

# Troubleshooting

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## **1106C-E70TA and 1106D-E70TA Industrial Engines**

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PV (Engine)  
PW (Engine)



## Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

**Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.**

**Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.**

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

**Perkins cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Perkins is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.**

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Perkins dealers or Perkins distributors have the most current information available.



**When replacement parts are required for this product Perkins recommends using Perkins replacement parts.**

**Failure to heed this warning can lead to premature failures, product damage, personal injury or death.**

## Table of Contents

### Troubleshooting Section

#### Electronic Troubleshooting

Welding Precaution .....	5
System Overview.....	5
Glossary .....	9
Electronic Service Tools .....	13
Indicator Lamps .....	14
Replacing the ECM.....	17
Self-Diagnostics.....	19
Sensors and Electrical Connectors .....	19
Engine Wiring Information .....	22
ECM Harness Connector Terminals .....	26

#### Programming Parameters

Programming Parameters .....	28
Test ECM Mode .....	28
Factory Passwords .....	28
Flash Programming .....	29
Mode Switch Setup.....	29
Throttle Setup .....	30
Multiposition Switch Setup.....	33

#### Customer Specified Parameters

Customer Specified Parameters.....	34
Customer Specified Parameters Table .....	40
Customer Specified Parameters Worksheet . .	44

#### System Configuration Parameters

System Configuration Parameters.....	48
--------------------------------------	----

#### Symptom Troubleshooting

Acceleration Is Poor or Throttle Response Is Poor .....	49
Alternator Is Noisy .....	53
Alternator Problem.....	55
Battery Problem.....	56
Coolant Contains Oil.....	57
Coolant Level Is Low .....	58
Coolant Temperature Is High.....	59
Cylinder Is Noisy.....	62
ECM Does Not Communicate with Other Modules .....	65
ECM Will Not Accept Factory Passwords.....	65
Electronic Service Tool Does Not Communicate.....	65
Engine Cranks but Does Not Start.....	68
Engine Does Not Crank.....	73

Engine Has Early Wear .....	75
Engine Has Mechanical Noise (Knock).....	77
Engine Misfires, Runs Rough or Is Unstable. .	80
Engine Overspeeds.....	82
Engine Shutdown Occurs Intermittently .....	84
Engine Speed Does Not Change .....	86
Engine Stalls at Low RPM .....	87
Engine Top Speed Is Not Obtained .....	89
Engine Vibration Is Excessive .....	92
Exhaust Has Excessive Black Smoke.....	94
Exhaust Has Excessive White Smoke .....	97
Fuel Consumption Is Excessive .....	100
Fuel Contains Water .....	103
Fuel Rail Pressure Problem.....	104
Inlet Air Is Restricted.....	107
Inlet Air Temperature Is High .....	108
Intake Manifold Air Pressure Is High .....	110
Intake Manifold Air Pressure Is Low .....	111
Intake Manifold Air Temperature Is High....	113
Oil Consumption Is Excessive.....	116
Oil Contains Coolant.....	119
Oil Contains Fuel .....	120
Oil Pressure Is Low.....	122
Power Is Intermittently Low or Power Cutout Is Intermittent.....	126
Valve Lash Is Excessive .....	129

#### Troubleshooting with a Diagnostic Code

Diagnostic Trouble Codes .....	130
Diagnostic Code Cross Reference .....	133

#### Troubleshooting with an Event Code

Event Codes .....	136
-------------------	-----

#### Diagnostic Functional Tests

CAN Data Link - Test .....	138
Data Link - Test.....	141
Electrical Connector - Inspect.....	149
Electrical Power Supply - Test .....	153
Ether Starting Aid - Test.....	159
Glow Plug Starting Aid - Test .....	164
Idle Validation - Test.....	171
Indicator Lamp - Test .....	178
Injector Solenoid - Test .....	181
Mode Selection - Test .....	188
Power Take-Off - Test .....	193
Sensor Supply - Test.....	196
Sensor Signal (Analog, Active) - Test .....	203
Sensor Signal (Analog, Passive) - Test .....	209
Solenoid Valve - Test .....	214
Speed Control (Analog) - Test .....	219

Table of Contents

---

Speed Control (PWM) - Test.....	225
Speed/Timing - Test.....	231
Switch Circuits - Test .....	236
Water in Fuel - Test.....	240

**Index Section**

Index.....	244
------------	-----

# Troubleshooting Section

## Electronic Troubleshooting

### Welding Precaution

Correct welding procedures are necessary in order to avoid damage to the following components:

- Electronic Control Module (ECM) on the engine
- Sensors
- Associated components

Components for the driven equipment should also be considered. When possible, remove the component that requires welding. When welding on an engine that is equipped with an ECM and removal of the component is not possible, the following procedure must be followed. This procedure minimizes the risk to the electronic components.

1. Stop the engine. Remove the electrical power from the ECM.
2. Ensure that the fuel supply to the engine is turned off.
3. Disconnect the negative battery cable from the battery. If a battery disconnect switch is installed, open the switch.
4. Disconnect all electronic components from the wiring harnesses. Include the following components:
  - Electronic components for the driven equipment
  - ECM
  - Sensors
  - Electronically controlled valves
  - Relays

#### NOTICE

Do not use electrical components (ECM or ECM sensors) or electronic component grounding points for grounding the welder.

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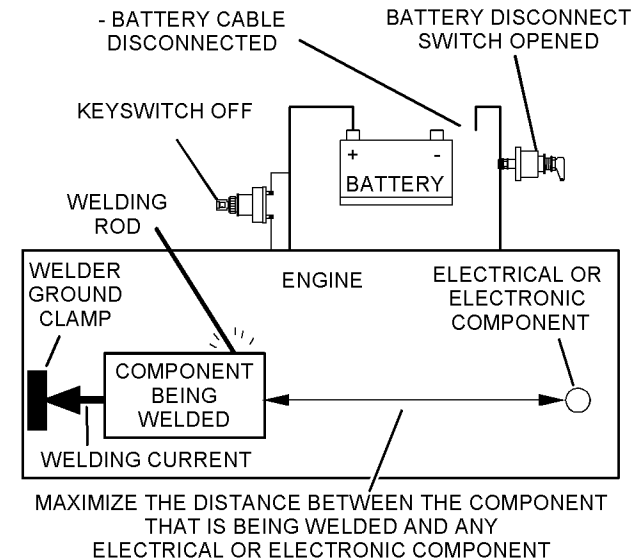


Illustration 1

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#### Service welding guide (typical diagram)

5. When possible, connect the ground clamp for the welding equipment directly to the engine component that will be welded. Place the clamp as close as possible to the weld. Close positioning reduces the risk of welding current damage to the engine bearings, to the electrical components, and to other components.
6. Protect the wiring harnesses from welding debris and/or from welding spatter.
7. Use standard welding procedures to weld the materials together.

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## System Overview

The engine has an electronic control system. The system controls the engine.

The control system consists of the following components:

- Electronic Control Module (ECM)
- Software (flash file)
- Wiring
- Sensors
- Actuators

The following information provides a general description of the control system. Refer to Systems Operation, Testing, and Adjusting for detailed information about the control system.

# Electronic Control Circuit Diagram

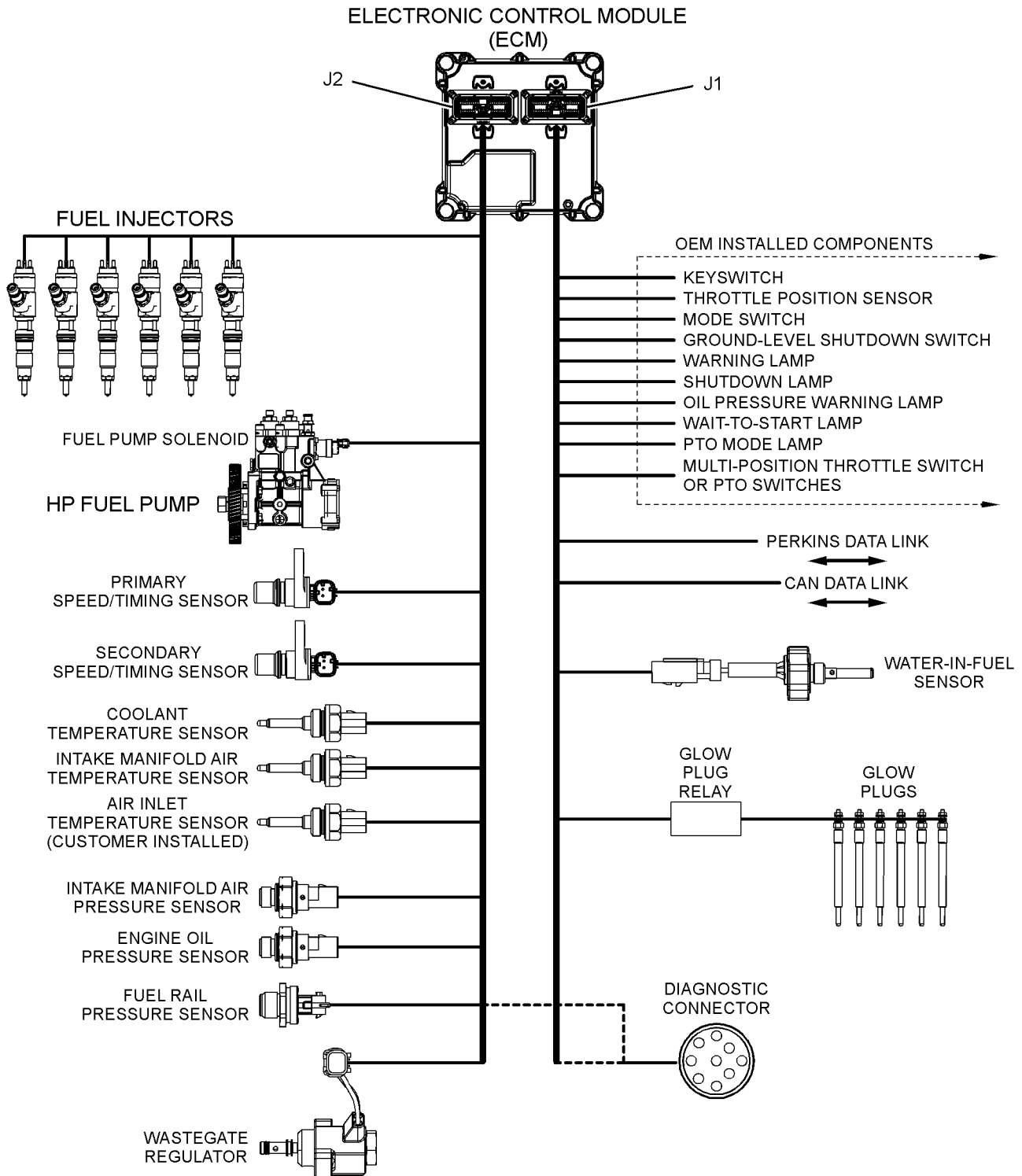


Illustration 2  
Electronic control circuit diagram

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## Block Diagrams

Illustration 3 is a block diagram of the engine control system.

