or driven equipment oil cooler (if fitted)
- Failure of cylinder head gasket or coolant seals

Perform the following tests in order:

- 1 Inspect each cooler and replace or repair faulty oil cooler.
- 2 Check cylinder liner projection. Install a new cylinder head gasket and new coolant seals in the spacer plate. Tighten the cylinder head bolts according to the procedure in the Workshop Manual.

Fuel in cooling system

P-420

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Internal cylinder head problem

Perform the following tests in order:

1 Remove the valve cover. Remove the fuel supply and fuel return line from cylinder head. Cap the fuel return connector and apply 700 kPa (100 psi) maximum air pressure to the fuel supply connector. Check for fuel leakage around the unit injector. If leakage is present, it will be necessary to remove the unit injector and install a new O-Ring seal.

Coolant in lubricating oil

P-421

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Failure of any of the oil cooler cores
- Failure of cylinder head gasket or coolant seals
- Crack in cylinder head
- Cracked or broken cylinder liner
- Crack in cylinder block

Perform the following tests in order:

- 1 Install a new oil cooler core. Drain crankcase and refill with clean lubricant. Install new oil filters.
- 2 Check cylinder liner projection. Install a new cylinder head gasket and new liner coolant seals in the spacer plate. Tighten the cylinder head bolts according to the procedure in the Workshop Manual.
- 3 Check for cracks in cylinder head. Repair or replace as required.
- 4 Check for cracked liners. Replace cracked cylinder liners.
- 5 Repair or replace cylinder block.

Fuel dilution of lubricating oil

P-422

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Leaking fuel seals on unit injector case or barrel
- Leaking fuel seals on cylinder head adapters
- Unit injector nozzle tip leakage or breakage
- Cracked fuel supply manifold
- Fuel transfer pump seal leaking with plugged weep hole

Perform the following tests in order:

- 1 Inspect for signs of damage to unit injector fuel seals, replace if required.
- 2 Inspect for signs of damage to cylinder head fuel seals, replace if required.
- 3 Inspect for signs of unit injector damage, replace as required.
- 4 Inspect for signs of fuel supply manifold damage, replace if required.
- 5 Repair or replace fuel lift pump.

Engine has early wear

P-423

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Dirt in lubricating oil
- Air inlet leaks
- Fuel leakage into lubricating oil
- Low oil pressure

Perform the following tests in order:

- 1 Remove dirty lubricating oil. Install new filters. Put clean oil in the engine. Check oil filter bypass valve for a weak or broken spring.
- 2 Inspect all gaskets and connections. Repair if leaks are found.
- 3 Fuel leakage into lubricating oil will cause high fuel consumption and low engine oil pressure. This condition may also increase the oil level in the crankcase. Refer to [P-422: Fuel dilution of lubricating oil on page 53](#).
- 4 Refer to [P-424: Engine has low oil pressure on page 55](#).

Engine has low oil pressure

P-424

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Caution: Do not operate engine with low oil pressure, engine damage will result. If measured oil pressure is low, discontinue engine operation until the problem is corrected.

Probable root causes:

- Low Engine Oil Pressure Warning (event code) **360-01**
Oil pressure data is below normal operating range for two seconds. The fault and event will be active, and logged only if the engine has been running for at least 15 seconds. The warning lamp is also illuminated.
- Low Engine Oil Pressure Action Alert (event code) **360-02**
Oil pressure data is below normal operating range for two seconds. The fault and event will be logged.
- Low Engine Oil Pressure Shutdown (event code) **360-03**
Engine oil pressure has reached a level where the engine is shutdown unless Critical Override is active.
- Oil level may be too low
- Dirty oil filters or restriction in oil cooler(s)
- Diesel fuel in lubricating oil
- Oil pressure relief valve does not close
- Oil pump suction pipe problem, faulty oil pump or scavenge oil pump
- Too much clearance between rocker arm shaft and rocker arms
- Too much clearance between camshaft and camshaft bearings.
- Too much clearance between crankshaft and crankshaft bearings

Perform the following tests in order:

- 1 Add oil if required.
- 2 Check the operation of the bypass valve for the filter. Install new oil filters if required. Clean or install new oil cooler core(s). Remove dirty oil from the engine. Put clean oil in the engine.
- 3 Check for presence of fuel in lubricating oil. Refer to [P-422: Fuel dilution of lubricating oil on page 53](#).
- 4 Clean the bypass valve and housing. Install new parts as necessary.
- 5 Check the oil pump inlet screen for obstructions. Check for air leakage into the supply to the oil pump. Examine oil pump for excessive wear. Repair or replace as needed.
- 6 Install new camshaft and camshaft bearings if necessary.
- 7 Inspect the main bearings and replace as necessary.

Engine uses too much lubricating oil

P-425

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Oil leaks
- Too much lubricating oil in engine
- Oil temperature is too high
- Too much oil in the valve compartment
- Turbocharger seal ring failure
- Worn valve guides
- Worn piston rings

Perform the following tests in order:

- 1 Find all oil leaks. Repair as required. Check for dirty crankcase breather(s).
- 2 Remove extra oil. Find where extra fluid comes from. Repair as required. Put correct amount of oil in engine.
- 3 Check for restrictions in the oil cooler or an oil cooler bypass valve stuck in the open position.
- 4 Check for high coolant temperature. Refer to [P-426: Engine coolant is too hot on page 57](#).
- 5 Verify the dowel is installed in the left bolt hole of the rocker shaft. This dowel is located between the rocker shaft and valve cover base. Check shaft and valve cover base. Check for dirty breather element.
- 6 Check inlet manifold for oil and repair the turbocharger if necessary.
- 7 Reconditioning of the cylinder head is required.
- 8 Inspect and install new parts as required.

Engine coolant is too hot

P-426

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- **High Coolant Temperature Warning (event code) 361-01**
The engine is running, the coolant temperature sensor reading is greater than or equal to the preset temperature for two seconds. Diagnostic codes 262-03 (+5V Supply Above Normal) or Code 262-04 (+5V Supply Below Normal) are not active.
- **High Coolant Temperature Action Alert (event code) 361-02**
The coolant temperature sensor reading is greater than or equal to the preset temperature for two seconds. Diagnostic code 262-03 (+5V Supply Above Normal) is not active. The fault and event will be logged.
- **High Coolant Temperature Shutdown (event code) 360-03**
Engine coolant temperature has reached a level where the engine is shutdown unless Critical Override is active.
- Radiator damage or obstruction
- Low coolant level in system
- Combustion gases in coolant
- Incorrect fuel injection timing calibration
- Faulty coolant thermostats
- Faulty coolant pump
- Too much load on the system

Perform the following tests in order:

- 1 Clean obstructions in the radiator
- 2 Add coolant to cooling system. Check for leaks.
- 3 Inspect coolant for presence of bubbles. Refer to the Workshop Manual.
- 4 Check coolant thermostats for correct operation. Inspect coolant pump impeller vanes for damage or erosion. Repair as necessary.
- 5 Reduce the load.

Oil at the exhaust

P-427

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Turbocharger seal ring failure
- Too much oil in the valve compartment
- Worn valve guides
- Worn piston rings

Perform the following tests in order:

- 1 Check inlet manifold for oil and repair the turbocharger if necessary.
- 2 Verify the dowel is installed in the left bolt hole of the rocker shaft.
- 3 Reconditioning of the cylinder head is required.
- 4 Inspect and install new parts as required.

Engine has a fuel supply problem

P-428

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- Low fuel level
- Poor fuel quality
- Unit injector priming problem
- Low supply pressure
- Fuel supply circuit

Perform the following tests in order:

- 1** Visually check fuel level (do not rely on fuel gauge only). Verify fuel pressure.
- 2** In temperatures below 0 °C (32 °F) check for congealed fuel (wax). Check fuel tank for foreign objects which may block the fuel supply.
- 3** Check for fuel line restrictions and repair or replace as required. Refer to the Workshop Manual.
- 4** Monitor exhaust for smoke while cranking. If smoke is not present there may be a fuel supply problem.
- 5** Check for air in the low pressure fuel supply system. Purge air from the low pressure fuel supply circuit with the hand priming pump and cranking the engine in 30 second cycles, pausing at least 2 minutes between cranking cycles to allow the starter motor to cool. Loosen low pressure fuel line fitting on inlet to pressure regulating valve and hand prime again if air in fuel continues. Also, use of a sight glass in the low pressure supply line can be helpful in diagnosing air in the fuel.
- 6** Check fuel pressure after the filter in the supply circuit during cranking. Refer to the Workshop Manual for correct pressure values. If pressure is low, check for plugged fuel filters. If pressure is still low, repair or replace fuel lift pump, fuel lift pump coupling, and fuel pressure regulating valve as needed.
- 7** Check for air in the low pressure fuel supply system after replacing filters, working on the low pressure fuel supply circuit or replacing unit injectors. Check fuel pressure after the filter in the supply circuit during cranking. Refer to the Workshop Manual for correct pressure values. If pressure is low, check for plugged fuel filters. If pressure is still low, repair or replace fuel lift pump, fuel lift pump coupling, and fuel pressure regulating valve as needed.

Indicator lamp not functioning correctly

P-429

Probable root causes:

Note: For details regarding wiring harness refer to the engine electrical schematic. This wiring is the responsibility of the OEM.

- Faulty bulb
- Engine wiring
- Battery voltage

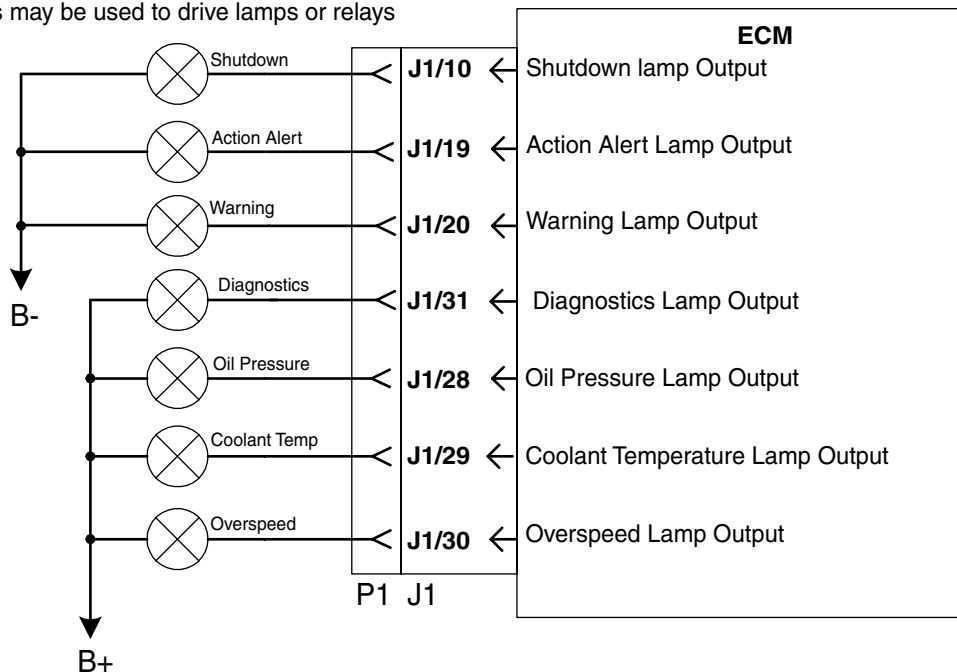
Perform the following tests in order:

- 1 Turn key switch OFF and check ECM connector J1/P1 and associated wiring for damage, abrasion, corrosion or incorrect attachment. Refer to [Test 1: Inspecting electrical connectors on page 80](#).
- 2 Turn key switch to the ON position, engine OFF. If the indicator lamp does not illuminate for five seconds measure the voltage at the lamp socket when the key switch is first turned on. The voltage should be between 22.0 and 27.0 VDC for a 24 Volt system. If the voltage is in range replace the bulb.
- 3 Measure the voltage between (+Battery) and (-Battery) at ECM connector J1/P1. The voltage should be between 22.0 and 27.0 VDC for a 24 Volt system. If the voltage is out of range refer to [Test 2: Electrical power supply to the ECM on page 85](#).
- 4 Connect a jumper wire between the suspect lamp driver of ECM connector J1/P1 and (-Battery) for J1/28 to J1/31 or (+Battery) for J1/10, J1/19 and J1/20. If the lamp illuminates the circuit is functioning normally but the ECM is not completing the lamp circuit. Refer to [Test 2: Electrical power supply to the ECM on page 85](#).

Indicator lamp schematic

Note: Outputs may be used to drive lamps or relays. Refer to the wiring diagrams for full connection details.

Outputs may be used to drive lamps or relays



Inlet air manifold temperature is too high

P-430

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- **High Inlet Air Temperature Warning (event code) 368-01**
The engine is running, the inlet air manifold temperature sensor reading is greater than the preset level for two seconds. Diagnostic codes 262-03 (+5 VDC Supply Above Normal) or 262-04 (+5 VDC Supply Below Normal) are not active. The event code and diagnostic code will be logged.
- **High Inlet Air Temperature Action Alert (event code) 368-02**
The engine is running, the inlet air manifold temperature sensor reading is greater than or equal to the preset level for at least two seconds. Diagnostic codes 262-03 (+5 VDC Supply Above Normal) or 262-04 (+5 VDC Supply Below Normal) are not active. The event code and diagnostic code will be logged.
- Incorrect fuel injection timing calibration
- Low air inlet system pressure
- Air inlet system has a restriction

Perform the following tests in order:

- 1** Connect an electronic service tool and check for engine speed/timing error. [Test 9: Engine speed/timing calibration on page 129.](#)
- 2** Check pressure in the air inlet manifold. Check for air inlet leaks. Look for restrictions at the air cleaner. Check for leaks between inlet manifold and turbocharger. Repair or replace as necessary.
- 3** Check for air inlet restrictions. Refer to the Workshop Manual. Repair as necessary.

Engine has a high fuel temperature

P-431

Note: This is NOT an electronic system problem. Refer to the Workshop Manual for additional information on the following tests.

Probable root causes:

- High Fuel Temp Warning (event code) **363-01**
The engine speed is greater than 1000 rev/min, the fuel temperature sensor reading is greater than 90 °C (194 °F) for 30 seconds. Diagnostic codes 262-03 (+5V Supply Above Normal) or 262-04 (+5V Supply Below Normal) are not active. The event code and diagnostic code will be logged and the warning lamp is illuminated.
- Incorrect sensor installation
- Low fuel level
- Poor fuel quality
- Low supply pressure
- Insufficient size of fuel tank

Perform the following tests in order:

- 1 Verify that the fuel temperature sensor has been correctly installed. Refer to the Workshop Manual.
- 2 Refer to [P-428: Engine has a fuel supply problem on page 59](#).

5

Troubleshooting with an event code

General information

This chapter is to be used for troubleshooting problems that have Event Codes but do not have ACTIVE Diagnostic codes.

Before using this chapter, be sure that you have gathered information about the complaint to adequately describe the symptoms, verified that the complaint is not due to normal engine operation, and repaired all ACTIVE Diagnostic codes. Refer to [Chapter 6, Troubleshooting with a diagnostic code](#).

The basic philosophy of troubleshooting this engine is to follow the three steps listed below FIRST to diagnose a malfunctioning engine:

- 1 Gather operator information. Verify complaint is not due to normal engine operation.
- 2 Perform a visual inspection of engine. Check oil level, supply and/or condition. Check for visible wiring and connector problems or damaged components.
- 3 Check and repair all ACTIVE/LOGGED diagnostic codes using the troubleshooting procedures in [Chapter 6, Troubleshooting with a diagnostic code](#).

If ALL three of these steps reveal no problems, **identify probable causes** using the procedure or procedures in this chapter that best describes the symptoms. Narrow the probable causes given in the procedure by considering operator information, operating conditions, and repair history of the engine.

Operator information

- What happened, and when ?
- Under what conditions ?
- Was the engine rev/min (speed) high or low ?
- Was the engine under load ?
- Are there any customer or dealer installed systems that could cause this symptom ?
- What else occurred ?
- When did the symptoms begin (and what else happened at that time) ?

Logged diagnostic codes

- Do they correlate to probable causes ?
- Did they occur at the same time as the symptoms ?
- Are some codes logged repeatedly ?

Other symptoms

- Are they related to this symptom ?
- Do they have common probable causes ?

Finally, test each probable cause using the tests suggested by the procedure. Be sure to check connectors, especially on intermittent problems. Refer to [Test 1: Inspecting electrical connectors on page 80](#) for details.

Event codes

Event codes indicate an actual engine fault, e.g. low oil pressure, rather than an electronic component failure. There are three possible levels of severity of the fault.

Level 1 - Operator warning

To warn the operator or machine control system of a possible condition that requires operator attention.

Level 2 - Action (Derate or Alert)

To inform the operator or machine control system to take action to enable the correct control of the system. In most cases the OEM will use this level for a controlled shutdown of the engine in order to protect it from damage.

Level 3 - Shutdown

At this level the ECM will immediately stop the engine unless Critical Override is enabled and signal that a critical fault level has been reached.

Caution: *If Critical Override is enabled the product is now operating in a condition outside its scope of supply and may cause injury or be damaged in such a way as to invalidate the warranty.*

Low coolant temperature Action Alert

E36-2

Probable root causes:

- Faulty coolant immersion heater (if fitted)
- Faulty coolant temperature sensor circuit

Perform the following tests:**1** Faulty coolant immersion heater (if fitted)

Determine that the coolant immersion heaters are functioning correctly.

2 Coolant temperature sensor circuit

Check the coolant temperature reading on TIPSS and ensure it is reasonable. The coolant temperature reading should rise steadily as the engine is warmed. If the reading is not correct, troubleshoot the sensor circuit.

High boost pressure Warning	E162-1
High boost pressure Action Alert	E162-2

Probable root causes:

- Engine overload

Low oil pressure Warning	E360-1
Low oil pressure Action Alert	E360-2
Low oil pressure Shutdown	E360-3

Probable root causes:

- Low oil level
- High oil temperature/low viscosity
- Blocked oil filter
- Oil pressure sensor circuit
- Blocked oil cooler
- Faulty oil pump/oil pump bypass valve

Perform the following tests:**1 Low oil level**

Check oil level and add oil as necessary.

2 High oil temperature/low viscosity

If present, troubleshoot the oil cooler circuit. High oil temperature causes oil viscosity to be low which can cause low oil pressure.

3 Blocked oil filter

Replace oil filters if there is any doubt as to their condition.

4 Oil pressure sensor circuit

Troubleshoot the sensor circuit.

5 Blocked oil cooler

An oil cooler restriction can cause low oil pressure and high oil temperature.

High coolant temperature Warning	E361-1
High coolant temperature Action Alert	E361-2
High coolant temperature Shutdown	E361-3

Probable root causes:

- High ambient temperature
- Low coolant level/cooling system leaks
- Insufficient air or coolant flow through heat exchanger or radiator
- Faulty coolant thermostats
- Coolant temperature sensor circuit
- Insufficient coolant flow
- High inlet air temperature
- Exhaust restriction
- Combustion gasses in coolant

Perform the following tests:

1 High ambient temperature

Determine if ambient air temperature is within design specifications for the cooling system.

2 Low coolant level/cooling system leaks

Check coolant level. Low coolant level can be the effect of overheating rather than the cause. Run the engine to operating temperature and determine if leaks occur before the engine overheats.

3 Insufficient air or coolant flow through heat exchanger or radiator

Check radiator cooling fins for obstructions. Check radiator cooling fan (if fitted) operation. Check for sufficient flow and temperature of coolant through the heat exchanger (if fitted).

4 Faulty coolant temperature control

Check thermostats.

5 Coolant temperature sensor circuit

Check the coolant temperature reading on TIPSS and ensure it is reasonable. The coolant temperature reading should rise steadily as the engine is warmed. If the reading is not correct, troubleshoot the sensor circuit.

6 Insufficient coolant flow

Check the coolant pumps for correct operation. Check the coolant thermostats for correct operation.

7 High inlet air temperature

Check air temperature into the engine.

8 Exhaust restriction

Check exhaust system back pressure.

Engine overspeed Warning	E362-1
Engine overspeed Action Alert	E362-2
Engine overspeed Shutdown	E362-3

Probable root causes:

- Engine overspeed set point
- Incorrect speed setting
- Driven equipment motoring
- Slow governor response

Perform the following tests:**1 Engine overspeed set point**

Verify that the engine overspeed set point is correctly programmed. This is set is not field re-settable.

2 Check analogue, PWM or remote manual throttle settings.**3 Driven equipment motoring**

Determine if the driven equipment has additional energy inputs that could drive the engine beyond it's rated rev/min.

4 Slow governor response

Watch the engine response to worst case step loading and step unloading on the TIPSS graphing screen.

Refer to "[Governor Gain parameters](#)" on [page 29](#) if the engine speed undershoot or engine speed overshoot is excessive.

High fuel temperature Warning	E363-1
High fuel temperature Action Alert	E363-1

Probable root causes:

- Fuel temperature sensor circuit
- Inadequate size of fuel tank or low fuel level in tank

Perform the following tests:**1** Fuel temperature sensor circuit

Check the temperature reading on TIPSS and ensure it is reasonable. If the reading is not correct, troubleshoot the sensor circuit.

2 Fuel is used to cool the injectors and surplus fuel is passed back to the fuel tank

If the fuel tank capacity is inadequate this return fuel will heat up the tank until the fuel temperature is unacceptable.

High inlet air temperature Warning	E368-1
High inlet air temperature Action Alert	E368-2

Probable root causes:

- Air temperature sensor circuit
- Insufficient coolant flow through charge cooler
- High ambient temperature

Perform the following tests:**1** Air temperature sensor circuit

Check the air temperature reading on TIPSS and ensure it is reasonable and rises steadily as the engine is warmed. If the reading is not correct, troubleshoot the sensor circuit.

2 Insufficient coolant flow through charge cooler

Check the coolant inlet temperature and compare to regulated temperature. If OK, check air cooler coolant outlet temperature. A high temperature difference between outlet and inlet temperature indicates insufficient flow rate.

3 If ambient temperature exceeds 50 °C (122 °F) engine power must be derated.

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6

Troubleshooting with a diagnostic code

Diagnostic codes

Diagnostic codes alert the operator that a problem exists and indicate the nature of the problem to the service technician. Diagnostic codes may be viewed using an electronic service tool (TIPSS-EST).

Diagnostic codes consist of three parts, MID, CID and FMI

- The **MID** or **Module IDentifier** indicates which electronic module generated the diagnostic code. The ECM is MID=24.
- The **CID**, or **Component IDentifier**, indicates which component in the system the diagnostic code is for.
- The **FMI**, or **Failure Mode Identifier** indicates what the failure mode is. Refer to ["Diagnostic terminology" on page 75](#) for additional details.

To troubleshoot a diagnostic code, refer to the ["Quick reference for ECM diagnostic codes" on page 76](#) under the specific code number. The code number will direct you to a procedure in [Chapter 7, Functional tests](#).

Note: Do **not** confuse diagnostic codes with diagnostic events (refer to Logged Events in this chapter). Events can be logged in the ECM to track information about the engine. An example would be a low oil pressure event. An event is generated when the engine oil pressure is low but not out of range for the sensor. This **does not** indicate a problem with the sensor, rather it indicates a problem with the engine oil pressure. Refer to Logged Events later in this chapter for more information.

Active diagnostic codes

An active diagnostic code represents a problem with the electronic control system that should be investigated and corrected **as soon as possible**.

When an active diagnostic code is generated, the Active Alarm warning indicator is activated to alert the operator. If the condition generating the diagnostic occurs only for a brief moment, the message will disappear and the diagnostic code will be Logged in the ECM memory.

Logged diagnostic codes

When the ECM generates a diagnostic code, it usually logs the code in permanent memory within the ECM. The ECM has an internal diagnostic clock and will record the hour of the first occurrence, the hour of the last occurrence and the number of occurrences of the code.

Knowing when and how often the code was generated can be a valuable indicator when troubleshooting intermittent problems.

An electronic service tool can retrieve and delete Logged codes. Any Logged diagnostic codes will automatically be deleted if no additional occurrences are recorded in 100 hours.

When investigating logged diagnostic codes, keep in mind the following information.

