CATERPILLAR®

Electrical and Electronic Application and Installation Guide

- **2000 C-10, C-12, C-15, & C-16 Truck Engines**

LEBT9010-01

11-99

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INTRODUCTION AND PURPOSE

Electronic engine controls have been developed for heavy duty diesel truck engines to improve performance and fuel consumption. Caterpillar developed an electronic control system and fuel system with electronically controlled unit injectors for the C-10, C-12, C-15 and C-16 truck engines. A description of that system follows.

This document is intended to provide necessary information for correct electrical & electronic application and installation of the C-10, C-12, C-15 and C-16 truck engines into an on-highway truck, bus, motor coach or vocational chassis. Caterpillar expects there will be some additions and modifications to this document as the engine program development continues, and as OEM requests for information not currently addressed are added. The information contained in this version of the document reflects the Caterpillar design for production engines built as of the publication date with NOV99 Personality Module Software.

General Electronic Engine Operation

1.0 Engine Functions

1.1 Electronic Governing

A full engine speed range electronic governor is used. The electronic governor functions like the Caterpillar mechanical governor in the mid operating range but includes the special features of isochronous low idle and the reduction of governor overrun.

1.2 Fuel/Air Ratio Control

The control system has full authority over engine fuel delivery. The mechanical fuel/air ratio control is eliminated. Electronic control of the fuel/air ratio provides optimum performance while limiting emissions.

1.3 Injection Timing Control

Injection timing is varied as a function of engine operating conditions to optimize engine performance for emissions, noise, fuel consumption, and drivability.

1.4 Torque Rise Shaping

Electronic controls provide increased flexibility to tailor the torque curve over a wide speed range.

1.5 Engine Monitoring

The control system includes an Engine Monitoring feature which monitors engine oil pressure, engine coolant temperature and intake manifold air temperature. Coolant Level is also available as an OEM installed option. All C-10, C-12, C-15 and C-16 engines are shipped with the Caterpillar oil pressure sensor, coolant temperature sensor and intake manifold air temperature sensor installed. There are four Customer Programmable Levels for the Engine Monitoring system:

1) Off

2) Warning

3) Derate

4) Shutdown

1.5.1 Engine Monitoring Coolant Level Sensor

The OEM is responsible for providing, installing, and programming the ECM to monitor the coolant level sensor. The coolant level sensor will respond to the programmed level of Engine Monitoring System. Coolant Level is selected/programmed through a separate Customer Programmable Parameter “Coolant Level Sensor” with a default factory setting of No (Not Installed). For installation guidelines, programming options, and sensor electrical requirements refer to “11.0 Coolant Level Sensor” on page 42.

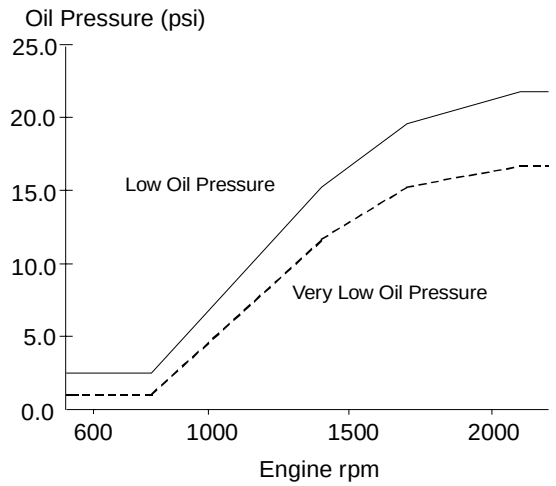
1.5.2 Engine Monitoring Programmed "Off"

The ECM will not indicate low oil pressure, low coolant level, high coolant temperature or high intake manifold air temperatures. Coolant Temperature will be used for Cold Mode and cooling fan control. Intake Manifold Air Temperature is used for cold air operation and for cooling fan control. Coolant Level sensing is not used.

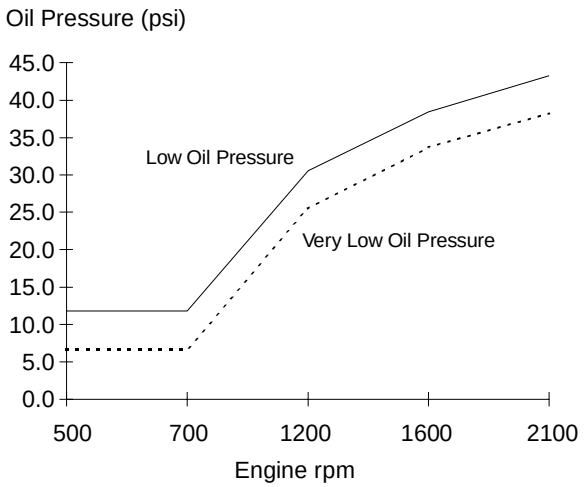
1.5.3 Engine Monitoring Programmed to "Warning"

If Engine Monitoring is programmed to Warning, the ECM monitors oil pressure, coolant temperature, intake manifold air temperature, and coolant level (if a coolant level sensor is installed). The following table and graph indicate the diagnostic codes available, their trip point, and their effect on engine performance when active. The Check Engine Lamp will flash and the Warning Lamp will illuminate as indicated in the table when the diagnostic code is active.

PID-FMI	Code Description	C-10 and C-12 Trip Points	C-15 and C-16 Trip Point	Warning Lamp	Derate
100-01	Low Oil Pressure Warning	See Figure1	See Figure1	SOLID	NONE
100-11	Very Low Oil Pressure	See Figure1	See Figure1	SOLID	NONE
105-00	High Intake Manifold Air Temp. Warning	195°F (91°C)	195°F (91°C)	SOLID	NONE
105-11	Very High Intake Manifold Air Temp.	229°F (109°C)	229°F (109°C)	SOLID	NONE
110-00	High Coolant Temp. Warning	218°F (103°C)	227°F (108°C)	SOLID	NONE
110-11	Very High Coolant Temperature	224°F (107°C)	233°F (112°C)	SOLID	NONE
111-01	Low Coolant Level Warning	See Figure 2	See Figure 2	SOLID	NONE
111-11	Very Low Coolant Level	See Figure 2	See Figure 2	SOLID	NONE



C-10 & C-12 Engine Monitoring Oil Pressure Graph



C-15 & C-16 Engine Monitoring Oil Pressure Graph

Figure 1 - Low Oil Pressure Graphs

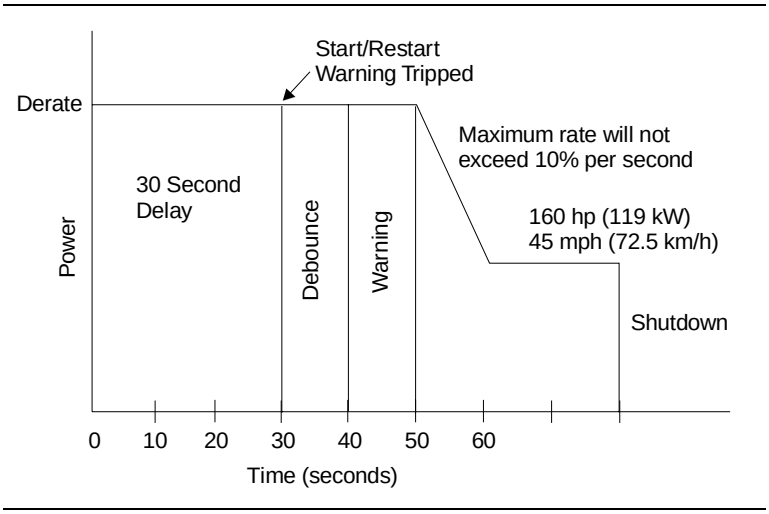


Figure 2 - Low and Very Low Coolant Level Graph

1.5.4 Engine Monitoring Programmed to "Derate" or "Shutdown"

If Engine Monitoring is programmed to Derate or Shutdown the ECM will alter engine performance when operating parameters are exceeded. Whenever the engine is derated, the Check Engine Lamp (due to active diagnostic) and Warning Lamp will flash. For the DERATE column in the following table, mph indicates vehicle speed is limited (maximum speed is 45 mph [72.5 km/h]), "pwr" indicates engine power is limited (maximum derate is 160 hp [119 kW]), and rpm indicates engine speed is limited (maximum derate is 1350 rpm). For operating conditions causing these codes see the appropriate section for the sensor under consideration.

PID-FMI	Code Description	C-10 and C-12 Trip Points	C-15 and C-16 Trip Point	Warning Lamp	Derate
100-01	Low Oil Pressure Warning	See Figure1	See Figure1	SOLID	NONE
100-11	Very Low Oil Pressure	See Figure1	See Figure1	FLASH	mph, pwr, rpm
105-00	High Intake Manifold Air Temp. Warning	195°F (91°C)	195°F (91°C)	SOLID	NONE
105-11	Very High Intake Manifold Air Temp.	229°F (109°C)	229°F (109°C)	SOLID	NONE
110-00	High Coolant Temperature Warning	218°F (103°C)	227°F (108°C)	FLASH	mph, pwr
110-11	Very High Coolant Temperature	224°F (106°C)	233°F (112°C)	FLASH	mph, pwr
111-01	Low Coolant Level Warning	See Figure 2	See Figure 2	SOLID	NONE
111-11	Very Low Coolant Level	See Figure 2	See Figure 2	FLASH	mph, pwr

1.5.5 Engine Monitoring Time to Shutdown

The following table indicates active diagnostic codes capable of shutting down the engine when the ECM is programmed to Shutdown. The “Time to Shutdown” column indicates the minimum time before the engine will shutdown if the engine has already been running for at least 30 seconds. “Start/Restart Time” is running time if the code is active when the engine starts, or following an Engine Monitoring caused shutdown. “NO” indicates the code will not shutdown the engine. Note these times assume the condition causing the code exists continuously and is not intermittent.

PID-FMI	Code Description	Time To Shutdown	Start/Restart Time
100-01	Low Oil Pressure Warning	NO	NO
100-11	Very Low Oil Pressure	30 SEC.	18 SEC.
105-00	High Intake Manifold Air Temperature Warning	NO	NO
105-11	Very High Intake Manifold Air Temperature	NO	NO
110-00	High Coolant Temperature Warning	NO	NO
110-11	Very High Coolant Temperature	20 SEC.	60 SEC.
111-01	Low Coolant Level Warning	NO	NO
111-11	Very Low Coolant Level	30 SEC.	80 SEC.