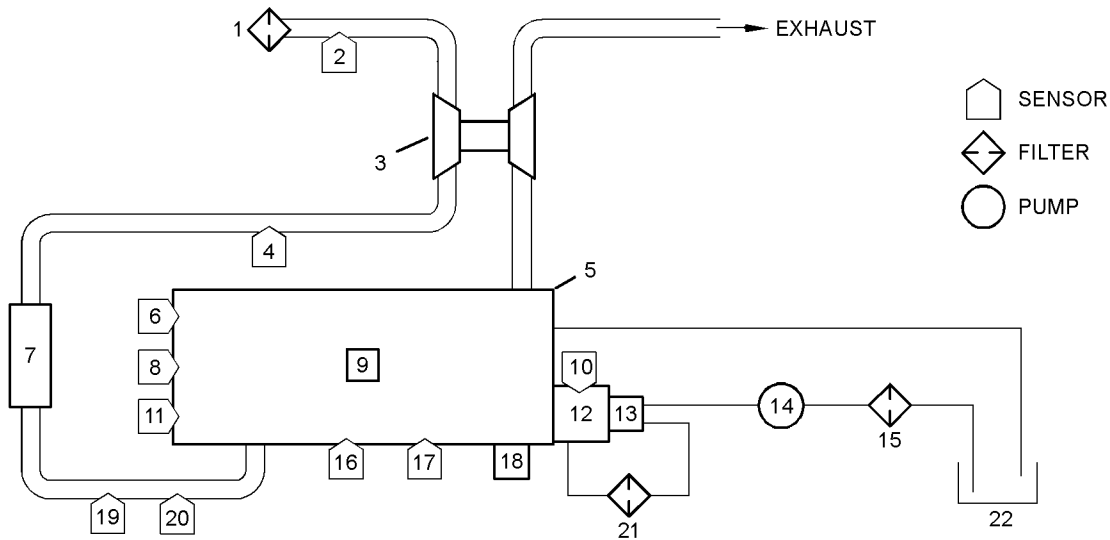


Illustration 3

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**Block diagram for the engine**

- |                                  |                                    |   |
|----------------------------------|------------------------------------|---|
| (1) Air cleaner                  | (9) Fuel injectors                 | (17) Oil pressure sensor                    |
| (2) Air inlet temperature sensor | (10) HP fuel pump solenoid         | (18) ECM                                    |
| (3) Turbocharger                 | (11) Secondary speed/timing sensor | (19) Intake manifold pressure sensor        |
| (4) Wastegate regulator          | (12) High-pressure fuel pump       | (20) Intake manifold air temperature sensor |
| (5) Engine                       | (13) Fuel transfer pump            | (21) Secondary fuel filter                  |
| (6) Coolant temperature sensor   | (14) Priming pump                  | (22) Fuel tank                              |
| (7) Air-to-air aftercooler       | (15) Primary fuel filter           |   |
| (8) Primary speed/timing sensor  | (16) Fuel rail pressure sensor     |   |

**System Operation**

**Engine Governor**

The ECM governs the engine. The ECM determines the timing, the injection pressure, and the amount of fuel that is delivered to each cylinder. These factors are based on the actual conditions and on the desired conditions at any given time during starting and operation.

The governor uses the throttle position sensor to determine the desired engine speed. The governor compares the desired engine speed to the actual engine speed. The actual engine speed is determined through interpretation of the signals that are received by the ECM from the engine speed/timing sensors. If the desired engine speed is greater than the actual engine speed, the governor injects more fuel in order to increase engine speed.

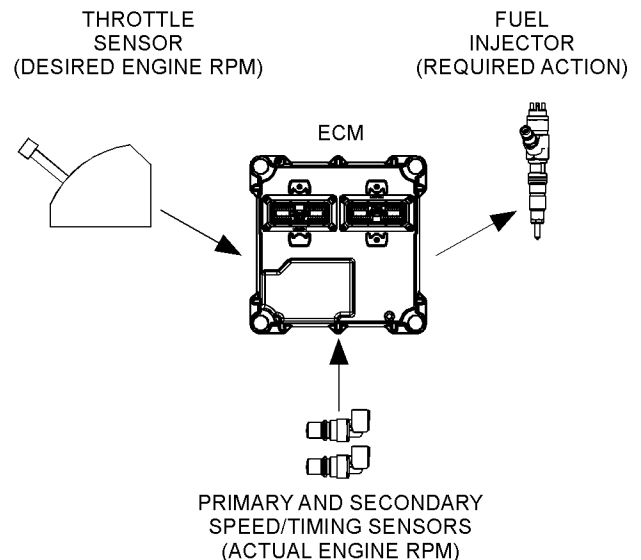


Illustration 4

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**Typical example**

The desired engine speed is typically determined by one of the following conditions:

- The position of the throttle
- The desired engine speed in Power Take-Off (PTO)

## Timing Considerations

Once the governor has determined the amount of fuel that is required, the governor must determine the timing of the fuel injection. Fuel injection timing is determined by the ECM after considering input from the following components:

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

The ECM adjusts timing for optimum engine performance and for fuel economy. Actual timing and desired timing cannot be viewed with the electronic service tool. The ECM determines the location of top center of the number one cylinder from the signals that are provided by the engine speed/timing sensors. The ECM determines when injection should occur relative to top center. The ECM then provides the signal to the injector at the desired time.

## Fuel Injection

The ECM sends a high voltage signal to the injector solenoids in order to energize the solenoids. By controlling the timing and the duration of the high voltage signal, the ECM can control the following aspects of injection:

- Injection timing
- Fuel delivery

The flash file inside the ECM establishes certain limits on the amount of fuel that can be injected. The “FRC Fuel Limit” is a limit that is based on the intake manifold pressure. The “FRC Fuel Limit” is used to control the air/fuel ratio for control of emissions. When the ECM senses a higher intake manifold pressure, the ECM increases the “FRC Fuel Limit”. A higher intake manifold pressure indicates that there is more air in the cylinder. When the ECM increases the “FRC Fuel Limit”, the ECM allows more fuel into the cylinder.

The “Rated Fuel Limit” is a limit that is based on the power rating of the engine and on the engine rpm. The “Rated Fuel Limit” is like the rack stops and the torque spring on a mechanically governed engine. The “Rated Fuel Limit” provides the power curves and the torque curves for a specific engine family and a specific engine rating. All of these limits are determined at the factory. These limits cannot be changed.

## Customer Parameters and Engine Speed Governing

A unique feature with electronic engines is customer specified parameters. These parameters allow the owner of the machine to fine-tune the ECM for engine operation. Fine-tuning the ECM allows the machine owner to accommodate the typical usage of the machine and the power train of the machine.

Many of the customer parameters provide additional restrictions on the actions that will be performed by the ECM in response to input from the operator. The “PTO Top Engine Limit” is an engine rpm limit that is used by the ECM to limit the fuel during operation of the PTO. The ECM will not fuel the injectors above this rpm.

Some parameters are intended to notify the operator of potential engine damage (engine monitoring parameters). Some parameters enhance fuel economy (machine speed, engine speed limit, and idle shutdown). Other parameters are used to enhance the engine installation into the machine. Other parameters are used to provide engine operating information to the owner of the machine.

## Other ECM Functions for Performance

The ECM can also provide enhanced control of the engine for machine functions such as controlling the cooling fan. Refer to Troubleshooting, “Customer Specified Parameters” for additional information.

## ECM Lifetime Totals

The ECM maintains total data of the engine for the following parameters:

- “Total Operating Hours”
- “Engine Lifetime Hours”
- “Total Idle Time”
- “Total Idle Fuel”
- “Total Fuel”
- “Total Max Fuel”
- “Engine Starts”
- “Lifetime Total Engine Revolutions”
- “Average Load Factor”

The “Total Operating Hours” is the operating hours of the engine. The operating hours do not include the time when the ECM is powered but the engine is not running.

The “Engine Lifetime Hours” is the number of hours when electrical power has been applied to the engine. These hours will include the time when the ECM is powered but the engine is not running.

“Total Idle Time” and “Total Idle Fuel” can include operating time when the engine is not operating under a load.

Fuel Information can be displayed in US gallons or in liters.

“Total Fuel” is the total amount of fuel that is consumed by the engine during operation.



“Total Max Fuel” is the maximum amount of fuel that could have been consumed by the engine during operation.

“Engine Starts” is the total number of times when the engine has been started.

“Lifetime Total Engine Revolutions” is the total number of revolutions that have been completed by the engine crankshaft.

“Average Load Factor” provides relative engine operating information. “Average Load Factor” compares actual operating information of the engine to the maximum engine operation that is available. “Average Load Factor” is determined by using “Total Max Fuel”, “Total Idle Fuel” and “Total Fuel”. All of these parameters are available with the electronic service tool. These parameters are available within the menu for “Current Totals”.

## Programmable Parameters

Certain parameters that affect engine operation may be changed with the electronic service tool. The parameters are stored in the ECM, and the parameters are protected from unauthorized changes by passwords. These parameters are either system configuration parameters or customer parameters.

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

Customer parameters are variable. Customer parameters can be used to adjust the following characteristics of the engine within preset limits:

- Rpm ratings
- Power ratings

Customer passwords may be required to change customer specified parameters.

Some of the parameters may affect engine operation in an unusual way. An operator might not expect this type of effect. Without adequate training, these parameters may lead to power complaints or performance complaints even though the performance of the engine is to the specification.

Refer to Troubleshooting, “Configuration Parameters” for additional information on this subject.

## Passwords

System configuration parameters are protected by factory passwords. Factory passwords are calculated on a computer system that is available only to Perkins dealers and distributors. Since factory passwords contain alphabetic characters, only the electronic service tool may change system configuration parameters. System configuration parameters affect the power rating family or emissions.

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 customer passwords are lost.

Refer to Troubleshooting, “Factory Passwords” for additional information on this subject.

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## Glossary

**Active Diagnostic Code** – An active diagnostic code alerts the operator or the service technician that an electronic system malfunction is currently present. Refer to the term “Diagnostic Code” in this glossary.

**Alternating Current (AC)** – Alternating current is an electric current that reverses direction at a regular interval that is reoccurring.

**Before Top Center (BTC)** – BTC is the 180 degrees of crankshaft rotation before the piston reaches the top center position in the normal direction of rotation.

**Breakout Harness** – A breakout harness is a test harness that is designed to connect into the engine harness. This connection allows a normal circuit operation and the connection simultaneously provides a Breakout T in order to measure the signals.

**Bypass Circuit** – A bypass circuit is a circuit that is used as a substitute circuit for an existing circuit. A bypass circuit is typically used as a test circuit.

**CAN Data Links (see also J1939 CAN Data Link)** – The CAN Data Links are serial communications buses that are used for communication with other microprocessor-based devices.