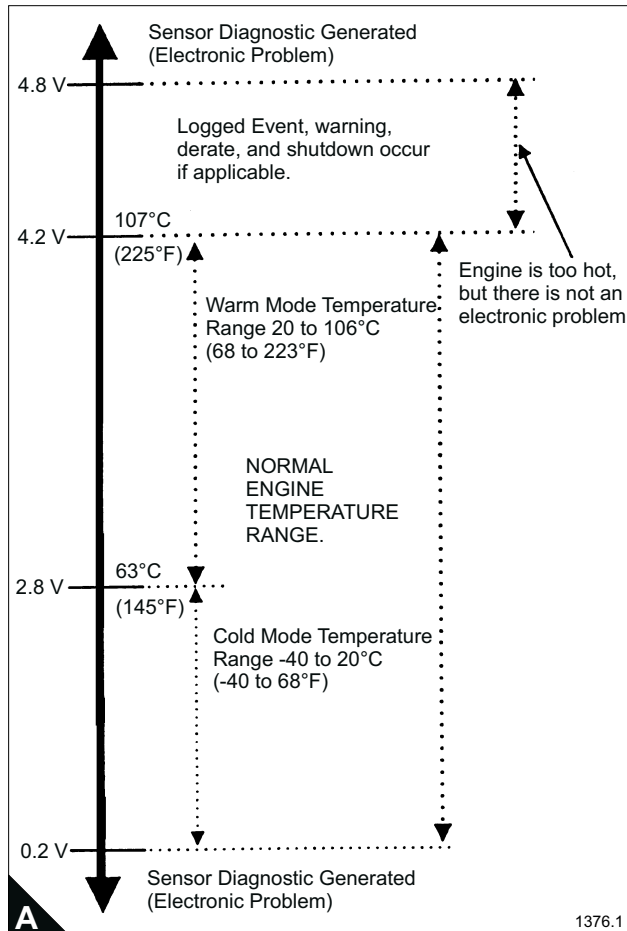
- Some diagnostic codes may be easily triggered and do not result in operator complaints. If the time the code was logged does not relate to a complaint, **there may be nothing to fix**.
- The most likely cause of an intermittent problem is a faulty connection or damaged wiring. Next likely is a component failure (sensor or switch). **Least likely is failure of the ECM itself**.
- Diagnostic codes that are logged repeatedly may indicate a problem that needs special investigation.

Continued

To troubleshoot a logged diagnostic code, refer to ["Quick reference for ECM diagnostic codes" on page 76](#). The code number will direct you to a procedure in [Chapter 7, Functional tests](#). If the symptoms continue, use the appropriate procedure for troubleshooting the symptoms that have been experienced by the operator. Refer to [Chapter 4, Troubleshooting without a diagnostic code](#).

Note: Always clear logged diagnostic codes after investigating and correcting the problem which generated the code.

Example: Output voltage from coolant temperature sensor. This diagram is for reference only and should not be used to troubleshoot the coolant temperature sensor.



Logged events

The GECEM can log events. Events refer to engine operating conditions such as low oil pressure or high coolant temperature. Logged events **do not** indicate an electronic system problem, but may indicate an engine system problem. The example diagram shown indicates the output voltage from a coolant temperature sensor and how the GECEM responds to that voltage.

Diagnostic terminology

Module Identifier (MID) - Two or three digit code which is assigned to each module or control system.

Module ID	Description
024	Engine Control Module (ECM)

Component Identifier (CID) - Two or three digit code which is assigned to each component or system.

Failure Mode Identifier (FMI) - Type of failure the component experienced (adopted from SAE standard practice J1587 diagnostics).

Failure Mode Identifier	Description
00	Data valid , but above normal operational range
01	Data valid , but below normal operational range
02	Data erratic, intermittent, or incorrect
03	Voltage above normal or shorted high
04	Voltage below normal or open circuit
05	Current below normal or open circuit
06	Current above normal or grounded circuit
07	Mechanical system not responding correctly
08	Abnormal frequency, pulse width, or period
09	Abnormal update
10	Abnormal rate of change
11	Failure mode not identifiable
12	Faulty device or component
13	Uncalibrated device or component
14 - 31	Reserved for future assignment

Active Code - The MID, CID and FMI can be viewed on TIPSS-EST.

Logged Code - The diagnostic will be entered into the permanent memory (Diagnostic Log) when it becomes Active. The number of occurrences will be saved in the **good to bad counter** in the permanent memory (Diagnostic Log). First and last occurrence time (engine hours) will also be saved in the permanent memory (Diagnostic Log). This information is then available for display on TIPSS-EST.

Quick reference for ECM diagnostic codes

CID-FMI	Diagnostic code description	Troubleshooting
1-11	Injector Cylinder #1 Fault	See Test 10 on page 133
2-11	Injector Cylinder #2 Fault	See Test 10 on page 133
3-11	Injector Cylinder #3 Fault	See Test 10 on page 133
4-11	Injector Cylinder #4 Fault	See Test 10 on page 133
5-11	Injector Cylinder #5 Fault	See Test 10 on page 133
6-11	Injector Cylinder #6 Fault	See Test 10 on page 133
41-03	ECM 8 Volt DC Supply Open/Short to B+	See Test 6 on page 107
41-04	ECM 8 Volt DC Supply Short to ground	See Test 6 on page 107
91-08	PWM Speed Control Abnormal	See Test 6 on page 107
100-03	Engine Oil Pressure Sensor Open/Short to B+	See Test 3 on page 88
100-04	Engine Oil Pressure Sensor Short to ground	See Test 3 on page 88
110-03	Engine Coolant Temperature Sensor Open/Short to B+	See Test 3 on page 88
110-04	Engine Coolant Temperature Sensor Short to ground	See Test 3 on page 88
168-02	Intermittent Battery Power to the ECM	See Test 2 on page 85
172-03	Inlet Air Temperature Sensor Open/Short to B+	See Test 3 on page 88
172-04	Inlet Air Temperature Sensor Short to ground	See Test 3 on page 88
174-03	Fuel Temperature Sensor Open/Short to B+	See Test 3 on page 88
174-04	Fuel Temperature Sensor Short to ground	See Test 3 on page 88
190-02	Engine Speed Sensor Data Intermittent	See Test 8 on page 121
190-09	Engine Speed Sensor Abnormal Update	See Test 8 on page 121
190-11,190-12	Engine Speed Sensor Mechanical Fault	See Test 8 on page 121
252-11	Incorrect Engine Software	See page 23
253-02	Check Customer or System Parameters	See page 26
261-13	Engine Timing Calibration Required	See Test 9 on page 129
262-03	5 Volt Sensor Power Supply Open/Short to B+	See Test 5 on page 102
262-04	5 Volt Sensor Power Supply Short to ground	See Test 5 on page 102
268-02	Check Programmable Parameters	See page 26
273-03	Turbo Outlet Pressure Sensor Open/Short to B+	See Test 3 on page 88
273-04	Turbo Outlet Pressure Sensor Short to ground	See Test 3 on page 88
274-03	Atmospheric Pressure Sensor Open/Short to B+	See Test 3 on page 88
274-04	Atmospheric Pressure Sensor Short to ground	See Test 3 on page 88
281-03	Action Alert lamp Open/Short to B+	See Test 4 on page 97
281-04	Action Alert lamp Short to ground	See Test 4 on page 97
281-05	Action Alert Lamp Open Circuit	See Test 4 on page 97
282-03	Overspeed lamp Open/Short to B+	See Test 4 on page 97
282-04	Overspeed lamp Short to ground	See Test 4 on page 97
285-03	Coolant temperature lamp Open/Short to B+	See Test 4 on page 97
285-04	Coolant temperature lamp Short to ground	See Test 4 on page 97
286-03	Lub oil pressure lamp Open/Short to B+	See Test 4 on page 97
286-04	Lub oil pressure lamp Short to ground	See Test 4 on page 97
286-05	Lub Oil Pressure Lamp Open Circuit	See Test 4 on page 97
323-03	Shutdown lamp Open/Short to B+	See Test 4 on page 97

CID-FMI	Diagnostic code description	Troubleshooting
323-04	Shutdown lamp Short to ground	See Test 4 on page 97
323-05	Shutdown Lamp Open Circuit	See Test 4 on page 97
324-03	Warning lamp Open/Short to B+	See Test 4 on page 97
324-04	Warning lamp Short to ground	See Test 4 on page 97
324-05	Warning Lamp Open Circuit	See Test 4 on page 97
342-02	Secondary Engine Speed Sensor Data Intermittent	See Test 8 on page 121
342-11, 342-12	Secondary Engine Speed Sensor Mechanical Fault	See Test 8 on page 121
861-03	Diagnostic lamp Open/Short to B+	See Test 4 on page 97
861-04	Diagnostic lamp Short to ground	See Test 4 on page 97

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7

Functional tests

General information

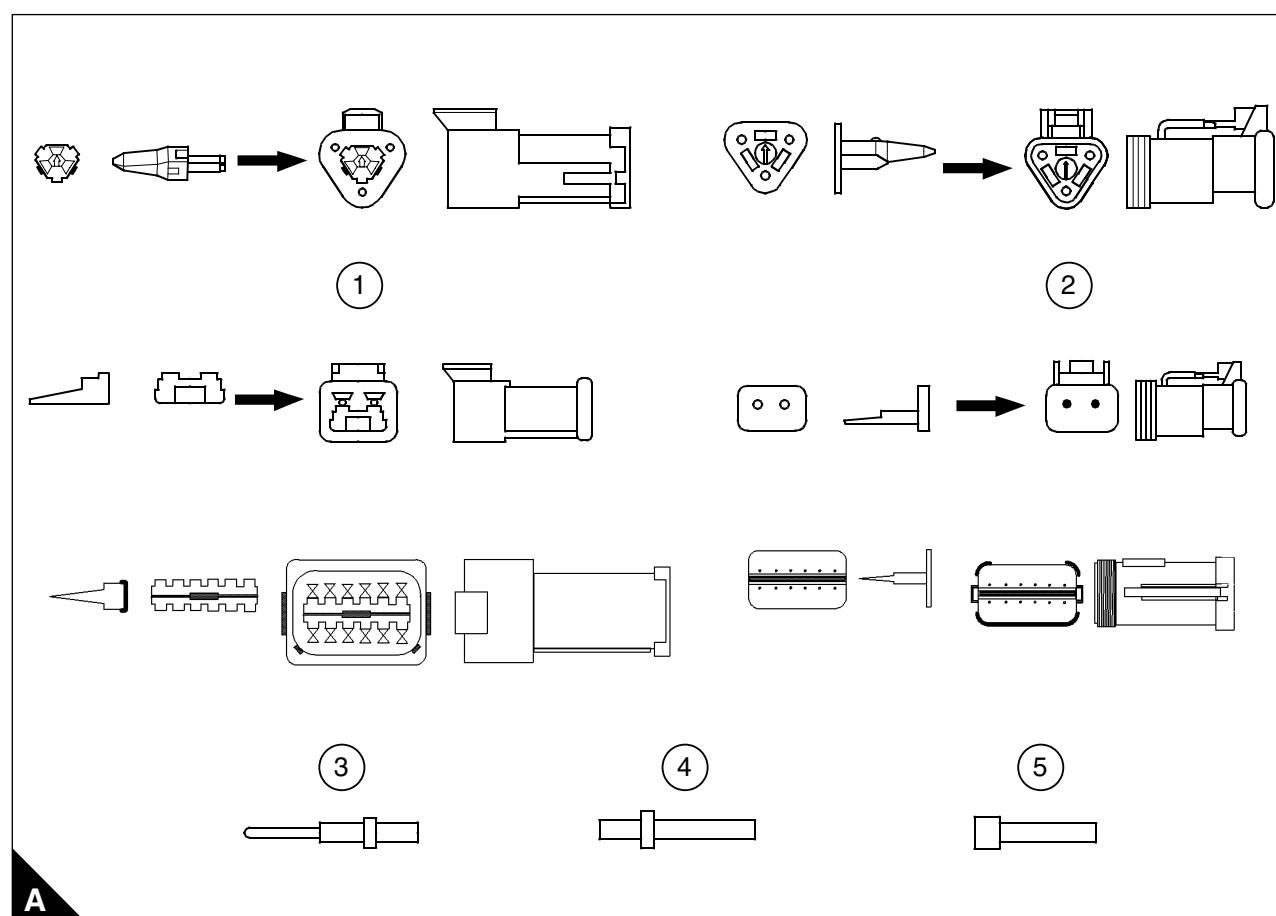
Some of the wiring detailed in this chapter may be supplied by the OEM and may differ from the diagrams in this manual.

Refer to the OEM supplied wiring diagrams where appropriate.

Connectors

Deutsch connectors - These connectors have a plastic housing. The pins and sockets are crimped onto the electrical wires. The connector has a locking mechanism to hold the pins and sockets. These connectors are repairable without cutting the wires.

- 1 Deutsch DT connector receptacles
- 2 Deutsch DT connector plugs
- 3 Deutsch and AMP pin
- 4 Deutsch and AMP socket
- 5 Deutsch and AMP sealing plug



Inspecting electrical connectors

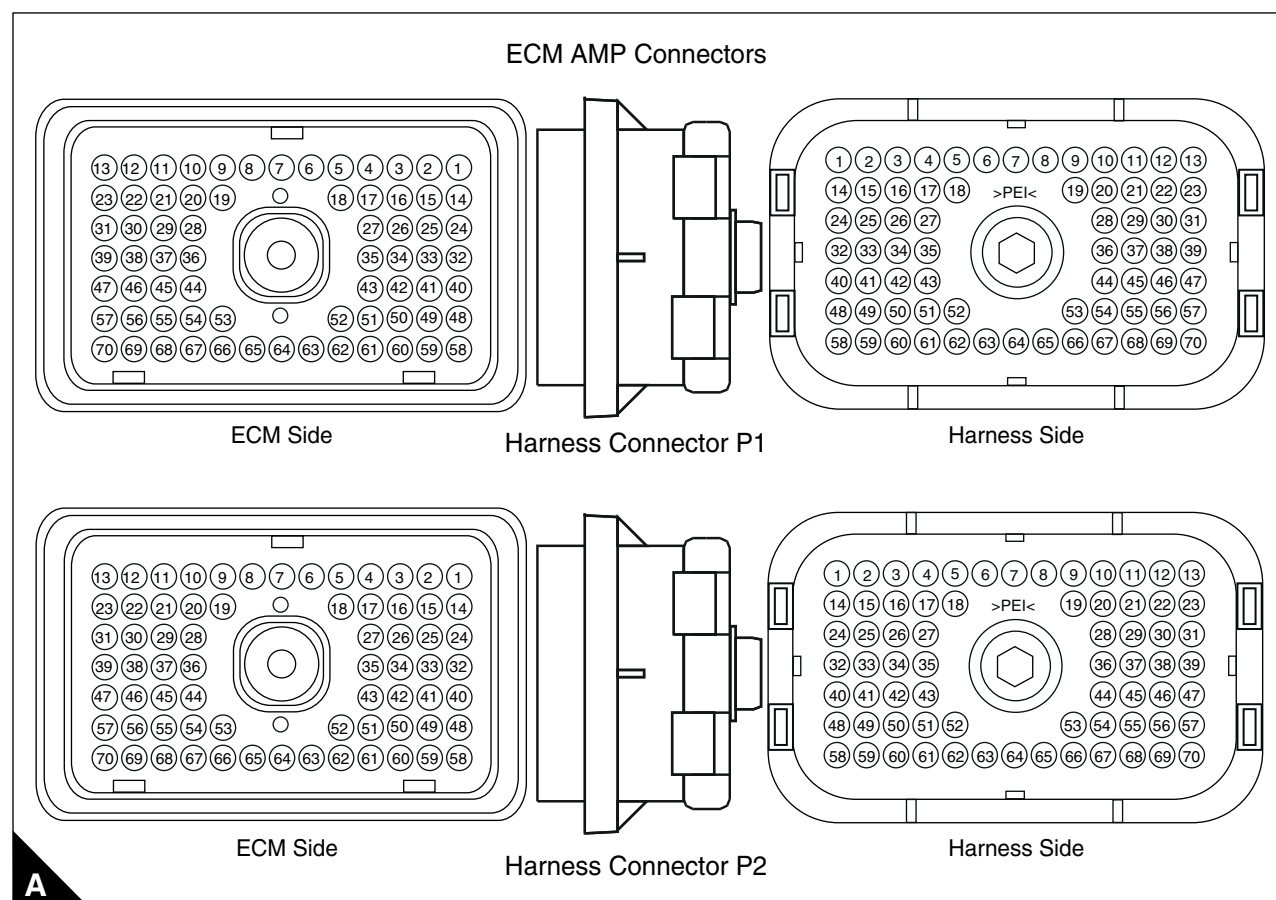
Test 1

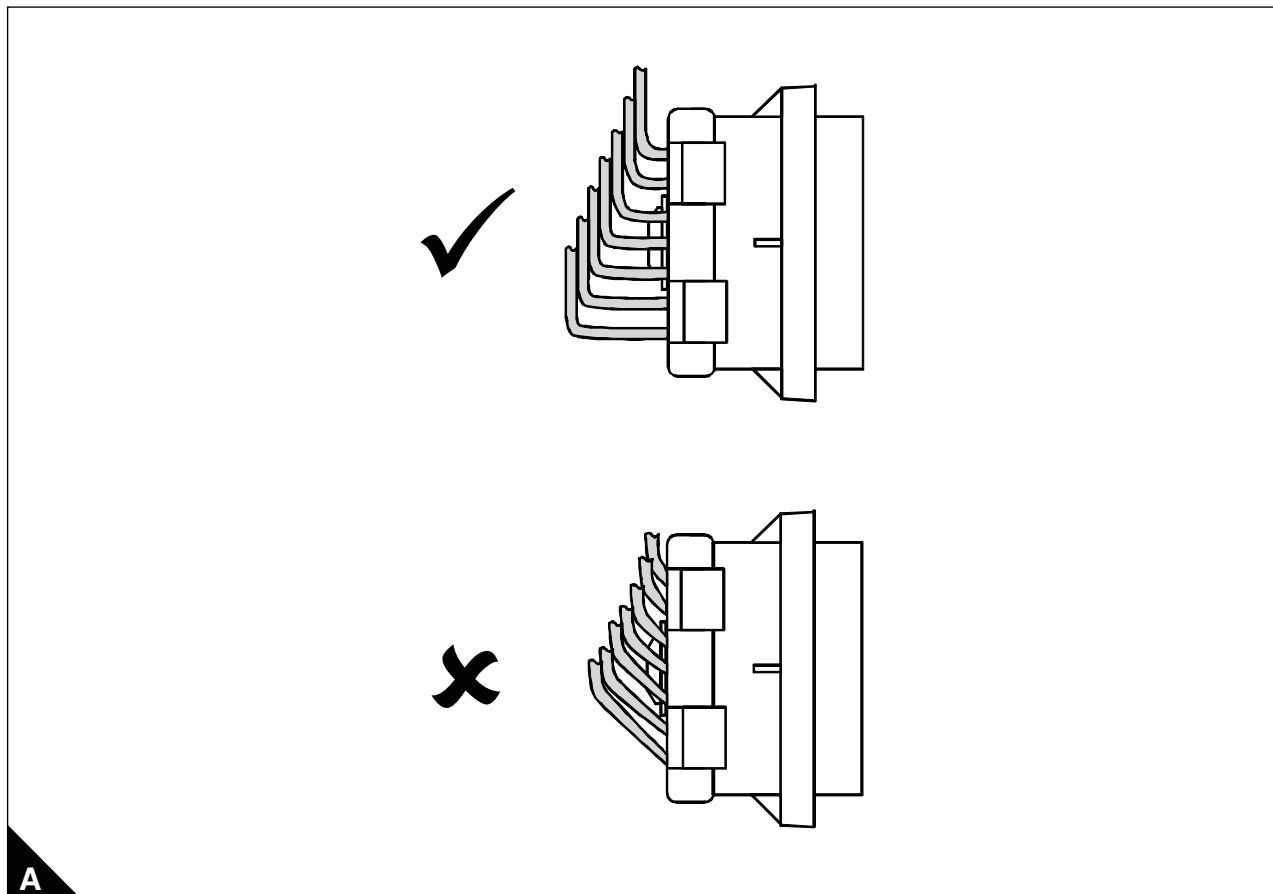
System operation

Many of the operational procedures and diagnostic code procedures in this manual will direct you to check a specific electrical connector. Use the following steps to help determine if the connector is the cause of the problem. If a problem is found in the electrical connector, repair the connector and verify that the problem has been corrected.

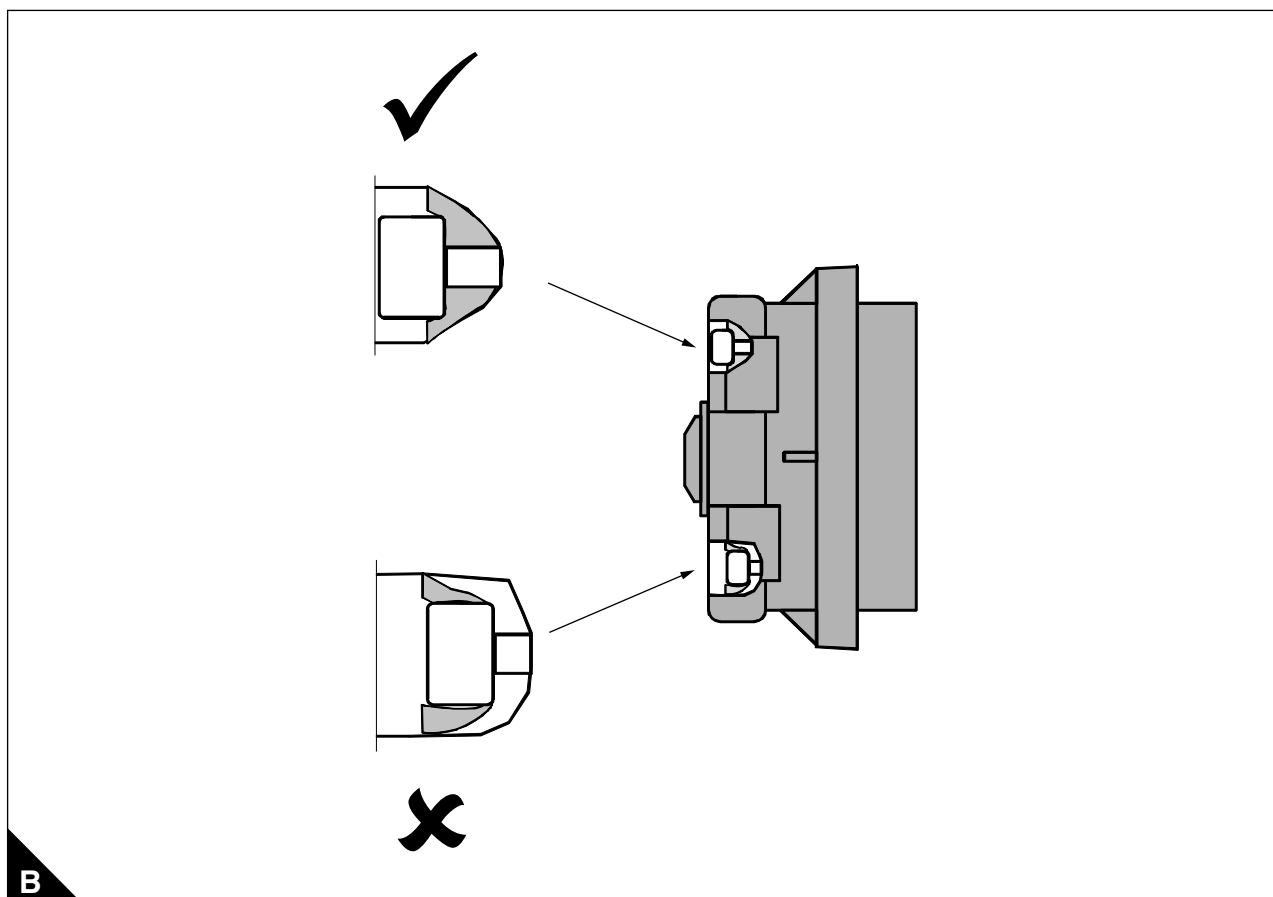
Intermittent electrical problems are often caused by poor connections. Always check for an active diagnostic code before breaking any connections and check again immediately after reconnecting the connector to see if the problem disappears. Simply disconnecting and then reconnecting connectors can sometimes solve a problem. If this occurs, likely causes are loose terminals, bent terminals, incorrectly crimped terminals or corrosion. Follow this procedure to thoroughly inspect the connectors to determine if connectors are the cause of the problem.