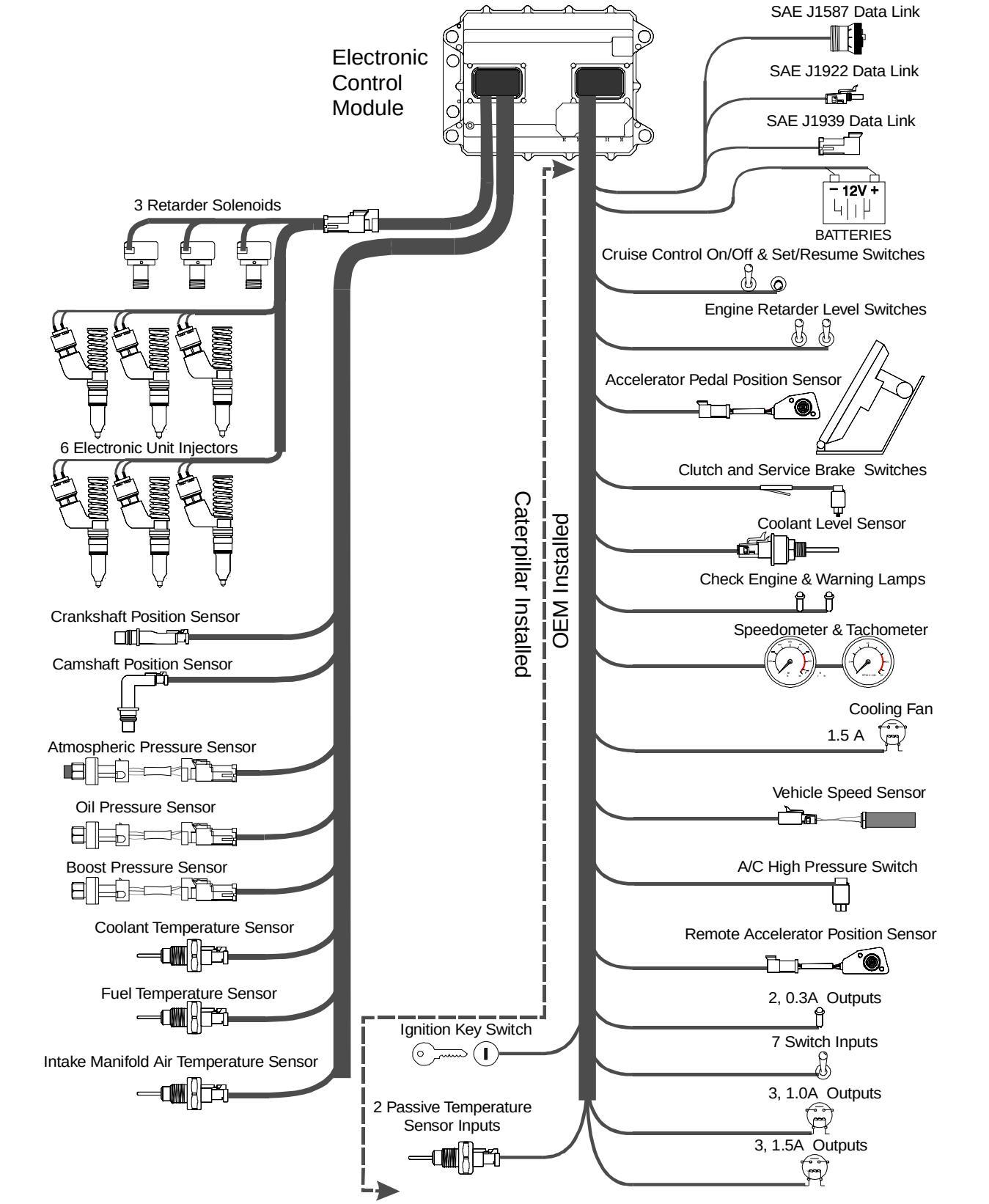


Figure 3 - C-10, C-12, C-15 and C-16 Component Diagram

2.0 Engine Component Overview

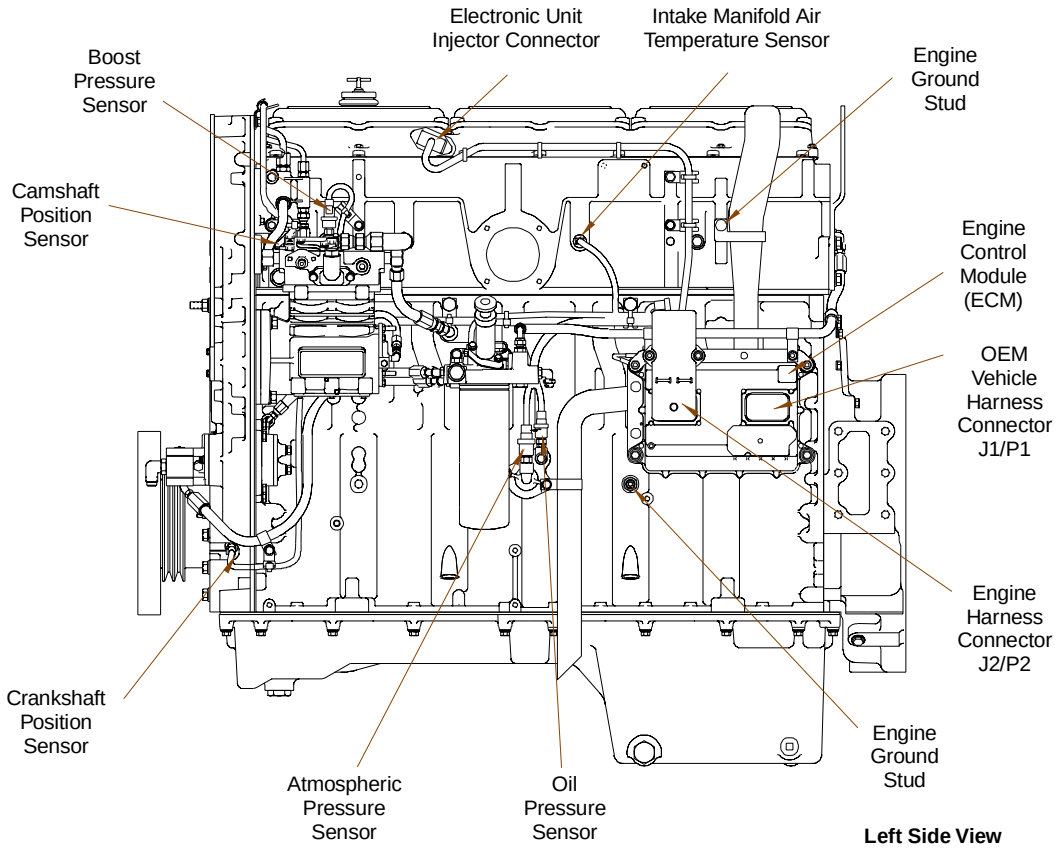


Figure 4 - C-15 and C-16 Left Side View

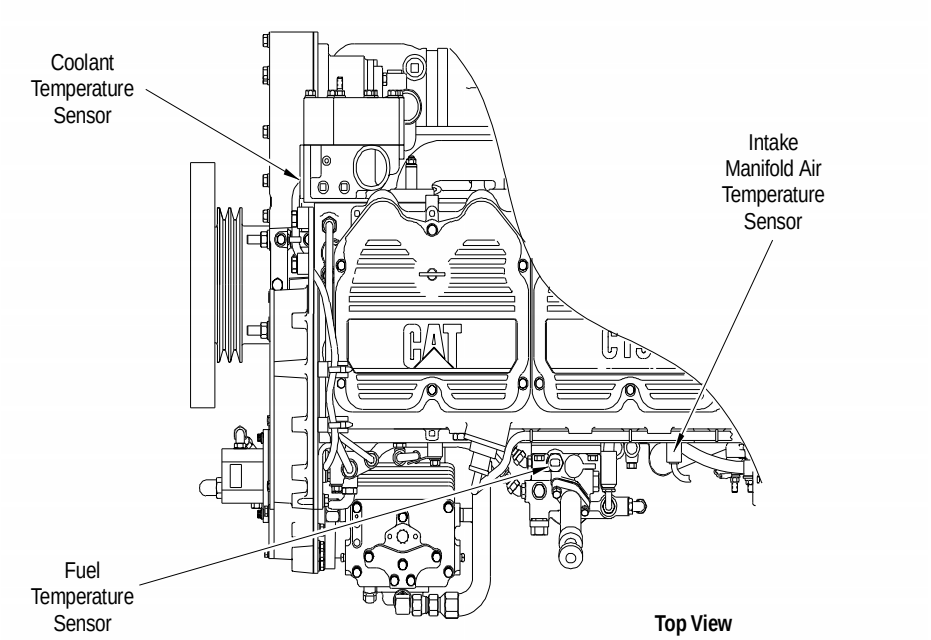


Figure 5 - C-15 and C-16 Right Side and Front View

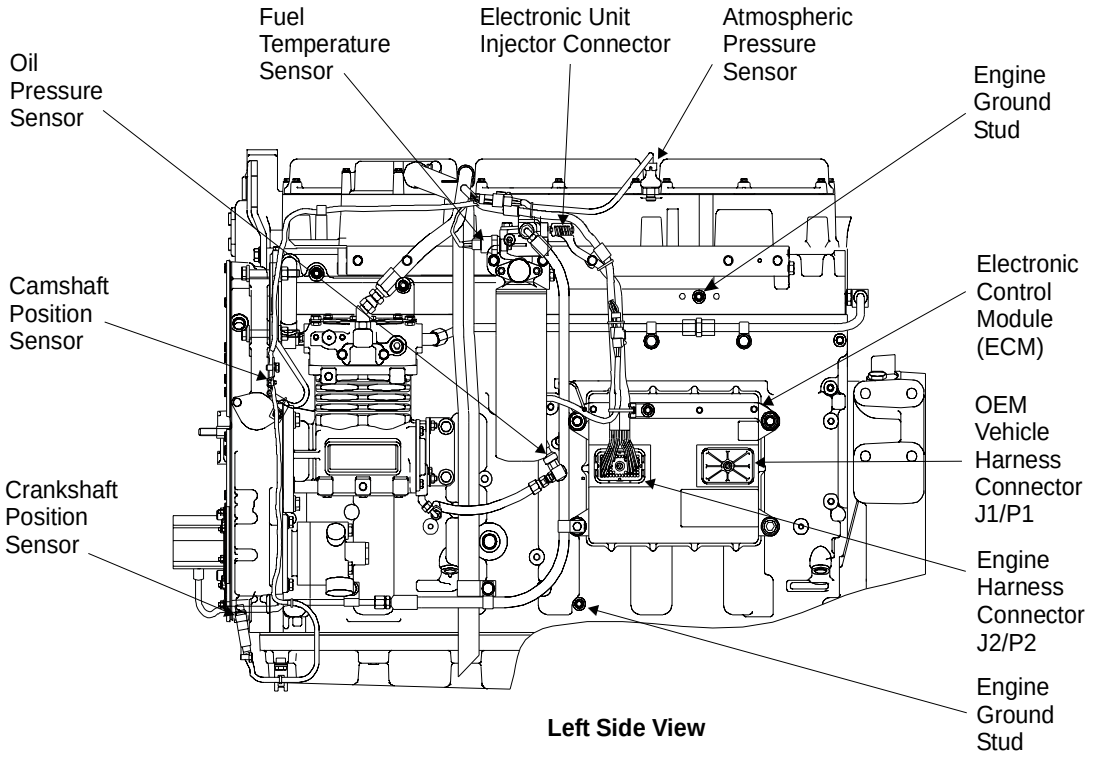


Figure 6 - C-10 and C-12 Left Side View

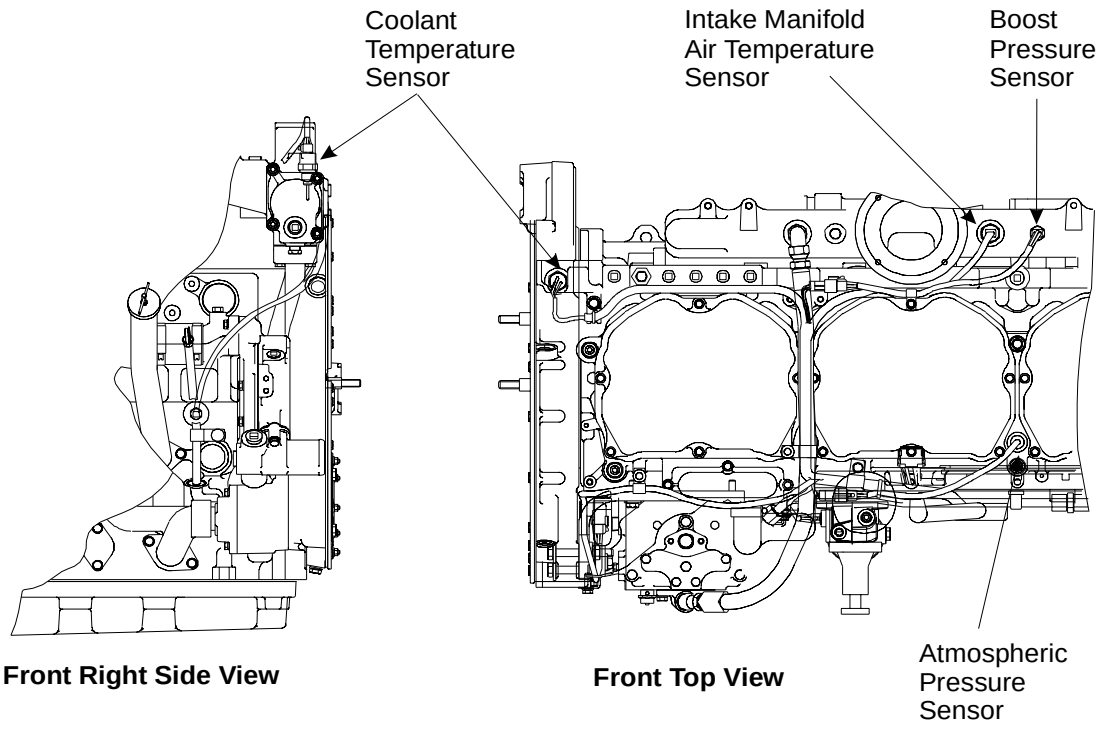


Figure 7 - C-10 and C-12 Right Side and Top View

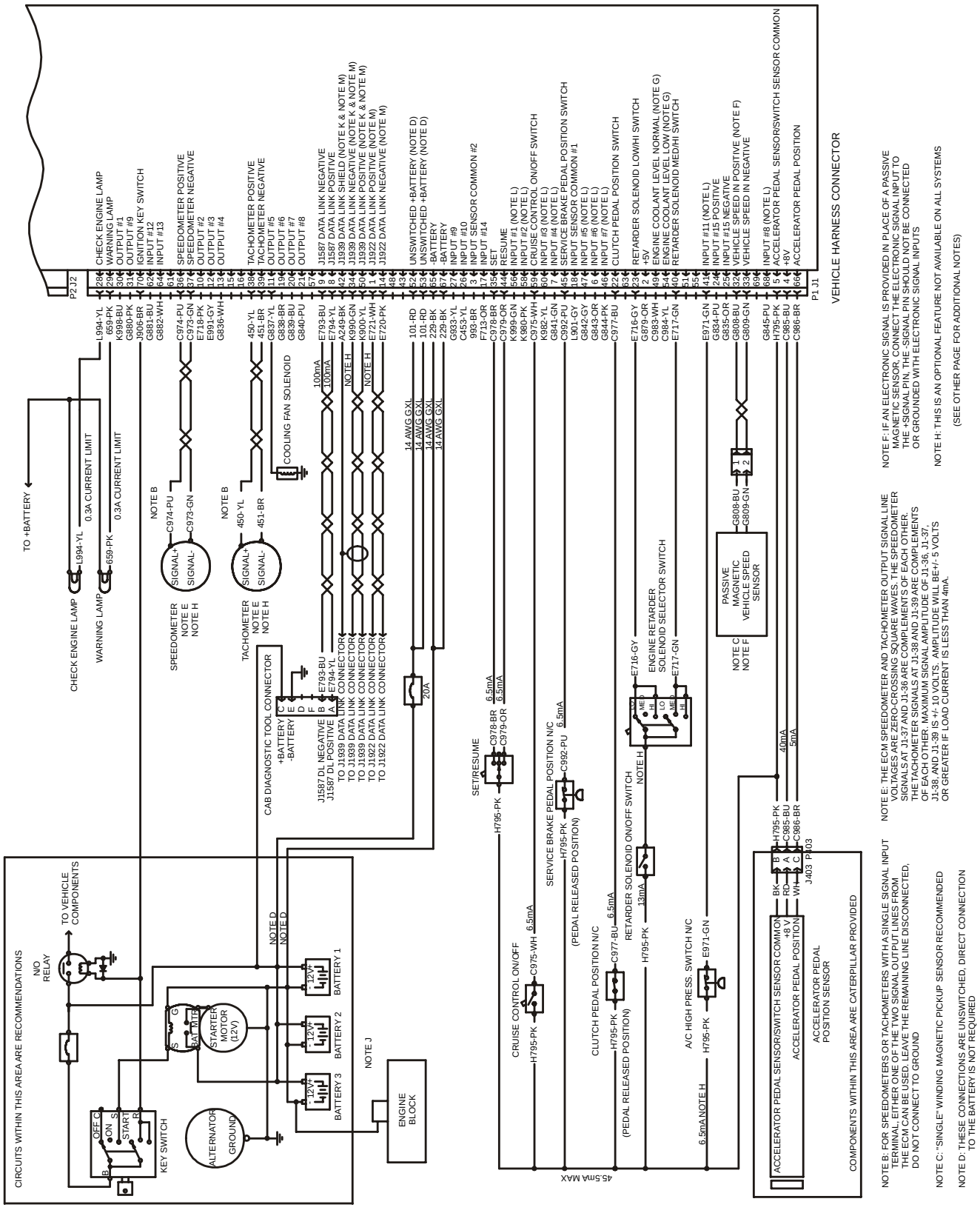


Figure 8 - C-10, C-12, C-15 and C-16 Vehicle Harness Wiring Diagram

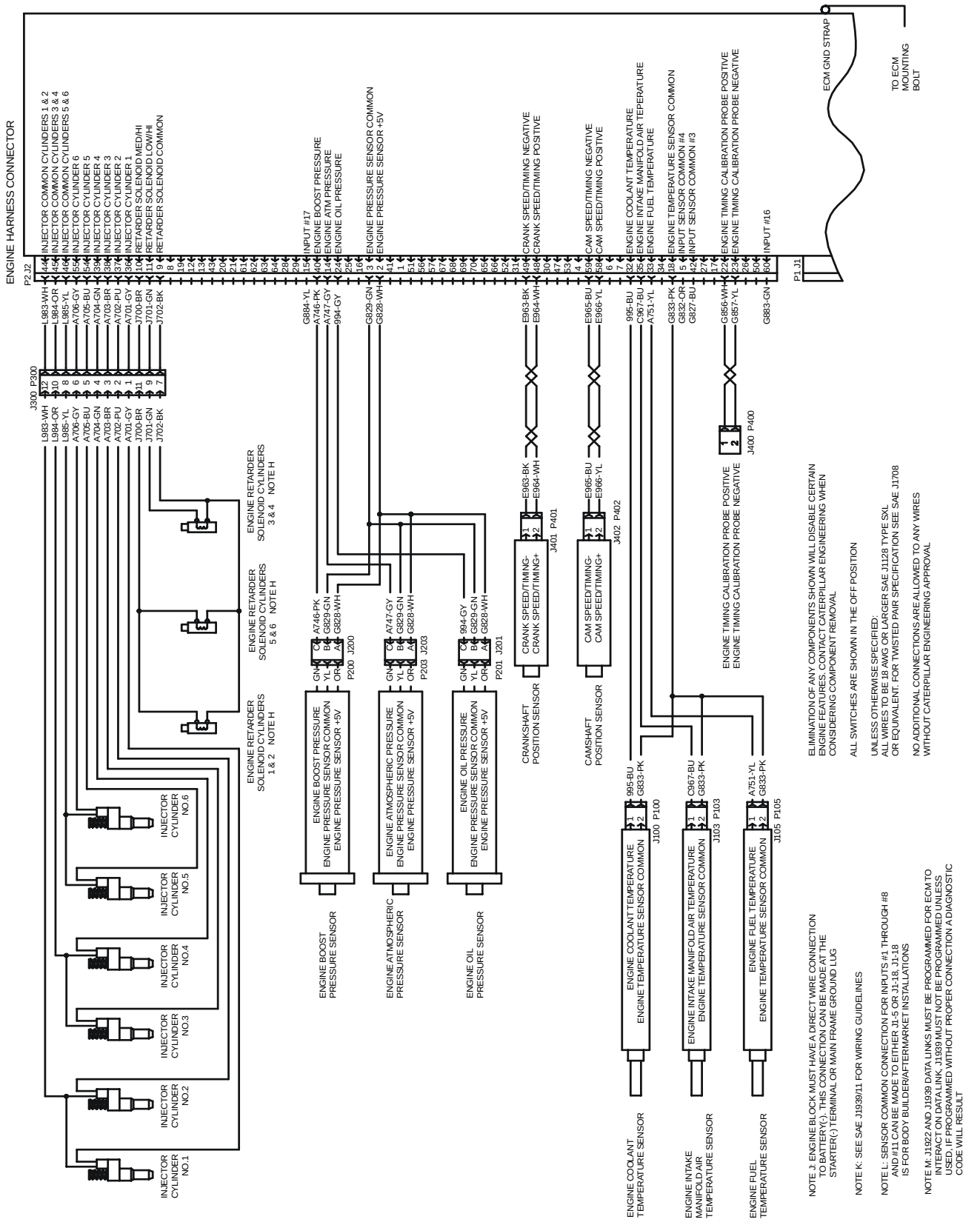


Figure 9 - C-10, C-12, C-15 and C-16 Engine Harness Wiring Diagram

2.1 Engine Control Module (ECM)

The ECM is located on the left rear side of the engine. The ECM has two connectors, one for the Caterpillar Engine Harness, the other for the Vehicle OEM Harness.

2.2 Boost Pressure Sensor

The Boost Pressure Sensor is an absolute pressure sensor measuring intake manifold air pressure. Boost Pressure as displayed by service tools and communicated over the data link is the value obtained by subtracting the atmospheric pressure (as measured by the Atmospheric Pressure Sensor) from the absolute value measured by the Boost Pressure Sensor for all C-10, C-12, C-15 and C-16 engines.

The Boost Pressure Sensor can measures pressures from 0 kPa (0 psi) up to 472 kPa (68 psi). The sensor is supplied by the ECM with 5 Volts DC.

2.3 Atmospheric Pressure Sensor

The Atmospheric Pressure Sensor is an absolute pressure sensor measuring crankcase pressure. Both the Boost Pressure and Oil Pressure communicated to service tools and over the data link is calculated by subtracting the Atmospheric Pressure Sensor reading.

The Atmospheric Pressure Sensor can measure pressures from 0 kPa (0 psi) to 116 kPa (16.8 psi). The sensor is supplied by the ECM with 5 Volts DC.

2.4 Oil Pressure Sensor

The Oil Pressure Sensor is an absolute pressure sensor measuring oil pressure in the oil gallery. The difference between the pressure measured by this sensor (oil pressure) and the atmospheric pressure is the Oil Pressure as displayed on the service tools and communicated over the data link. The ECM uses this sensor input only if the parameter for engine monitoring is programmed to Warning, Derate, or Shutdown.

The Oil Pressure Sensor can measures pressure from 0 kPa (0 psi) to 1135 kPa (165 psi). The sensor is supplied by the ECM with 5 Volts DC.

2.4.1 Oil Pressure Engine Monitoring Operation

If Engine Monitoring is programmed to Warning, Derate or Shutdown the graphs in Figure 1 - “Low Oil Pressure Graphs” on page 8 determine engine operation. The C-10, C-12, C-15 and C-16 engines use different trip points to determine both the Low and Very Low Oil Pressure values. Low and Very Low are used because they indicate the trip points for the associated diagnostic codes.

2.5 Coolant Temperature Sensor

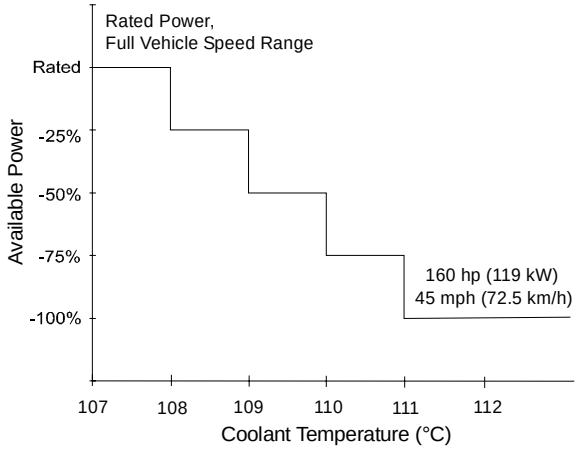
Coolant Temperature is used to control “Cold Mode” operation and for Engine Monitoring. The coolant temperature sensor is a thermistor (passive sensor) not requiring a supply voltage.

2.5.1 Cold Mode Operation

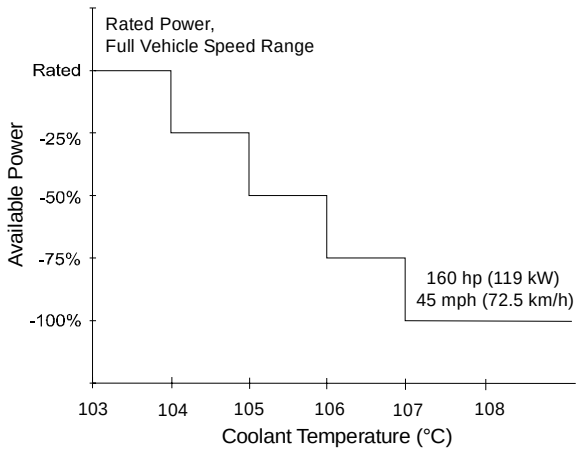
Cold Mode Operation is activated whenever the coolant temperature is below 64°F (18°C). Cold Mode remains active until Coolant Temperature exceeds 18°C (64°F). In Cold Mode, engine power is limited and the low idle engine speed may be elevated. Cold Mode is not disabled if the Engine Monitoring feature is programmed to OFF.