**Code** – Refer to “Diagnostic Trouble Code”.

**Communication Adapter Tool** – The communication adapter provides a communication link between the ECM and the electronic service tool.

**Coolant Temperature Sensor** – The coolant temperature sensor detects the engine coolant temperature for all normal operating conditions and for engine monitoring.

**Data Link** – The data link is a serial communication bus that is used for communication with other devices such as the electronic service tool.

**Derate** – Certain engine conditions will generate event codes. Also, engine may be derated. The map for the engine derate is programmed into the ECM software. The type of derate can be one or more of three types: reduction of rated power, reduction of rated engine speed and reduction of rated machine speed for OEM products.

**Desired Engine Speed** – The desired engine speed is input to the electronic governor within the ECM. The electronic governor uses the throttle position sensor signal, the engine speed/timing sensor, and

other sensors in order to determine the desired engine speed.

**Diagnostic Trouble Code** – A diagnostic trouble code is sometimes referred to as a fault code. These codes indicate an electronic system malfunction.

**Diagnostic Lamp** – The diagnostic lamp is also called the warning lamp. The diagnostic lamp is used to warn the operator of the presence of an active diagnostic code. The lamp may not be included in all applications.

**Digital Sensor Return** – The common line (ground) from the ECM is used as ground for the digital sensors.

**Digital Sensors** – Digital sensors produce a pulse width modulated signal. Digital sensors are supplied with power from the ECM.

**Digital Sensor Supply** – The power supply for the digital sensors is provided by the ECM.

**Direct Current (DC)** – Direct current is the type of current that flows consistently in only one direction.

**DT, DT Connector, or Deutsch DT** – This design is a type of connector that is used on this engine. The connectors are manufactured by Deutsch .

**Duty Cycle** – Refer to “Pulse Width Modulation” .

**Electronic Engine Control** – The electronic engine control is a complete electronic system. The electronic engine control monitors the engine operation under all conditions. The electronic engine control also controls the engine operation under all conditions.

**Electronic Control Module (ECM)** – The ECM is the control computer of the engine. The ECM provides power to the electronics. The ECM monitors data that is input from the sensors on the engine and the aftertreatment. The ECM acts as a governor in order to control the speed and the power of the engine.

**Electronic Service Tool** – The electronic service tool allows a computer (PC) to communicate with the ECM.

**Engine Monitoring** – Engine Monitoring is the part of the electronic engine control that monitors the sensors. Engine monitoring also warns the operator of detected problems.

**Engine Oil Pressure Sensor** – The engine oil pressure sensor measures engine oil pressure. The sensor sends a signal to the ECM that is dependent on the engine oil pressure.

**Engine Speed/Timing Sensor** – An engine speed/timing sensor is a hall effect switch that provides a digital signal to the ECM. The ECM interprets this signal as the crankshaft position and the engine speed. Two sensors are used to provide the speed and timing signals to the ECM. The primary sensor is associated with the crankshaft and the secondary sensor is associated with the camshaft.

**Ether Injection** – Ether injection is a starting aid in cold conditions. Glow plugs are used as a starting aid

when the ambient temperature is between 5° C (41° F) and –25° C (–13° F). At a temperature that is lower than –25° C (–13° F), the glow plugs are disabled and ether injection is used.

**Event Code** – An event code may be activated in order to indicate an abnormal engine operating condition. These codes usually indicate a mechanical problem instead of an electrical system problem.

**Failure Mode Identifier (FMI)** – This identifier indicates the type of failure that is associated with the component. The FMI has been adopted from the SAE practice of J1587 diagnostics. The FMI follows the parameter identifier (PID) in the descriptions of the fault code. The descriptions of the FMIs are in the following list.

**0** – The data is valid but the data is above the normal operational range.

**1** – The data is valid but the data is below the normal operational range.

**2** – The data is erratic, intermittent, or incorrect.

**3** – The voltage is above normal or the voltage is shorted high.

**4** – The voltage is below normal or the voltage is 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** – There is an abnormal frequency, an abnormal pulse width, or an abnormal time period.

**9** – There has been an abnormal update.

**10** – There is an abnormal rate of change.

**11** – The failure mode is not identifiable.

**12** – The device or the component is damaged.

**13** – The device requires calibration.

**14** – There is a special instruction for the device.

**15** – The signal from the device is high (least severe)

**16** – The signal from the device is high (moderate severity) .

**17** – The signal from the device is low (least severe) .

**18** – The signal from the device is low (moderate severity) .

**19** – There is an error in the data from the device.

**31** – The device has failed and the engine has shut down.

**Flash File** – This file is software that is inside the ECM. The file contains all the instructions (software)

for the ECM and the file contains the performance maps for a specific engine. The file may be reprogrammed through flash programming.

**Flash Programming** – Flash programming is the method of programming or updating an ECM with an electronic service tool over the data link instead of replacing components.

**FRC** – See “Fuel Ratio Control” .

**Fuel Pump** – See “High Pressure Fuel Pump” .

**Fuel Rail** – This item is sometimes referred to as the High Pressure Fuel Rail. The fuel rail supplies fuel to the electronic unit injectors. The high-pressure fuel pump and the fuel rail pressure sensor work with the ECM to maintain the desired fuel pressure in the fuel rail. This pressure is determined by calibration of the engine in order to enable the engine to meet emissions and performance requirements.

**Fuel Rail Pressure Sensor** – The fuel rail pressure sensor sends a signal to the ECM that is dependent on the pressure of the fuel in the fuel rail.

**Fuel Ratio Control (FRC)** – The FRC is a limit that is based on the control of the ratio of the fuel to air. The FRC is used for purposes of emission control. When the ECM senses a higher intake manifold air pressure, the FRC increases the FRC Limit.

**Full Load Setting (FLS)** – The FLS is the parameter that represents the fuel system adjustment. This adjustment is made at the factory in order to fine-tune the fuel system. This parameter must be programmed.

**Full Torque Setting (FTS)** – The FTS is the parameter that represents the adjustment for the engine torque. This adjustment is made at the factory in order to fine-tune the fuel system. This adjustment is made with the FLS. This parameter must be programmed.

**Glow Plug** – The glow plug is an optional starting aid for cold conditions. One glow plug is installed in each combustion chamber in order to improve the ability of the engine to start. The ECM uses information from the engine sensors to determine when the glow plug relay must provide power to each glow plug. Each of the glow plugs then provides a hot surface in the combustion chamber in order to vaporize the mixture of air and fuel. The vaporization improves ignition during the compression stroke of the cylinder.

**Glow Plug Relay** – The glow plug relay is controlled by the ECM in order to provide high current to the glow plugs.

**Harness** – The harness is the bundle of wiring (loom) that connects all components of the electronic system.

**Hertz (Hz)** – Hertz is the measure of electrical frequency in cycles per second.

**High Pressure Fuel Pump** – This device supplies fuel under pressure to the fuel rail (high-pressure fuel rail).

**High Pressure Fuel Rail** – See “Fuel Rail” .

**Injector Trim Codes** – Injector trim codes are codes that contain 30 characters. The codes are supplied with new injectors. The code is input through the electronic service tool into the ECM. The injector trim codes compensate for variances in manufacturing of the electronic unit injector and for the life of the electronic unit injector.

**Intake Manifold Air Temperature Sensor** – The intake manifold air temperature sensor detects the air temperature in the intake manifold. The ECM monitors the air temperature and other data in the intake manifold in order to adjust injection timing and other performance functions.

**Intake Manifold Pressure Sensor** – The Intake Manifold Pressure Sensor measures the pressure in the intake manifold. The pressure in the intake manifold may be different to the pressure outside the engine (atmospheric pressure). The difference in pressure may be caused by an increase in air pressure by a turbocharger.

**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 CAN Data Links** – These data links are SAE standard diagnostic communications data links that are used to communicate between the ECM and other electronic devices.

**Logged Diagnostic Codes** – Logged diagnostic codes are codes which are stored in the memory. These codes are an indicator of possible causes for intermittent problems. Refer to the term “Diagnostic Trouble Codes” for more information.

**OEM** – OEM is an abbreviation for the Original Equipment Manufacturer. The OEM is the manufacturer of the machine or the vehicle that uses the engine.

**Open Circuit** – An open circuit is a condition that is caused by an open switch, or by an electrical wire or a connection that is broken. When this condition exists, the signal or the supply voltage can no longer reach the intended destination.

**Parameter** – A parameter is a value or a limit that is programmable. A parameter helps determine specific characteristics or behaviors of the engine.

**Password** – A password is a group of numeric characters or a group of alphanumeric characters that is designed to restrict access to parameters. The electronic system requires correct passwords in order to change some parameters (Factory Passwords). Refer to Troubleshooting, “Factory Passwords” for more information.

**Personality Module** – See “Flash File” .

**Power Cycling** – Power cycling refers to the action of cycling the keyswitch from any position to the OFF position, and to the START/RUN position.

**Pressure Limiting Valve (PLV)** – The PLV is a valve in the fuel rail that prevents excessive pressure.

The PLV will reduce the pressure to a safe level that will limit engine operation but the reduced pressure will not stop the engine.

**Primary Speed/Timing Sensor** – This sensor determines the position of the crankshaft during engine operation. If the primary speed/timing sensor fails during engine operation, the secondary speed/timing sensor is used to provide the signal.

**Pulse Width Modulation (PWM)** – The PWM is a signal that consists of pulses that are of variable width. These pulses occur at fixed intervals. The ratio of “TIME ON” versus “TIME OFF” can be varied. This ratio is also referred to as a duty cycle.

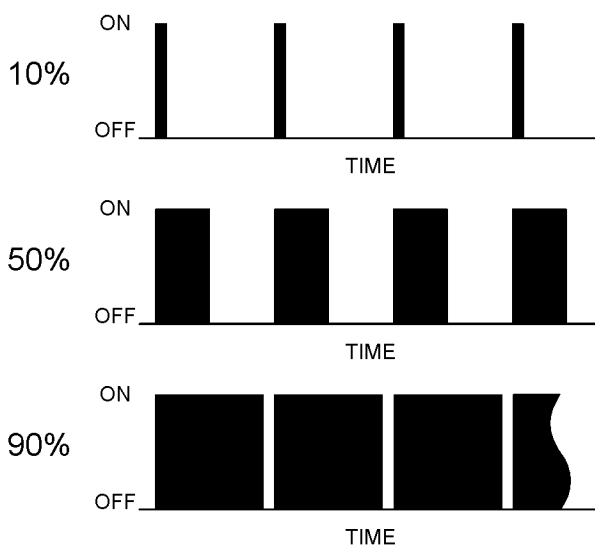


Illustration 5

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**Rated Fuel Limit** – The rated fuel limit is based on the power rating of the engine and on the engine rpm. The Rated Fuel Limit enables the engine power and torque outputs to conform to the power and torque curves of a specific engine model. These limits are in the flash file and these limits cannot be changed.

**Reference Voltage** – Reference voltage is a regulated voltage that is supplied by the ECM to a sensor. The reference voltage is used by the sensor to generate a signal voltage.