ECM terminal connections - general layout





Sealing plug insertion



Functional test

Test step	Result	Action
Step 1: Check connector mating - Deutsch HD style connectors - Make sure the plug and receptacle are aligned using index markings. Check that the receptacle coupling is fully turned clockwise and has clicked into the locked position. Make sure the two halves cannot be pulled apart. The connector will securely lock. The connector and locking mechanism is without cracks or breaks.	OK ⇒ NOT OK ⇒	Proceed to next step. Repair or replace as necessary. STOP.
Step 2: Check ECM connector “Allen screw” - Ensure the connector bolt is correctly tightened, but be careful not to over tighten and break the bolt. - Do not exceed 6,0 Nm (4.4 lb ft) of torque on the ECM connector bolt when mating the 70-terminal “AMP” connector to the ECM. The ECM connector is secure and the ECM connector bolt is correctly torqued.	OK ⇒ NOT OK ⇒	Proceed to next step. Repair or replace as necessary. STOP.
Step 3: Perform 45 N (10 lb) pull test on each terminal/wire Each terminal and connector should easily withstand 45 N (10 lb) of pull, and remain in the connector body. This test checks whether the wire was correctly crimped in the terminal and whether the terminal was correctly inserted into the connector. Note: Terminals should always be crimped onto the wires using an appropriate tool. Do not solder terminals.	OK ⇒ NOT OK ⇒	Proceed to next step. Repair or replace as necessary. STOP.
Each terminal and connector easily withstands 45 N (10 lb) of pull, and remains in the connector body.		

Test step	Result	Action
Step 4: Monitor the electronic service tool while tugging on wiring and connectors Warning! <i>There is a strong electrical shock hazard while the engine is turning. Do not touch wires associated with the injector circuit while the engine is cranking or running.</i> - If there is an active diagnostic code pertaining to the circuit: - Monitor the TIPSS-EST Active Code screen while tugging on all harnesses and connectors that connect to the component with the active diagnostic code. If the active diagnostic code disappears while tugging on the harness, there is a problem in the wiring or connector. - If there are no active diagnostic codes: - Monitor the TIPSS-EST Status screen for the component while tugging on the harnesses. If the reading changes erratically while tugging, there is a problem in the wiring or connector. - If there are no active diagnostic codes and there are complaints about sudden intermittent engine speed changes or cutouts: - Run the engine and listen for burps or cutouts while pulling on the wiring or connectors. If the engine speed changes cuts out while tugging on the harness, there is a problem in the wiring or connector. The problem appears to be external to the harnesses and connectors. Tugging on the harnesses and connectors has no affect on the active diagnostic code, component status, or engine performance.	OK ⇒ NOT OK ⇒	Proceed to next step. Repair or replace as necessary. STOP.
Step 5: Check wires for insulation nicks or abrasion - Carefully inspect each wire for signs of abrasion, nicks, or cuts. Likely locations to check are anywhere the insulation is exposed, points where the wire rubs against the engine or a sharp point. - Check all harness hold down clamps to verify the harness is correctly clamped and the clamp is not compressing the harness. Pull the harness sleeves away to check for flattened wires where the clamp holds the harness. The wires are free of abrasion, nicks, or cuts and the harness is correctly clamped.	OK ⇒ NOT OK ⇒	Proceed to next step. Repair or replace as necessary. STOP.

Test step	Result	Action
Step 6: Check connectors for moisture or corrosion - Ensure the connector seals and white sealing plugs are in place. If any of the seals or plugs are missing, replace the seal, plug, or if necessary, the connector. - Check all wiring harnesses to verify the harness does not make a sharp bend out of a connector. This will deform the connector seal and create a moisture entry path. - Thoroughly inspect ECM connectors J1/P1 and J2/P2 for evidence of moisture entry. Note: It is normal to see some minor seal abrasion on the ECM connector seals. Minor seal abrasion will not allow moisture entry. - If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and repaired or the problem will reoccur. Simply drying the connector will not fix the problem. Likely moisture entry paths are missing or incorrectly installed seals, nicks in exposed insulation, or unmated connectors. Moisture can also travel or “wick” from one connector through the inside of a wire to the ECM connector. If moisture is found in the ECM connector, thoroughly check all connectors and wires on the harness that connect to the ECM. The ECM is not the source of the moisture. Do not replace an ECM if moisture is found in either ECM connector. Note: If corrosion is evident on pins, sockets or the connector itself, use only denatured alcohol to clean/remove the corrosion with a cotton swab or a soft brush. Do not use any cleaners that contain 1,1,1 trichloro-ethylene because it may damage the connector. All connectors/seals should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.	OK ⇒ NOT OK ⇒	Proceed to next step. Repair or replace wiring or connectors as necessary. Ensure all seals are correctly installed and that connectors are completely mated. Verify the repair eliminates the problem by running the engine for several minutes and check again for moisture. If moisture reappears, it is wicking into the connector. Even if the moisture entry path is repaired, it may be necessary to replace the wires that have moisture wicking through them as the wires may have moisture trapped inside the insulation. Verify the repair eliminates the problem. STOP.
Step 7: Inspect the connector terminals Verify the terminals are not damaged. Verify correct alignment and location of terminals in the connector. The terminals are correctly aligned and appear undamaged.	OK ⇒ NOT OK ⇒	Proceed to next step. Repair or replace as necessary. STOP.
Step 8: Check individual pin retention into the socket This is especially important for intermittent problems. Using a new pin, insert the pin into each socket (one at a time) to check for a good grip on the pin by the socket. Repeat for each pin on the mating side of the connector, using a new socket for the test. The terminal contact (pin or socket) should stay in place when the connector is held upside down. The pins and sockets appear to be OK.	OK ⇒ NOT OK ⇒	STOP. Repair or replace as necessary. STOP.

Electrical power supply to the ECM

Test 2

System operation

This procedure tests whether correct voltage is supplied to the ECM by the equipment wiring. Use this procedure if a 168-02 Low or Intermittent Battery Power To ECM diagnostic codes is logged, or anytime you suspect the ECM is not receiving battery supply voltage.

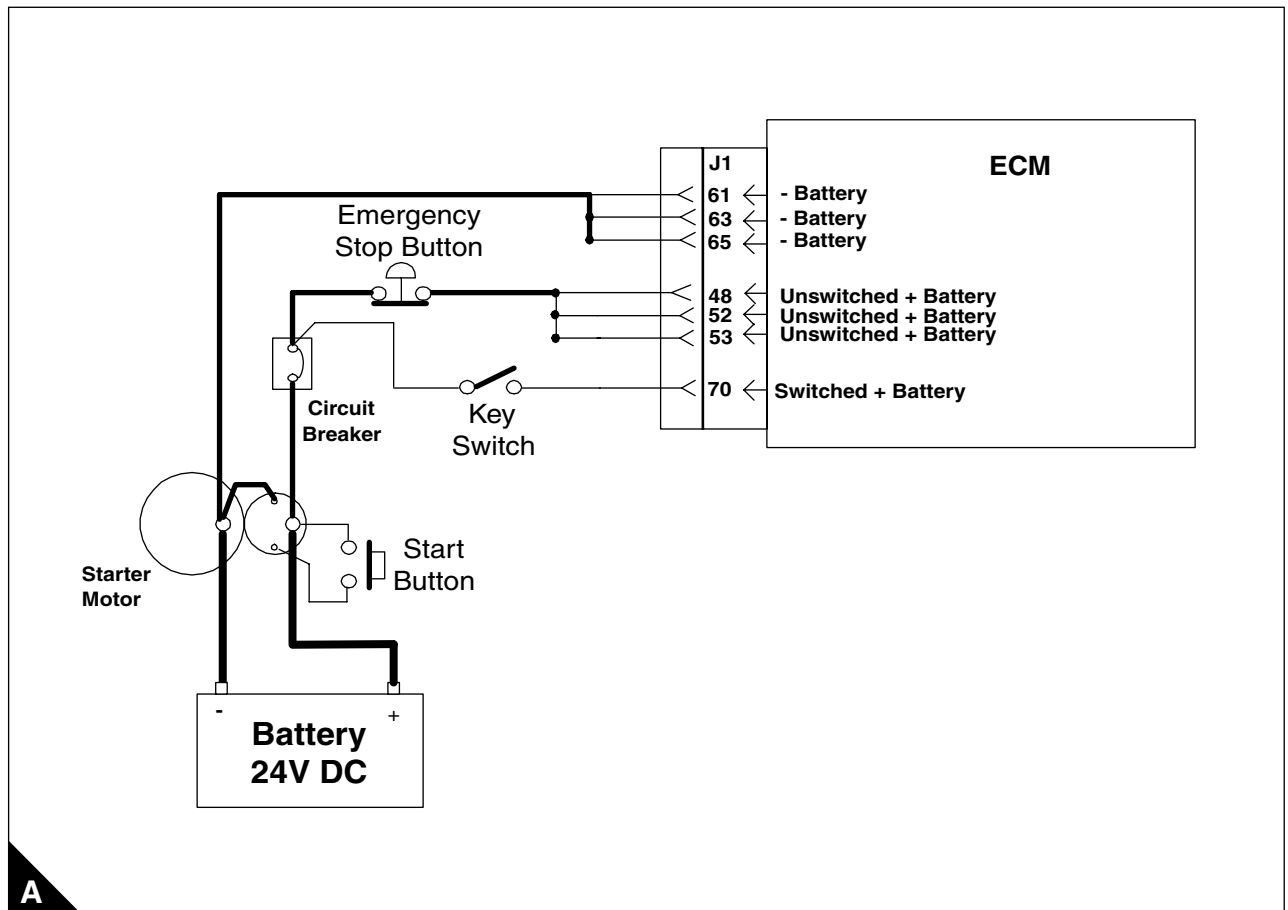
The ECM input at connector P1 terminal-70 (SWITCHED +BATTERY) receives battery voltage from the engine key switch supplied by the OEM. When the ECM detects battery voltage at this input, the ECM will power up.

When battery voltage is removed from this input, the ECM will power down after the engine has safely shut down.

The cause of an intermittent power supply to the ECM can occur on either the positive (UNSWITCHED +BATTERY) or negative (-BATTERY) side. Both sides are routed from the ECM to the battery. The three Unswitched +Battery connections should be routed through a dedicated protection circuit.

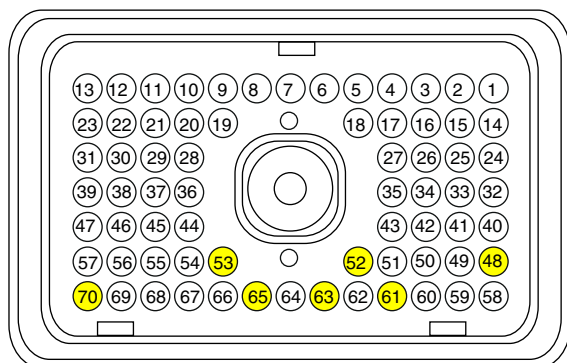
ECM Electrical power supply schematic

Note: Refer to the wiring diagram for full connection details. This wiring is supplied by the OEM.



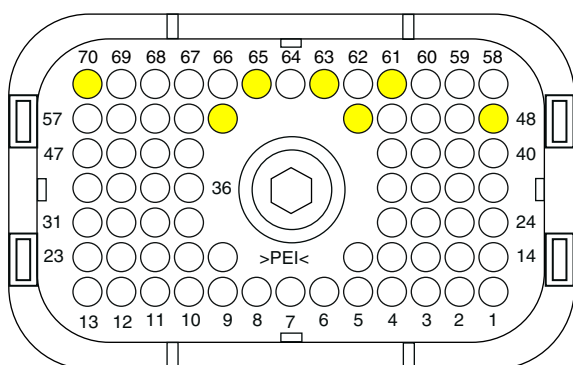
ECM Terminal connections

Note: Using ECM connector P1.



Terminal side

Function	Pin Location
Unswitched + Battery	48
Unswitched + Battery	52
Unswitched + Battery	53
Switched + Battery	70
- Battery	61
- Battery	63
- Battery	65



Wire side

A

Diagnostic codes

CID-FMI	Conditions which generate this code:	Systems response:	Troubleshooting
168-02	Intermittent Battery Power To The ECM Indicates the battery circuit to the ECM has either an intermittent or low battery condition while the engine is running. If battery voltage disappears without returning, the ECM will not log this diagnostic code and the engine will shut down.	The engine may experience engine rev/min burps, intermittent and/or complete engine shutdowns while the conditions causing this diagnostic code are present.	Proceed with Test 2: Electrical power supply to the ECM

Functional test

Test step	Result	Action
Step 1: Inspect electrical connectors and wiring - Thoroughly inspect ECM connector J1/P1, breaker and battery connections, and the connections to the engine key switch. Refer to Test 1: Inspecting electrical connectors for details. Check the emergency stop push button. - Perform 45 N (10 lb) pull test on each of the wires in the ECM connector associated with the Unswitched +Battery (terminal-52, 53 and 48), -Battery (terminal-63, 65 and 61), and Switched +Battery (terminal-70) connections. - Check that the ECM connector Allen screw is correctly tightened to not more than 6,0 Nm (4.4 lb ft). - Check the harness and wiring for abrasion and pinch points from the battery to the ECM, and from the key switch to the ECM. Refer to "ECM Terminal connections" on page 86. All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.	OK ⇒ NOT OK ⇒	Proceed to next step. Repair or replace wiring or connectors as necessary. Ensure all seals are correctly installed and that connectors are completely mated. Verify the repair eliminates the problem. STOP.
Step 2: Check battery input voltage at ECM - Turn the key switch to the ON position. - Measure and record the voltage at the battery post terminals. If the voltage at the battery posts is not between 24.8 and 29 VDC, troubleshoot the charging system. Note: If using a power supply instead of batteries, the minimum requirement is 22 VDC at 16 Amps. - Measure the voltage between P1 terminal-52 (UNSWITCHED +BATTERY) and P1 terminal-63 (-BATTERY). Refer to "ECM Terminal connections" on page 86. The voltage measurements at P1 should be constant and within 2 VDC of the voltage measured at the battery posts.	OK ⇒ NOT OK ⇒	The ECM is currently receiving the correct voltage. Refer to Test 1: Inspecting electrical connectors if troubleshooting an intermittent problem. STOP. The correct voltages do not appear at P1. Check for breakers and emergency stop buttons. Check through the wiring with a voltmeter to find the source of the voltage drop. Refer to electrical system schematic. Repair as required. STOP.

Analogue sensor open or short circuit test

Test 3**System operation**

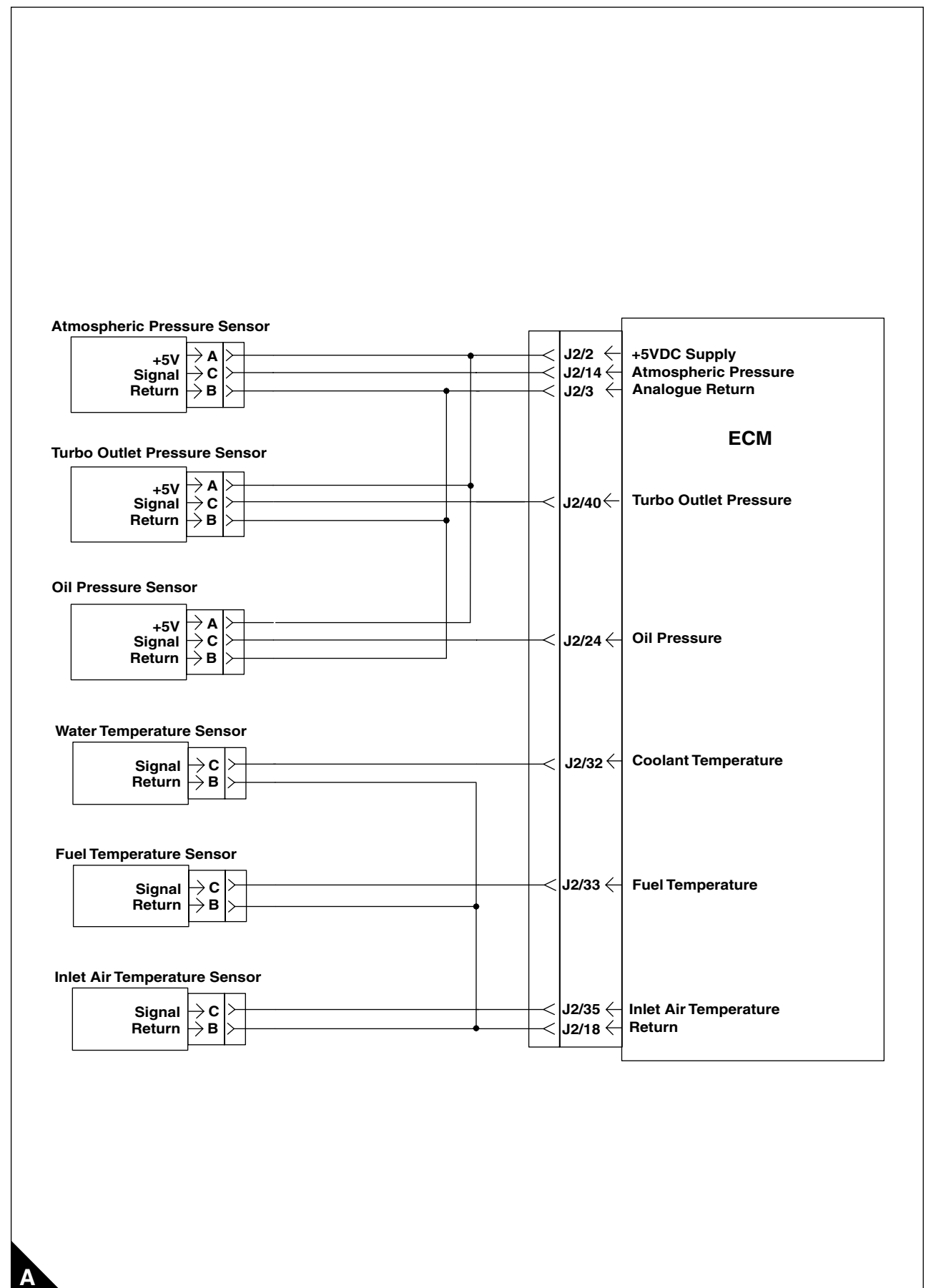
Use this procedure to troubleshoot open or short circuit diagnostic codes for the oil pressure sensor, atmospheric pressure sensor, turbo outlet pressure sensor, fuel temperature sensor, engine coolant temperature sensor, and inlet air temperature sensor.

Note: The engine coolant temperature sensor, fuel temperature sensor and inlet air temperature sensor do not require +5 VDC supply voltage from the ECM.

The troubleshooting procedures for each sensor open and short circuit diagnostic code are identical. The ECM provides supply voltage from ECM connector J2/P2 terminal-2 (+5 VDC Supply) to the sensor connector terminal-A. The sensor return (ground) connection is also shared, provided from ECM connector J2/P2 terminal-3 (analogue return) to each sensor connector terminal-B. The signal voltage from each sensor is supplied from the sensor connector terminal-C to the appropriate sensor signal terminal at ECM connector J2/P2. Refer to the schematic for details.

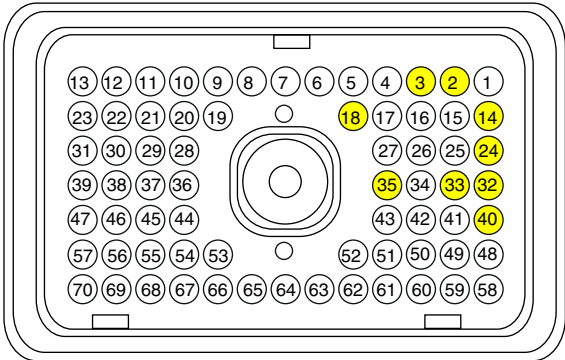
Analog sensor schematic

Note: Refer to the wiring diagram for full connection details.

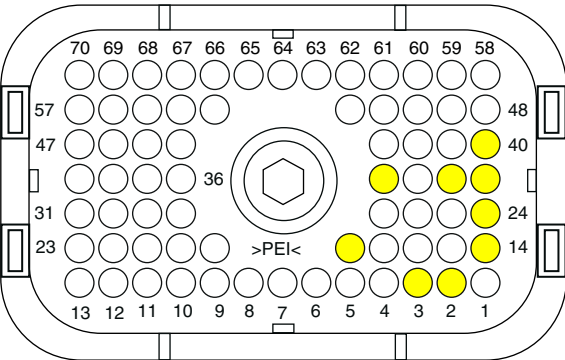


ECM terminal connections

Note: Using ECM connector P2.



Terminal side

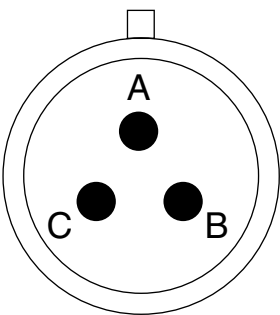


Wire side

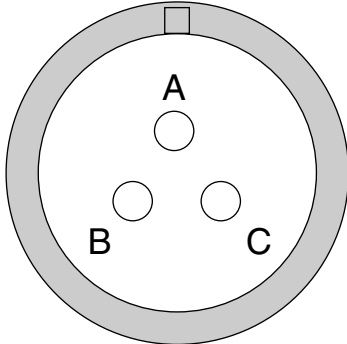
Function	Pin Location
+5 VDC Supply	2
Analog Return	3
Inlet Air Temperature	35
Coolant Temperature	32
Fuel Temperature	33
Turbo Outlet Pressure	40
Atmospheric Pressure	14
Oil Pressure	24
Temperature Sensor Return	18

HD connectors

Note: Using Deutsch HD connectors - terminal side shown.