2.5.2 Coolant Temperature Engine Monitoring Operation

If Engine Monitoring is programmed to Derate or Shutdown, the ECM will cause the Check Engine and Warning Lamp to flash if an excessive coolant temperature is detected. The graphs in Figure 10 - “Coolant Temperature Graphs” on page 17 indicate engine operation with Engine Monitoring Programmed to Derate. The diagnostic codes High Coolant Temperature Warning (110-00) and Very High Coolant Temperature (110-11) are triggered at 218°F (103°C) and 224°F (107°C) respectively for C-10 and C-12 and at 227°F (108°C) and 233°F (112°C) respectively for the C-15 and C-16. If Engine Monitoring is programmed to Warning, the ECM will log the appropriate code, turn the Warning Lamp on solid and take no further action. The ECM will not derate the engine if programmed to Warning.



C-15 & C-16 Coolant Temperature Graph



C-10 and C-12 Coolant Temperature Graph

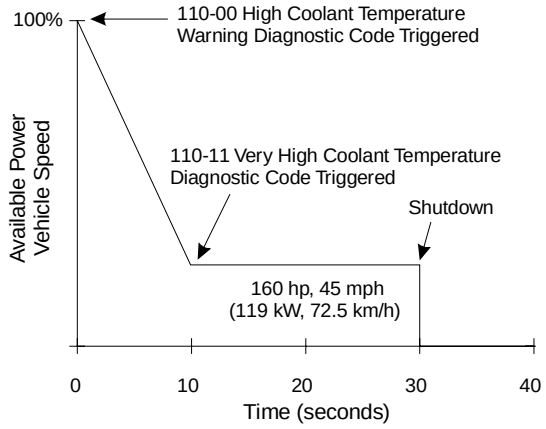
Figure 10 - Coolant Temperature Graphs

The ECM derates available power and limits vehicle speed in steps as temperature increases. Each step represents a reduction in available power and limits vehicle speed as follows:

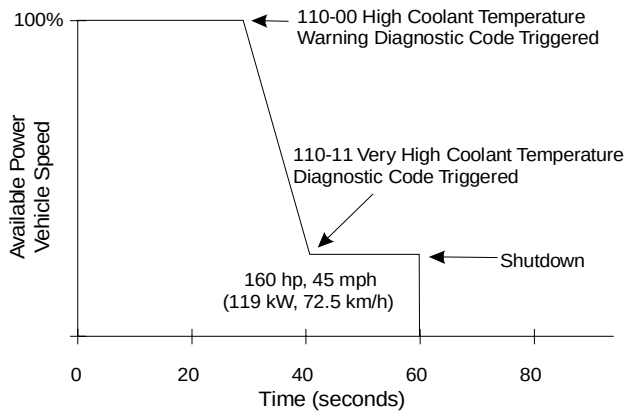
HP REDUCTION = 25% X (rated HP - 160 hp [119 kW])

VSL REDUCTION = 25% X (VSL - 45 mph [72.5 km/h])

The actual rate of change of HP or VSL reduction is limited to 10% per second maximum.



Initial Shutdown for Excessive Coolant Temperature



Start/Restart Shutdown For Excessive Coolant Temperature

Figure 11 - Minimum Time To Shutdown For Excessive Coolant Temperature Graphs

Figure 11 - “Minimum Time To Shutdown For Excessive Coolant Temperature Graphs” on page 17 indicates the minimum time to shutdown due to excessive coolant temperature, assuming the coolant temperature is 107°C (224°F) for the C-10 and C-12 or 112°C (233°F) for the C-15 and C-16 or higher. Actual time to shutdown will vary if the coolant temperature lingers in the 103 - 105°C (217 - 221°F) range.

Customer Parameter programming required:

1) Engine Monitoring Mode programmed to Warning, Derate or Shutdown.

2.6 Intake Manifold Air Temperature Sensor

Intake Manifold Air Temperature is used to control the cooling fan output and for Engine Monitoring. The intake manifold air temperature sensor is a thermistor (passive sensor) not requiring a supply voltage.

2.6.1 Intake Manifold Air Temperature Engine Monitoring Operation

Intake Manifold Air Temperature is used to warn the driver of an excessive intake manifold air temperature. It will not cause the ECM to derate or shutdown the engine when Engine Monitoring is programmed to Derate or Shutdown.

Before a diagnostic code is logged immediately following engine start up, Intake Manifold Air Temperature must exceed the triggering temperatures indicated for 30 seconds. A High Intake Manifold Air Temperature Warning diagnostic code is triggered at 195°F (91°C), and a Very High Intake Manifold Air Temperature at 229°F (109°C). Unlike the other diagnostic codes associated with Engine Monitoring, those codes associated with Intake Manifold Air Temperature are still available when Engine Monitoring is programmed Off.

In addition to the Check Engine Lamp, the Warning Lamp is also turned ON if Engine Monitoring is programmed to Warning, Derate, or Shutdown.

Customer Parameter programming required:

1) Engine Monitoring Mode programmed to Warning, Derate or Shutdown.