**Relay** – A relay is an electromechanical switch. A flow of electricity in one circuit is used to control the flow of electricity in another circuit. A small current or voltage is applied to a relay in order to switch a much larger current or voltage.

**Secondary Speed/Timing Sensor** – This sensor determines the position of the camshaft during engine operation. If the primary speed/timing sensor fails during engine operation, the secondary speed/timing sensor is used to provide the signal.

**Sensor** – A sensor is a device that is used to detect the current value of pressure or temperature, or mechanical movement. The information that is detected is converted into an electrical signal.

**Short Circuit** – A short circuit is a condition that has an electrical circuit that is inadvertently connected to an undesirable point. An example of a short circuit is a wire which rubs against a vehicle frame and this rubbing eventually wears off the wire insulation. Electrical contact with the frame is made and results in a short circuit.

**Signal** – The signal is a voltage or a waveform that is used in order to transmit information typically from a sensor to the ECM.

**Suction Control Valve (SCV)** – The SCV is a control device in the high-pressure fuel pump. The valve controls the pressure in the fuel rail by varying the amount of fuel that enters the chambers in the pump.

**Supply Voltage** – The supply voltage is a continuous voltage that is supplied to a component. The power may be generated by the ECM or the power may be battery voltage that is supplied by the engine wiring.

**Suspect Parameter Number (SPN)** – The SPN is a J1939 number that identifies the specific component of the electronic control system that has experienced a fault.

**System Configuration Parameters** – System configuration parameters are parameters that affect emissions and/or operating characteristics of the engine.

**Tattletale** – Certain parameters that affect the operation of the engine are stored in the ECM. These parameters can be changed by use of the electronic service tool. The tattletale logs the number of changes that have been made to the parameter. The tattletale is stored in the ECM.

**Throttle Position** – The throttle position is the interpretation by the ECM of the signal from the throttle position sensor or the throttle switch.

**Throttle Position Sensor** – The throttle position sensor is a sensor that is connected to an accelerator pedal or a hand lever. This sensor sends a signal to the ECM that is used to calculate desired engine speed.

**Throttle Switch** – The throttle switch sends a signal to the ECM that is used to calculate desired engine speed.

**Top Center Position** – The top center position refers to the crankshaft position when the engine piston position is at the highest point of travel. The engine must be turned in the normal direction of rotation in order to reach this point.

**Total Tattletale** – The total tattletale is the total number of changes to all the parameters that are stored in the ECM.

**Wait To Start Lamp** – This lamp is included in the cold starting aid circuit in order to indicate when the wait to start period is active. The lamp will go off when the engine is ready to be started. The glow plugs may not have deactivated.

**Wastegate** – The wastegate is a device in a turbocharged engine that controls the maximum boost pressure that is provided to the inlet manifold.

**Wastegate Regulator** – The wastegate regulator controls the pressure in the intake manifold to a value that is determined by the ECM. The wastegate regulator provides the interface between the ECM and the mechanical system.

i04020489

## Electronic Service Tools

Perkins electronic service tools are designed to help the service technician:

- Retrieve diagnostic codes.
- Diagnose electrical problems.
- Read parameters.
- Program parameters.
- Install trim files.

## Required Service Tools

Table 1

Required Service Tools	
Part Number	Description
CH11155	Crimp Tool 12-AWG TO 18-AWG
2900A019	Wire Removal Tool
27610285	Removal Tool
-	Suitable Digital Multimeter

Two short jumper wires are needed to check the continuity of some wiring harness circuits by shorting two adjacent terminals together in a connector. A long extension wire may also be needed to check the continuity of some wiring harness circuits.

## Optional Service Tools

Table 2 lists the optional service tools that can be used when the engine is serviced.

Table 2

Part Number	Description
U5MK1092	Spoon Probe Kit MULTIMETER
- or -	Suitable Digital Pressure Indicator or Engine Pressure Group
-	Suitable Battery Load Tester

(Table 2, contd)

-	Suitable Temperature Adapter MULTIMETER
28170107	Bypass Harness As
2900A038	Harness As

## Perkins Electronic Service Tool

The Perkins Electronic Service Tool can display the following information:

- Status of all pressure sensors and temperature sensors
- Programmable parameter settings
- Active diagnostic codes and logged diagnostic codes
- Active events and Logged events
- Histograms

The Electronic Service Tool can also be used to perform the following functions:

- Diagnostic tests
- Programming of flash files
- Parameter programming
- Copy configuration function for ECM replacement
- Data logging
- Graphs (real time)

Table 3 lists the service tools that are required in order to use the Electronic Service Tool.

Table 3

Service Tools for the Use of the Electronic Service Tool	
Part Number	Description
-(1)	Single Use Program License
-(1)	Data Subscription for All Engines
27610251	Communication Adapter (Electronic Service Tool to ECM interface)
27610164	Adapter Cable As

(1) Refer to Perkins Engine Company Limited .

**Note:** For more information regarding the use of the Electronic Service Tool and the PC requirements for the Electronic Service Tool, refer to the documentation that accompanies your Perkins Electronic Service Tool software.

(continued)

## Connecting the Electronic Service Tool and the Communication Adapter II

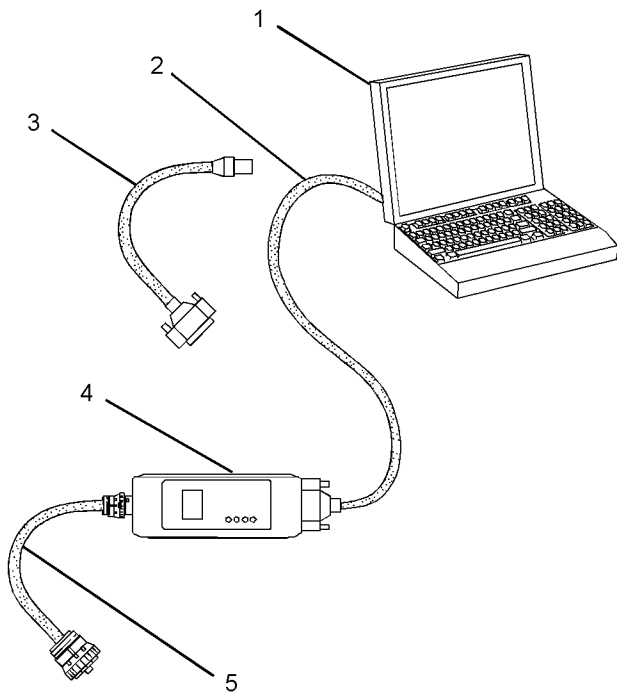


Illustration 6

g02194714

- (1) Personal Computer (PC)
- (2) Adapter Cable (Computer Serial Port)
- (3) Adapter Cable Assembly
- (4) Communication Adapter II
- (5) Adapter Cable Assembly

**Note:** Items (2), (3) and (4) are part of the Communication Adapter II kit.

Use the following procedure in order to connect the Electronic Service Tool and the Communication Adapter II.

1. Turn the keyswitch to the OFF position.
2. Connect cable (2) between the “COMPUTER” end of communication adapter (4) and the RS232 serial port of PC (1).

**Note:** The Adapter Cable Assembly(3) is required to connect to the USB port on computers that are not equipped with a RS232 serial port.

3. Connect cable (5) between the “DATA LINK” end of communication adapter (4) and the diagnostic connector.
4. Place the keyswitch in the ON position. If the Electronic Service Tool and the communication adapter do not communicate with the Electronic Control Module (ECM), refer to the diagnostic procedure Troubleshooting, “Electronic Service Tool Will Not Communicate With ECM”.

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## Indicator Lamps

### Indicator Lamps

The functions of the indicator lamps are designed to display the maximum amount of information on the minimum number of lamps.

Five lamps are available as options. The “Shutdown” lamp and the “Warning” lamp will normally be installed in the application. Dedicated optional lamps for other items may also be installed. The remaining optional lamps are “Wait to start”, “Low oil pressure” and “Maintenance Indicator”.

The “Shutdown” lamp and the “Warning” lamp can also be used to indicate a diagnostic code by use of the “Flash Code” feature. The “Flash Code” feature can be used to indicate all active diagnostic codes and logged diagnostic codes.

### Functions of the Lamps

#### Shutdown Lamp

**Lamp check** – When the keyswitch is turned to ON, the lamp will come on for 2 seconds. The lamp will then go off unless there is an active warning.

**Flashing** – The lamp will be flashing when the engine has been derated as a result of an active diagnostic code. An example of an active diagnostic code is “System Voltage High”.

**On** – The lamp will be on when the shutdown level in the engine protection strategy has been reached. The “Warning” lamp will also be on.

#### Warning Lamp

**Lamp check** – When the keyswitch is turned to ON, the lamp will come on for 2 seconds. The lamp will then go off unless there is an active warning.

**Flashing** – The lamp will be flashing when a “warning” or a “warning and derate” is active. An example is low oil pressure.

**On** – The lamp will be on when the shutdown level has been reached. The “Shutdown” lamp will also be on.

## Wait to Start Lamp

**Lamp check** – When the keyswitch is turned to ON, the lamp will come on for 2 seconds. The lamp will then go off unless “Wait to Start” is active.

**On** – The lamp is on during a “Wait to Start” period.

## Low Oil Pressure

**Lamp check** – When the keyswitch is turned to ON, the lamp will come on for 2 seconds. The lamp will then go off unless there is an active warning.

**On** – The lamp will come on when a low oil pressure event is detected. The “Warning” lamp and the “Shutdown” lamp may also come on.

## Maintenance Indicator Lamp

**Lamp check** – The lamp will come on for 2 seconds. The lamp will then go off unless the PTO mode is active.

**On** – The lamp will come on when scheduled maintenance is required.

## Color of Lamps

Typically, the “Shutdown” lamp is colored red and the “Warning” lamp is colored amber. The other lamps are optional.

## Operation of the Indicator Lamps

Table 4

Warning Lamp (Alert Lamp)	Shutdown Lamp (Action Lamp)	Lamp State	Description of the Indication	Engine State
On	On	Lamp Check	When the keyswitch is in the ON position, the lamps come on for 2 seconds and the lamps will then go off.	The keyswitch is in the ON position but the engine has not yet been cranked.
Off	Off	No Faults	With the engine in operation, there are no active warnings, diagnostic codes, or event codes.	The engine is operating with no detected faults.
On	Off	Active Diagnostic	The warning lamp coming on during engine operation indicates that an active diagnostic code (an electrical fault) is present.	The engine is operating normally but there is one or more faults with the electronic management system for the engine.
On	Flashing	Derate (An engine derate is caused by certain active codes.)	The warning lamp coming on and the shutdown lamp flashing during engine operation indicates that an active diagnostic code (an electrical fault) is present. The diagnostic is sufficiently serious in order to cause an engine derate.	The engine is operating but there is one or more active diagnostic codes that have initiated an engine derate.
Flashing	Off	Warning (Warning only)	The warning lamp flashing during operation of the engine indicates that one or more warning values for the engine protection strategy have been exceeded. However, the value has not been exceeded to a level that will cause an engine derate or a shutdown.	The engine is operating normally. However, there is one or more of the monitored engine parameters that are outside of the range that is acceptable.
Flashing	Flashing	Derate (Warning and Derate)	The warning lamp and shutdown lamp both flashing during engine operation indicate that a value in the engine protection strategy has caused an engine derate.	The engine is operating. However, one or more of the monitored engine parameters is outside of the acceptable range. The acceptable range has been exceeded to a level which requires a warning and an engine derate.
On	On	Engine Shutdown	The warning lamp and the shutdown lamp coming on during engine operation indicate one of the following conditions.  1. One or more of the shutdown values for the engine protection strategy has been exceeded.  2. A serious active diagnostic code has been detected.  After a short time, the engine will shut down.	The engine is either shutdown or an engine shutdown is imminent. One or more monitored engine parameters have exceeded the limit for an engine shutdown. This pattern of lamps can be caused by the detection of a serious active diagnostic code.