Jack



Plug

D1017

Diagnostic codes

CID-FMI	Conditions which generate this code:	Systems response:	Troubleshooting
100-03	Pressure Sensor Open Or Shorted High The oil pressure sensor signal input to the ECM is greater than 4.8 VDC, indicating an open circuit or short to a positive voltage source AND A +5 VDC Sensor Supply diagnostic code (262-03 or 262-04) is NOT active.	The ECM assumes a default filtered oil pressure and engine protection monitoring for low or excessive oil pressure is disabled. This diagnostic code remains active until the engine control switch is turned to the OFF position. Note: Since engine protection is no longer available, the engine is shut down.	Proceed with Test 3: Analogue sensor open or short circuit test
100-04	Oil Pressure Sensor Short To Ground The oil pressure sensor signal input to the ECM is less than 0.2 VDC, indicating a short to ground AND A +5 VDC Sensor Supply diagnostic code (262-03 or 262-04) is NOT active.	The ECM assumes a default filtered oil pressure and engine protection monitoring for low or excessive oil pressure is disabled. This diagnostic code remains active until the engine control switch is turned to the OFF position. Note: Since engine protection is no longer available, the engine is shut down.	Proceed with Test 3: Analogue sensor open or short circuit test
110-03	Coolant Temperature Sensor Open The coolant temperature sensor signal input to the ECM is above acceptable range, indicating an open circuit or short to a positive voltage source	The ECM assumes a default coolant temperature and engine protection monitoring for low or excessive coolant temperature is disabled. This diagnostic code remains active until the engine control switch is turned to the OFF position. Note: Since engine protection is no longer available, the engine is shut down.	Proceed with Test 3: Analogue sensor open or short circuit test
110-04	Coolant Temperature Sensor Short to Ground The coolant temperature sensor signal input to the ECM is below acceptable range, indicating a short to ground	The ECM assumes a default coolant temperature, and engine protection monitoring for low or excessive coolant temperature is disabled. This diagnostic code remains active until the engine control switch is turned to the OFF position. Note: Since engine protection is no longer available, the engine is shut down.	Proceed with Test 3: Analogue sensor open or short circuit test

CID-FMI	Conditions which generate this code:	Systems response:	Troubleshooting
172-03	Inlet Air Temperature Sensor Open The inlet air temperature sensor signal input to the ECM is greater than 4.8 VDC, indicating an open circuit or short to a positive voltage source	The ECM assumes a default inlet air temperature. Engine protection monitoring for excessive inlet manifold temperature is disabled and the air-fuel ratio control no longer compensates for manifold temperature. Engine performance may be affected.	Proceed with Test 3: Analogue sensor open or short circuit test
175-03	Fuel Temperature Sensor Open The fuel temperature sensor signal input to the ECM is greater than 4.8 VDC, indicating an open circuit or short to a positive voltage source	The ECM assumes a default fuel temperature and engine protection monitoring for high fuel temperature is disabled. This diagnostic code remains active until the engine control switch is turned to the OFF position.	Proceed with Test 3: Analogue sensor open or short circuit test
175-04	Engine Fuel Temperature Short To Ground The fuel temperature sensor signal input to the ECM is less than 0.2 VDC, indicating a short to ground	The ECM assumes a default fuel temperature and engine protection monitoring for high fuel temperature is disabled. This diagnostic code remains active until the engine control switch is turned to the OFF position.	Proceed with Test 3: Analogue sensor open or short circuit test
274-03	Atmospheric Pressure Sensor Open The atmospheric pressure sensor signal input to the ECM is greater than 4.8 VDC, indicating an open circuit or short to a positive voltage source AND A +5 VDC Sensor Supply diagnostic code (262-03 or 262-04) is NOT active.	The ECM assumes a default pressure and engine power may be de-rated.	Proceed with Test 3: Analogue sensor open or short circuit test
274-04	Turbo Outlet Pressure Sensor Short To Ground Turbo Outlet Pressure Sensor signal input to the ECM is less than 0.2 VDC, indicating a short to ground AND A +5 VDC Sensor Supply diagnostic code (262-03 or 262-04) is NOT active.	The ECM assumes a default pressure and engine protection monitoring for boost pressure is disabled.	Proceed with Test 3: Analogue sensor open or short circuit test

Test step	Result	Action
Step 3: Disconnect sensor to create an open circuit - Turn the key switch to the OFF position. - Disconnect the sensor with the SHORT circuit diagnostic code. - Turn the key switch to the ON position. - Access the Active Diagnostic Code screen of the electronic service tool. Wait 10 seconds after turning the key switch ON. Check for an active OPEN circuit diagnostic code. - Measure the voltage between pin-A (+5 V) and pin-B (Return) on the engine harness sensor connector (ignore this step if troubleshooting the temperature sensors). An OPEN circuit diagnostic code for the disconnected sensor is now active.	OK ⇒	A SHORT circuit diagnostic code was active before disconnecting the sensor. An OPEN circuit diagnostic code became active after disconnecting the sensor. Temporarily reconnect the suspect sensor. If the sensor short circuit diagnostic code reappears, replace the sensor. Verify the diagnostic code is no longer active with the new sensor installed. Clear all logged diagnostic codes. STOP.
	NOT OK ⇒	There is a short circuit between the sensor harness connector and the ECM. Leave the sensor disconnected. Refer to Test 1: Inspecting electrical connectors . If NOT OK, proceed to Step 6.
	+5 VDC SUPPLY NOT OK ⇒	There is an open circuit in the sensor supply. Refer to Test 1: Inspecting electrical connectors . STOP.
Step 4: Verify supply voltage is present at the sensor - Disconnect the suspect sensor. - Proceed to the next step if troubleshooting the temperature sensors (+5 VDC supply not used). - Measure the voltage between pin-A (+5 V) and pin-B (Return) on the engine harness sensor connector. See "HD connectors" on page 90. The voltage should measure between 4.5 and 5.5 VDC.	OK ⇒	Supply voltage is present at the sensor. Proceed to next step.
	NOT OK ⇒	The +5 V sensor supply voltage is not reaching the sensor. Most likely there is an OPEN circuit in either the sensor common or sensor supply wire in the engine harness between the ECM and the sensor. Refer to Test 1: Inspecting electrical connectors . STOP.

Test step	Result	Action
Step 5: Create short circuit between signal and return terminals at the sensor connector		
• Turn the key switch to the OFF position. • Fabricate a jumper wire (100 to 150 mm, 4 to 6 inches long) with Deutsch terminals on both ends. • Install the jumper wire (short circuit) between the signal and return inputs of the suspect sensor connector (engine harness side). • Turn the key switch to the STOP position. Wait at least 10 seconds for the SHORT circuit diagnostic code to become active. See "HD connectors" on page 90. A sensor SHORT circuit diagnostic code is active with the jumper installed.	OK ⇒	The engine harness and ECM have checked OK. Thoroughly inspect the sensor connector. Refer to Test 1: Inspecting electrical connectors. Reconnect the sensor. If the OPEN circuit diagnostic code reappears, temporarily replace the sensor (connect a new sensor to the harness, but do not install it into the engine). Ensure the diagnostic code is no longer active. If the diagnostic code disappears when the new sensor is connected, replace the old sensor. Clear all logged diagnostic codes. STOP.
	NOT OK ⇒	Most likely there is an OPEN circuit in either the sensor common or sensor signal wire in the engine harness between the ECM and the sensor. Remove the jumper. Refer to Test 1: Inspecting electrical connectors. If NOT OK, proceed to next step.

Test step	Result	Action
Step 6: Check ECM operation by creating open and short circuits at the ECM connector - Remove power from the engine control system. Turn the key switch to the OFF position. - Disconnect ECM engine harness connector J2/P2. Thoroughly inspect both halves of the connector for signs of corrosion or moisture. Repair as necessary. - Reconnect J2/P2. - Use a terminal removal tool to remove the signal wire for the circuit creating the open or short circuit diagnostic code. - Restore power to the engine control system and turn the key switch to the ON position. - Monitor the TIPSS-EST Active Diagnostic Code screen. Wait at least 10 seconds for diagnostic codes to appear. - An OPEN circuit diagnostic code should be active for the suspect sensor. - Turn the key switch to the OFF position. - Fabricate a jumper wire with Deutsch Pins on both ends. - Insert the jumper wire between the suspect sensor input terminal and ECM ground. - Turn the key switch to the ON position. - A SHORT circuit diagnostic code should be active with the jumper wire installed. Wait at least 10 seconds for diagnostic codes to appear. See "HD connectors" on page 90. See "ECM terminal connections" on page 90. OPEN circuit and SHORT circuit diagnostic codes are active as indicated by the test procedure.	OK ⇒ NOT OK ⇒	The ECM is operating correctly. Repair or replace the defective wiring harness as necessary. Clear all diagnostic codes. Verify the repair eliminates the problem. STOP. Either the OPEN circuit diagnostic code is NOT active with the harness disconnected (open circuit), or the SHORT circuit diagnostic code is NOT active with the jumper wire (short circuit) installed. Replace the ECM. STOP.

ECM Status indicator output circuit test

Test 4

System operation

The ECM has seven available outputs that indicate engine operating status:

- Overspeed
- Coolant temperature
- Oil pressure
- Diagnostics
- Warning
- Action alert
- Shutdown

They can be used to drive indicator lamps or to interface with other controls. Each output provides a 0,3 Amp maximum current connection to either battery positive or battery negative when ON, and an open circuit when OFF.

The DIAGNOSTICS output indicates that a fault exists on the electronic system rather than with the engine. The TIPSS-EST service tool should be used to diagnose the fault.

The OVERSPEED output indicates that an overspeed fault exists. The severity of the fault is indicated by the WARNING, ACTION ALERT or SHUTDOWN lamps.

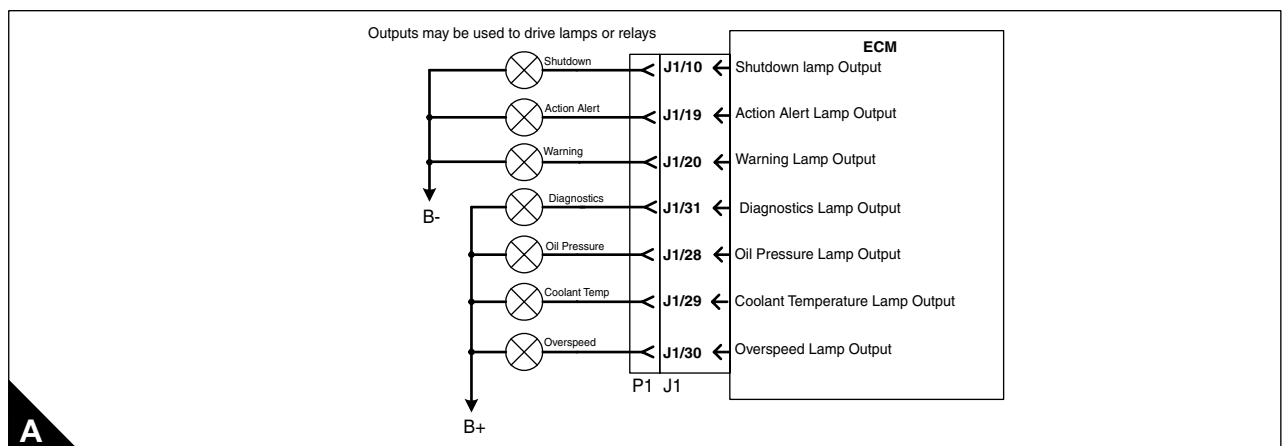
The COOLANT TEMPERATURE lamp indicates a high coolant temperature fault. The severity of the fault is indicated by the WARNING, ACTION ALERT or SHUTDOWN lamps.

The OIL PRESSURE lamp indicates an engine low oil pressure fault. The severity of the fault is indicated by the WARNING, ACTION ALERT or SHUTDOWN lamps.

The ACTION ALERT output indicates the existence of an engine fault of sufficient severity that the engine should be shutdown. This output would normally be used by the OEM to trip the generator circuit breaker and stop the engine.

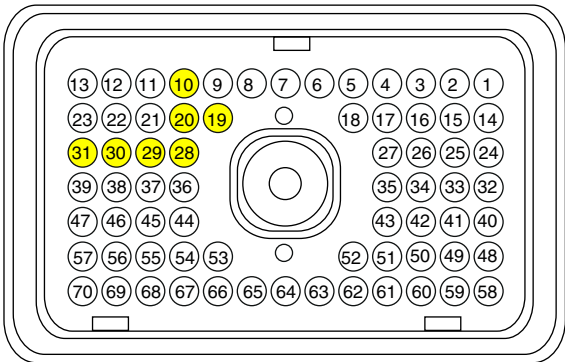
ECM Status indicator output circuit schematic

Note: Outputs may be used to drive lamps or relays. Refer to the wiring diagrams for full connection details.



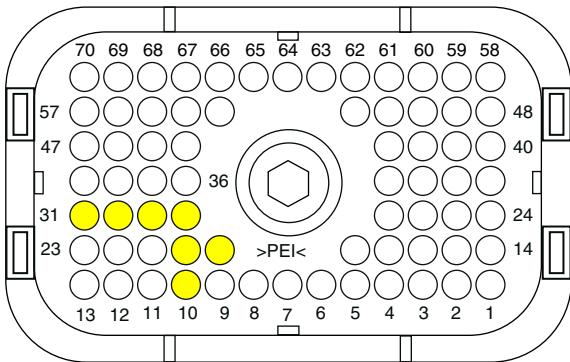
ECM terminal connections

Note: Using ECM connector P1.



Terminal side

Function	Pin Location
Shutdown Lamp	10
Action Alert Lamp	19
Warning Lamp	20
Diagnostics Lamp	31
Oil Pressure Lamp	28
Coolant Temp Lamp	29
Overspeed Lamp	30



Wire side

A

Diagnostic codes

CID-FMI	Conditions which generate this code:	Systems response:	Troubleshooting
281-04	Action Alert Output Shorted Low The ECM detects excessive output current, indicating a short to +Battery. Note: This code does not occur when the output is OFF.	The ECM will limit fault current to 1 Amp and the status display will not be correct.	Proceed with Test 4: ECM Status indicator output circuit test
282-04	Overspeed Output Shorted High The ECM detects excessive output current, indicating a short to +Battery. Note: This code does not occur when the output is OFF.	The ECM will limit fault current to 0,3 Amps and the indicator status will not be correct.	Proceed with Test 4: ECM Status indicator output circuit test
323-03	Engine Shutdown Lamp Output Shorted Low The ECM detects excessive output current, indicating a short to +Battery. Note: This code does not occur when the output is OFF.	The ECM will limit fault current to 1,5 Amps and the status display will not be correct.	Proceed with Test 4: ECM Status indicator output circuit test
324-03	Engine Warning Lamp Output Shorted Low The ECM detects excessive output current, indicating a short to +Battery. Note: This code does not occur when the output is OFF.	The ECM will limit fault current to 1 Amp and the status display will not be correct.	Proceed with Test 4: ECM Status indicator output circuit test
285-04	Coolant Temperature Output Shorted High The ECM detects excessive CRANK TERMINATE output current, indicating a short to +Battery. Note: This code does not occur when the output is OFF.	The ECM will limit fault current to 0,3 Amps and the status display will not be correct.	Proceed with Test 4: ECM Status indicator output circuit test
286-03	Oil Pressure Output Shorted High The ECM detects excessive RUN output current, indicating a short to +Battery. Note: This code does not occur when the output is OFF.	The ECM will limit fault current to 0,3 Amps and the indicator status will not be correct.	Proceed with Test 4: ECM Status indicator output circuit test
861-03	Diagnostics Output Shorted High The ECM detects excessive ENGINE SHUTDOWN LAMP output current, indicating a short to +Battery. Note: This code does not occur when the output is OFF.	The ECM will limit fault current to 0,3 Amps and the status display will not be correct.	Proceed with Test 4: ECM Status indicator output circuit test

Functional test

Test step	Result	Action
Step 1: Inspect electrical connectors and wiring • Check and replace any burned out engine status indicator lamps (if fitted). • Check equipment wiring to determine if engine status indicators are present and directly controlled by the ECM status indicator circuit. Some indicator panels may obtain engine status over a data link. If status indicators are not directly controlled by the ECM, stop this test. • Thoroughly inspect ECM connector J1/P1 and the indicator circuit wiring and connectors. Refer to Test 1: Inspecting electrical connectors for details. • Perform 45 N (10 lb) pull test on each of the wires associated with the status indicator circuit. Refer to the schematic. • Check that the ECM connector Allen screw is correctly tightened to not more than 6,0 Nm (4.4 lb ft). • Check the harness and wiring for abrasion and pinch points from the status indicators back to the ECM. See "ECM Status indicator output circuit schematic" on page 97. See "ECM terminal connections" on page 98. All connectors/pins/sockets should be completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.	OK ⇒ NOT OK ⇒ STOP TEST ⇒	Proceed to next step. Repair or replace the harness as necessary. STOP. STOP.
Step 2: Check for active status indicator diagnostic codes • Connect the TIPSS-EST service tool at the service tool connector. • Attempt to start the engine while viewing the status indicators. • Check for active diagnostic codes. Diagnostic codes 281-04, 282-04, 285-03, 286-03, 323-04 or 861-03 should NOT be active.	OK ⇒ NOT OK ⇒	Proceed to Step 4 Proceed to next step
Step 3: Check indicator for shorts • Disconnect the suspect indicator control wire at the electrical indicator (i.e., lamp or PLC input). • Attempt to start the engine while viewing the status indicators. • Check for active diagnostic codes. Diagnostic codes 281-04, 282-04, 285-03, 286-03, 323-04 or 861-03 should NOT be active.	OK ⇒ NOT OK ⇒	The short is no longer present. Repair or replace ECM driven indicator as necessary. STOP. Proceed to Step 5

Test step	Result	Action
Step 4: Check indicator circuit using a jumper wire		
• Turn the key switch to the OFF position. • Disconnect ECM connector J1/P1. • Turn the key switch to the ON position. • Observe the engine status indicators while using a jumper wire with Deutsch pins crimped on each end to connect between: • P1 pin 10 and B+ • P1 pin 19 and B+ • P1 pin 20 and B+ • P1 pin 31 and B- • P1 pin 28 and B- • P1 pin 29 and B- • P1 pin 30 and B- Each lamp should illuminate only when the appropriate jumper is inserted at the ECM connector P1.	OK ⇒ NOT OK ⇒	The harness and indicators check OK. Reconnect all connectors and recheck ECM indicator operation. If the problem still exists, replace the ECM. STOP. There is a problem in the indicator circuit. Recheck electrical connections, wiring, etc., for damage, corrosion, or abrasion. Repair as required. STOP.
Step 5: Check for shorts in the harness		
• Use a wire removal tool to disconnect the suspect indicator control wire from the ECM connector. • Attempt to start the engine while viewing the status indicators. • Check for active diagnostic codes. See "ECM terminal connections" on page 98. Diagnostic codes 281-04, 282-04, 285-03, 286-03, 323-04 or 861-03 should NOT be active.	OK ⇒ NOT OK ⇒	The short is in the harness. The short circuit diagnostic code is present when the circuit is disconnected from the ECM. Disconnect J1/P1 and check for damage or corrosion. Refer to Test 1: Inspecting electrical connectors. If the problem is not resolved, replace the ECM. STOP.

+5 V Sensor voltage supply circuit test**Test 5****System operation**

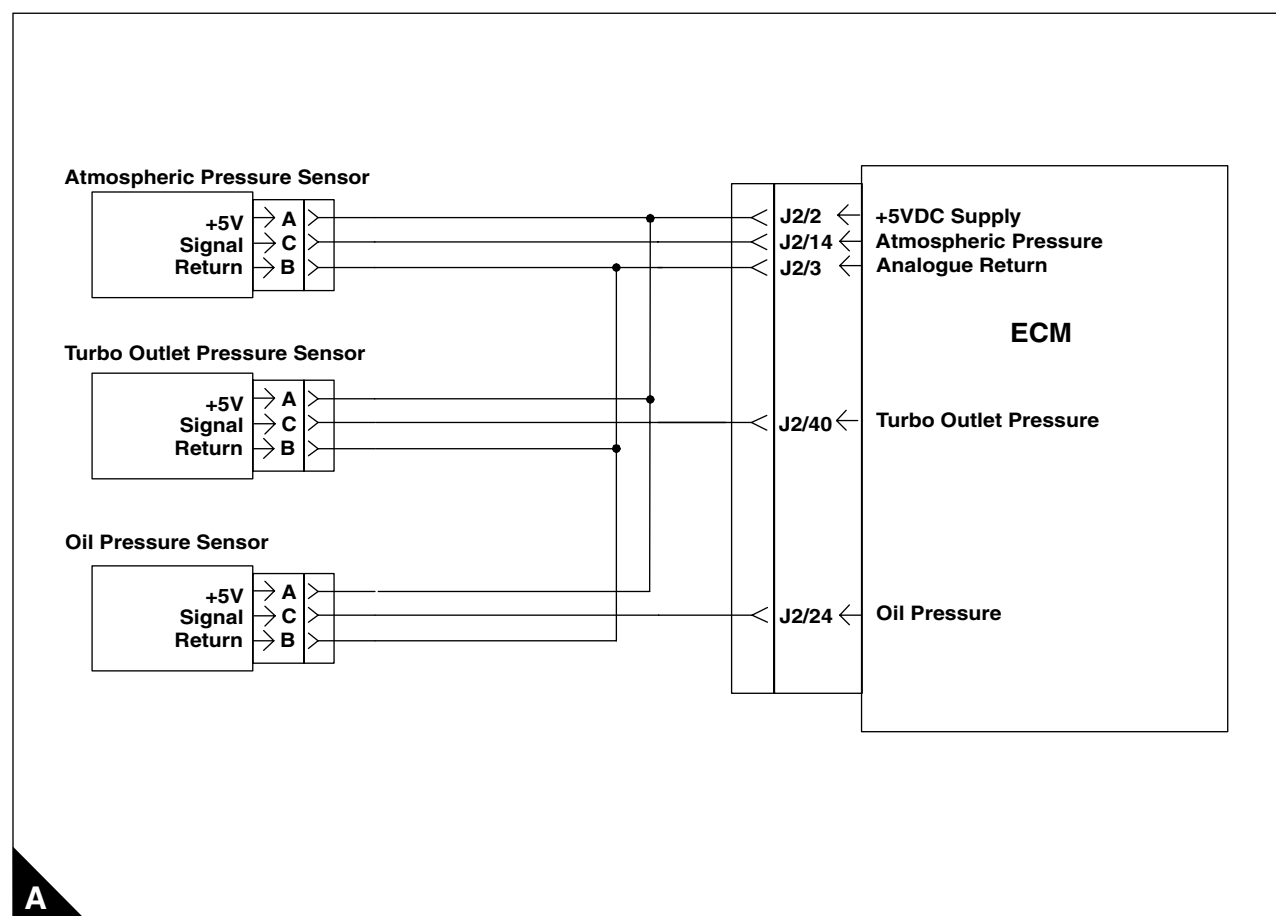
Use this procedure to troubleshoot the system when there is an active, or easily repeated, 262-03 +5 Volt Supply Above Normal or 262-04 +5 Volt Supply Below Normal or if directed here by another troubleshooting procedure.

The Electronic Control Module (ECM) supplies +5 VDC to the oil pressure, atmospheric pressure and turbo outlet pressure sensors. The +5 V sensor supply is routed from the ECM through ECM engine harness connector J2/P2 terminal-2 to terminal-A of each +5 VDC sensor connector. The supply voltage is 5.0 ± 0.5 VDC.

The +5 V short circuit diagnostic code is most likely caused by a short or open circuit in the harness, next likely is a sensor, and least likely is the ECM.

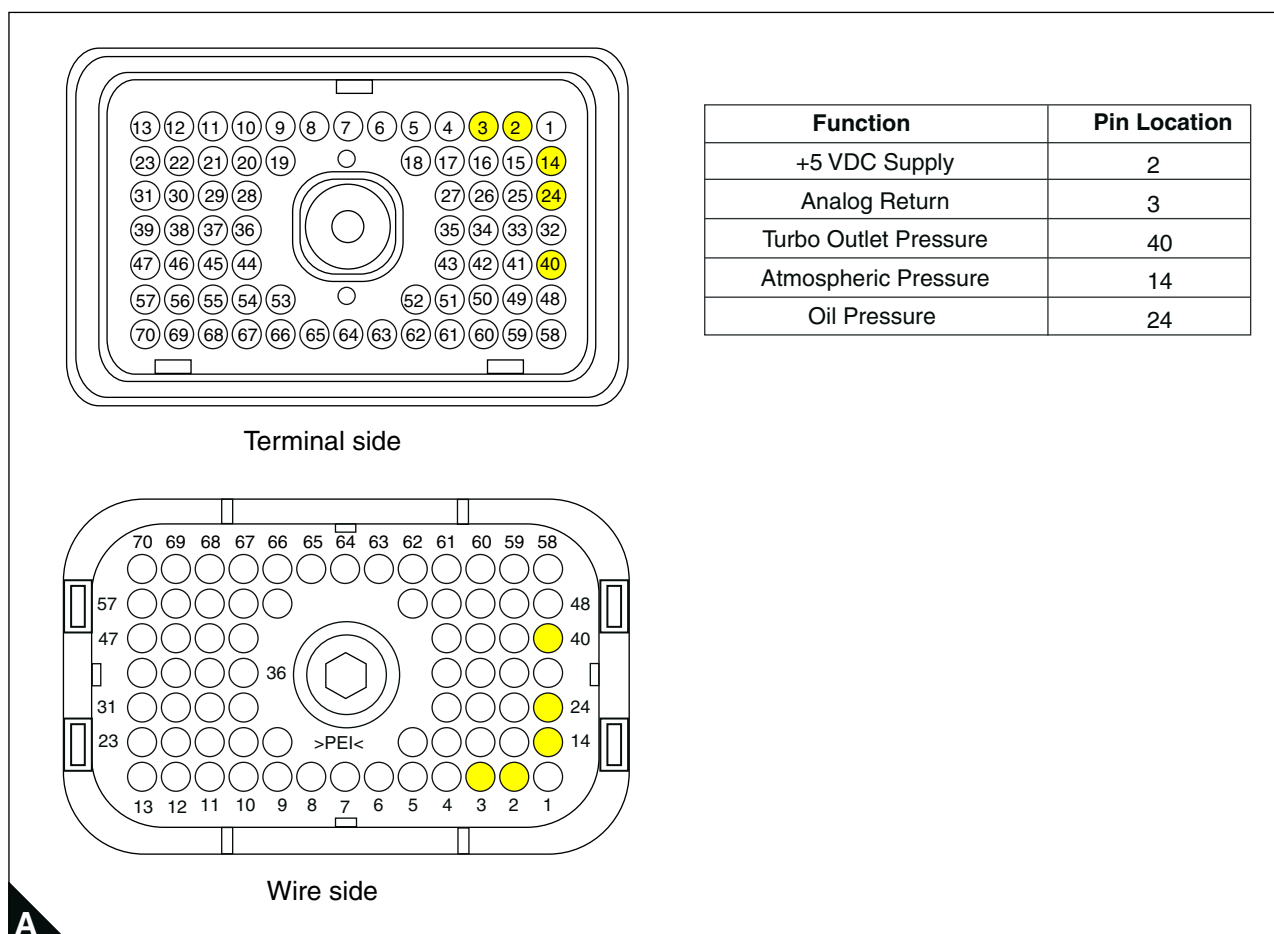
5 V supply to analog sensor schematic

Note: Refer to the wiring diagrams for full connection details.