2.7 Fuel Temperature Sensor

Fuel Temperature is monitored to adjust fuel rate calculations, and for fuel temperature power correction when fuel temperatures exceed 30°C (86°F) to provide constant power. Maximum power correction is achieved at 70 °C (158°F). Fuel temperatures exceeding 90°C (194°F) for 10 minutes cause a diagnostic code to be logged. The C-10, C-12, C-15 and C-16 engines include a Fuel Temperature Sensor as standard equipment.

Fuel Temperature power correction can be temporarily disabled for dynamometer testing using an Electronic Service Tool. This is intended to prevent problems caused by the engine fuel temperature power correction operating simultaneously with a dynamometer which also power corrects for fuel temperature.

2.8 Engine Speed/Timing Sensors

The engine speed/timing sensors are used to determine both engine speed and fuel injection timing. The Camshaft Position Sensor detects this information from a gear on the camshaft and the Crankshaft Position Sensor detects this information from a gear on the crankshaft. Timing calibration is performed by connecting a special magnetic sensor to the engine harness which senses motion from a notch on the crankshaft. Under normal operating conditions the engine monitors both the Camshaft and Crankshaft Position Sensor while cranking (starting) and the Crankshaft Position Sensor while running. However, the design provides for a redundant system. Should a failure occur in either of the sensor circuits, the engine can be started and will run with only one sensor.

OEM INSTALLED COMPONENT REQUIREMENTS and FEATURES

All of the functions described in the following text are available or enhanced if the vehicle OEM provides and installs appropriate components. Many of the features require programming of Customer Parameters as well as hardware components. The components (and programming of customer parameters) required for each feature are listed with the particular feature description. It is assumed the associated wire harness necessary for component connection is part of the component. Refer to the wiring harness diagram for connection details.

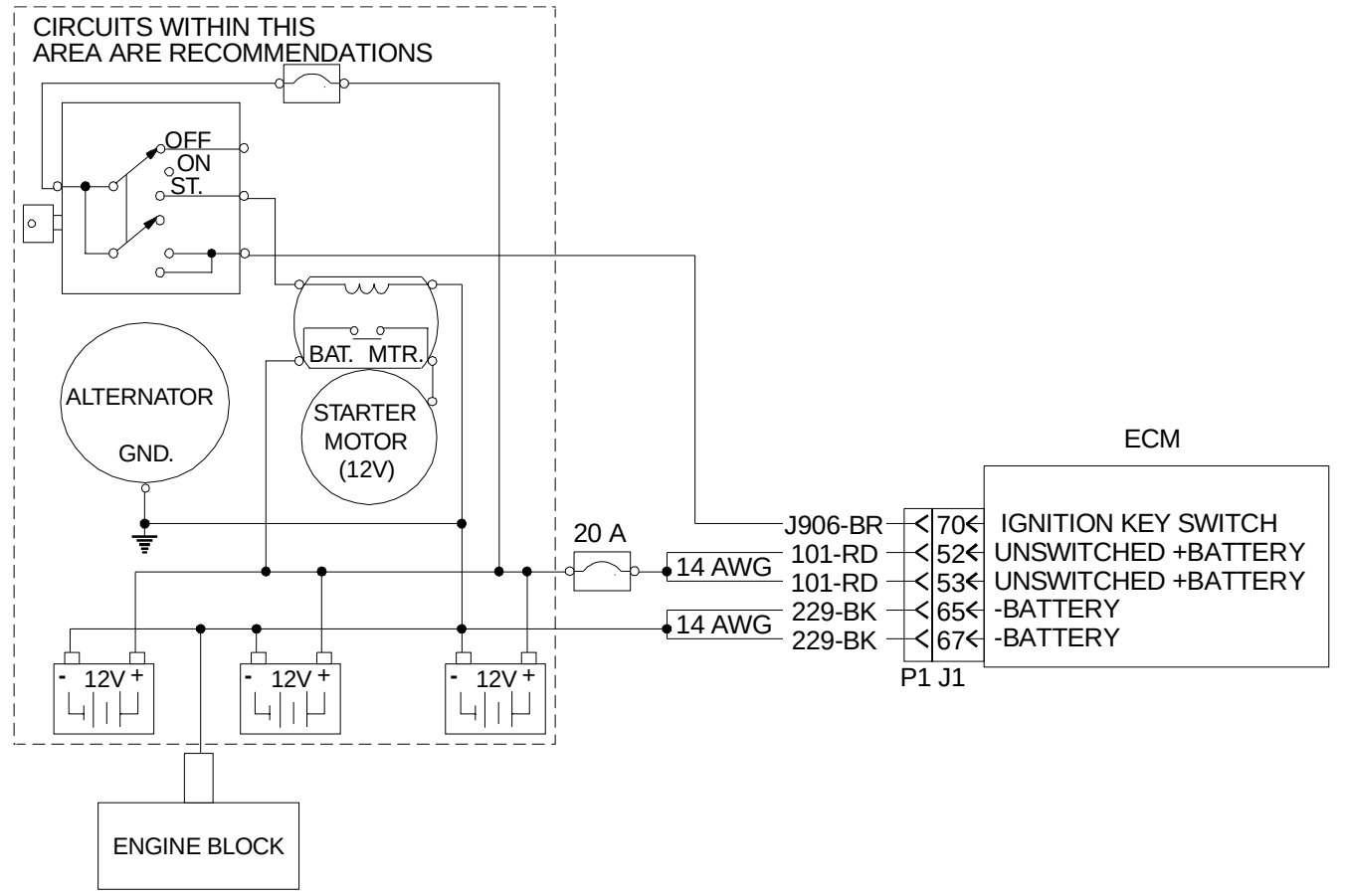
3.0 Power and Grounding Requirements and Considerations

The ECM requires unswitched power and ground connections. An Ignition Key Switch input is used to turn the ECM ON, allowing the engine to start and run.

3.1 Grounding

Proper grounding for vehicle and engine electrical systems is necessary for proper performance and reliability. Improper grounding results in unreliable electrical circuit paths. Stray electrical currents can damage main bearings, crankshaft journal surfaces, and aluminum components. They can also cause electrical noise degrading control system, vehicle, speedometer, and radio performance. These problems are often very difficult to diagnose and repair.

All ground paths must be capable of carrying any conceivable fault currents. An AWG #4 or larger cable is recommended between the engine ground stud and the frame or starter negative post to handle alternator currents. A maximum of three ring terminals are to be connected to the engine ground stud to insure ground connection integrity. More than three terminals can cause the stud to loosen too easily. Caterpillar recommends splicing like size wires together as a method of reducing ring terminal congestion at the ground stud.



Wiring Diagram 1 - ECM and Engine Stud Battery Connections

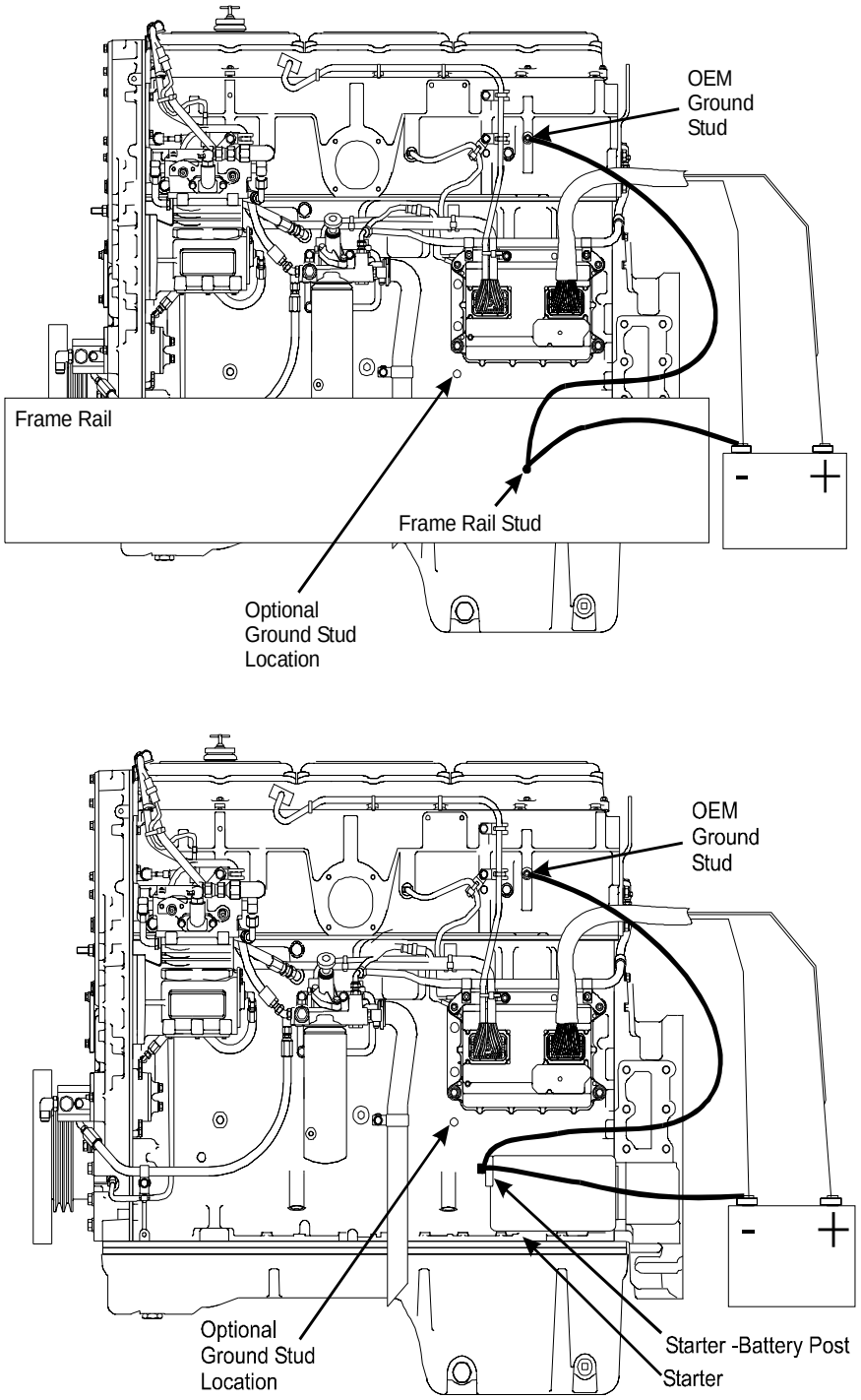


Figure 12 - Ground Stud To Frame Rail and Ground Stud to Starter Connections

3.2 Engine Connection To Vehicle Battery Ground

To insure proper functioning of the vehicle and engine electrical systems, there must be a direct wire path from the engine ground stud to the battery negative post. Caterpillar prefers this connection route through the starter negative post. In the Figures above an additional ground stud location is identified. Either one of the two locations can be used and must be specified when ordering.

A connection routed to a main frame ground, can also be made if the following guidelines are followed:

1) Connections to the frame must not be made with star washers. Star washers should not be counted on to remove paint from painted surfaces. Use flat washers for this connection, with the paint completely removed in this area.

2) Any paint must be completely removed from the frame rail at the point where the connection is made. Failure to do so reduces the effectiveness of the connection.

3) The ground path is not made through frame cross members. Bolted connections of frame cross members may not always provide required continuity for this critical connection.

4) Conductive grease or other methods used to reduce/eliminate the affect of corrosion on the frame rail connection.

Caterpillar does not recommend a connection from the engine ground stud to the main frame rail at a connection point different than where the battery ground connection is made. A two-point frame rail connection method depends on frame rail connections. Manufacturing process control of frame rail connections is difficult to control. This multiple frame rail connection scheme is also more difficult to troubleshoot.

3.3 ECM Negative Battery Connections

Caterpillar requires the OEM to install the ECM “-Battery” wires into their harness connector. These connections should be #14 AWG GXL wire. Refer to Wiring Diagram 1 - “ECM and Engine Stud Battery Connections” on page 19. Refer to 5.2 “ECM Connector Wire Gauge Size” on page 25 for more information about ECM Connector wire size.

3.3.1 C-15 and C-16 Ground Stud

The C-15 and C-16 engine ground stud, located on the cylinder head, is a 3/8 inch X 16 Thread Stud with 7/8 inch stud length.

3.3.2 C-10, C-12 Ground Stud

The C-10 and C-12 engines use a M8 X 1.25-6g thread stud with a 20 mm stud length located on the cylinder head.

3.4 Air Starter Equipped Vehicles

A connection from main frame ground can be used if the following guidelines are followed:

1) Connections to the frame must not be made with star washers. Star washers should not be counted on to remove paint from painted surfaces. Use flat washers for this connection, with the paint completely removed in this area.

2) Any paint must be completely removed from the frame rail at the point where the “-Battery” connection is made. Failure to do so reduces the effectiveness of the connection.

3) The ground path is not made through frame cross members. Bolted connections of frame cross members may not always provide required continuity for this critical connection.

4) Use conductive grease or other methods to reduce/eliminate the affect of corrosion on the frame rail connection.

3.5 Sensor Common Connections

Only those components interfacing directly to the ECM should be connected to the ECM Sensor Commons. ECM Connector P1 terminal 5 should be used to connect the ground side of the following engine control connected items: all OEM installed switches (used for engine control purposes - cruise control switches, clutch pedal position switch, service brake pedal position switch, A/C high pressure switch), engine retarder solenoid switches and the accelerator pedal position sensor. These components must not be connected to any vehicle ground.

Additional Sensor Common connections are also available. ECM terminal-18 (Input Sensor Common #1) and terminal-3 (Input Sensor Common #2) can be used if required by the harness design, for example, to splice all cab components together at terminal 5, and engine compartment components at terminal-18 or terminal-3.

Caterpillar recommends that Input Sensor Common #2 remain open for Aftermarket / Body Builder connections. If additional Sensor Common connections are required, please contact Caterpillar.

All switches connected to the control system must be externally grounded, two wire design. Internally grounded or case grounded switches must not be used.