### Flash Codes

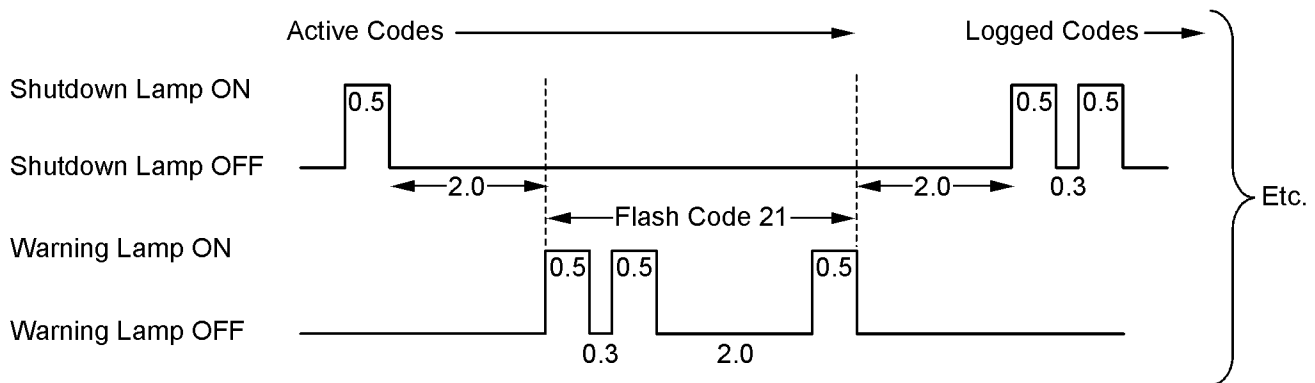
The "Flash Code" feature is used to flash the code of all active diagnostic codes and logged diagnostic codes.

The sequence for the flash code is started by cycling the keyswitch twice within a period of 3 seconds. After a delay of 2 seconds, the "Shutdown" lamp will flash once for half a second. This sequence indicates the start of the active fault codes. After a further delay of 2 seconds, the "Warning" lamp will flash repeatedly in order to indicate the active diagnostic codes. Each flash will be on for half a second and off for 300 milliseconds. The "Warning" lamp will remain off for 2 seconds between each digit of a code. If there is more than one active diagnostic code, the "Shutdown" lamp will go off for 2 seconds. The lamp will then come on for half a second. The "Warning" lamp will go off for 2 seconds before starting the next code. If there are no active diagnostic codes, the "Warning" lamp will flash the code "551". Refer to Troubleshooting Guide, "No Diagnostic Code Detected".



For example, a diagnostic code of “21” is indicated by the “Warning” lamp as follows:

- On for 500 ms
- Off for 300 ms
- On for 500 ms
- Off for 2000 ms
- On for 500 ms
- Off



Note: All times shown in seconds

Illustration 7

g01779334

### Timing of the flash codes

After all of the active diagnostic codes have been displayed, the “Shutdown” lamp will go off for 2 seconds. The “Shutdown” lamp will flash twice in order to indicate the start of the sequence that will display the logged diagnostic codes. The process for flashing logged diagnostic codes is identical to the process for flashing active diagnostic codes.

**Note:** If there are no logged codes, the “551” code should be flashed again.

After all of the codes have been displayed, the “Shutdown” lamp will flash three times in order to indicate that there are no further codes. Cycling the keyswitch twice within a period of 3 seconds will start the process again. All codes will be displayed in ascending numerical order.

Refer to the Troubleshooting Guide, “Diagnostic Codes” for the diagnostic code that relates to the flash code.

**Note:** Flash codes are always sent in ascending numerical order.

i03805671

## Replacing the ECM

### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

### NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

## Electronic Troubleshooting

The engine is equipped with an Electronic Control Module (ECM). The ECM contains no moving parts. Follow the troubleshooting procedures in this manual in order to be sure that replacing the ECM will correct the problem. Verify that the suspect ECM is the cause of the problem.

**Note:** Ensure that the ECM is receiving power and that the ECM is properly grounded before replacement of the ECM is attempted. Refer to the schematic diagram.

A test ECM can be used in order to determine if the ECM on the engine is faulty. Install a test ECM in place of the suspect ECM. Install the flash file with the correct part number into the test ECM. Program the parameters for the test ECM. The parameters must match the parameters in the suspect ECM. Refer to the following test steps for details. If the test ECM resolves the problem, reconnect the suspect ECM. Verify that the problem returns. If the problem returns, replace the ECM.

**Note:** If an ECM is intended to be used as a test ECM, "Test ECM Mode" must be selected on the electronic service tool before the engine serial number is entered.

Use the electronic service tool to read the parameters in the suspect ECM. Record the parameters in the suspect ECM. Install the flash file into the new ECM. After the ECM is installed on the engine, the parameters must be programmed into the new ECM.

**Note:** When a new ECM is not available, an ECM can be used from an engine that is not in service. The ECM must have the same serial number suffix. Ensure that the replacement ECM and the part number for the flash file match the suspect ECM. Be sure to record the parameters from the replacement ECM. Use the "Copy Configuration ECM Replacement" function in the electronic service tool.

---

**NOTICE**

If the flash file and engine application are not matched, engine damage may result.

---

Perform the following procedure in order to replace the ECM.

1. Connect the electronic service tool to the diagnostic connector.
2. Use the "Copy Configuration ECM Replacement" function from the electronic service tool. If the "Copy Configuration" is successful, proceed to Step 4. If the "Copy Configuration" failed, proceed to Step 3.

**Note:** Record any Logged Faults and Events for your records.

3. Record the following parameters:

- Record all of the parameters on the "Configuration" screen.
- Record all of the parameters on the "Throttle Configuration" screen.
- Record all of the parameters on the "Mode Configuration" screen.
- Record the serial numbers of the electronic unit injectors. The injector serial numbers are shown on the "Injector Trim Calibration" screen.

**Note:** If the parameters cannot be read, the parameters must be obtained elsewhere. Some parameters are stamped on the engine information plate, but most parameters must be obtained from the PTMI data on the Perkins intranet.

4. Remove power from the ECM.
  5. Remove the ECM. Refer to Disassembly and Assembly, "Electronic Control Module - Remove and Install".
  6. Install the replacement ECM. Refer to Disassembly and Assembly, "Electronic Control Module - Remove and Install".
  7. If the replacement ECM is intended to be used as a test ECM, select "Test ECM Mode" on the electronic service tool.
  8. Download the flash file.
    - a. Connect the electronic service tool to the diagnostic connector.
    - b. Select "WinFlash" from the "Utilities" menu of the electronic service tool.
    - c. Select the downloaded flash file.
  9. If necessary, use the electronic service tool to clear the rating interlock. To clear the rating interlock, enter the factory password when the electronic service tool is first connected. Activating the Test ECM mode will also clear the rating interlock.
  10. Use the electronic service tool to program the parameters. Perform the following procedure.
    - a. If the "Copy Configuration" procedure was successful, use the "Copy Configuration, ECM Replacement" function to load the configuration file into the ECM.
- Note:** During the following procedure, factory passwords may be required.
- b. If the "Copy Configuration" procedure failed, configure the parameters individually. The parameters should match the parameters from step 3.

Perform the “Fuel System Verification Test” .

i05223342

11. Check for logged diagnostic codes. Factory passwords are required to clear logged events.

i03538621

## Self-Diagnostics

The Electronic Control Module (ECM) has the ability to detect faults in the electronic system and with engine operation. A self-diagnostic check is also performed whenever power is applied to the ECM.

When a fault is detected, a code is generated. An alarm may also be generated. There are two types of codes:

- Diagnostic codes
- Event codes

**Diagnostic Code** – When a fault in the electronic system is detected, the ECM generates a diagnostic code. This indicates the specific fault in the circuitry.

Diagnostic codes can have two different states:

- Active
- Logged

**Active Code** – An active diagnostic code indicates that an active fault has been detected by the control system. Active codes require immediate attention. Always service active codes prior to servicing logged codes.

**Logged Code** – Every generated code is stored in the permanent memory of the ECM. The codes are logged for 100 operating hours unless a code is cleared by use of the electronic service tool.

**Event Code** – An event code is generated by the detection of an abnormal engine operating condition. For example, an event code will be generated if the oil pressure is too low. In this case, the event code indicates the symptom of a fault.

Logged codes may not indicate that a repair is needed. The fault may have been temporary. The fault may have been resolved since the logging of the code. If the system is powered, it is possible to generate an active diagnostic code whenever a component is disconnected. When the component is reconnected, the code is no longer active. Logged codes may be useful to help troubleshoot intermittent faults. Logged codes can also be used to review the performance of the engine and the electronic system.

## Sensors and Electrical Connectors

The Electronic Control Module (ECM) and most of the engine sensors are located on the left side of the engine. Refer to Illustration 8 . For the remaining sensors that are attached to the engine, refer to Illustration 10 .