ECM terminal connections

Note: Using ECM connector P2.



Diagnostic codes

CID-FMI	Conditions which generate this code:	Systems response:	Troubleshooting
262-03	+5 VDC Supply Shorted High The ECM supply voltage for the sensors is exceeding normal level, indicating a possible short to a positive voltage source.	Electronic system response All ECM 5 VDC analogue sensor inputs assume default values and all diagnostic codes for ECM 5 VDC analogue sensors are disabled while this diagnostic code is active. TIPSS may indicate DIAG next to the default value Sensor Status to indicate the sensor is operating at the value shown due to an active diagnostic code. This diagnostic code remains active until the engine control switch is turned to the OFF position. Note: Since engine protection is no longer available, the engine is shut down.	Proceed with Test 5: +5 V Sensor voltage supply circuit test

CID-FMI	Conditions which generate this code:	Systems response:	Troubleshooting
262-04	+5 VDC Supply Below Normal The ECM supply voltage for the turbo outlet pressure, atmospheric pressure and oil pressure sensors is below normal level, indicating a possible short to ground or short between sensor supply and return.	Electronic system response All ECM 5 VDC analogue sensor inputs assume default values and all diagnostic codes for ECM 5 VDC analogue sensors are disabled while this diagnostic code is active. TIPSS may indicate DIAG next to the default value Sensor Status to indicate the sensor is operating at the value shown due to an active diagnostic code. This diagnostic code remains active until the key switch is turned to the OFF position. Note: Since engine protection is no longer available, the engine is shut down.	Proceed with Test 4: ECM Status indicator output circuit test

Functional test

Test step	Result	Action
Step 1: Connect an electronic service tool and note all active diagnostic codes		
- Connect the TIPSS-EST service tool to the service tool connector. - Turn the key switch to the ON position. - Access the TIPSS Active and Logged Diagnostic Code screen(s) (wait at least 15 seconds for diagnostic codes to become active). - Check for active or logged 262-03 +5 Volt Supply Above Normal or 262-04 +5 Volt Supply Below Normal diagnostic codes. Select the condition of code 262-03 or 262-04.	ACTIVE ⇒ LOGGED ONLY ⇒ NOT ACTIVE OR LOGGED ⇒	A 262-03 or 262-04 diagnostic code is active. Proceed to next step. A 262-03 or 262-04 diagnostic code is logged but NOT active. Refer to Test 1: Inspecting electrical connectors. If OK, proceed to Step 4. The +5 Volt sensor supply is operating correctly at this time. STOP.

Test step	Result	Action
Step 2: Disconnect +5 V sensors and monitor active diagnostic codes - Access the Active Diagnostic Code screen and verify there is an active +5 V Sensor Supply diagnostic code (262-03 or 262-04). - Disconnect the following sensors and turn the key switch to the OFF position, then to the ON position: oil pressure, atmospheric pressure and turbo outlet pressure sensors. Check the TIPSS-EST screen after disconnecting each sensor to determine if disconnection of a specific sensor deactivates the +5 V diagnostic code. Note: When the sensors are disconnected and the key switch is in the ON position, open circuit diagnostic codes will be active/logged when the +5 V diagnostic codes are no longer active. This is normal. Clear these diagnostic codes after this test step is completed. Is the original +5 V diagnostic code (262-03 or 262-04) still active ?	YES ⇒ NO ⇒	The +5 V diagnostic code is still active. Leave the sensors disconnected. Proceed to next step. Disconnecting a specific sensor makes the +5 V diagnostic code no longer active. Reconnect the sensor suspected of causing the problem. If the problem reappears, and then disappears following disconnection, replace the sensor. Clear all diagnostic codes. Verify the repair eliminates the problem. STOP.
Step 3: Isolate the sensor supply harness From The ECM - Remove power from the engine control system. Turn the key switch to the OFF position and disconnect the power from the engine. - Disconnect J2/P2 and inspect for damage or corrosion. Repair as necessary. - Use a wire removal tool to remove the +5 VDC supply wire from ECM connector P2 terminal-2. Reconnect J2/P2. - Restore power to the engine control system and turn the key switch to the ON position. - Access the Active Diagnostic Code screen and determine there is an active +5 V Sensor Supply diagnostic code (262-03 or 262-04). Does the +5 V diagnostic code remain active with the engine harness isolated ?	YES ⇒ NO ⇒	Isolating the engine harness from the ECM does not eliminate the active +5 V Sensor diagnostic code. Replace the ECM. STOP. The +5 V diagnostic code is no longer active when the harness is isolated. There is a short circuit in the harness. Refer to Test 1: Inspecting electrical connectors If OK, proceed to next step.

Test step	Result	Action
Step 4: Check the engine harness		
- Remove power from the engine control system. Turn the key switch to the OFF position and disconnect the power from the engine. - Disconnect P2 and verify ALL of the +5 V engine sensors attached to the P2 engine harness are disconnected (oil pressure, atmospheric pressure and turbo outlet pressure sensors). - Set a multimeter to measure resistance on the range closest to, but not less than, 2k Ohms. Measure from P1 terminal-2 (+5 VDC Supply) to each of the sensor signal terminals (P1 terminals-14, 17, 24, 26, and 27) and to P1 terminal-3 (analogue return). Wiggle the harness during measurement to reveal any intermittent short condition. - Measure the resistance from P2 terminal-2 (+5 VDC Supply) to engine ground. See "ECM terminal connections" on page 103. Each resistance measurement is more than 2k Ohms.	OK ⇒ NOT OK ⇒	The +5 V line is not shorted in the engine harness. Reconnect all connectors. There does not appear to be a problem at this time. Clear all diagnostic codes. Continue to troubleshoot until the original condition is resolved. STOP. Repair the engine harness. Clear all logged diagnostic codes. Verify the repair eliminates the problem. STOP.

PWM desired speed setting circuit test

Test 6**System operation**

Note: This procedure is only applicable if the PWM speed control method is selected.

Use this procedure if a 91-08 Invalid PWM Speed Control Signal, 41-03 8 Volt Supply Above Normal or 41-04 8 Volt Supply Below Normal diagnostic code is indicated.

PWM speed control

The PWM speed control is used to provide a desired speed setting signal to the ECM. Output is a constant frequency signal with a pulse width that varies with the speed control signal. This output signal is referred to as either "Duty Cycle" or a "Pulse Width Modulated" (PWM) signal and is expressed as a percentage between 3 and 100 percent.

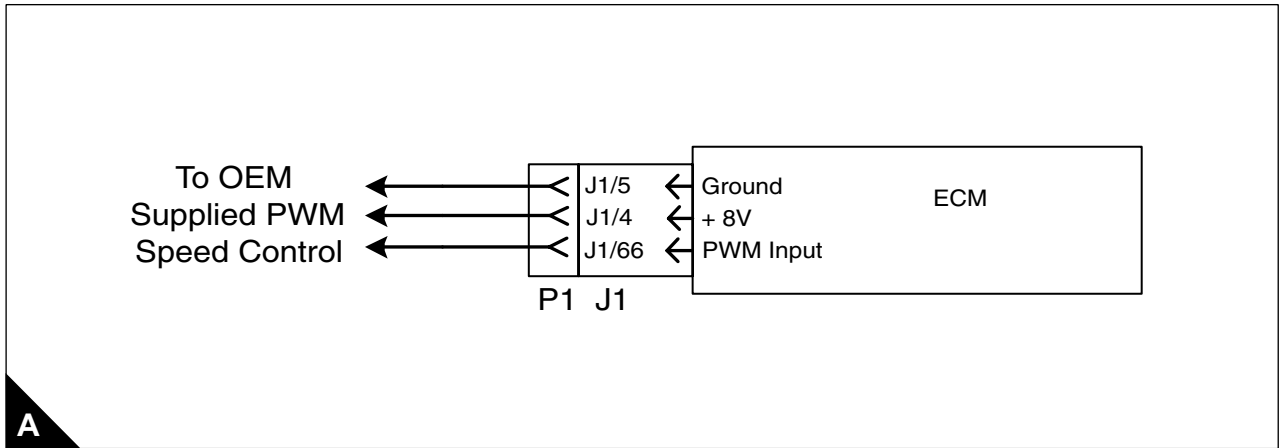
Note: The PWM speed control is an external device supplied by the OEM.

The speed control must produce a duty cycle of 2.6 to 9.9 percent for 1141 rev/min (1369 rev/min if 1800 rev/min is selected) and 90.1 to 95 percent for full speed of 1621 rev/min (1945 rev/min if 1800 rev/min is selected).

The PWM speed control may be powered by the ECM supplied from +8 V from connector P1 terminal-4.

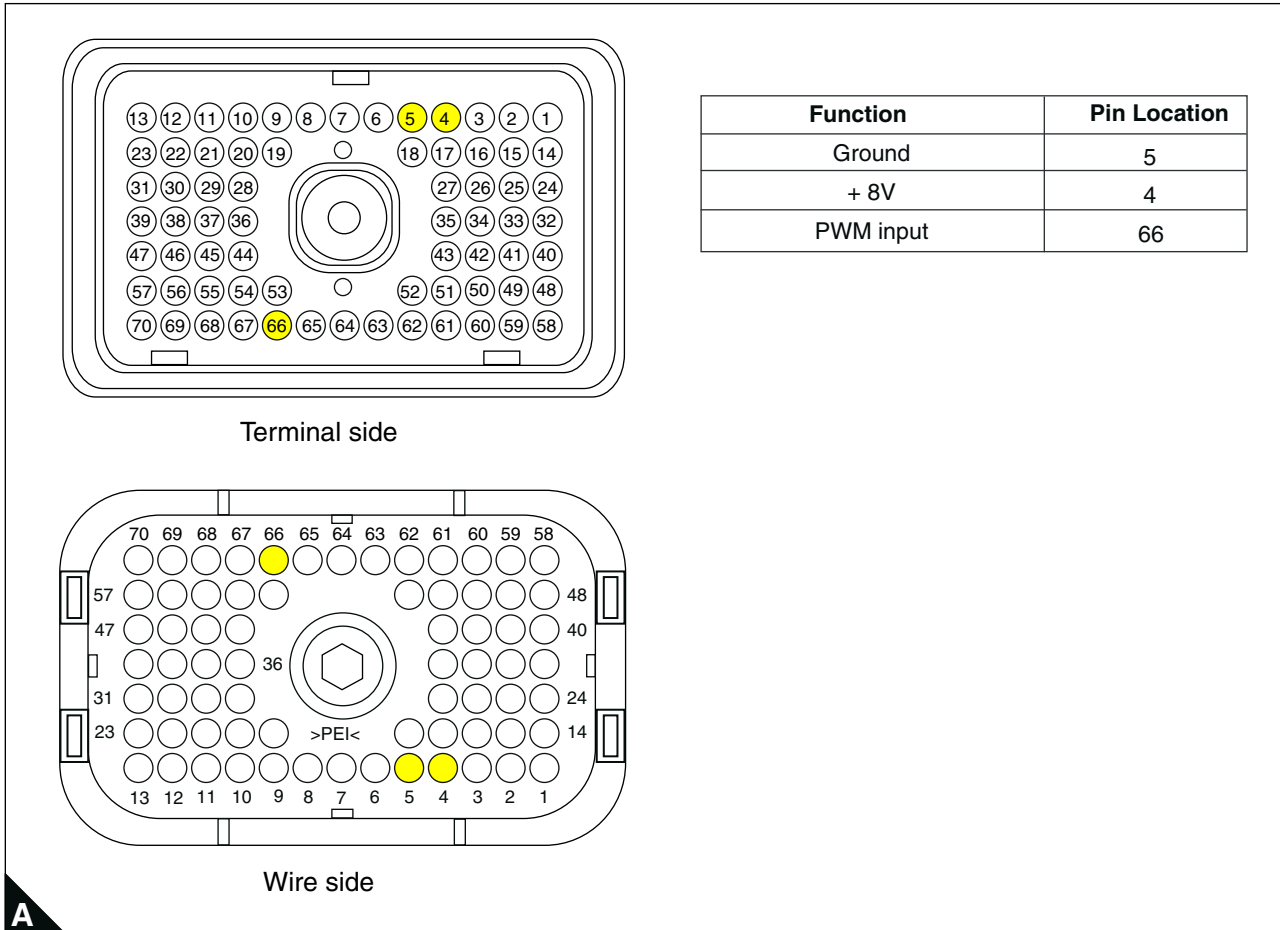
PWM Speed control circuit

Note: Refer to the wiring diagrams for full connection details.



ECM terminal connections

Note: Using ECM connector P1.



Diagnostic codes

CID-FMI	Conditions which generate this code:	Systems response:	Troubleshooting
41-03	8 Volt Supply Above Normal The PWM speed control supply voltage is higher than it should be.	Engine response An active diagnostic code may not cause any noticeable effect on engine response unless the voltage is significantly above 8 volts. The engine may be limited to low idle.	Proceed with Test 6: PWM desired speed setting circuit test
41-04	8 Volt Supply Below Normal The PWM speed control supply voltage is lower than it should be.	Engine response An active diagnostic code may not cause any noticeable effect on engine response unless the voltage is significantly below 8 volts. The engine may be limited to low idle.	Proceed with Test 6: PWM desired speed setting circuit test
91-08	Invalid PWM Speed Control Signal The ECM is not receiving a correct speed control signal from either the PWM or analogue speed control input, according to the control selected.	Electronic system response The ECM returns the engine to nominal speed as soon as the problem is detected. The diagnostic code is only logged if the engine is running. Engine response The engine will remain at nominal speed while the diagnostic code is active.	The diagnostic code is most likely caused by an open circuit in the PWM or analogue speed control signal circuit, or voltage supply circuit. Proceed with Test 6: PWM desired speed setting circuit test

Functional test

Test step	Result	Action
Step 1: Inspect electrical connectors and wiring - Thoroughly inspect ECM connector J1/P1, the OEM connector and the external wiring. Refer to Test 1: Inspecting electrical connectors. - Perform a 45 N (10 lb) pull test on each of the wires in the ECM connector P1 associated with the PWM speed control (terminals 3, 4, 5, 66 and 68). Refer to "ECM terminal connections" on page 108 - Check that the ECM connector Allen screw is correctly tightened to not more than 6,0 Nm (4.4 lb ft). - Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. All connectors, pins and sockets are completely mated/inserted, and the harness/wiring should be free of corrosion, abrasion or pinch points.	OK ⇒ NOT OK ⇒	Proceed to next step. Repair or replace wiring or connectors as necessary. Ensure that all seals are correctly installed and that connectors are completely mated. Verify that the repair eliminates the problem. If the conditions are not resolved, proceed to next step.
Step 2: Check for active diagnostic codes - Connect an electronic service tool to the data link connector. - Turn the key switch ON, engine OFF. - Monitor the electronic service tool Active Diagnostic Code screen, check and record active diagnostic codes. Note: When the ECM is first powered it automatically calibrates new duty cycle values for the low and high speed positions. It assumes 10 percent at low speed and 95 percent for the high speed duty cycle. Following some cycling of the speed input between the low and high positions, the ECM will adjust its calibration automatically, provided that the high idle stop position is within the 90 to 95 percent duty cycle range and the low speed is in the 2.6 to 9.9 percent duty cycle range. Result 1 - Diagnostic code 91-08 is active. Result 2 - Diagnostic code 41-03 or 41-04 is active. Result 3 - There are NO active diagnostic codes that are related to the speed control circuit at this time, but a problem is suspected with its operation.	RESULT 1 ⇒ RESULT 2 ⇒ RESULT 3 ⇒	Proceed to next step. Proceed to Step 5. Proceed to next step.
Step 3: Check PWM speed control duty cycle - Connect an electronic service tool to the data link connector (if not already installed). - Turn the key switch ON, engine OFF - Monitor the speed control range on the electronic service tool.	YES ⇒ NO ⇒	The PWM speed control is currently operating correctly. STOP. The PWM speed control circuit is not operating correctly. Proceed to next step.

Test step	Result	Action
Step 4: Check PWM speed control supply voltage at the speed control		
• Connect a voltmeter to the +8 V and ground terminals. • Turn the key switch ON, engine OFF. • Measure the voltage at the +8 V supply with reference to ground. Is the measured voltage between 7.5 and 8.5 VDC ?	OK ⇒ +8 Volt ⇒ NOT OK	Proceed to Step 7. The speed control is not receiving the correct voltage. Proceed to next step.
Step 5: Disconnect PWM speed control while monitoring active diagnostic codes		
• Access the Active Diagnostic Code screen of the electronic service tool. Ensure that either a 41-03 8 Volt Supply Above Normal or 41-04 8 Volt Supply Below Normal diagnostic code is active before proceeding. • Monitor the Active Diagnostic Code screen while disconnecting and reconnecting the PWM speed control. Is the 41-03 8 Volt Supply Above Normal or 41-04 8 Volt Supply Below Normal still active after the control is disconnected ?	YES ⇒ NO ⇒	Ensure the speed control has been reconnected before continuing. Proceed to next step. Temporarily install another PWM speed control. Use an electronic service tool and check if the +8 V diagnostic code is still active. If the problem is corrected with the new speed control and returns when the old speed control is connected, permanently replace the speed control. STOP.

Test step	Result	Action
Step 6: Disconnect PWM speed control supply terminals at the ECM • Turn the key switch OFF, engine OFF. • Remove terminal-4 (+8 V) and terminal-5 (SENSOR/ SWITCH SENSOR COMMON) from machine harness connector P1 (disconnect ECM harness connector J1/P1 if necessary). • Reconnect ECM connector J1/P1. • Turn the key switch ON, engine OFF. • Use an electronic service tool and check if the diagnostic code is still active. Is the 41-03 8 Volt Supply Above Normal or 41-04 8 Volt Supply Below Normal still active after the power terminals are disconnected ?	YES ⇒ NO ⇒	Check the battery voltage from P1 terminal-61 and terminal-63 (UNSWITCHED +BATTERY) to terminal-48 and terminal-52 (-BATTERY) to ensure that it is 22.0 to 27.0 VDC for a 24 Volt system. If the battery voltage is correct, temporarily connect a test ECM. Use an electronic service tool and check if the diagnostic code is still active. If the problem is corrected with the test ECM, reconnect the old ECM and verify that the problem returns. If the test ECM works and the old ECM does not, permanently replace the ECM. STOP. There is a problem in the wiring between the ECM and the PWM speed control. Connect the removed wires one at a time while watching if the diagnostic code reappears. First connect terminal 5 and then connect terminal 4 to determine which is causing the problem. Repair or replace the damaged wire as necessary. Verify that the repair eliminates the problem. STOP.
Step 7: Check PWM speed control duty cycle at the speed control		
Refer to OEM instructions for the correct procedure.	OK ⇒ NOT OK ⇒	Proceed to next step. Replace the speed control unit STOP.

Test step	Result	Action
Step 8: Check PWM speed control duty cycle at the ECM • Turn the key switch OFF, engine OFF. • Use a multimeter capable of measuring PWM duty cycle. • Remove the speed control wire (terminal-66) from the machine harness side (P1) of ECM connector P1/J1. It may be necessary to disconnect ECM connector P1 in order to remove the speed control signal terminal. • Connect multimeter probes between the removed wire and terminal 5 (SENSOR/SWITCH SENSOR COMMON) of P1. • Reconnect ECM connector P1 to the ECM. • Turn the key switch ON, engine OFF. • Use the multimeter to display the duty cycle output of the PWM speed control while moving the sensor assembly from low idle to high idle. Record the results. Does the duty cycle measure between 10 percent at the low speed position and increase to 90 percent in the high speed position ? • Turn the key switch OFF, engine OFF. • Insert terminal-66 into the 70-terminal ECM connector P1/J1.	OK ⇒ NOT OK ⇒	A good speed control signal is reaching the ECM. Verify that the ECM is receiving the correct battery voltage. If so temporarily connect a test ECM. If the problem disappears with the test ECM connected, reconnect the suspect ECM to verify the problem returns. If the test ECM works and the old one does not permanently replace the ECM. STOP. There is a problem with speed control signal wire in the machine wiring harness. Proceed to next step.
Step 9: Route supply bypass wires to the PWM speed control • Turn the key switch OFF, engine OFF. • Remove the speed control wire (terminal-66) from the ECM connector P1. • Route new wiring from the ECM to the external speed control. • Turn the key switch ON, engine OFF. • Check the speed control duty cycle with an electronic service tool while changing the speed setting over the full range. Does the duty cycle measure between 10 percent at the low speed position and increase to 90 percent in the high speed position ?	YES ⇒ NO ⇒	The wiring from the ECM to the speed control appears faulty. Permanently install new wiring. Verify that the repair eliminates the problem. STOP. Double check the wiring, the ECM machine harness connector J1/P1 and the connectors. If a problem still exists, restart the test procedure. STOP.

Perkins Data Link circuit test

Test 7**System operation**

Use this procedure if the electronic service tool will not power up or communicate with the ECM through the data link.

Background

The Perkins Data Link is the standard data link used by the ECM to communicate with electronic service tools such as TIPSS-EST.

The ECM provides two data link connection terminals from the ECM machine harness connector J1, terminal-9 (DATA LINK NEGATIVE) and terminal-8 (DATA LINK POSITIVE).

The OEM provides twisted pair wiring from the ECM to the data link connector.

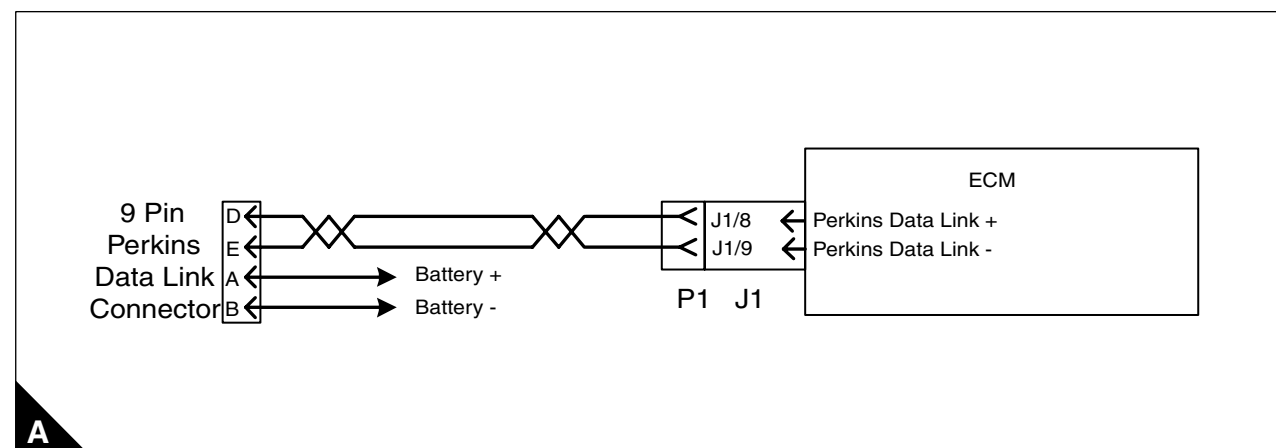
Communication with the key switch OFF

With the key switch OFF, the ECM will not communicate with the electronic service tool. In order to avoid this problem turn the key switch ON when working with the electronic service tool.