OEM installed components used as inputs to the ECM must not be connected to the vehicle or cab ground, and must not be case grounded. OEM installed switches must be grounded to an ECM Sensor Common via a dedicated return line to the ECM.

Terminal Description	ECM Terminal Assignment
AP Sensor/Switch Sensor Common	Terminal 5
Input Sensor Common #1	Terminal 18
Input Sensor Common #2	Terminal 3

3.6 Suppression Of Voltage Transients

Caterpillar recommends transient suppression be installed at the source of the transient in addition to the suppression in the ECM. Caterpillar controls are designed to comply with SAE J1455.

The use of inductive devices such as relays and solenoids can result in the generation of voltage transients on the battery lines. Unsuppressed voltage transients can exceed SAE J1455 specifications and degrade control system performance. Some specific devices that should use transient suppression are fan clutch solenoids, A/C clutch solenoids, and all relays. This is not an all-inclusive list. The OEM should specify relays and solenoids with built-in voltage transient suppression on the vehicle where possible.

Refer to Figure 14 - “Examples of Voltage Transient Suppression” for an illustration of several possible suppression techniques to minimize the generation of voltage transients from relays and solenoids without built-in voltage transient suppression. These include, but are not limited to, installing a properly sized diode or resistor in parallel with solenoid and relay coils.

Inductive devices should be located to maximize the distance from control system components. OEM installed wiring harnesses should be routed to maximize the distance from the control system wiring harness to avoid inductive coupling of noise transients.

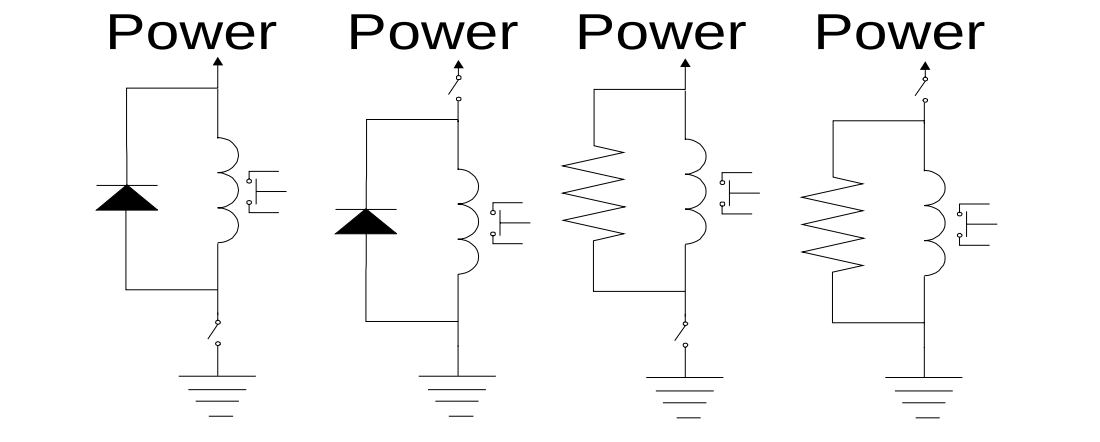


Figure 14 - Examples of Voltage Transient Suppression

3.6.1 EMI/RFI Testing

Caterpillar EMI/RFI testing on the C-10, C-12, C-15 and C-16 is performed at both the component and system level.

Component level testing is performed in a TEM cell and screen room. This radiated susceptibility testing is performed using the substitution method.

In-vehicle radiated susceptibility testing is also performed.

3.7 ECM Positive Battery Connections

There are two unswitched positive battery connections from ECM Connector P1 terminals 52 and 53 necessary for the C-10, C-12, C-15 and C-16 system. Other battery connections may be necessary, but do not directly connect to the ECM, for example, if the installation requires a Caterpillar BrakeSaver, or other auxiliary brake device.

In addition to suppressing inductive loads, powering the control system on a dedicated fused circuit will reduce the possibility of degraded control system performance due to voltage transients. No additional loads should be connected between the ECM and ECM circuit protection, refer to Wiring Diagram 1 - “ECM and Engine Stud Battery Connections” on page 19.

To prevent shutdown in the event of a short circuit in the vehicle harness the control system must be powered on a dedicated protected circuit. The wire size must be #14 AWG GXL. This connection should be made through unswitched battery providing power when the vehicle key switch is in the OFF position. Circuit protection for this circuit must be 20 amps and rated for a continuous duty load of 10 Amperes at 12 Volts DC. **Caterpillar prefers the circuit protection be located in the cab if possible. If not in the cab the circuit protection should be located in an easily accessible, and on-vehicle-documented location for service.**

The ECM monitors ECM battery voltage, and triggers a diagnostic code if the voltage to the ECM drops below 6 Volts DC and then returns above 6 Volts DC.

4.0 Voltage Requirements and Considerations

The control system has been designed to operate on 12 Volt or 24 Volt electrical systems. The control system is protected against jump start conditions and short circuits to positive battery and negative battery.

Minimum voltage requirements and maximum current draw for the C-10, C-12, C-15 and C-16 control system is as follows:

Condition	Minimum Voltage	Maximum Current Draw
Normal operation	11.0 Volts DC	10.0 Amperes
Engine cranking	6.0 Volts DC	13.0 Amperes
Ignition Key On, Engine Off	9.0 Volts DC	1.0 Amperes

Minimum voltages are specified at the OEM connector (P1 - terminals 52, 53 and P1 - terminals 65, 67).

4.0.1 Operation in 24 Volt Systems

The C-10, C-12, C-15 and C-16 can operate in 24 volt electrical systems. Circuit protection is 20 amps (same for 12 volt systems). The Output Drivers are current limited and will supply the same amount of current regardless of system operating voltage.

NOTE: If using a 24 volt system, please contact Caterpillar to determine the availability of Eaton Top 2.

4.0.2 Other Battery Connections

The pedal mounted accelerator pedal position sensor does not require separate circuit protection because it is powered from the ECM provided +8V. Installation of a remotely mounted accelerator pedal position sensor still requires separate +Battery circuit protection for this circuit. Integration of a Caterpillar factory installed engine retarder eliminates separate circuit protection for the retarder solenoid circuit.

4.0.3 ECM Supplied +5V and +8V

These supplies are designed to provide power for connection to the OEM provided and installed 4-Pin Coolant Level Sensor (+5V), and Caterpillar provides OEM installed Accelerator Pedal Position Sensor (+8V). No other vehicle components can be connected to these supplies.

4.1 Ignition Key Off Current

The ECM draws less than 20 mA while the Ignition Key Switch is OFF.

4.2 Welding on a Vehicle Equipped with a C-10, C-12, C-15 and C-16 Engine

Before welding on a vehicle equipped with an electronic engine, the following precautions should be observed.

1. Turn the engine OFF. Place the ignition key switch in the OFF position.
2. Disconnect the negative battery cable from the battery. If the vehicle is equipped with a battery disconnect switch, open the switch.

NOTICE

DO NOT use electrical components in order to ground the welder. Do not use the ECM or sensors or any other electronic component in order to ground the welder. Clamp the ground cable for the welder to the component that will be welded.

Place that clamp as close as possible to the weld. This will reduce the possibility of damage to the bearings of the drive train, hydraulic components, ground straps, and other components of the vehicle.

3. Clamp the ground cable of the welder to the component that will be welded. Place the clamp as close as possible to the weld.
4. Protect any wiring harnesses from welding debris and spatter. Use proper welding procedures in order to weld the materials.

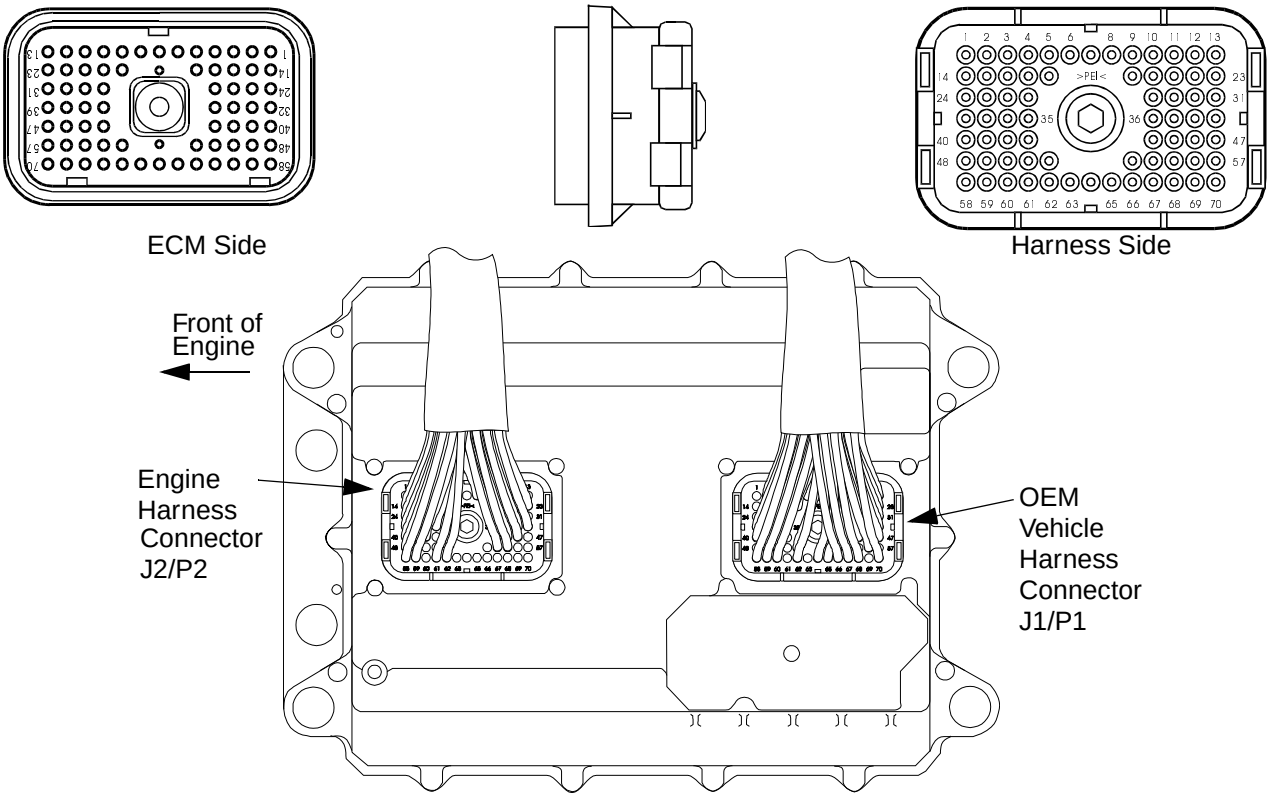


Figure 15 - ADEM 2000™ ECM and Wiring Harness Connectors

5.0 Connectors and Wiring Harness Requirements

5.1 ECM Connector

5.1.1 70 Terminal ECM Connector Part Numbers

The ECM uses an integral rectangular 70 Terminal AMP connector to interface to the OEM vehicle wiring harness (AMP part number 776241-1, Caterpillar part number 160-7689). The ECM also uses a 70 Terminal AMP connector to interface to the engine electronics (AMP part number 776241-2, Caterpillar part number 160-7690).

5.1.2 ECM 70 Terminal Connector Allen Screw Torque

ECM Connector Screw torque should be 6 N•m ±1 N•m (4.4 lb.- ft. ± 0.7 lb.- ft., 53 lb. - in. ± 8.9 lb. - in.).

5.2 ECM Connector Wire Gauge Size

The battery positive and negative connections must be made with #14 AWG SAE J1128 type GXL wire for the AMP 776093-1 stamped and formed terminal or the Deutsch 0462-209-1631 solid terminal. All other connections may be #16 or #18 AWG SAE J1128 type SXL or #16 or #18 AWG SAE J1128 type GXL (or equivalent wire).

5.2.1 ECM 70 Terminal Connector Wire Insulation and Size Range

Insulation material is cross - linked polyethylene. Outside diameter insulation range is 2.26 to 3.94 mm (0.089 to 0.131 in.). The table below provides insulation diameter range for each gauge and wire type.

ECM Connector Wire Insulation and Gauge Size

Wire Type	Wire Gauge	Insulation Diameter
GXL	14	0.114 - 0.125
	16	0.098 - 0.112
	18	0.089 - 0.098
SXL	16	0.116 - 0.131
	18	0.103 - 0.118

5.3 ECM Connector Terminals and Sealing Plugs

The OEM connector socket terminals must be compatible with the wire size used. All unused connector socket slots must be filled with plugs to insure connector sealing.

5.3.1 ECM 70 Terminal Connector Terminals

The following table provides terminal and plug part numbers. All terminals used in this connector must be gold or selective gold flash terminals.

Required ECM 70 Terminal Connector Parts

Description	Usage	Vendor - Part Number	Caterpillar Part Number
70 Terminal Plug, Keyed 1	OEM Vehicle Harness	AMP - 776241-1	160-7689
AMP Gold Socket Contact (stamped & formed)	#16 & #18 AWG SXL and #14, #16 & #18 AWG GXL wire	AMP - 776093-1	126-1766
Deutsch Gold Socket Contact (machined - for field service)	#14 AWG SXL and #14 AWG GXL wire	Deutsch - 0462-209-1631	126-1768
Deutsch Gold Socket Contact (machined - for field service)	#16 & #18 AWG SXL and #16 & #18 AWG GXL wire	Deutsch - 0462-201-1631	9X - 3402
Sealing Plug #14 - 18 AWG	Unused Connector Slots	PEI Genesis - 225-0093-000	9G-3695
Sealing Plug #14 - 18 AWG	Unused Connector Slots	Deutsch - 114017	8T-8737

5.3.2 ECM Connector Terminal Installation Guidelines

Two options are available for AMP terminals. It is critical the harness supplier use the correct crimp tools and tool calibration/set-up procedures, when selecting AMP and Deutsch connector terminals. The following tables indicate proper crimp tooling, go-no-go criteria, and crimp dimensions for each contact- wire combination.