**Note:** In the following illustrations, some components have been removed in order to improve visibility.

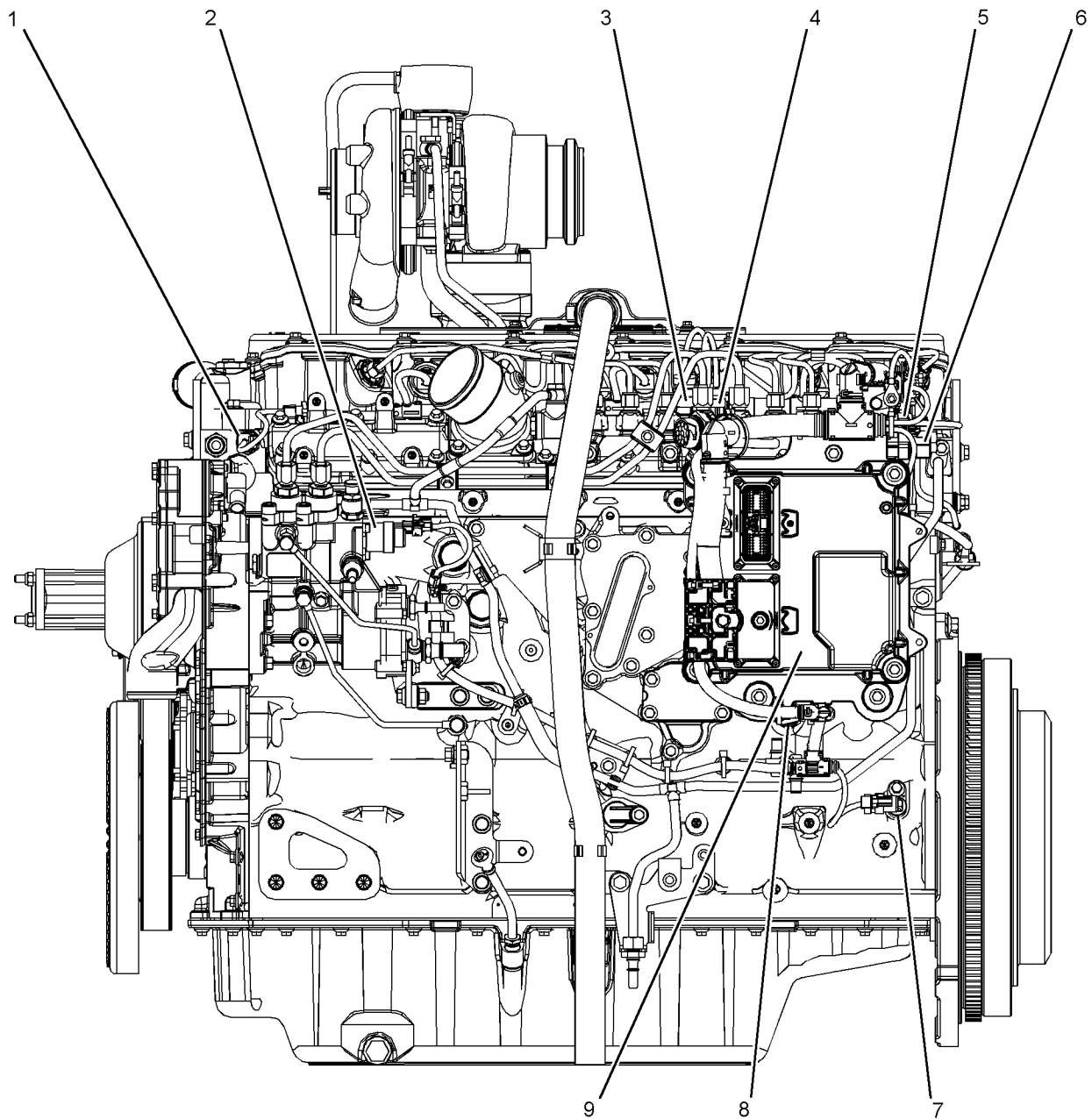


Illustration 8

g03338328

Sensor locations on the left side of the engine

- |  |  |                                     |
|--|--|-------------------------------------|
| (1) Coolant temperature sensor               | (4) Intake manifold air temperature sensor | (7) Primary speed/timing sensor     |
| (2) Solenoid for the high-pressure fuel pump | (5) Fuel rail pressure sensor              | (8) Oil pressure sensor             |
| (3) Intake manifold pressure sensor          | (6) Wastegate regulator                    | (9) Electronic Control Module (ECM) |

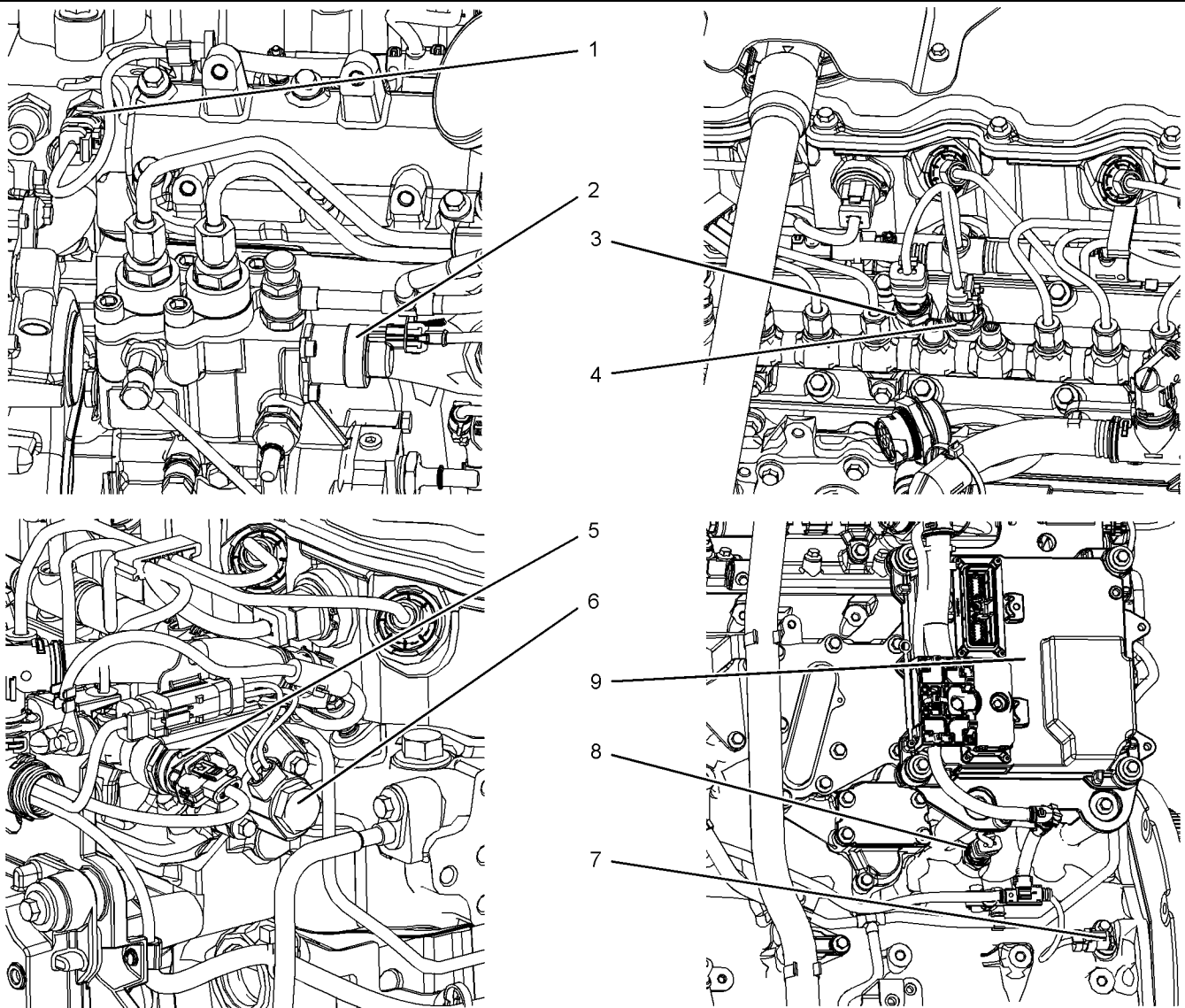


Illustration 9

g03338348

Close up views of sensor locations on the left side of the engine

- |  |  |                                     |
|--|--|-------------------------------------|
| (1) Coolant temperature sensor               | (4) Intake manifold air temperature sensor | (7) Primary speed/timing sensor     |
| (2) Solenoid for the high-pressure fuel pump | (5) Fuel rail pressure sensor              | (8) Oil pressure sensor             |
| (3) Intake manifold pressure sensor          | (6) Wastegate regulator                    | (9) Electronic Control Module (ECM) |

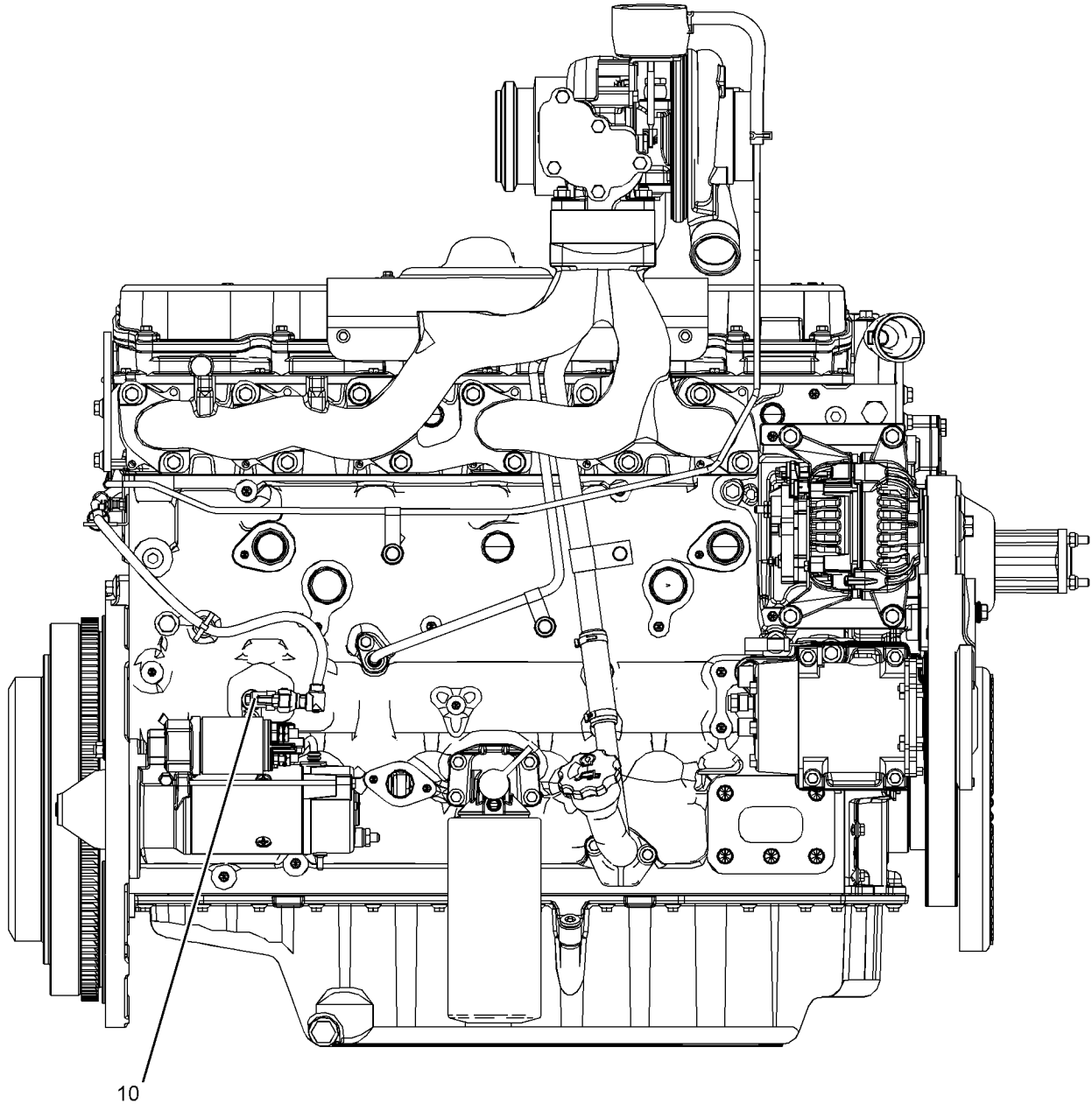


Illustration 10  
Sensor locations on the right side and top of the engine

g03338385

(10) Secondary speed/timing sensor

i05357841

Table 5

## Engine Wiring Information

Color Codes for the Harness Wire			
Color Code	Color	Color Code	Color
BK	Black	BU	Blue
BR	Brown	PU	Purple

### Harness Wire Identification

Perkins identifies all wires with 11 solid colors. The circuit number is stamped on the wire at a 25 mm (1 inch) spacing. Table 5 lists the wire colors and the color codes.