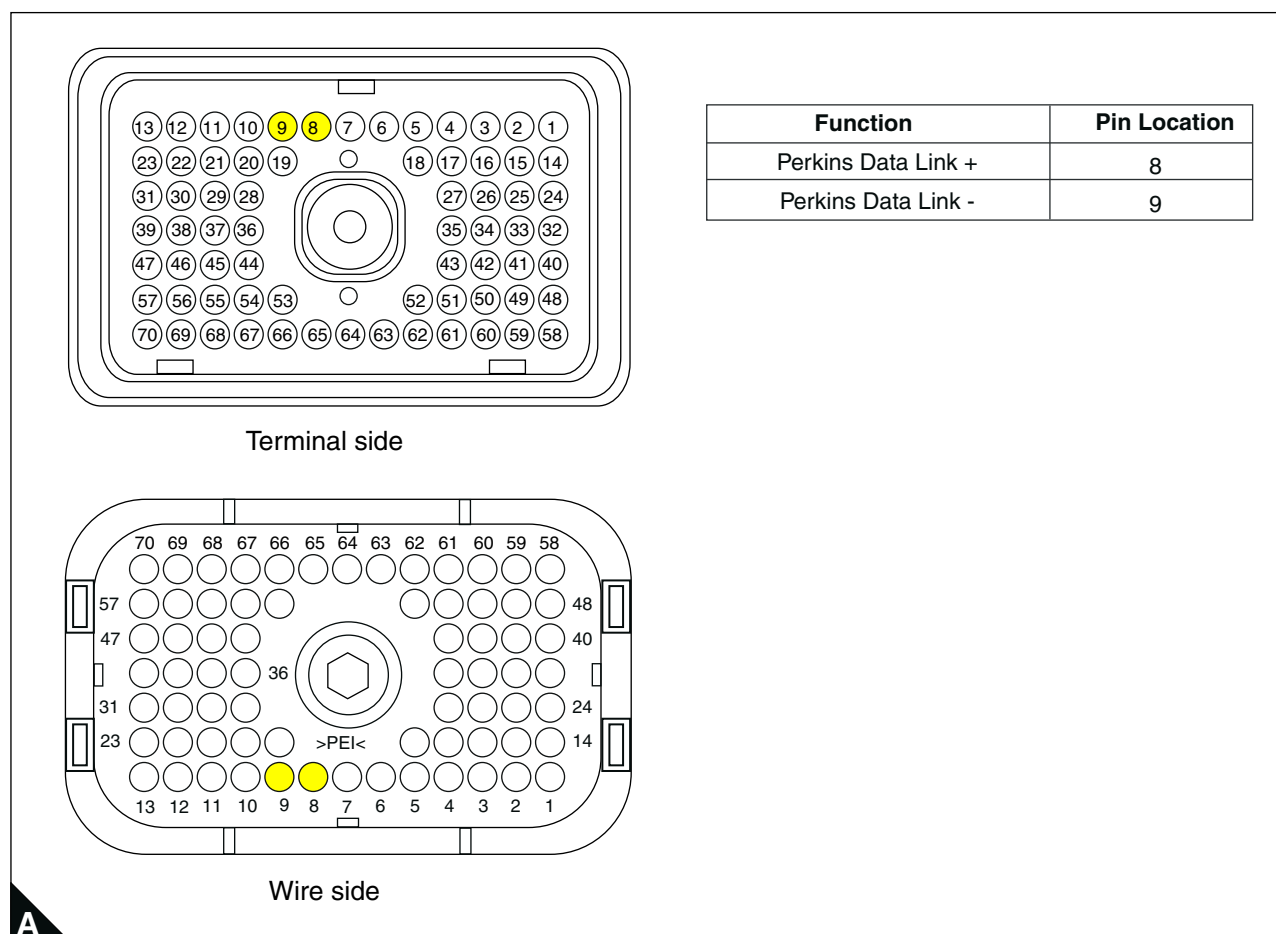
TIPSS-EST may indicate an error message that the ECM version is not recognized and the integrity of the changed parameters and displayed data is not guaranteed. This will indicate that you have not installed the latest release of the TIPSS-EST software or the ECM software is newer than the TIPSS-EST software.

Perkins Data Link schematic

Note: Refer to the wiring diagrams for full connection details.

**ECM terminal connections**

Note: Using ECM connector P1.

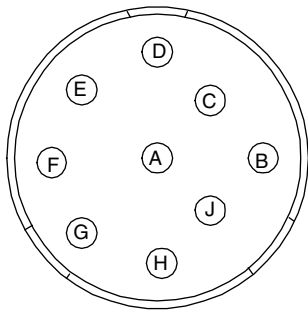


Functional test

Test step	Result	Action
Step 1: Check electrical connectors and wiring - Thoroughly inspect the ECM machine harness connector J1/P1, data link connector, electronic service tool connectors and cables, and the Perkins Data Link (terminals-8 and 9) in the connectors. Refer to Test 1: Inspecting electrical connectors. - Perform a 45 N (10 lb) pull test on each of the wires in the connectors associated with the Perkins Data Link. - Check that the ECM connector Allen screw is correctly tightened to not more than 6,0 Nm (4.4 lb ft). - Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. See "ECM terminal connections" on page 115 All connectors, pins and sockets should be completely mated/inserted and the harness/wiring should be free of corrosion, abrasion or pinch points.	OK ⇒ NOT OK ⇒	Proceed to next step. Replace or repair wiring or connectors as necessary. Ensure all seals are correctly installed and that connectors are completely mated. Verify the repair eliminates the problem. STOP
Step 2: Determine the type of data link problem - Connect an electronic service tool to the data link connector. - Start the engine. Result 1 - Engine starts and electronic service tool powers up and communicates without error. Result 2 - Engine starts and electronic service tool powers up but displays an error. Result 3 - Engine cranks but will not start regardless of the condition of the electronic service tool. Result 4 - Engine will not crank regardless of the condition of the electronic service tool. Result 5 - Engine starts but the electronic service tool does not power up. Note: To determine if the electronic service tool has powered up, check the display screen or check the communication adapter display. The electronic service tool will display information that shows if the tool is getting power, and will be blank if it is not. If the electronic service tool or the communication adapter powers up, the data link connector is receiving power.	RESULT 1 ⇒ RESULT 2 ⇒ RESULT 3 ⇒ RESULT 4 ⇒ RESULT 5 ⇒	There is not a problem with the data link at this time. If an intermittent condition exists, thoroughly inspect all wiring and connectors. Refer to Test 1: Inspecting electrical connectors STOP The electronic service tool displays an error message. The ECM is receiving battery power. Proceed to Step 5. Refer to P-401: Engine will not crank on page 32. STOP Refer to P-402: Engine cranks but will not start on page 33. STOP The electronic service tool or communications adapter does not power up. Ensure that the ECM is receiving the correct battery power. Proceed to next step.

Test step	Result	Action
Step 3: Check the battery voltage supply to the data link connector • Turn the key switch ON, engine OFF • Use a multimeter to measure the voltage from the data link connector + BATTERY terminal to the - BATTERY terminal. See "Pin allocation for communications connector" on page 118. Is the voltage is between 22.0 and 27.0 Volts for a 24 Volt system ?	YES ⇒ NO ⇒	The data link connector is currently receiving the correct voltage. Proceed to next step. The data link connector is not receiving the correct voltage. Inspect the wiring and fuses to the connector. Repair or replace the wiring or batteries as required. Verify that the repair eliminates the problem. STOP.
Step 4: Change electronic service tool components • If another engine or ECM is available connect the electronic service tool to the other engine using the same cables. • Turn the key switch ON, engine OFF. Determine if the electronic service tool operates correctly on the other engine. If another engine is not available, find a different set of electronic service tool cables. • Connect the electronic service tool to the data link connector using the new cables. • Turn the key switch ON, engine OFF. • If changing cables allows the electronic service tool to operate correctly, replace (one at a time) the pieces from the old cable set into the one that does operate and repower the electronic service tool each time to determine which piece is faulty. • If changing cables does not allow the electronic service tool to operate correctly, connect a different electronic service tool. • Turn key switch to the ON, engine OFF. Result 1 - The original electronic service tool works on another engine. Result 2 - A different electronic service tool works on the original engine while the engine is being tested.	RESULT 1 ⇒ RESULT 2 ⇒	Proceed to next step. Send the faulty electronic service tool for repair. STOP.

Pin allocation for communications connector



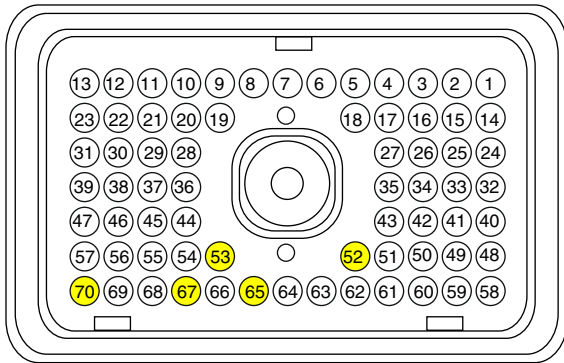
Deutsch 9 Pin Perkins Data Link Connector

Pin No.	Description
A	Battery +
B	Battery -
C	CAN Bus Screen
D	Perkins Data Link +
E	Perkins Data Link -
F	J1939 CAN -
G	J1939 CAN +
H	J1922 Bus +
J	J1922 Bus -

A

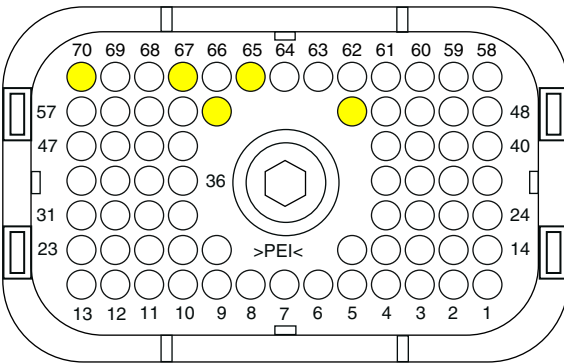
Breakout connector

Note: Using ECM connector P1.



Terminal side

Function	Pin Location
Unswitched Battery +	52
Unswitched Battery +	53
Key switch	70
Battery -	67
Battery -	65



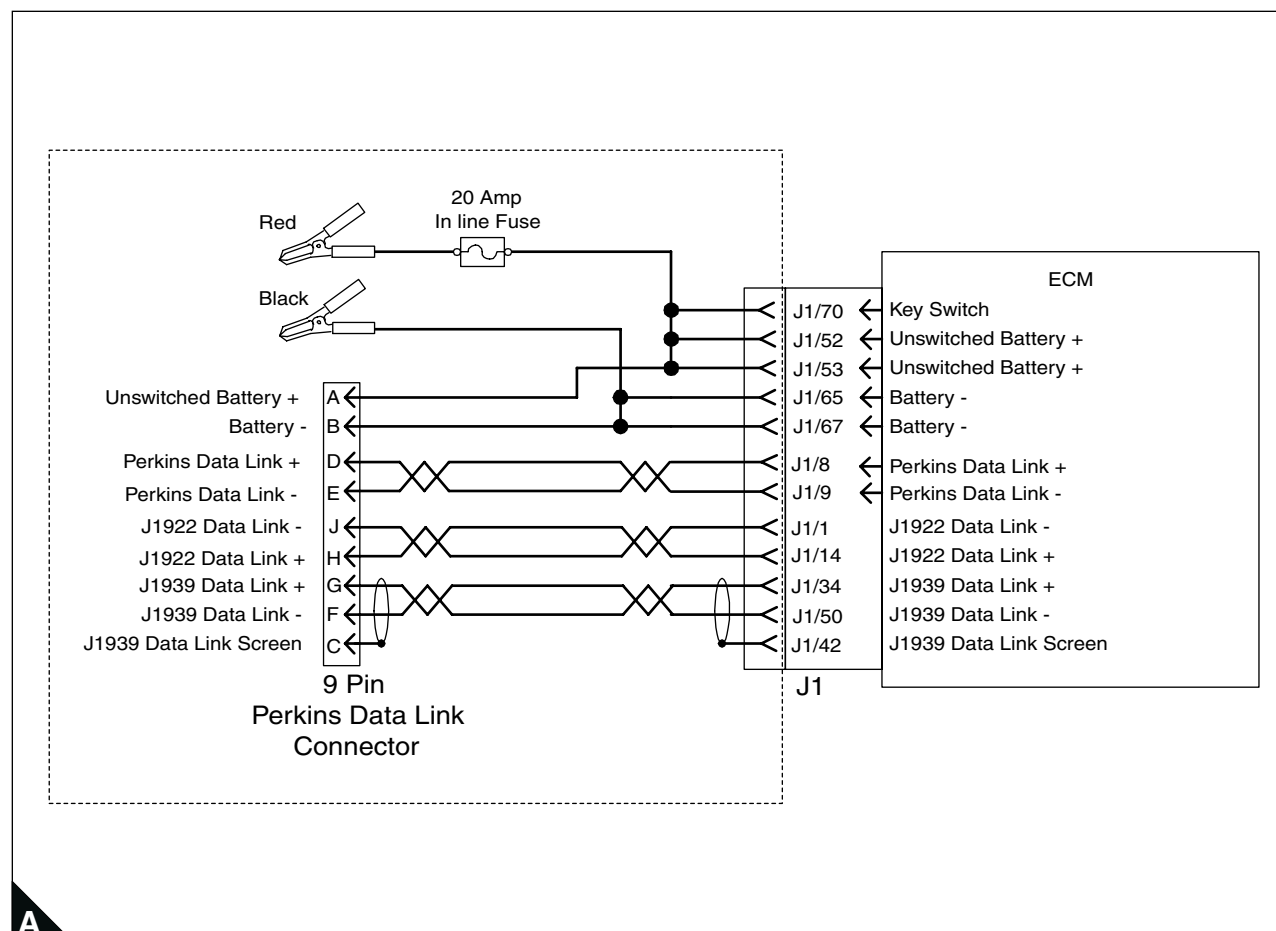
Wire side

A

Test step	Result	Action
Step 5: Check battery voltage at the ECM • Ensure that the electronic service tool is connected to the data link connector. • Disconnect the ECM machine harness connector J1/P1 and insert a 70-terminal breakout T in series, or if signal reading probes are available and ECM connector P1 is accessible (without disconnecting), insert probes into terminal-52 (UNSWITCHED +BATTERY) and terminal-65 (-BATTERY). • Turn the key switch ON, engine OFF. • Measure the voltage between ECM connector PP terminal-52 (UNSWITCHED +BATTERY) and terminal-65 (-BATTERY). • Measure the voltage between P1 terminal-70 (KEY SWITCH) and terminal-65 (- BATTERY). See "Breakout connector" on page 118. The voltage is between 22.0 and 27.0 Volts with the key switch ON ?	YES ⇒ The ECM is currently receiving the correct voltage. Proceed to next step. NO ⇒ The ECM is not receiving the correct voltage. Ensure that there is not an aftermarket engine protection switch overriding battery power to the ECM. Refer to Test 2: Electrical power supply to the ECM. STOP	
Step 6: Connect the electronic service tool directly to the ECM Warnings! • <i>Batteries give off flammable fumes which can explode. Do not strike a match, cause a spark, or smoke in the vicinity of a battery during the test procedure.</i> • <i>Do not connect the electronic service tool bypass harness to the battery until the 20 Amp in-line fuse has been removed from the +Battery line. If the fuse is not removed before connection to the battery a spark may result.</i> • Turn the key switch OFF, engine OFF. • Disconnect the ECM machine harness connector J1/P1 from the ECM. • Install an electronic service tool power bypass cable. Connect the bypass directly to the electronic service tool harness and ECM. See "Service tool bypass harness schematic" on page 120. Note: This bypass connects the key switch circuit directly to the ECM. The ECM will remain powered until the connection to the +BATTERY line is disconnected. Remove the 20 Amp fuse from the in-line fuse holder to power down the ECM. Do not connect or remove the bypass connections to the battery posts without first removing the 20 Amp in-line fuse. Is the electronic service tool operating correctly ?	YES ⇒ There is a problem in the machine wiring. Re-insert the two data link lines into the ECM connector P1. Contact the OEM for repair. Verify that the repair eliminates the problem. STOP NO ⇒ Verify that the 20 Amp fuse in the bypass harness of the electronic service tool is not open (blown). Proceed to next step.	

Test step	Result	Action
Step 7: Connect the electronic service tool and ECM to another battery		
Warnings! - Batteries give off flammable fumes which can explode. Do not strike a match, cause a spark, or smoke in the vicinity of a battery during the test procedure. - Do not connect the electronic service tool bypass harness to the battery until the 20 Amp in-line fuse has been removed from the +Battery line. If the fuse is not removed before connection to the battery a spark may result. - Connect the battery wires from the bypass harness of the electronic service tool to a different battery not on the engine. See the "Service tool bypass harness schematic" below. Does the electronic service tool operate correctly ?	YES ⇒ NO ⇒	Refer to Test 2: Electrical power supply to the ECM STOP Temporarily connect a test ECM. Repeat the test step. If the problem is corrected with the test ECM, and returns when the old ECM is connected, permanently replace the ECM. Verify the repair eliminates the problem. STOP.

Service tool bypass harness schematic



A

Engine speed/timing circuit test

Test 8

System operation

Use this procedure to troubleshoot the system only when there is an active or easily repeated diagnostic code that is associated with either the crankshaft or camshaft position sensor circuit or if you have been referred to this test from [Chapter 4, Troubleshooting without a diagnostic code](#).

The engine uses two engine speed/timing sensors. One sensor picks up the camshaft gear and the other the crankshaft gear. Both detect engine speed and timing reference from a unique pattern on the gear. The ECM counts the time between pulses created by the sensor as the gear rotates in order to determine rev/min.

Under normal operation, the camshaft position sensor is used to determine timing (when the piston in cylinder number 1 is at the top of the compression stroke) for starting purposes. When the timing has been established, the crankshaft position sensor is then used to determine engine speed and the camshaft position sensor signal is ignored.

After locating No. 1 cylinder, the ECM triggers each injector in the correct firing order and at the correct time. The actual timing and duration of each injection is based on engine rev/min and load. If the engine is running and the signal from the crankshaft position sensor is lost, a slight change in engine performance will be noticed when the ECM switches to the camshaft position sensor.

Loss of the camshaft position sensor signal during engine operation will not result in any noticeable change in engine performance. However, if the camshaft position sensor signal is not present during start-up the engine may take slightly longer to start, or may run rough for a few seconds until the ECM determines the correct firing order by using the crankshaft position sensor only.

The engine will start and run when only one sensor signal is present from either of the sensors. The loss of the signal from both sensors will result in the ECM terminating injection and shutting down the engine, or preventing it from starting.

Both sensors are magnetic with an integral connector.

Caution: *The two sensors are not interchangeable, do not switch sensor positions.*

If the sensors are replaced a timing calibration is NOT necessary for the engine.

Note: Timing calibration is only necessary after replacing an ECM that will not communicate.

If a replacement of the ECM is required the ECM parameters and the timing calibration can be transferred from the suspect ECM to the replacement ECM. Timing calibration will NOT be necessary. This feature requires TIPSS-EST and is only possible if the existing ECM can communicate with the TIPSS-EST.

The crankshaft position sensor is connected to the ECM through the engine harness connector J2/P2 terminal-48 (CRANK SPEED/TIMING POSITIVE) and terminal-49 (CRANK SPEED/TIMING NEGATIVE).

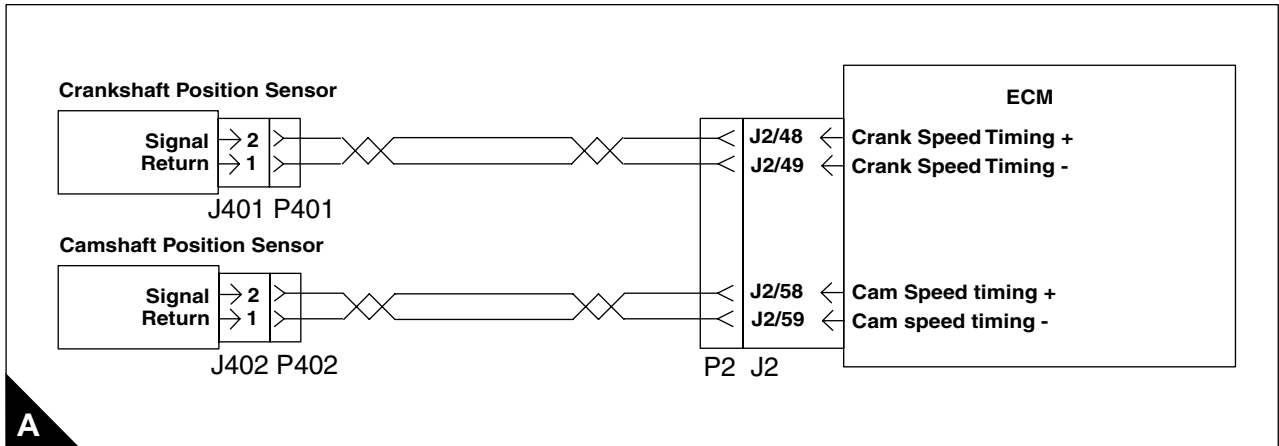
The camshaft position sensor is connected to the ECM through engine harness connector J2/P2 terminal-58 (CAM SPEED/TIMING POSITIVE) and terminal-59 (CAM SPEED/TIMING NEGATIVE).

When installing the sensors

- Lubricate the O-ring with oil.
- Ensure that the sensor has a connector face seal inside the connector body. If a seal is damaged or missing, replace the seal.
- Ensure that the sensor is fully seated into the engine before tightening the bracket bolt.
- Ensure that the connector is latched on both sides.
- Ensure that the harness is correctly secured and the tie-wraps are placed in the correct location.

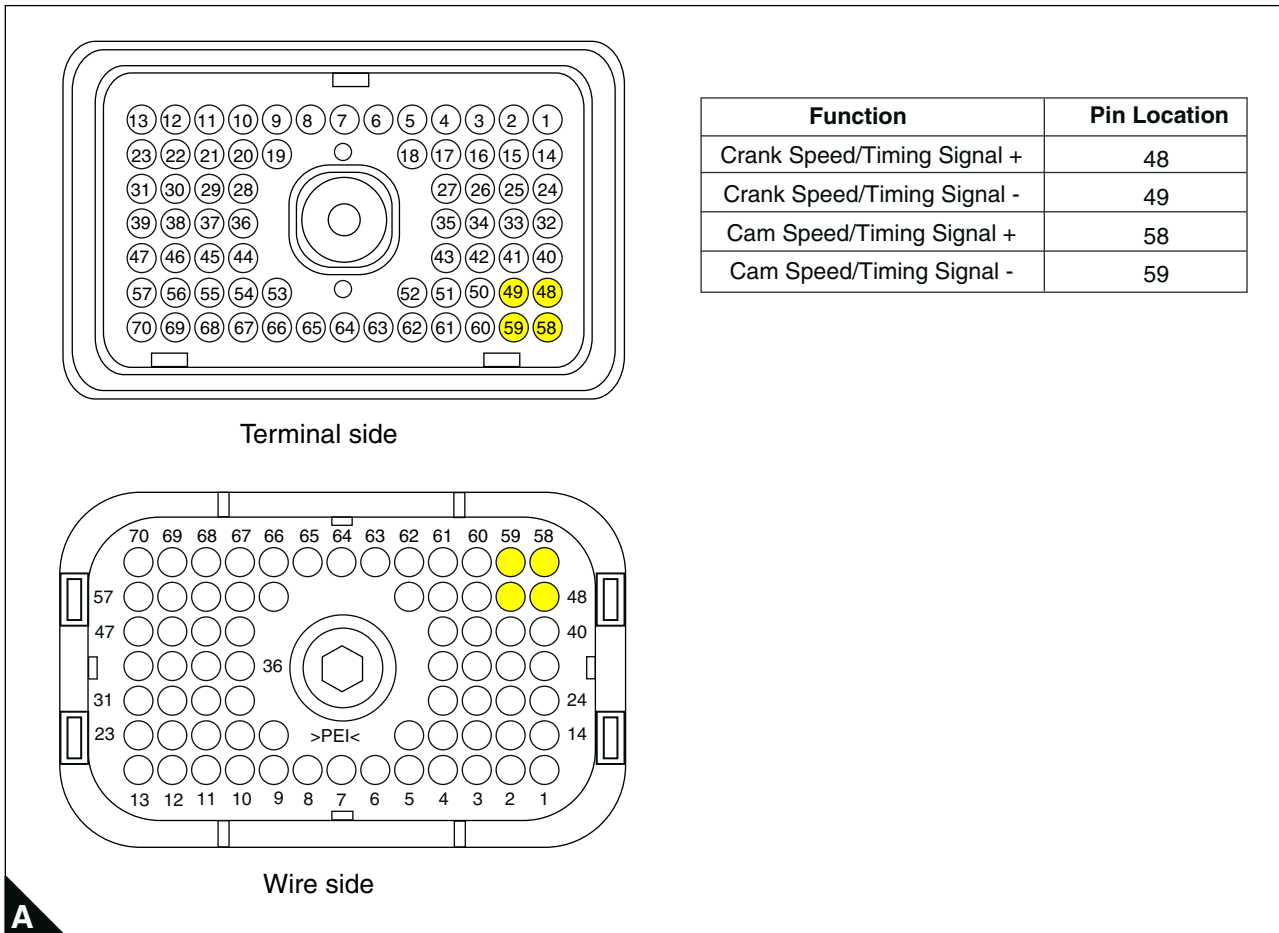
Speed/timing sensors schematic

Note: Refer to the wiring diagrams for full connection details.