***AMP 776093-1 Stamped & Formed Socket with #16 and #18 AWG SXL Wire or with #14, #16 or #18 AWG GXL Wire (Caterpillar P/N 126-1766)**

Wire Type	Wire Gauge	Crimp Height (+/- 0.002 in.)	Crimp Width (in.)
GXL	14	0.064	0.100
	16	0.059	0.100
	18	0.054	0.100
SXL	16	0.054	0.100
	18	0.059	0.100

*Insulation barrel crimp height for AMP 776093-1 stamped and formed sockets must be set according to the insulation diameter. Crimp width for all insulations is 0.145 inches maximum.

Deutsch 0462-209-1631 Solid Socket with #14 AWG Wire (Caterpillar P/N 126-1768)

Crimp Tool Options	DIE	Locator	GO (in.)	NO-GO (in.)
Deutsch Hand Tool HDT-48-00	N/A	N/A	.052	.057
Pico Model 400	414DA- 16N	4301-16	.043	.050

Deutsch 0462-201-1631 Solid Socket with #16 and #18 AWG Wire (Caterpillar P/N 9X3402)

Crimp Tool Options	DIE	Locator	GO (in.)	NO-GO (in.)
Deutsch Hand Tool HDT-48-00	N/A	N/A	.045	.050
Pico Model 400	414DA- 16N	4301-16	.043	.050

5.3.3 ECM 70 Terminal Connector Sealing Plugs

Two options are available for plugging unused connector cavities. Either the Deutsch 114017 (Caterpillar part number 8T-8737) or PEI Genesis 225-0093-000 (Caterpillar part number 9G-3695) sealing plugs can be used.

Correct installation of either of these cavity plugs is critical to maintain connector sealing integrity. Figure 16 - “Insertion of Plug in Unused Connector Cavities” on page 27 indicates correct insertion of the plug. The plug cap is designed to rest against the seal, not inserted in the hole in the seal.

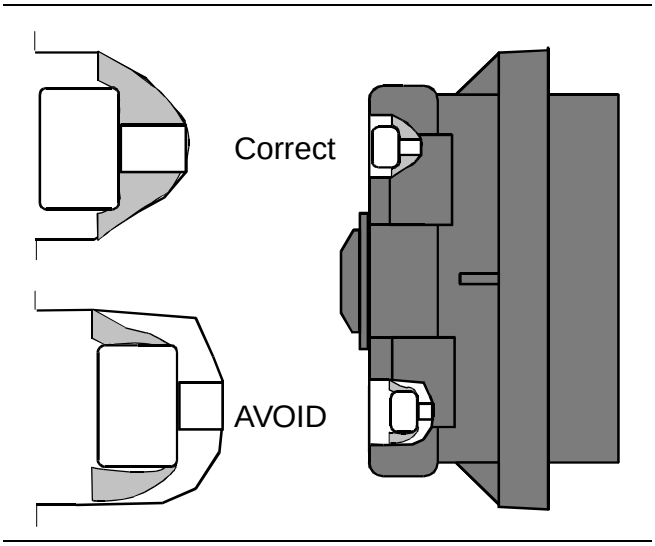


Figure 16 - Insertion of Plug in Unused Connector Cavities

5.3.4 ECM 70 Terminal Connector Interface Seal

The ECM Connector Interface seal is serviceable using Caterpillar part number 159-9322.

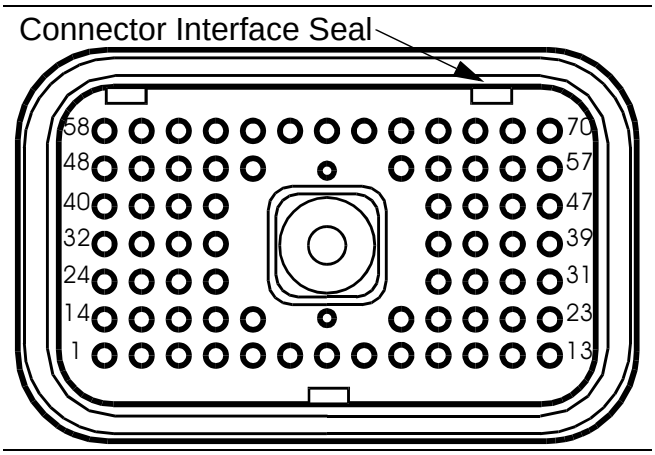


Figure 17 - ECM 70 Terminal Connector Interface Seal

5.4 Sealing Splices and Ring Terminals

Caterpillar requires all ring terminals and splices connected to the Engine ECM be sealed using Raychem ES2000 or equivalent.

5.5 OEM Harness Routing

Routing of the harness should insure connector seals are not stressed because the harness curvature is too close to the connector. This applies to routing of OEM lines on or near the engine harness as well as the OEM ECM Connector.

Figure 18 - “Wire Harness Routing At Connector” on page 28 illustrates the problem if the harness curvature is too close to the connector. When this occurs the connector seal is stretched away from the wire, providing an opening for moisture entry. The wire should exit perpendicular to the connector before curving as necessary for routing. The harness bundle should have a bend radius greater than twice the harness diameter.

Caterpillar recommends the OEM harness supplier preform the harness to provide the correct bend radius, assuring connector sealing and preventing harness abrasion.

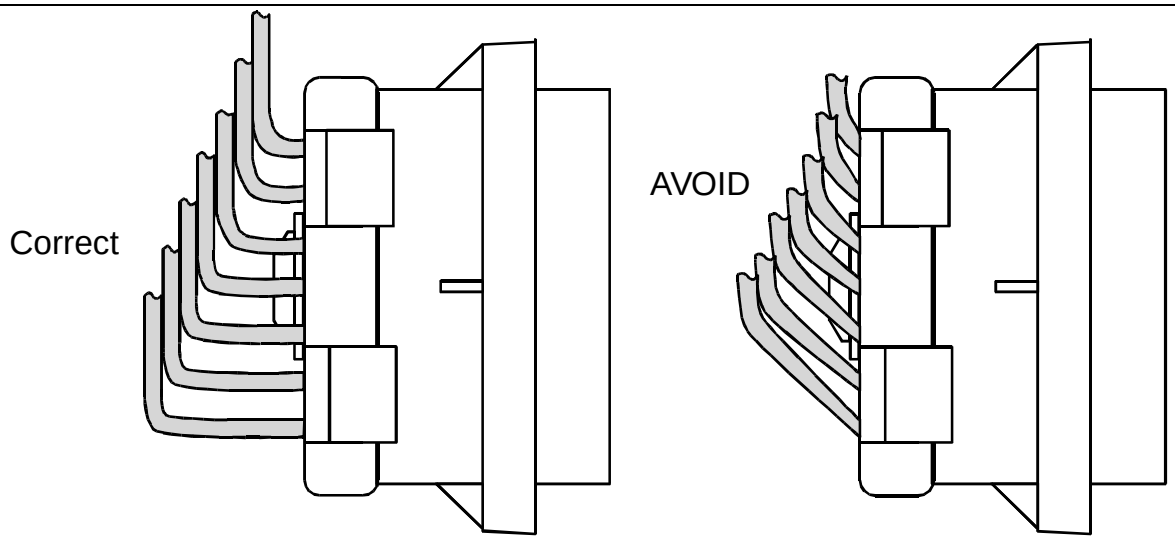


Figure 18 - Wire Harness Routing At Connector

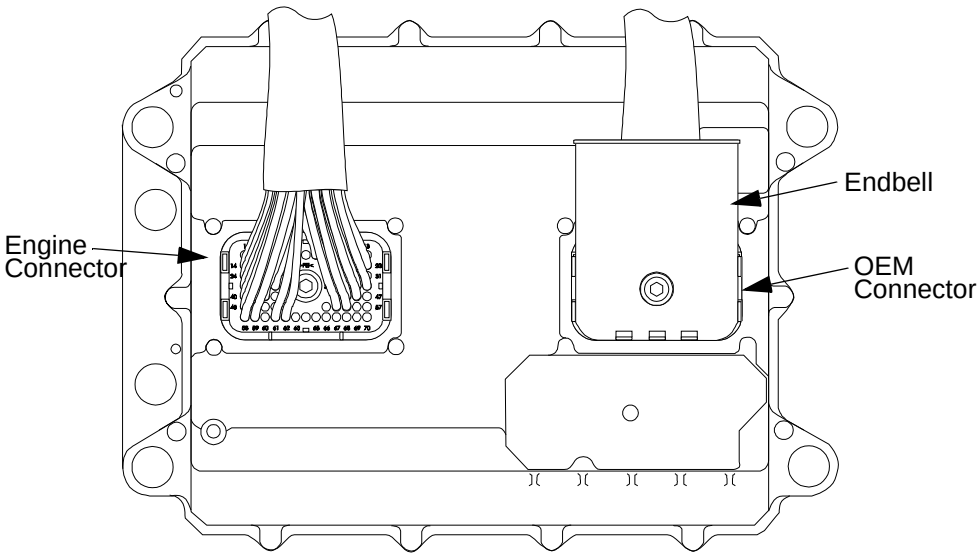


Figure 19 - 70 Terminal ECM AMP Connector Endbell

5.5.1 ECM Connector Endbell

An AMP 638092-1 (Caterpillar part number 126-1774) Connector Endbell is available to provide additional protection and controlled wire routing for the harness at the ECM.

5.5.2 Twisted Pair Wiring

Twisted pair wiring must be used for the SAE J1587 Data Link, SAE J1922 Data Link, and the vehicle speed signal wires. There should be a minimum of one twist per inch within the harness. All twisted pair wires should not be twisted within an inch of the connector to avoid seal stress. The speedometer and tachometer outputs should also use twisted pair wiring. SAE J1939 Data Link wiring should comply with SAE J1939/11 specifications.

5.6 Accelerator Pedal Position Sensor Connector

5.6.1 Accelerator Pedal Position Sensor with Three Terminal Deutsch Connector

The 176-1602 (32 inch [81 cm] harness) and 176-1604 (6 inch [15 cm] harness) Accelerator Pedal Position Sensors require a Deutsch DT06-3S-EP04 (Caterpillar part number 3E-3367) mating connector with a Deutsch W3S (Caterpillar part number 3E3368) connector plug wedge.

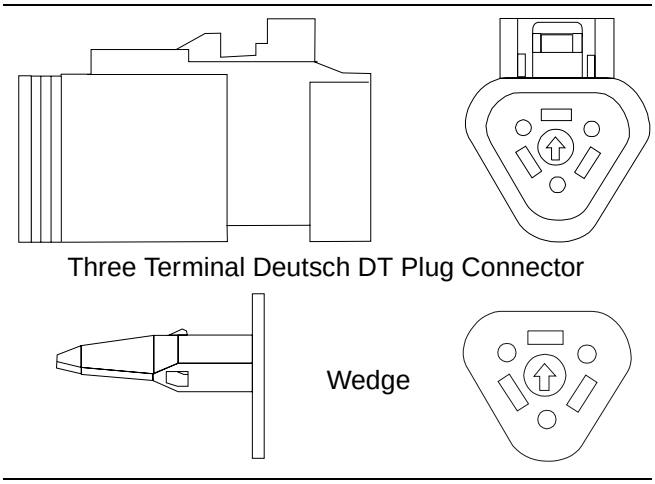


Figure 20 - Three Terminal Accelerator Pedal Position Sensor Deutsch DT Connector

5.6.2 Accelerator Pedal Position Sensor (176-1602 and 176-1604) with Deutsch Three Terminal Connector Wire Gauge Size

The connections may be made with #16 or #18 AWG SAE J1128 type SXL, GXL or equivalent wire.

5.6.3 Accelerator Pedal Position Sensor (176-1602 and 176-1604) with Deutsch Three Terminal Connector Wire Insulation Size Range

Outside diameter insulation range is 2.24 mm to 3.81 mm (0.09 to 0.15 in).

5.6.4 Accelerator Pedal Position Sensor with Three Terminal Packard Electric Connector

The 176-1605 Accelerator Pedal Position Sensor (6 inch [15 cm] harness) requires a Packard Electric Division 12110293 (Caterpillar part number 124-5641) mating connector.

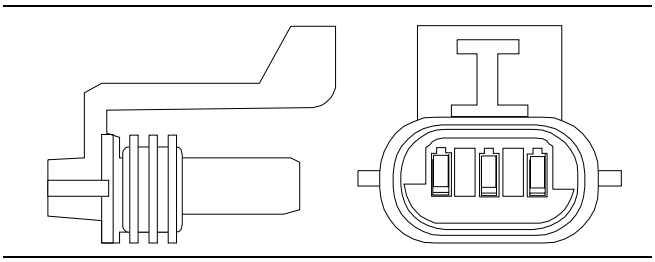


Figure 21 - Three Terminal Accelerator Pedal Position Sensor Packard Electric Connector

5.6.5 Accelerator Pedal Position Sensor (176-1605) with Packard Electric Three Terminal Connector Wire Gauge Size

The connections may be made with #18 AWG SAE J1128 type SXL (or GXL) or equivalent wire.

5.6.6 Accelerator Pedal Position Sensor (176-1605) with Packard Electric Three Terminal Connector Wire Insulation Size Range

Outside diameter insulation should be 2.80 mm (0.11 in.).

5.6.7 Accelerator Pedal Position Sensor Three Terminal Connector Terminals

The following table provides terminal part numbers

Required Deutsch Parts

Description	Usage	Part Number	Caterpillar Part Number
3 Terminal Plug w/Cap	APP Sensor Connector	Deutsch DT06-3S-EP04	3E-3367
3 Terminal Plug Wedge	APP Sensor Connector	Deutsch W3S	3E-3368
Socket Contact (machined)	#16 & #18 AWG Wire	Deutsch 0462-201-16141	8T-8730
Socket Contact (stamped & formed)	#18 AWG Wire	Deutsch 1062-16-0122	115-1051
3 Terminal Plug	APP Sensor Connector	Packard 12110293	124-5641
Socket Terminal	#18 / #20 AWG Wire	Packard 12048074	124-5640

6.0 Accelerator Pedal Position Sensors

The accelerator pedal position sensor converts the mechanical accelerator pedal position into an electrical signal for the ECM. Caterpillar requires one of the sensors described in this document for use with an accelerator pedal.