(continued)

(Table 5, contd)

RD	Red	GY	Gray
OR	Orange	WH	White
YL	Yellow	PK	Pink
GN	Green		

For example, a wire identification of T997-OR(Orange) on the schematic would signify an orange wire with the circuit number T997. T997-OR(Orange) identifies the power supply for the intake manifold pressure sensor.

**Note:** Always replace a harness wire with the same gauge of wire and with the same color code.

**Note:** In the following diagrams, "Pxxx" signifies a plug and "Jxxx" signifies a jack.

# Schematic Diagrams

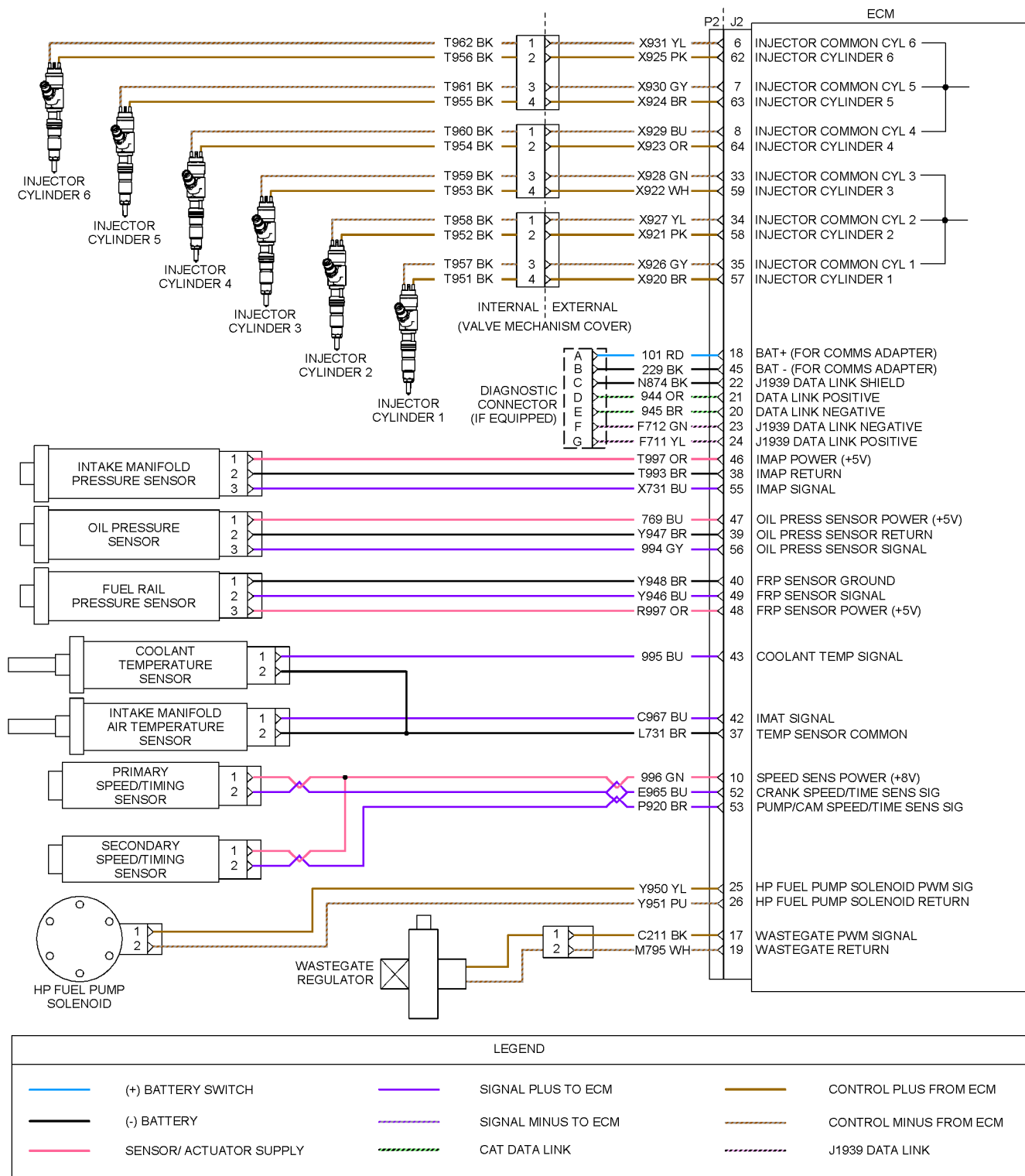


Illustration 11

Schematic diagram for the engine harness



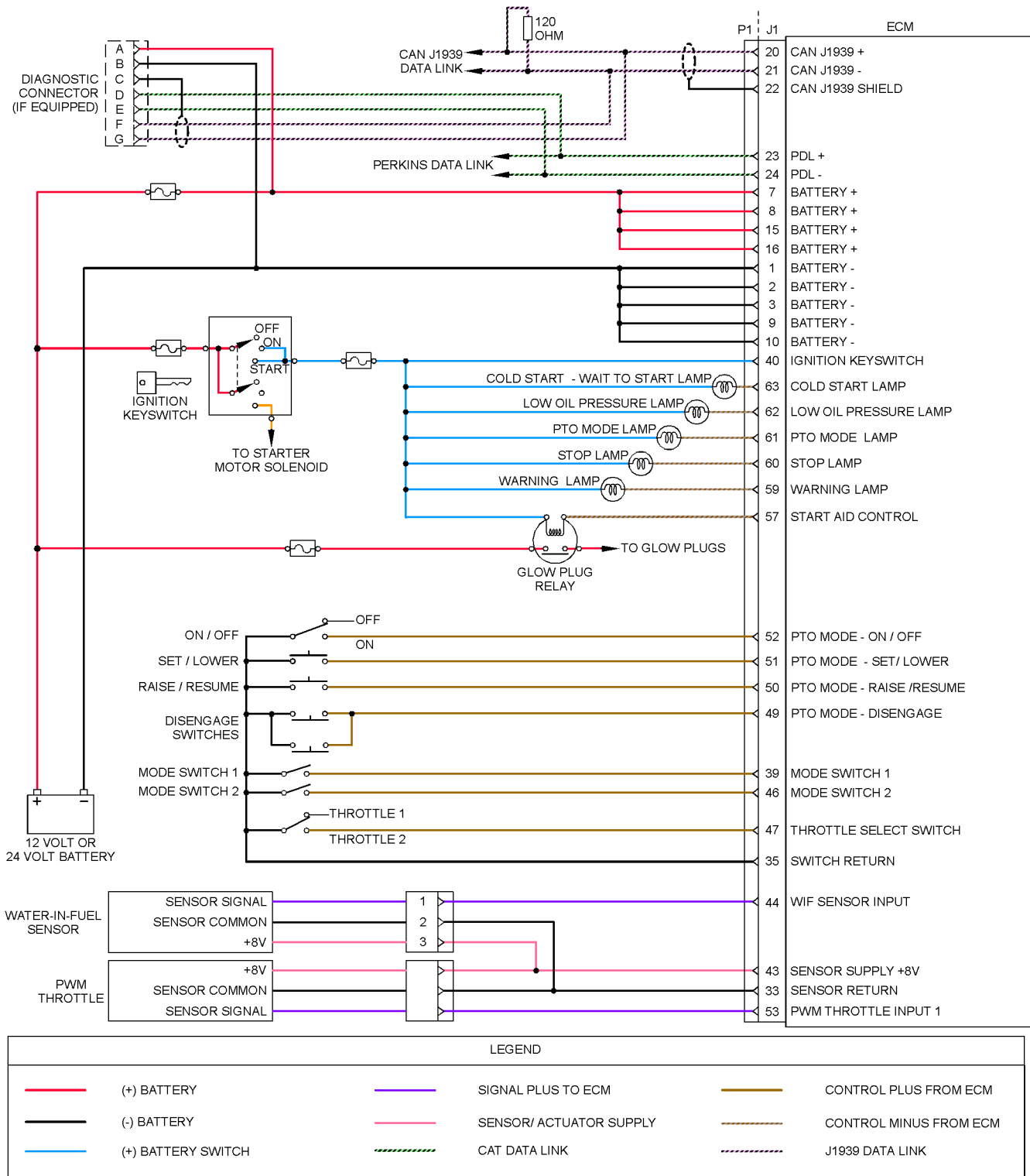


Illustration 12

Schematic Diagram for a Typical Application

g03393110

**Note:** The functionality of most of the connections to the J1 connector depend on the engine application.

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## ECM Harness Connector Terminals

The Electronic Control Module (ECM) uses connectors that have 64 terminals to interface to the wiring harness.

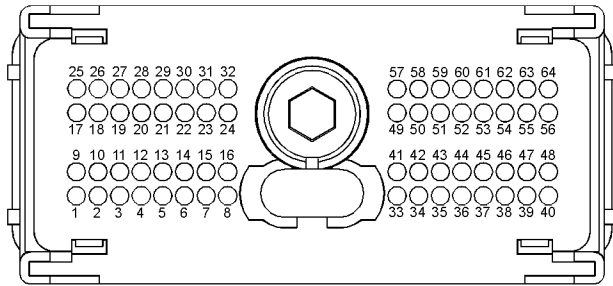


Illustration 13 g01784773

Layout of the Connector Pins (view from the rear)

## Removal and Installation of the Harness Connector Terminals

### Terminal Removal

Table 6

Required Tools		
Part Number	Part Description	Qty
27610285	Removal Tool	1

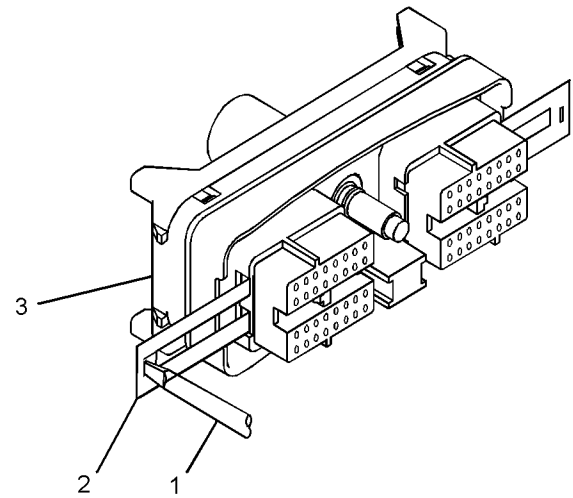


Illustration 14 g01784793

### Removal of Terminal Position Assurance Components

1. Remove the connector from the ECM. Refer to Disassembly and Assembly, "Electronic Control Module - Remove and Install".
2. Use a screwdriver that has a flat blade (1) to remove the two terminal position assurance components (2) from the connector (3).