ECM terminal connections

Note: Using ECM connector P2.



Diagnostic codes

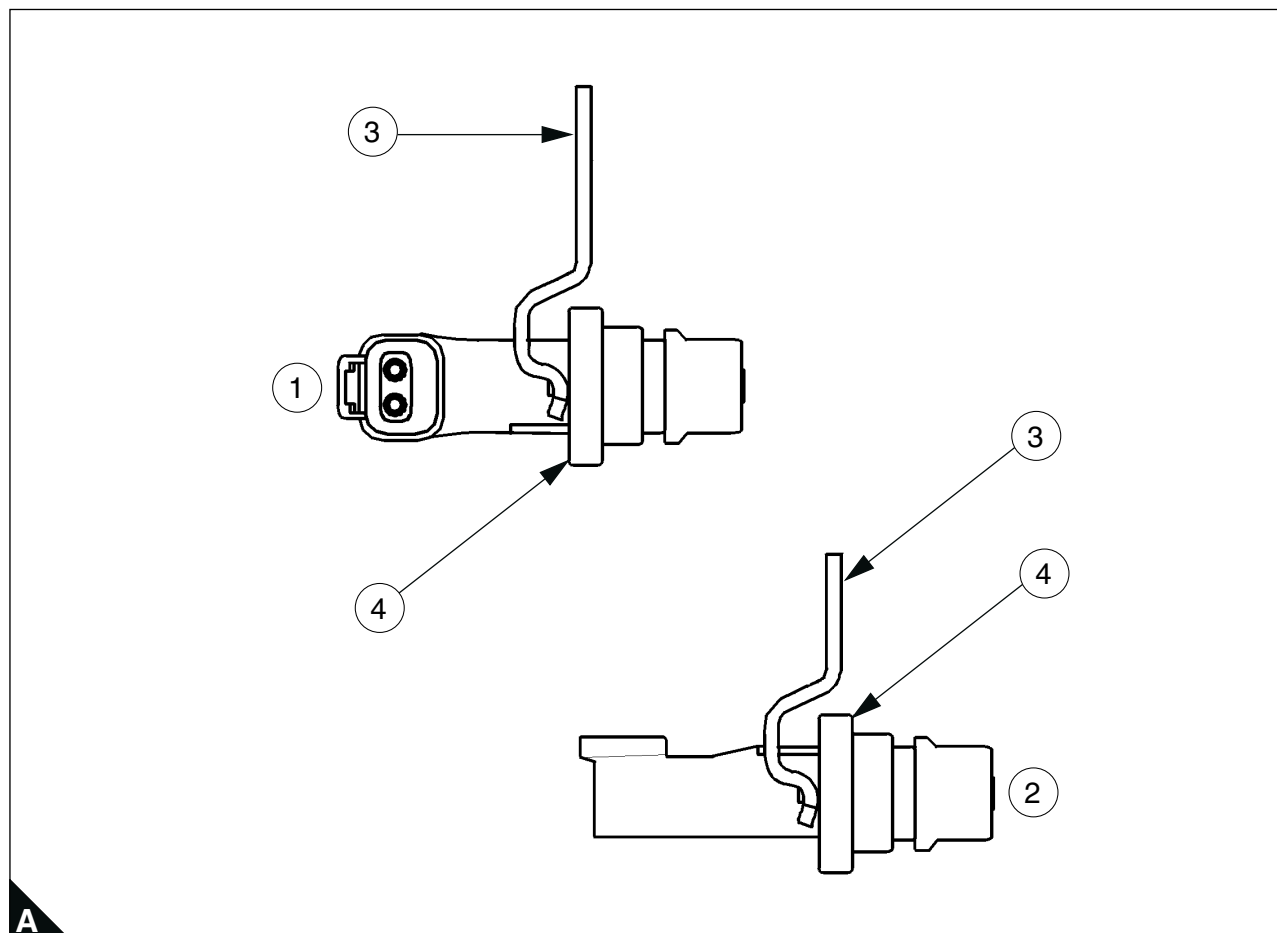
CID-FMI	Conditions which generate this code:	Systems response:	Troubleshooting
261-13	Cam Sensor To Crank Sensor Calibration A timing calibration has been correctly performed. The calibration between the camshaft position sensor and the crankshaft position sensor is offset by more than 4°. There may be a problem with the camshaft position sensor or engine assembly.	Electronic system response Default timing is used. This code is active only. This code will not be logged. The diagnostic lamp will be illuminated when this code is active. Engine response If the camshaft is incorrectly installed, poor engine response will occur.	Proceed with Test 8: Engine speed/timing circuit test
342-12 342-11 342-02	Loss Of Engine Cam Sensor rev/min Signal The signal for the camshaft position sensor is intermittent or lost.	Electronic system response The engine may misfire or run rough during starting. The diagnostic lamp will not be ON for this code unless the code has been active for 10 hours. The code is logged. Engine response There should not be a noticeable change in engine response unless the crankshaft position sensor signal is also lost, which will shut the engine down.	Proceed with Test 8: Engine speed/timing circuit test
190-12 190-11 190-02	Loss Of Engine Crank Sensor rev/min Signal The signal for the crankshaft position sensor is intermittent or lost. Engine Speed Sensor Mechanical Fault The wiring to the speed sensor is broken or the sensor is missing.	Electronic system response The ECM will use the camshaft position sensor to determine engine speed. The diagnostic lamp will not be ON for this code unless the code has been active for 10 hours. The code is logged.	Proceed with Test 8: Engine speed/timing circuit test
190-09	Engine Speed Sensor Abnormal Update The speed sensor is not seeing the correct pulse sequence.	Engine response There may be a slight change in engine response as the ECM switches to the camshaft position sensor.	

Functional test

Test step	Result	Action
Step 1: Connect an electronic service tool and note all active and logged diagnostic codes - Connect the electronic service tool to the data link connector. - Turn the key switch ON, engine OFF. - Check for one of the following logged or active diagnostic codes: 261-13 Camshaft Sensor To Crank Sensor Calibration 342-12 Loss Of Engine Cam Sensor rev/min Signal 190-12 Loss Of Engine Crank Sensor rev/min Signal Notes: - If the diagnostic code is logged but not active, run the engine until it is at normal operating temperature. The problem may only occur when the engine is at the normal operating temperature. If the engine will not start monitor the engine rev/min from the electronic service tool while cranking the engine. The electronic service tool may need to be powered from another battery while cranking the engine to ensure that the electronic service tool does not reset. - If there are occurrences of the 342-12 and 190-12 faults refer to Test 1: Inspecting electrical connectors. Are any of the diagnostic codes listed above logged or active ? Note: If you have been referred here from Chapter 4, Troubleshooting without a diagnostic code because engine rev/min was not indicated on an electronic service tool select NO ENGINE REV/MIN .	342-12, 190-12 or 261-13 ⇒ NO CODE ⇒ NO ENGINE REV/MIN ⇒	There is an active or logged diagnostic code. Proceed to Step 3. If none of the codes listed are active or logged and the engine is not running correctly, refer to the appropriate symptoms in Chapter 4, Troubleshooting without a diagnostic code. STOP. Engine rev/min is not indicated on an electronic service tool. Proceed to next Step
Step 2: Check Sensors and Bracket Installation - To ensure correct operation the sensor flange should be flush against the engine. - Inspect the bracket to ensure that the installation allows the sensor flange to be flush against the engine. Verify that the bracket is not bent. The bracket cannot be replaced separately. - Ensure that one O-ring has been installed on the sensor, and that it is free of damage. - If a 261-13 Camshaft Sensor To Crank Sensor Calibration diagnostic code is active, there may be a problem with the assembly of the engine. Refer to " Sensor flange and mounting bracket diagram " on page 125	OK ⇒ NOT OK ⇒	The sensors and the bracket are correctly installed. Proceed to next step. Loosen the bolt holding the sensor bracket to the engine. Seat the sensor and tighten the bolt. If the sensor will not seat, repair or replace the sensor as necessary. The sensor must not be removed from the bracket. Ensure that the sensor is correctly oriented and the harness is secured in the correct location. STOP.

Sensor flange and mounting bracket diagram**Key**

- 1 Camshaft position sensor
- 2 Crankshaft position sensor
- 3 Non-serviceable mounting bracket
- 4 Sensor flange



Test step	Result	Action
Step 3: Measure the sensor resistance through the engine harness - Turn the key switch OFF, engine OFF. - Thoroughly inspect ECM engine harness connector J2/P2. Refer to Test 1: Inspecting electrical connectors. - Perform a 45 N (10 lb) pull test on ECM engine harness connector P2 terminals-48, 49, 58 and 59. - Ensure that connector latching tab is correctly latched and is in the fully latched position. Refer to "ECM terminal connections" on page 122. - Check that the ECM connector Allen screw is correctly tightened to not more than 6,0 Nm (4.4 lb ft). - Repair the harness or connector if a problem is found. - Ensure that the wiring harness is correctly routed and secured at the correct locations. Note: Ensure that the wiring harness is not pulled too tight causing intermittent connections when vibration or movement occurs. - Inspect the sensor harness wiring for nicks and abrasions. - If the harness and the connector are OK, disconnect engine harness ECM connector J2/P2. - Use a multimeter to measure the sensor resistance (Ohms) from engine harness connector P2 as indicated below. Move the harness (pull/shake the wires, especially directly behind the sensors) while taking a measurement to check for an intermittent open or short circuit. Refer to "ECM terminal connections" on page 122. Crankshaft position sensor - The resistance from P2 terminal-48 (CRANK SPEED/TIMING POSITIVE) and terminal-49 (CRANK SPEED/TIMING NEGATIVE) is between 75.0 and 230.0 Ohms. Camshaft position sensor - The resistance from P2 terminal-58 (CAM SPEED/TIMING POSITIVE) and terminal-59 (CAM SPEED/TIMING NEGATIVE) is between 600 and 1800 Ohms. The readings agree with the values listed above.	OK ⇒ NOT OK ⇒	The engine harness and sensor do not indicate a short or open circuit. Proceed to Step 5. The sensor resistance is not within the acceptable range when measured through the engine harness. Proceed to next Step

Test step	Result	Action
Step 4: Measure sensor resistance at the sensor • Turn the key switch OFF, engine OFF. • Check the harness and wiring for abrasion and pinch points from the sensor back to the ECM. • Disconnect the suspect sensor from the engine harness as described below. • Thoroughly inspect ECM engine harness sensor connector J401/P401 or J402/P402. Refer to Test 1: Inspecting electrical connectors for details. • Use a multimeter to measure the sensor resistance (Ohms) at the sensor connector between terminal-A and terminal-B. Crankshaft position sensor - The resistance from J401 terminal-2 (CRANK SPEED/TIMING POSITIVE) and J401 terminal-1 (CRANK SPEED/TIMING NEGATIVE) is between 75.0 and 230.0 Ohms. Camshaft position sensor - The resistance from J402 terminal-2 (CAM SPEED/TIMING POSITIVE) and J402 terminal-1 (CAM SPEED/TIMING NEGATIVE) is between 600 and 1800 Ohms. Note: Timing calibration is not necessary following replacement of the Crankshaft Position or camshaft position sensor. Refer to "When installing the sensors" on page 121. The readings agree with the values that are listed above.	OK ⇒ NOT OK ⇒	The sensor resistance is correct. Proceed to next step. The sensor resistance is out of range, obtain a new sensor. Before installing the new sensor, measure the resistance of the new sensor as outlined in the test step using the same test setup (test harness, multimeter and meter settings). If the new sensor is in range, install the new sensor in the engine. Loosen the bolt holding the sensor bracket to the engine. Ensure the O-ring is installed and free of damage. Seat the sensor and tighten the bolt. If the sensor will not seat, repair or replace the sensor, as necessary. The sensor must not be removed from the bracket. Ensure that the sensor is correctly oriented and the harness is secured in the correct location. STOP.
Step 5: Install engine speed/timing bypass harness • Ensure the key switch is OFF, engine OFF. • Disconnect engine harness ECM connector J2/P2 (if not already disconnected). • For the crankshaft position sensor - install 16 AWG wires from J2/P2 terminal-48 to P401 terminal-2 and from J2/P2 terminal-49 to P401 terminal-1. • For the camshaft position sensor - install 16 AWG wires from J2/P2 terminal-58 to P402 terminal-2 and from J2/P2 terminal-59 to P402 terminal-1. • Reconnect the engine harness connector J2/P2. • Start the engine to determine if the bypass harness repairs the problem. Is the problem corrected with the bypass installed ?	YES ⇒ NO ⇒	Permanently install a new harness section. STOP. Double check to verify that the correct terminals have been installed in the correct location of the ECM engine harness connector P2. If the temporary harness was installed correctly, install the original wiring. Proceed to next Step.

Test step	Result	Action
Step 6: Check the ECM		
• Turn the key switch OFF, engine OFF. • Temporarily connect a test ECM. • Start the engine and run it to repeat the conditions when the problem occurs. Determine if the problem is corrected with the test ECM. • If the problem does not return with the test ECM, reinstall the suspect ECM and ensure that the problem returns.	YES ⇒ NO ⇒	If the test ECM works and the suspect ECM does not, replace the ECM. STOP. Replace the sensor and ensure that the problem is corrected. STOP.
Does the problem remain with the suspect ECM ?		

System operation

Use this procedure if diagnostic code 261-13 Check Timing Sensor Calibration is present, if the ECM has been replaced or if work has been done to the engine front drive train.

The crankshaft position sensor provides an engine speed signal (rev/min) to the ECM. The signal is created as the crankshaft gear rotates past the pickup of the crankshaft position sensor. The camshaft position sensor provides the timing signal to the ECM. The signal is created as the camshaft gear rotates past the pickup of the camshaft position sensor. A unique pattern on the gear allows the ECM to determine the crankshaft position and when the cylinder number one piston is at the top of the compression stroke. In the event that the signal is lost from one of the sensors, a diagnostic code is generated. The ECM then uses special logic to allow the engine to start and run on only one sensor.

If the ECM requires replacement and will not communicate with the service tool to allow the timing calibration to be copied, or if work has been performed on the front drive train, a timing calibration must be performed.

Timing calibration is accomplished by installing a special magnetic pickup into the side of the engine block. The magnetic pickup senses a special slot on the crankshaft counterweight. The magnetic pickup is then connected to the ECM through the engine harness speed/timing calibration connector P400, while the engine is running.

When Timing Calibration Mode is selected in the electronic service tool, the engine speed will be set to 1100 rev/min.

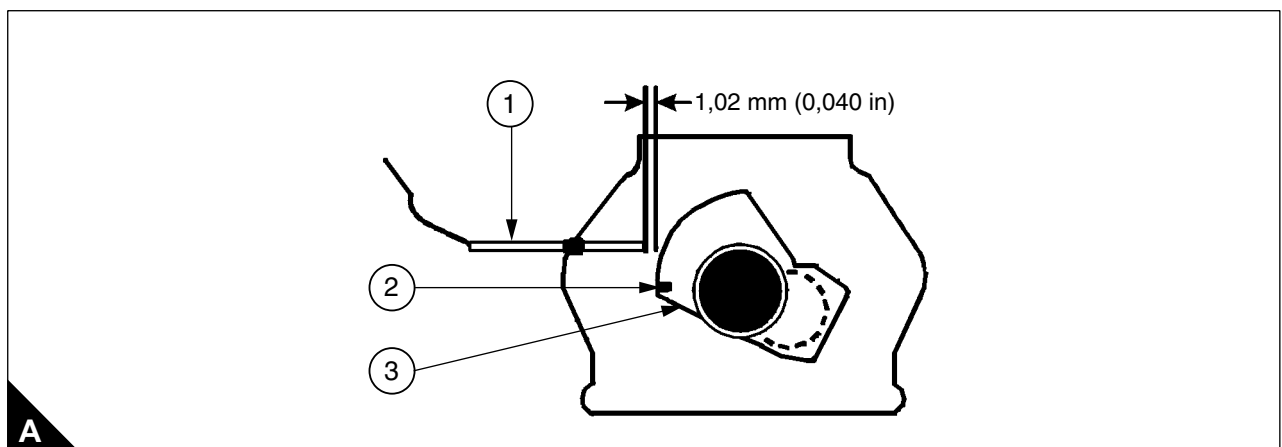
Note: Timing calibration will not increase or decrease the available engine power. Do not calibrate the engine timing expecting an increase in engine power.

Replacement ECM

If a replacement ECM is required, the ECM parameters and the timing calibration can be transferred from the suspect ECM to the replacement ECM. Timing calibration will NOT be necessary. This feature requires TIPSS-EST and is only possible if the existing ECM can communicate with TIPSS-EST.

Timing calibration

- 1 6V-2197 TC probe
- 2 Slot
- 3 Counterweight



Special tools

Part Number	Description
6V-2197	Timing calibration probe
7X-1695	Harness adapter for deutsch "DT" timing probe connection
7X-1171	Timing calibration probe adapter sleeve
9S-9802	Engine turning tool

Diagnostic codes

CID-FMI	Conditions which generate this code:	Systems response:	Troubleshooting
261-13	Check Timing Sensor Calibration Timing has not been calibrated since the ECM was installed or the calibration is out of specification more than the ECM will allow.	Electronic system response The ECM uses default timing. Timing can be out of specification by as much as 4°. Engine response The engine may run rough, emit white smoke in the exhaust or there may not be any noticeable performance effect.	Proceed with Test 9: Engine speed/timing calibration

Functional test

Test step	Result	Action
Step 1: Install the timing adapter group - Turn the key switch OFF, engine OFF - Use the turning tool to put either the No. 1 or No. 6 piston at top centre. After locating top centre, rotate the engine back (rotate the engine in opposite direction of correct engine rotation) 60°. - Remove the timing calibration plug from the left side of the engine and install the timing probe adapter sleeve into the hole for the plug.	OK ⇒	Proceed to next step.
Step 2: Install 6V-2197 TC probe on the engine Caution: If the crankshaft is not in the correct position when the timing probe is installed, the timing probe will be damaged when the engine is started. - Put a 2D-6392 O-ring on the end of the magnetic pickup sensor (a small amount of clean engine oil will allow the seal to slide onto the sensor more easily). - Push the sensor through the adapter until it comes in contact with the outermost portion of the crankshaft counterweight. Move the O-ring downward against the adapter. - Withdraw the magnetic transducer 1,0 mm (0.04 inch) and hand tighten the nut on the adapter sleeve in order to secure the magnetic pickup in place. - Connect the 6V-2197 timing probe to the 7X-1695 Deutsch DT timing harness adapter.	OK ⇒	Proceed to next step.

Test step	Result	Action
Step 3: Start engine and allow coolant to reach operating temperature - Start the engine and run until the engine has warmed up enough to exit cold mode operation. The electronic service tool Status screen will display "COLD MODE" in the upper corner when cold mode operation exists. - Check for ACTIVE diagnostic codes. Use the procedures in this manual to troubleshoot and repair any ACTIVE diagnostic codes before attempting a calibration check. The engine must not have any diagnostic fault conditions present during the timing calibration, other than 261-13 Check Timing Sensor Calibration. - Stop the engine.	OK ⇒	Proceed to next step.
Step 4: Connect an electronic service tool - Connect an electronic service tool to the data link connector. - Access the Timing Calibration screen located under the Service\Calibrations menu of the electronic service tool. Note: To perform a timing calibration, the engine rev/min must be held as steady as possible at approximately 1100 rev/min. Any changes to engine rev/min (greater than 100 rev/min) will slow down the procedure and reduce accuracy. The correct engine speed is set automatically when Continue is selected on the Calibration screen. - Connect the 7X-1695 Deutsch DT adapter harness for the 6V-2197 timing probe to the speed/timing calibration connector P400. - Be certain that all connections (TC Probe, electronic service tool, etc) are made correctly. - Start the engine	OK ⇒	Proceed to next step.

Test step	Result	Action
Step 5: Calibrate the speed/timing sensor To calibrate the timing to the correct setting select Continue on the electronic service tool and wait until the electronic service tool indicates that the timing is CALIBRATED. Note: If the electronic service tool display reads CALIBRATION UNSUCCESSFUL, the electronic injection timing has not been set. Recheck the tool installation and tool operation and try again to calibrate electronic injection timing. If the crankshaft and camshaft gears have been reassembled incorrectly (relative to each other), the engine will not calibrate. If the timing calibration has been successfully completed, do not exit the Timing Calibration Screen on the electronic service tool until you have disconnected the timing probe from the speed/timing calibration connector P400.	OK ⇒ NOT OK ⇒	The timing calibration procedure was completed successfully. Proceed to next step. Verify that the engine rev/min was stable during the testing (± 50 rev/min). If the engine rev/min was unstable or could not be controlled within ± 50 rev/min because of mechanical or electrical factors, refer to P-403: Engine misfires, runs rough or is unstable on page 34. If all of the checks are OK but the timing still will not calibrate, check the timing probe cable and timing probe to verify it is not bent. If it is not bent, restart this procedure.
Step 6: Disconnect timing probe before exiting electronic service tool Monitor/Calibrate Timing screen - Disconnect the timing probe from the speed/timing calibration connector P400. - Exit the electronic service tool Timing Calibration screen.	OK ⇒ NOT OK ⇒	STOP. If the timing probe is still installed following exit of the electronic service tool Timing Calibration Screen, engine speed diagnostic codes may be generated and should be cleared. STOP.

Injector solenoids circuit test

Test 10

System operation

Use this procedure if a 1-11, 2-11, 3-11, 4-11, 5-11, 6-11 Cylinder Fault is present or if you have been referred here after following the sequence of steps in **P-403: Engine misfires, runs rough or is unstable**, or **P-404: Low power/poor or no response to throttle**.

It is important to perform this procedure when the injector is under identical conditions as when the problem occurs. Typically, injector solenoid problems occur when the engine is warmed up and/or when the engine is under vibration (heavy loads).

The 2800 Series engines utilize electronic unit injectors that are mechanically actuated and electronically energized.

The injectors can be individually cut out while the engine is running to check for weak cylinders, or tested without the engine running to check for electrical circuit problems.