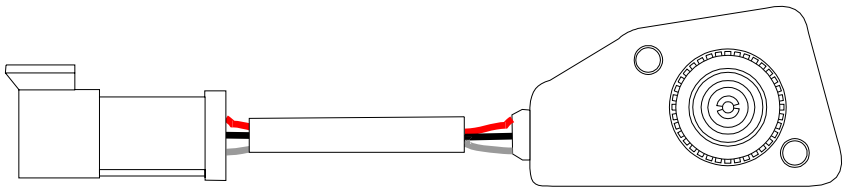


Figure 22 - 176-1602 or 176-1604 Accelerator Pedal Position Sensor with Deutsch DT Connector

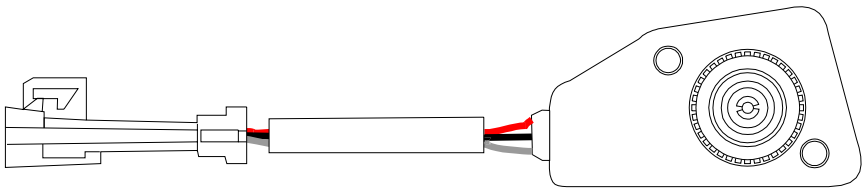


Figure 23 - 176-1605 Accelerator Pedal Position Sensor with Packard Connector

The accelerator pedal position sensor and ECM are designed to comply with FMVSS124 (Federal Motor Vehicle Safety Standard 124). The sensor also meets the SAE J1843 Recommended Practice.

176-1602, 176-1604, and the 176-1605 sensors mount directly to the accelerator pedal. This eliminates the need for accelerator pedal linkages and OEM adjustments. These sensors are designed to operate from the ECM + 8V supply. The 176-1602 (32 inch [81 cm] harness with Deutsch connector), 176-1604 (6 inch [15 cm] harness with Deutsch connector), and the 176-1605 (6 inch [15 cm] harness with Packard connector) use the same sensor but have different connectors or pigtail lengths as described.

6.1 Accelerator Pedal Position Sensor Electrical Specifications

The sensor output is a constant frequency signal whose pulse width (duty cycle) varies with accelerator pedal position. The Pulse Width Modulated (PWM) signal is expressed as a percentage (percent duty cycle) as shown in Figure 24 “Example PWM Signals”.

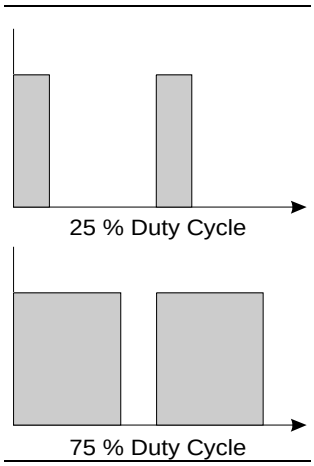


Figure 24 - Example PWM Signals

NOTE: When the ECM is first powered, it automatically calibrates (auto-cal) new values for the low idle and high idle throttle positions. It assumes 22 percent is low idle and 75 percent is high idle. As a result, the Throttle Position status may initially reach 100 percent well before the accelerator pedal is fully depressed, this is normal. Following some cycling of the accelerator pedal between the low and high idle positions, the ECM will adjust its calibration automatically, provided the high idle stop position is within the 75 to 90 percent duty cycle range, and the low idle is in the 10 to 22 percent duty cycle range. During initial operation it may require more accelerator pedal movement for the Throttle Position status to increase above 3 percent Throttle Position, and the status may reach 100 percent Throttle Position prior to the mechanical limit of the high idle position. This is done to ensure the throttle can reach these two critical points during engine operation.

6.2 ECM Supplied +8V

This supply is designed to provide power for connection to Caterpillar provided, OEM installed Accelerator Pedal Position Sensor (+8V). No other vehicle components can be connected to this supply.

6.2.1 Accelerator Pedal Position Sensor Connection

The 176-1602 accelerator pedal position sensor is designed to operate on 8 Volts DC supplied by the ECM. The ECM supplied +8V, AP Sensor/Switch Sensor Common, and Accelerator Pedal Position wiring must be connected to the control system through an OEM harness. Current draw for the sensor is less than 40 mA.

AP Sensor/Switch Sensor Common must not be connected to the vehicle cab ground. Connecting AP Sensor/ Switch Sensor Common to the vehicle cab ground can degrade control system performance. AP Sensor/Switch Sensor Common must be connected to the ECM at the OEM connector (P1 -Terminal 5) via a dedicated return line.

Refer to 5.6 “Accelerator Pedal Position Sensor Connector” on page 29 for OEM harness connector requirements. Connector terminal assignments are as follows:

Sensor Terminal Assignment	ECM Terminal Assignment	Terminal Description
Terminal A	Terminal 4	+ 8V
Terminal B	Terminal 5	AP Sensor/Switch Sensor Common
Terminal C	Terminal 66	Accelerator Pedal Position

6.2.2 Accelerator Pedal Position Sensor Duty Cycle

The Accelerator Pedal Position Sensor (APP Sensor) mounts directly to the pedal and should not be adjusted by the OEM. The OEM must insure that pedals supplied by the pedal manufacturer meet the following specification for sensor output duty cycle:

Accelerator Pedal Position	Duty Cycle
Low idle	10% - 22%
High idle	75% - 90%

The pedal assembly should also conform to SAE J1843.

6.2.3 Accelerator Position Sensor for Remote PTO Applications

For applications also requiring variable engine speed control from outside of the cab, or from a linkage for special applications, a second accelerator pedal sensor input is available.

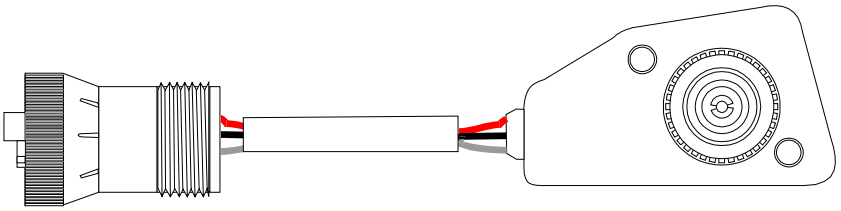


Figure 25 - 161-8906 Accelerator Position Sensor with Deutsch HD Connector

Caterpillar recommends the 161-8906 accelerator pedal position sensor for remote PTO applications. The sensor provides the same signal as the 176-1602, 176-1604, and the 176-1605 sensors, but requires battery voltage (12 or 24 volt systems) to operate.

6.2.4 161-8906 Accelerator Position Sensor Connector

The 161-8906 is supplied with a Deutsch HD plug connector (HD16-3-96S, Caterpillar P/N 8T-8731). The connecting harness will require a Deutsch HD receptacle connector (HD14-3-96P, Caterpillar P/N 8T-8732).

6.3 Mounting the Accelerator Position Sensor

The 161-8906 Accelerator Pedal Position Sensor can be attached to either an accelerator pedal assembly (contact the vehicle OEM for parts) or a Caterpillar 107-2281 PTO Accelerator Assembly. The PTO Accelerator Assembly does not include a handle. It may be used in applications where a mechanical linkage is required. The accelerator position sensor mounts directly to the PTO Accelerator Assembly and does not require additional sensor calibration.

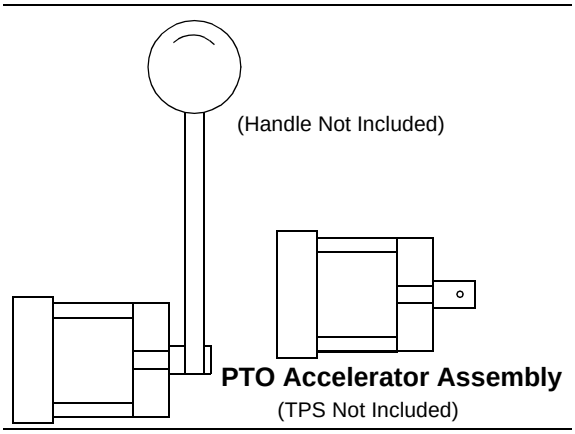


Figure 26 - Remote Accelerator Pedal/Accelerator Assembly

6.4 Remote Accelerator Position Sensor PWM Input, Input #8

Input # 8 is available for use as a Remote Accelerator Input for remote PTO applications.

OEM provided and installed components required:

1) Accelerator pedal or other linkage.

Customer Parameter programming required:

1) PTO Configuration programmed to Remote Throttle.

6.4.1 Input #8 (Remote Accelerator) Electrical Specifications

All signal requirements are identical to those outlined 6.2.2 “Accelerator Pedal Position Sensor Duty Cycle” on page 32, except the 161-8906 requires connection to battery voltage (12 VDC or 24 VDC) instead of the ECM supplied 8 VDC.

6.4.2 Accelerator Pedal Position Sensor Common Connections

Three different Sensor Common terminals can be used to ground the Remote Accelerator Pedal Position Sensor to the ECM (terminal-3, terminal-5 or terminal-18). However, Caterpillar recommends that Input Sensor Common #2 (terminal-3) remain open for aftermarket/body builder installation.

7.0 Vehicle Speed Circuit

Vehicle speed to the ECM is necessary in order to enable the following features:

a) Cruise Control.

b) PTO Control with Vehicle Speed Limits.

c) Auto Retarder in Cruise.

d) Vehicle Speed Limiting.

e) Soft Vehicle Speed Limit.

f) Upshift Engine Speed Control.

g) Idle Shutdown Timer.

h) Trip Recorder Functions.

i) Secure - Idle Theft Deterrent

7.1 General Vehicle Speed Source Requirements

Caterpillar recommends using single coil passive magnetic speed sensors for the vehicle speed sensor detecting speed via a transmission chopper wheel. The sensor should connect directly to the ECM using twisted pair wiring.

The vehicle speed sensor must detect vehicle speed directly from the transmission output shaft. The source should be a rigid chopper wheel immune to noise inducing vibration. Caterpillar does not recommend use of less rigid tone wheel rings using magnetic disks to provide the change in magnetic flux for the vehicle speed source. This arrangement is prone to vibration induced electrical noise. The sensor must not be detecting vehicle speed through a system that uses a cable linkage such as a mechanical speedometer drive to the transmission output shaft. The cable will tend to twist as it is torqued, causing opposing ends to deviate erratically from each other. This twisting results in erratic fluctuations in the vehicle speed signal, causing cruise control/PTO and Vehicle Speed Limit malfunctions.

Caterpillar will not accept vehicle speed from the SAE J1587 Data Link for control system purposes. Because vehicle speed is critical to cruise control operation, any unnecessary and erratic signal delays are unacceptable, as well as the reduced accuracy associated with SAE J1587 vehicle speed sources.

The signal frequency from the vehicle speed source should be between 0 and 5.3 kHz.

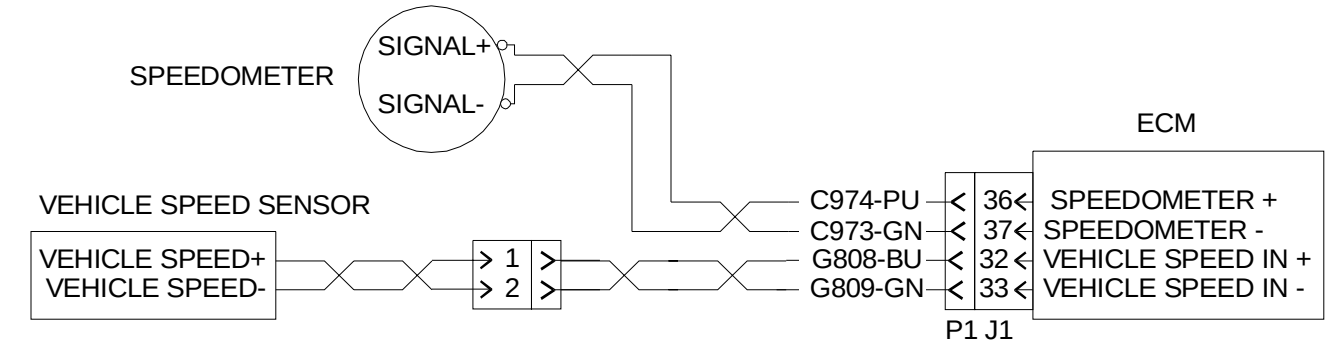
7.2 Passive Magnetic Vehicle Speed Sensor Electrical Requirements

The passive vehicle speed sensor must be a magnetic sensor with the sensor output signal resulting from variation in magnetic flux. Output voltage from the sensor at the ECM (at connector P1 terminals 32 and 33) should not be less than 0.40 Volts peak to peak (referenced to the ECM connector battery terminals) when vehicle speed is greater than 2 mph. Twisted pair wiring should be used to connect the vehicle speed sensor to the ECM. Caterpillar recommends a minimum of one twist per inch.

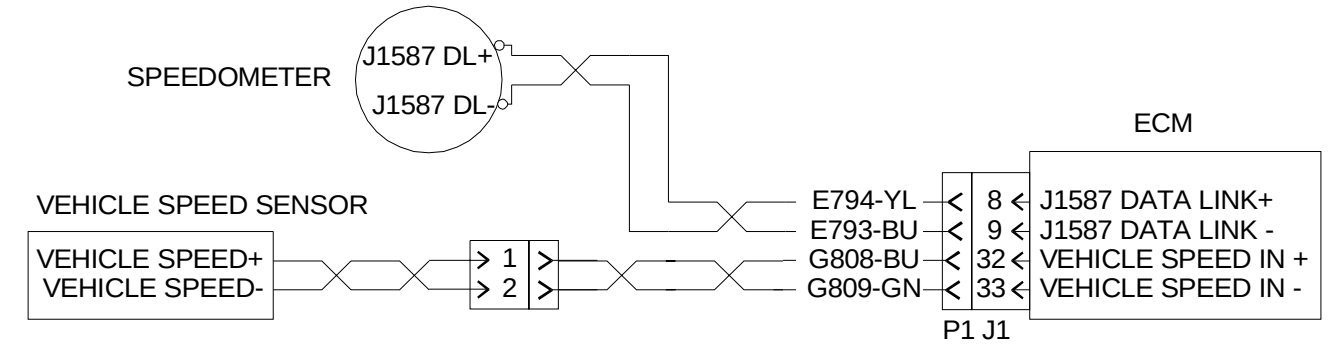
7.3 Passive Magnetic Vehicle Speed Circuit Options

Two options are outlined (refer to Wiring Diagram 2 - “Vehicle Speed Circuit Using One Single Coil Vehicle Speed Sensor and ECM Speedometer Output for Speedometer” on page 34, and Wiring Diagram 4 - “Vehicle Speed Circuit Using Two Single Coil Vehicle Speed Sensors” on page 35), using either one or two single coil speed sensors.