**Note:** Do not use the removal tool to remove the terminal position assurance components.

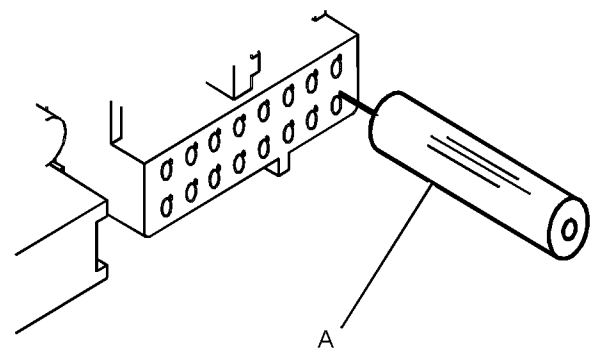


Illustration 15 g01784822

### Removal Tool

3. Insert the removal tool into the hole that is adjacent to the terminal in order to release the locking device.

**Note:** Make sure that the tool stays perpendicular to the face of the connector.

4. Hold the tool in position and gently pull the wire in order to remove the terminal from the rear of the connector (3).
5. Remove the removal tool from the face of the connector (3).

**Note:** If a terminal must be replaced, part number 28170085 must be used.

### **Terminal Insertion**

1. Push the terminal into the rear of the connector (3) until the terminal engages with the locking device.
2. Gently pull on the wire in order to make sure that the terminal is retained by the locking device.
3. Install the two terminal position assurance components (2) into the sides of the connector (3).
4. Connect the connector to the ECM. Refer to Disassembly and Assembly, "Electronic Control Module - Remove and Install".

# Programming Parameters

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## Programming Parameters

The electronic service tool can be used to view certain parameters that can affect the operation of the engine. The electronic service tool can also be used to change certain parameters. The parameters are stored in the Electronic Control Module (ECM). Some of the parameters are protected from unauthorized changes by passwords. Parameters that can be changed have a tattletale number. The tattletale number shows if a parameter has been changed.

i03478863

## Test ECM Mode

“Test ECM Mode” is a feature in the software that can be used to help troubleshoot an engine that may have a fault in the Electronic Control Module (ECM). This feature allows a standard ECM to be used as a test ECM. This feature eliminates the need to stock a test ECM.

1. Search for the latest flash file for the engine.

**Note:** If a newer software version is available for the engine, install the newest software on the suspect ECM. If the new software does not eliminate the fault, continue with this procedure.

2. Use the “Copy Configuration” feature on the electronic service tool to copy the parameters from the suspect ECM.

**Note:** If the “ECM Replacement” feature cannot be used, record the programmed values into the “Customer Specified Parameters Worksheet”. Also record the system configuration parameters.

3. Disconnect the suspect ECM. Temporarily connect the test ECM to the engine. Do not mount the test ECM on the engine.
4. Flash program the test ECM with the newest software that is available.
5. Start the “Test ECM Mode” on the electronic service tool. Access the feature through the “Service” menu. The electronic service tool will display the status of the test ECM and the hours that are remaining for the “Test ECM Mode”.

**Note:** “Test ECM Mode” can only be activated if the engine serial number has not already been programmed during normal operation of the ECM. If the engine serial number is programmed and the ECM is not in “Test ECM Mode”, the ECM can never be used as a test ECM.

6. Use the “Copy Configuration” feature on the electronic service tool to program the test ECM.

**Note:** If the “ECM Replacement” feature can not be used, program the test ECM with the values from the “Customer Specified Parameters Worksheet” and the values from the System Configuration Parameters.

7. Program the engine serial number into the test ECM.

**Note:** The “Test ECM Mode” must be activated before the engine serial number is programmed into the ECM.

8. Verify that the test ECM eliminates the fault.

When the “Test ECM Mode” is activated, an internal timer sets a 24 hour clock. This clock will count down only while the ECM is powered and the keyswitch is in the ON position. After the ECM has counted down the 24 hour period, the ECM will exit the “Test ECM Mode”. The parameters and the engine serial number will be set.

If the test ECM eliminates the fault, the engine can be released while the “Test ECM Mode” is still active.

Once an ECM has been activated in the “Test ECM Mode”, the ECM will stay in the “Test ECM Mode” until the timer times out. If the ECM is used as a test ECM for more than one engine, the “Test ECM Mode” must be reactivated. Anytime prior to the “Test ECM Mode” timing out, the ECM can be reset to 24 hours.

i03434261

## Factory Passwords

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### NOTICE

Operating the engine with a flash file not designed for that engine will damage the engine. Be sure the flash file is correct for your engine.

---

**Note:** Factory passwords are provided only to Perkins dealers.

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

- Program a new Electronic Control Module (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, some parameters are protected by factory passwords.

- Rerate the engine.

This may require changing the interlock code, which is protected by factory passwords.

- Clear engine events and certain diagnostic codes.

Most engine events require factory passwords in order to clear the code from ECM memory. Clear these codes only when you are certain that a fault has been rectified. For example, the E362-1 Engine Overspeed requires the use of factory passwords in order to clear the code from ECM memory.

Since factory passwords contain alphabetic characters, the electronic service tool must be used to perform these functions. In order to obtain factory passwords, proceed as if you already have the password. If factory passwords are needed, the electronic service tool will request the factory passwords and the electronic service tool will display the information that is required to obtain the passwords.

i03807230

## Flash Programming

**Flash Programming** – A method of loading a flash file into the Electronic Control Module (ECM)

The electronic service tool can be utilized to program a flash file into the ECM. The programming transfers the flash file from the PC to the ECM.

### Flash Programming a Flash File

1. Obtain the part number for the new flash file.

**Note:** If you do not have the part number for the flash file, use “PTMI” on the Perkins Intranet.

**Note:** You must have the engine serial number in order to search for the part number for the flash file.

2. Connect the electronic service tool to the service tool connector.
3. Turn the keyswitch to the ON position. Do not start the engine.

4. Select “WinFlash” from the “Utilities” menu on the electronic service tool.

**Note:** If “WinFlash” will not communicate with the ECM, refer to Troubleshooting, “Electronic Service Tool Will Not Communicate with ECM”.

5. Program the flash file into the ECM.
  - a. Select the engine ECM under the “Detected ECMs” .
  - b. Press the “Browse” button in order to select the part number of the flash file that will be programmed into the ECM.
  - c. When the correct flash file is selected, press the “Open” button.
  - d. Verify that the “File Values” match the application. If the “File Values” do not match the application, search for the correct flash file.
  - e. When the correct flash file is selected, press the “Begin Flash” button.
  - f. The electronic service tool will indicate when programming has been successfully completed.

6. Start the engine and check for proper operation.

7. Access the “Configuration” screen under the “Service” menu in order to determine the parameters that require programming. Look under the “Tattletale” column. All of the parameters should have a tattletale of 1 or more. If a parameter has a tattletale of 0, program that parameter.

### “WinFlash” Error Messages

If you receive any error messages during programming, click on the “Cancel” button in order to stop the process. Access the information about the “ECM Summary” under the “Information” menu. Ensure that you are programming the correct flash file for your engine.

i05353503

## Mode Switch Setup

The Mode Switches can be used to change the performance characteristics of the engine. The electronic service tool is used to program the characteristics. Select the “Service” drop-down menu and then select “Engine Operating Mode Configuration” . A maximum of two switches can be used. “Switch 1” is connected to J1:39 Mode Switch 1. “Switch 2” is connected to J1:46 Mode Switch 2. The other contact on both switches is connected to J1:35 Switch Return.

## Number of Switch Inputs

This number is the total number of switches that will be used. The switches can be individual switches or a multiple rotary switch.

Table 7

Range	Default
0 to 2	0

## Mode Selection Number

This parameter is a non-programmable parameter that represents the number of possible combinations of switch positions. This parameter is based on the value that is programmed into the “Number of Switch Inputs” parameter. “Open” signifies that the switch is in the OFF position. “Ground” signifies that the switch is in the ON position.

## Mode Selection Switch Input 2 and Mode Selection Switch Input 1

The number of these non-programmable parameters that are visible depends on the value that is programmed into the “Number of Switch Inputs” parameter. “Open” signifies that the switch is in the OFF position. “Ground” signifies that the switch is in the ON position.

## Enabled

If “Yes” is selected, the ECM is programmed to use the values in “Rating Number”, “Throttle 1 Droop Percentage”, “Throttle 2 Droop Percentage” and “TSC1 Droop Percentage” for the given combination of switch positions.

Table 8

Values	Default	Factory Password
Yes No	No	Yes

## Rating Number

This parameter is the engine rating that is used by the Electronic Control Module (ECM) for a given combination of switch positions. There is a maximum of four ratings in a flash file.

Table 9

Range	Default	Factory Password
1 to the maximum number of ratings in the currently installed Flash File	1	No

## Rated Speed (RPM)

This parameter represents the engine speed that is selected when the mode switch or the mode switches are in a particular position.

Table 10

Range	Default	Factory Password
“Programmed Low Idle” to “Programmed High Idle”	5.0%	No

## Throttle 1 Droop Percentage

This parameter represents the amount of droop that is applied to the “Throttle 1” input.

Table 11

Range	Default	Factory Password
0 to 10 percent	5.0%	No

## Throttle 2 Droop Percentage

This parameter represents the amount of droop that is applied to the “Throttle 2” input.

Table 12

Range	Default	Factory Password
0 to 10 percent	5.0%	No

## TSC1 Droop Percentage

This parameter represents the amount of droop that is applied to the “Torque Speed Control 1(TSC1)” input.

Table 13

Range	Default	Factory Password
0 to 10 percent	5.0%	No

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## Throttle Setup

The engine can have a digital throttle that uses a Pulse Width Modulated (PWM) signal, an analog throttle, or a multi-position switched throttle. The Electronic Control Module (ECM) must be programmed for the type of throttle input that is being used.

Table 14

Throttle 1	Throttle 2
PWM (Digital Throttle)	Analog Throttle
PWM (Digital Throttle)	None
PWM (Digital Throttle)	Multi-position Throttle Switch

(continued)

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