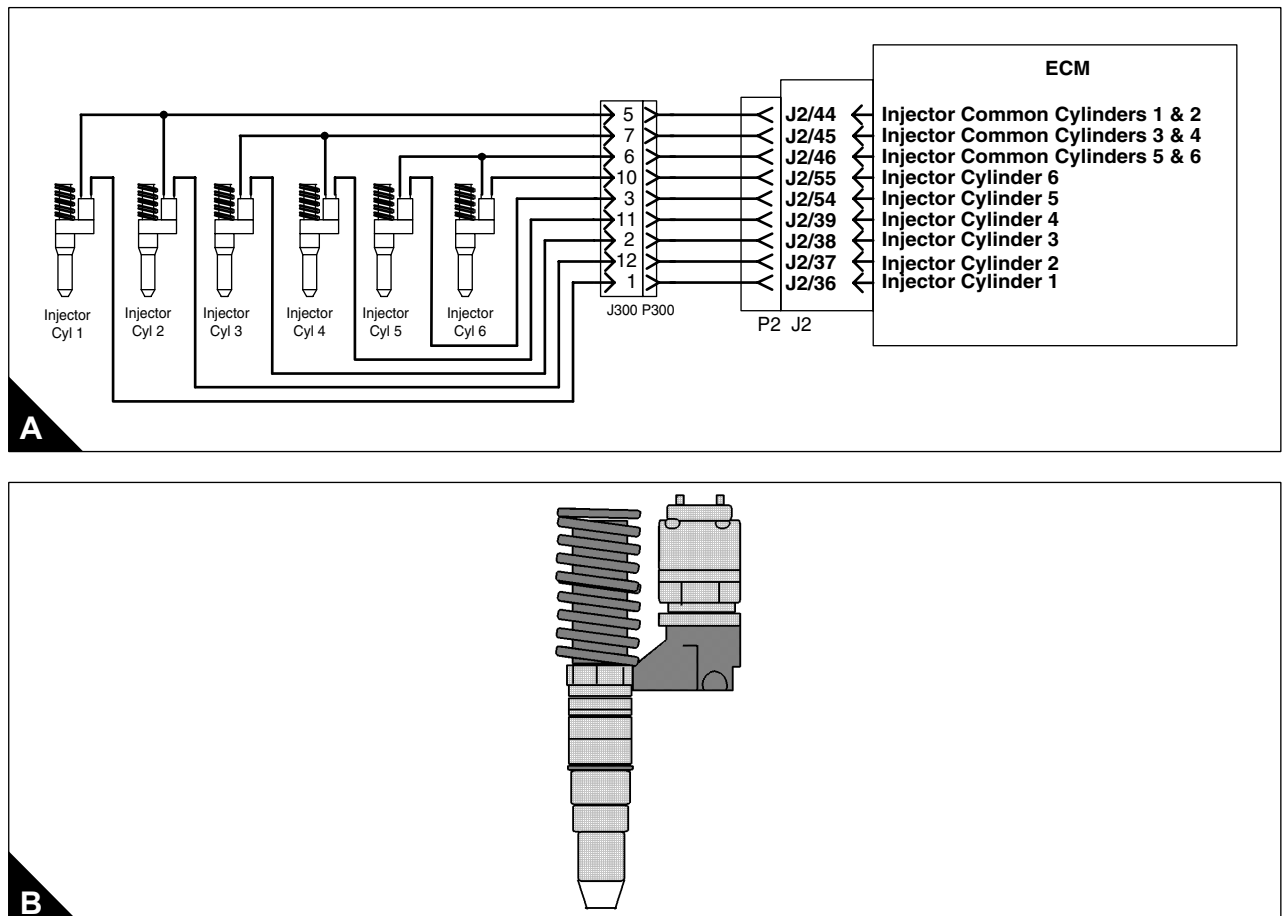
The injector solenoid is mounted on top of the fuel injector body along side the rocker arm return spring.

Injector Trim Codes provide a means to fine tune each individual injector for optimum performance. A 253-02 Check Customer or System Parameters diagnostic code will be active if the injector codes are not programmed.

If the ECM is replaced, all six injector codes must be programmed into the new ECM.

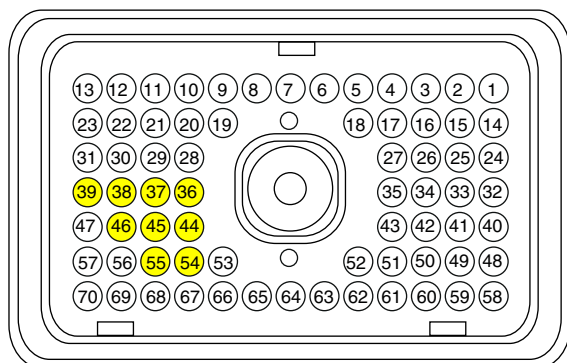
Injector schematic

Note: Refer to the wiring diagrams for full connection details.

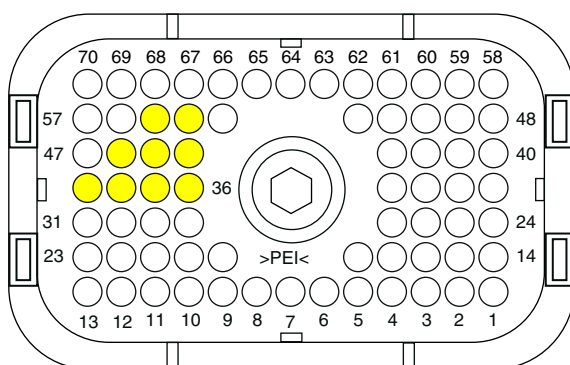


ECM terminal connections

Note: Using ECM connector P2.



Terminal side



Wire side

Function	Pin Location
Injector Common Cyls 1 & 2	44
Injector Common Cyls 3 & 4	45
Injector Common Cyls 5 & 6	46
Injector Cylinder 1	36
Injector Cylinder 2	37
Injector Cylinder 3	38
Injector Cylinder 4	39
Injector Cylinder 5	54
Injector Cylinder 6	55

Diagnostic codes

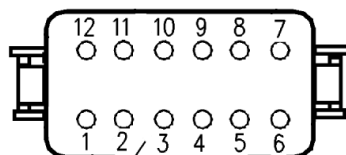
CID-FMI	Conditions which generate this code:	Systems response:	Troubleshooting
1-11	Cylinder 1 Fault	Electronic system response The ECM will turn the diagnostic lamp ON and log the diagnostic code. If the cause of the diagnostic code is a short circuit or an open circuit in the common line, two cylinders will be affected because of the shared common wiring for the injectors. Engine response The injector may not operate while the conditions exist.	Proceed with Test 10: Injector solenoids circuit test .
2-11	Cylinder 2 Fault		
3-11	Cylinder 3 Fault		
4-11	Cylinder 4 Fault		
5-11	Cylinder 5 Fault		
6-11	Cylinder 6 Fault The ECM detects one of the following after attempting to operate the injector • An open circuit in the injector wiring • An internal open circuit in the injector wiring • A electrical short circuit to ground (to the engine iron) • A internal injector solenoid electrical short circuit • A short circuit to battery voltage		

Test step	Result	Action
Step 4: Check injector solenoids using the service tool Injector Solenoid test - Start the engine. - Allow the engine to warm up to normal operating temperature - 77 °C (171 °F) - Turn the key switch OFF, engine OFF - Connect an electronic service tool at the data link connector. - Turn the key switch ON, engine OFF - After the engine is warmed to operating temperature, access and begin the Injector Solenoid test located under the Diagnostics\Diagnostic Tests menu of the electronic service tool. Note: The test is in the Interactive Diagnostic Tests. Do not confuse the Injector Solenoid test with the Cylinder Cutout test. The Cylinder Cutout test is used to shut off fuel to a specific cylinder while the engine is running. The Injector Solenoid test is used in order to actuate the injector solenoids in order to "hear" the injector solenoids click, when the engine is not running, to determine that the circuit is functioning correctly. - Perform the Injector Solenoid test two or three times. Do all cylinders indicate OK ?	YES ⇒ NO ⇒	There is not an electronic problem with the injectors at this time. If the Cylinder Cutout test returned a NOT OK for any injector, refer to P-403: Engine misfires, runs rough or is unstable on page 34 STOP. Note the cylinders that indicate OPEN and/or SHORT. Proceed to next step.
Step 5: Check engine harness from P2 to P300 for short circuits using the service tool injector solenoid test - Turn key switch OFF, engine OFF Warning! Ensure that the key switch is OFF. Possible strong electrical shock hazard if the key switch is not turned OFF. - Disconnect the injector solenoids connector J300/P300 - Turn the key switch ON, engine OFF - Perform the Injector Solenoid test two or three times. Do all cylinders indicate OPEN ?	YES ⇒ NO ⇒	Proceed to Step 7. Note which cylinders are indicating the short circuit. Proceed to next step.

Test step	Result	Action
Step 6: Check ECM for short circuits using service tool Injector Solenoid test		
• Turn key switch OFF, engine OFF Warning! Ensure that the key switch is OFF. Possible strong electrical shock hazard if the key switch is not turned OFF. • Disconnect ECM engine harness connector J2/P2 from the ECM and check for evidence of moisture entry. • Turn the key switch ON, engine OFF • Perform the Injector Solenoid test two or three times. Do all cylinders indicate OPEN with engine harness connector P2 disconnected from the ECM ? Note: With the engine harness disconnected all of the +5 V supplied sensor open circuit diagnostic codes will be active. This is normal. Clear all of these diagnostic codes after completing this test step.	YES ⇒ NO ⇒	The short circuit is in the engine harness. Repair or replace the engine harness as required. Clear all diagnostic codes after completing this test step. STOP. Temporarily connect another ECM. Repeat this test step. If the problem is resolved with the new ECM, reconnect the old ECM to verify the problem returns with the old ECM. If the new ECM works and the old one did not, replace the ECM. STOP.

Test step	Result	Action
Step 7: Check engine harness From P2 To P300 for open circuits using service tool Injector Solenoid test		
- Turn key switch OFF, engine OFF Warning! Ensure that the key switch is OFF. Possible strong electrical shock hazard if the key switch is not turned OFF. - Disconnect injector solenoids connector J300/P300. - Turn the key switch ON, engine OFF - Make a jumper wire 100 mm (4 in) long with a Deutsch Pin on both ends. - Insert the jumper wire between the injector common socket of the problem injector, and the problem injector socket of the injector solenoids connector P300. For example, if injector 5 is the problem injector, insert the jumper from terminal-5 (injector 5) to terminal-8 (injector common cylinders 5 & 6) of the injector solenoids connector P300. - Perform the Injector Solenoid rest two or three times. Does the cylinder with the jumper wire installed indicate SHORT ? - Repeat this test for each suspect injector. Ensure that the Injector Solenoid test is disabled before handling the jumper wires.	YES ⇒ NO ⇒	If the previous step indicated only one injector has an open or short, or one cylinder indicates an open but the injector sharing the injector common indicates a short proceed to Step 9. If the previous step indicated two injectors sharing an injector common are open proceed to Step 10. If the previous step indicated two injectors sharing an injector common are short proceed to Step 11. Proceed to next step.

Engine harness Injector connector



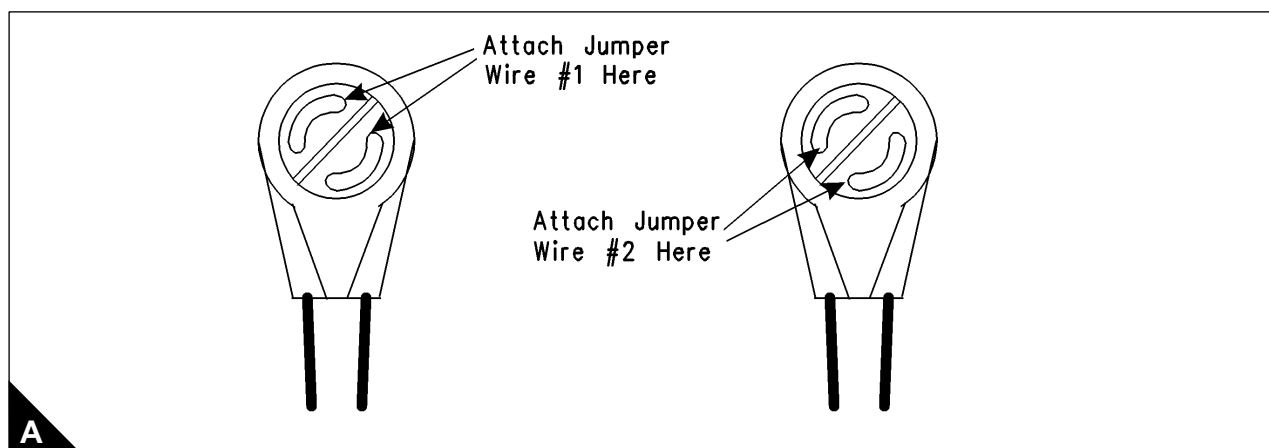
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Pin No.	Function
1	Injector Cylinder No. 1
2	Injector Cylinder No. 3
3	Injector Cylinder No. 5
5	Injector Common Cylinders 1 and 2
6	Injector Common Cylinders 5 and 6
7	Injector Common Cylinders 3 and 4
10	Injector Cylinder No. 6
11	Injector Cylinder No. 4
12	Injector Cylinder No. 2

Test step	Result	Action
Step 8: Check ECM for open circuit • Turn key switch OFF, engine OFF Warning! <i>Ensure that the key switch is OFF. Possible strong electrical shock hazard if the key switch is not turned OFF.</i> • Disconnect the engine harness from the ECM connector J2 and connect a 70-terminal breakout T to the ECM (do not connect the engine harness to the breakout T). • Use a jumper wire to short between the injector socket and the injector common socket of the suspect injector. • Perform the Injector Solenoid test two or three times. Does the cylinder with the jumper wire installed indicate SHORT ? Note: With the engine harness disconnected all of the +5 V supplied sensor open circuit diagnostic codes will be active. This is normal. Clear all of these diagnostic codes after completing this test step.	YES ⇒ NO ⇒	The ECM is OK. Replace or repair the engine harness. STOP. Temporarily connect another ECM. Repeat this test step. If the problem is resolved with the new ECM, reconnect the old ECM to verify the problem returns with the old ECM. If the new ECM works and the old one did not, replace the ECM. STOP.
Step 9: Check injector harness under valve cover • Turn key switch OFF, engine OFF Warning! <i>Ensure that the key switch is OFF. Possible strong electrical shock hazard if the key switch is not turned OFF.</i> • Remove the valve cover to gain access to the problem injector(s). • Disconnect the harness from the problem injector and from the other injector sharing the same injector common. • Thoroughly clean the terminals of both injectors and the harness. Exchange the harness between the two injectors sharing the common. • Turn key switch ON, engine OFF • Perform the Injector Solenoid test two or three times. Did the problem change to the other injector with the movement (exchanging terminals) of the harness ?	YES ⇒ NO ⇒	Replace the faulty injector indicating the problem. Restore the wiring to the correct injector(s). STOP. Replace the injector harness under the valve cover. STOP.

Test step	Result	Action
Step 10: Check engine harness under valve cover for an open circuit in the common - Turn key switch OFF, engine OFF Warning! Ensure that the key switch is OFF. Possible strong electrical shock hazard if the key switch is not turned OFF. - Remove the valve cover to gain access to the problem injector(s). - Disconnect each of the injectors indicating an OPEN from the wiring harness. Ensure that each of the connectors from the disconnected injector harness does not touch other components and short to ground. - Attach a jumper wire to both terminals of the injector harness for the two injectors sharing an injector common. - Turn key switch ON, engine OFF - Perform the Injector Solenoid test two or three times. Do both cylinders with the short in place indicate an OPEN ?	YES ⇒ NO ⇒	Replace the engine harness under the valve cover. Check new harness installation using the Injector Solenoid test before installing the valve covers. STOP. BOTH injectors indicate SHORT. Replace BOTH injectors. STOP

Electronic unit injector harness terminals



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8

Glossary

Glossary of terms

Active Diagnostic Code

Describes a condition that is currently present to alert the operator or service technician of an abnormal engine operation parameter. Refer to Diagnostic Fault Code.

Aftermarket Device

As used here, a device or an accessory that is installed by the customer or OEM after the engine has been delivered.

Alternating Current (AC)

The direction of current flow changes (alternates) regularly and constantly in a circuit.

Atmospheric Pressure Sensor

Analog sensor generates a signal proportional to atmospheric (barometric) air pressure in the crankcase and sends a signal to the ECM.

Before Top Center (BTC)

The 180 degrees of crankshaft rotation before the piston reaches the very top of its travel (normal direction of rotation).

Boost Pressure Sensor

This sensor measures inlet manifold air pressure and sends a signal to the ECM.

Bypass Circuit

A circuit, usually temporary, to substitute for an existing circuit, typically for test purposes.

Calibration

As used here, an electronic adjustment of a sensor signal.

Perkins Engine Monitoring

The part of the Perkins Electronic Engine Control that monitors Coolant Temperature, Oil Pressure, Intake Manifold Air Temperature and Coolant Level to alert the operator of detected problems. The Coolant Temperature, Intake Manifold Air Temperature, and Oil Pressure Sensors are supplied by Perkins and monitored by the ECM. Aftermarket engine monitoring systems do not interface with the Perkins Electronic Engine Control

Check Engine Lamp

Sometimes referred to as the Diagnostic Lamp, it is used to alert the operator of the presence of an active event.

Code

Refer to Diagnostic Fault Code and Diagnostic Event Code.

Cold Mode

A mode of engine operation where the timing is retarded and the low idle may be raised for engine protection, reduced smoke emissions and faster warm up time.

Component Identifier (CID)

The CID is a number that identifies the specific component of the electronic control system that has experienced a diagnostic code. This is part of the CDL.

Communication Adapter Tool

The communication adapter provides a communication link between the ECM and an electronic service tool.

Coolant Temperature Sensor

This sensor detects the engine coolant temperature for Cold Mode operation and Perkins Engine Monitoring.

Crankshaft Position Sensor

A sensor that measures the crankshaft position, the direction of rotation, and engine rev/min and sends signals to the ECM.

Customer Specified Parameter

A parameter value that can be changed and whose value is set by the customer. These parameters can be protected by Customer Passwords.

Desired Rev/Min

An input to the electronic governor in the ECM. The electronic governor uses inputs from the Crankshaft Position Sensor and Customer Parameters to determine 'Desired rev/min'.

Diagnostic Event Code

These codes indicate an event that describes an abnormal engine condition such as a Shutdown occurrence. These codes are not necessarily (or usually) an indication of problems within the electronic system.

Diagnostic Fault Code

Sometimes referred to as a "fault code". These codes indicate an electronic system malfunction or problem with the engine electronic system.

Diagnostic Lamp

Sometimes referred to as the "engine check lamp", it is used to alert the operator of the presence of an active diagnostic code.

Direct Current (DC)

The type of current where the direction of current flow is consistently in one direction.

Duty Cycle

Refer to Pulse Width Modulation.

Electronic Control Module (ECM)

The engine control computer that provides power to the engine electronics. It accepts inputs that monitor and outputs that control or change to act as a governor to control engine rev/min.

Electronically Controlled Unit Injector

The injection pump which is a mechanically actuated, electronically controlled unit injector, combining the pumping, electronic fuel metering and injecting elements in a single unit.

Electronic Engine Control

The complete electronic system that monitors and controls the engine operation under all conditions.

Engine Speed/Timing Sensor

Provides a variable amplitude and Pulse Width Modulated signal to the ECM, which the ECM interprets as crankshaft position and engine speed.

Estimated Dynamic Timing

The ECM's estimation of actual injection timing.

Failure Mode Identifier (FMI)

Type of failure that has been experienced by the component (adopted from the SAE standard practice of J1587 diagnostics).

(FMI) Description

- 0 The data is valid but is above the normal operational range
- 1 The data is valid but is below the normal operational range
- 2 The data is erratic, intermittent, or incorrect
- 3 The voltage is above normal or shorted high
- 4 The voltage is below normal or shorted low
- 5 The current is below normal or the circuit is open
- 6 The current is above normal or the circuit is grounded
- 7 The mechanical system is not responding properly
- 8 Abnormal frequency, pulse width, or period
- 9 Abnormal update
- 10 Abnormal rate of change
- 11 The failure mode is not identifiable
- 12 Damaged device or component
- 13 The device or the component is not calibrated
- 14/15 These locations are reserved for future assignment

Flash Programming

A method of programming or updating an ECM with an Electronic Service Tool over the data link instead of replacing components.

Fuel Position

An internal signal within the ECM, from the Electronic Governor to the Fuel Injection Control. It is based on Desired REV/MIN, FRC Fuel Limit, Rated Fuel Limit, and the actual engine rev/min.

Fuel Ratio Control (FRC)

A limit based on control of the fuel to air ratio and used for emission control purposes. When the ECM senses a higher boost pressure (more air into cylinder), it increases the **FRC Fuel Limit** (allows more fuel into cylinder).

Fuel Temperature Sensor

This sensor detects the fuel temperature. The ECM monitors the fuel temperature and adjusts the calculated fuel rate accordingly.

Full Load Setting (FLS)

Number representing fuel system adjustment made at the factory to "fine tune" the fuel system maximum fuel delivery. Correct value for this parameter is stamped on the engine information ratings plate. This parameter must be programmed or a 253-02 Check Customer or System Parameters diagnostic code will be generated.

Full Torque Setting (FTS)

Similar to the Full Load Setting. This parameter must be programmed or a 253-02 Check Customer or System Parameters diagnostic code will be generated.

Harness

The wiring bundle (loom) that connects all components of the Electronic System.

Hertz (Hz)

Measure of electrical frequency in cycles per second.

Histogram

A bar graph indicating the relative frequency of engine operation in specific operating ranges.

Injector Codes

Four digit code etched on the tappet or stamped on individual injectors of the electronic unit injectors.

Intake Manifold Air Temperature Sensor

This sensor detects the intake manifold air temperature. The ECM monitors the inlet air temperature and coolant temperature to adjust injection timing.

Integrated Electronic Controls

The engine is designed with the electronic controls as a necessary part of the system. The engine will not operate without the electronic controls.

J1939 Data Link

An SAE (Society of Automotive Engineers) standard data link used to communicate between the electronic engine, the transmission, and/or powertrain controls.

Logged Diagnostic Codes

Describes codes which are stored in memory. These codes are meant to be an indicator of possible causes for intermittent problems. Refer to Diagnostic Fault Code.

Oil Pressure Sensor

This sensor measures engine oil pressure and sends a signal to the ECM as part of Perkins Engine Monitoring.

Open Circuit

Condition where an electrical wire or connection is broken or a switch is open, so that the signal or the supply voltage can no longer reach its intended destination.

Original Equipment Manufacturer (OEM)

As used here, the manufacturer of equipment in which a Perkins engine is installed.

Parameter

A programmable value or limit which determines the characteristics or behavior of the engine.

Parameter Identifier (PID)

Two or three digit code which is assigned to each component in order to identify data via the data link to the ECM.

Password

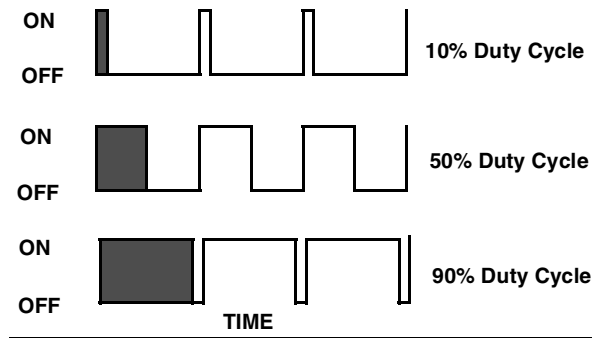
A group of numeric or alphanumeric characters that is designed to restrict access to parameters. The electronic system requires correct passwords in order to change Customer Specified Parameters (Customer Passwords) or certain engine specifications (Factory Passwords). Passwords are also required to clear certain diagnostic codes.

Personality Module or Ratings Personality Module

The software module inside the ECM which contains all the instructions (software) for the ECM and performance maps for a specific power family.

Pulse Width Modulation (PWM)

A signal consisting of variable width pulses at fixed intervals, whose ratio of "TIME ON" versus total "TIME OFF" can be varied (also referred to as "duty cycle").



Example of Pulse Width Modulation (PWM) Signals

Rated Fuel Limit

Indicates the maximum allowable fuel position (longest injection pulse). It will produce rated power for this engine configuration.

Reference Voltage

A regulated, unchanging voltage supplied by the ECM to a sensor. The reference voltage is used by the sensor to generate a signal voltage.

Sensor

A device that is used to detect and convert a change in pressure, temperature, or mechanical movement into an electrical signal.

Short Circuit

A condition where an electrical circuit is unintentionally connected to an undesirable point. An example of a short circuit is a wire which rubs against a vehicle frame until it eventually wears off its insulation and makes electrical contact with the frame.

Speed "burp"

A sudden, brief, unwanted change in the engine rev/min.

Subsystem

As used here, it is a part of the electronic system that relates to a particular function.

Supply Voltage

A constant voltage supplied to a component to provide electrical power for its operation. It may be generated by the ECM or may be battery voltage supplied by the equipment wiring.

System Configuration Parameters

Parameters that affect the power rating family or emissions.

"T" Harness

A test harness that is designed to connect into the engine harness which allows normal circuit operation while providing a breakout or "T" in order to measure signals.

Timing Calibration

The adjustment of an electrical signal as a means of correcting the timing error between the Crankshaft and Crankshaft Position Sensors.

TIPSS-EST

A service tool software program to run on a personal computer (PC).

Total Tattletale

Total number of changes to all the Customer Specified Parameters stored in the ECM.