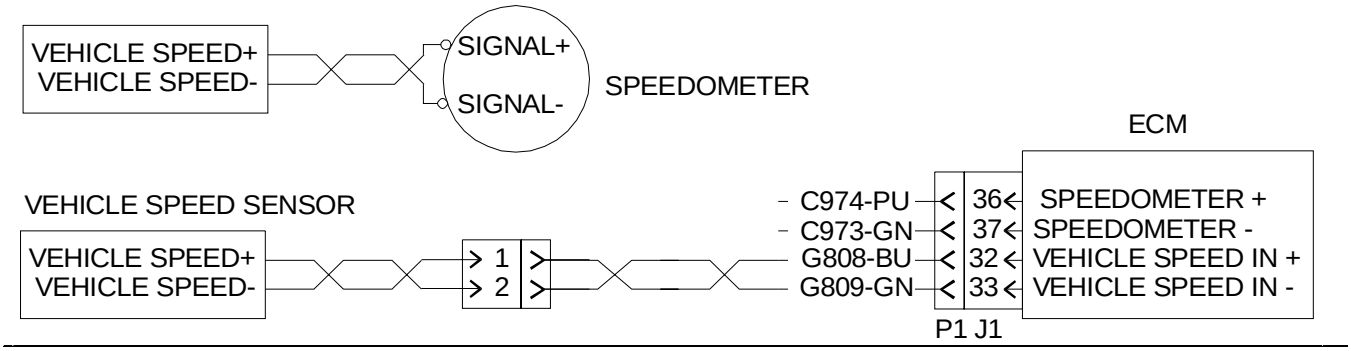
The vehicle speed sensor outputs must connect to the OEM connector P1 - terminals 32 and 33. Magnetic vehicle speed sensor connections to the control are not polarity sensitive (the wiring diagram terminal labels are “Vehicle Speed In +” and “Vehicle Speed In -”, **“Vehicle Speed In -” must not be used as a ground, connected to ground, or connected to the ECM Sensor Common**). Twisted pair wiring is specified to reduce extraneous noise interference into this critical circuit.



Wiring Diagram 2 - Vehicle Speed Circuit Using One Single Coil Vehicle Speed Sensor and ECM Speedometer Output for Speedometer



Wiring Diagram 3 - Vehicle Speed Circuit Using One Single Coil Vehicle Speed Sensor and Data Link for Speedometer



Wiring Diagram 4 - Vehicle Speed Circuit Using Two Single Coil Vehicle Speed Sensors

7.3.1 Option 1 - One Single Coil Speed Sensor

Use one single coil speed sensor, with the ECM Speedometer output supplying the speedometer input signal. Refer to “Wiring Diagram 2 - Vehicle Speed Circuit Using One Single Coil Vehicle Speed Sensor and ECM Speedometer Output for Speedometer” on page 34.

7.3.2 Option 2 - One Single Coil Speed Sensor

Use one single coil speed sensor, with the ECM J1587 Data Link output supplying the speedometer input signal. Refer to “Wiring Diagram 3 - Vehicle Speed Circuit Using One Single Coil Vehicle Speed Sensor and Data Link for Speedometer” on page 34.

7.3.3 Option 3 - Separate Single Coil Speed Sensors

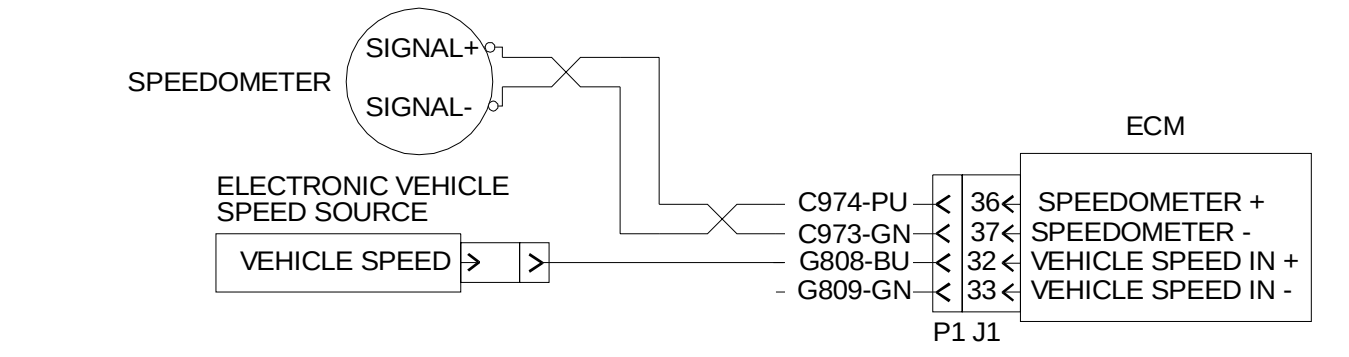
Using two speed sensors, one for the speedometer, and one for the ECM completely isolates the two circuits. Refer to “Wiring Diagram 4 - Vehicle Speed Circuit Using Two Single Coil Vehicle Speed Sensors” on page 35.

7.3.4 Dual Coil Speed Sensor

Dual coil magnetic speed sensors are not recommended because of the increased risk of electrical noise coupling into the engine control vehicle speed circuit. Ground noise from the circuit connected to the speedometer ground will be coupled into the vehicle speed circuit of the engine control degrading system performance.

7.4 Vehicle Speed Connections To Automatic Transmissions with Electronic Vehicle Speed Source

Some electronically controlled transmissions do not have a passive magnetic vehicle speed signal available. For these transmissions follow guidelines indicated below.



Wiring Diagram 5 - Vehicle Speed Circuit with Electronic Vehicle Speed Source

Connect the single vehicle speed signal line to the ECM “Vehicle Speed In +” (P1 terminal-32). Leave ECM “Vehicle Speed In -” (P1 terminal-33) unconnected, without a harness connection to this terminal.

NOTE: Do NOT connect terminal-33 to ground when using an electronic vehicle speed source.

No other devices should be receiving vehicle speed from the Vehicle Speed line providing vehicle speed to the Caterpillar ECM. Caterpillar recommends using the Caterpillar ECM Speedometer Driver for the speedometer signal or the SAE J1587 Data Link.

7.4.1 Allison Non-Electronic Transmissions

These transmissions should provide a passive magnetic sensor. Connect as outlined in Wiring Diagram 2, 3, or 4 on page 35.

8.0 ECM Speedometer and Tachometer Outputs

8.1 Speedometer And Tachometer

The engine control provides a complementary ±10V speedometer (30,000 pulses per mile) and tachometer signal (12.0 - 500.0 pulses per revolution). The ECM receives the vehicle speed from an OEM installed sensor and scales it to provide a speedometer signal. A speedometer may also be driven from the SAE J1587 Data Link if the gauge is capable.

The tachometer does not require an external sensor. A tachometer may also be driven from the SAE J1587 Data Link if the gauge is capable.

Refer to “8.2 Speedometer And Tachometer Output Electrical Specifications and Connections” on page 37 for electrical specifications, and “20.13 SAE J1587 Data Link Broadcast Parameters” on page 95 for details if the gauge will be driven using a data link.

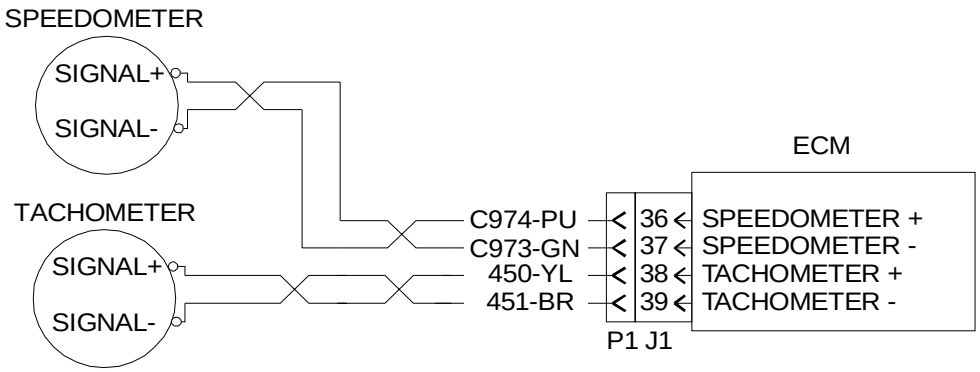
OEM provided and installed components required:

1) Vehicle speed source (for speedometer only).

Customer Parameter programming required:

1) Vehicle Speed Calibration (for speedometer only).

2) Tachometer Calibration (default is 134.0).



Wiring Diagram 6 - Speedometer and Tachometer Circuits

8.2 Speedometer And Tachometer Output Electrical Specifications and Connections

Terminal Description	ECM Terminal Assignment	Voltage
Speedometer +	Terminal 36	± 10 V
Speedometer -	Terminal 37	± 10 V
Tachometer +	Terminal 38	± 10 V
Tachometer -	Terminal 39	± 10 V

The optional speedometer driver provides a signal from the ECM (OEM Connector P1, terminals 36 and 37), as does the tachometer driver (Connector P1 terminals 38 and 39). The signals are zero-crossing square waves with an amplitude (unloaded) of ±10 Volts. The amplitude of the signals will be ±5 Volts or greater when the load current is less than 4 mA. Refer to “Figure 27 - Unloaded Speedometer/Tachometer Signal” on page 37 for a wave form example, and refer to “Figure 28 - Speedometer/Tachometer Signal vs. Load” on page 38 for the effect of load on the output signal. The output at terminal 36 (Terminal 38 for the tachometer) is the complement of terminal 37 (Terminal 39 for the tachometer) for those speedometers or tachometers requiring two signal lines. Connect either one of the two output lines from the ECM for speedometers or tachometers with a single input terminal. Leave the remaining line unconnected. When the control senses vehicle or engine speed, the driver signals will provide the following output voltages (unloaded).

NOTE: Do not connect the negative terminal of the ECM Speedometer or Tachometer Output to Sensor Common or Vehicle Ground.

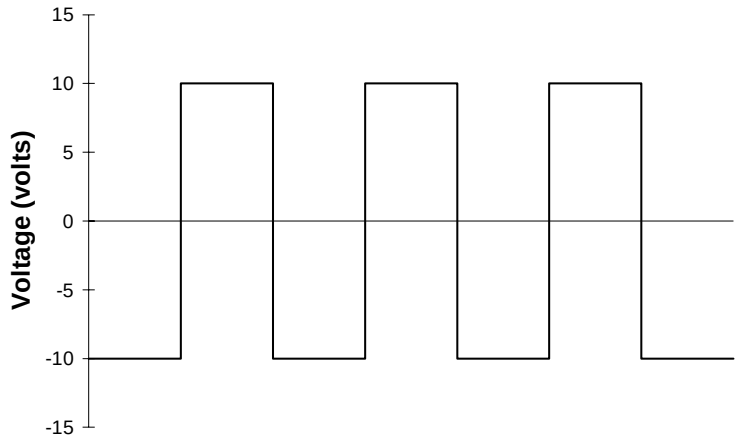


Figure 27 - Unloaded Speedometer/Tachometer Signal

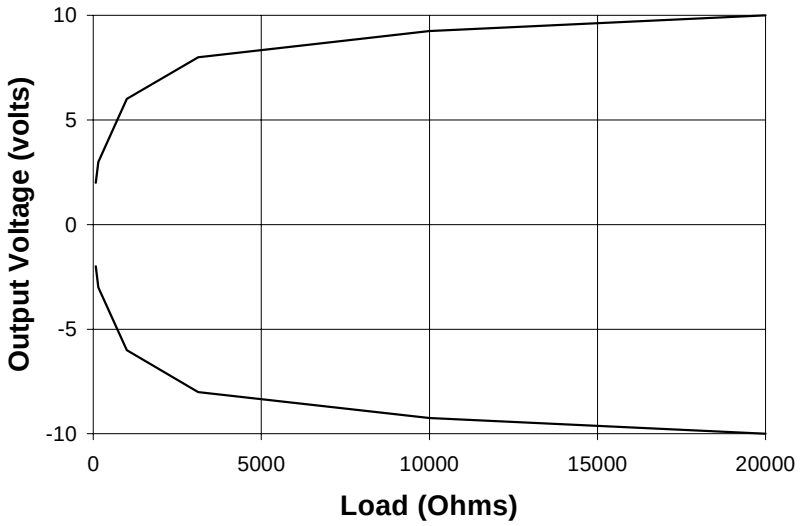


Figure 28 - Speedometer/Tachometer Signal vs. Load

The output signal for the speedometer is 30,000 pulses per mile, and for the tachometer the signal is programmable from 12.0 - 500.0 ppr (pulses per revolution, selectable in 0.1 increments through a Customer Parameter). Note that Caterpillar still provides a threaded hole in the flywheel housing for a magnetic engine speed sensor. Caterpillar requires twisted pair wiring if both signal connections from the ECM to the speedometer or tachometer are made. This is to prevent radiated electrical noise problems. Cab grounding of the speedometer is acceptable.

8.3 Connection Of Devices Other Than A Speedometer/Tachometer

Do not connect these drivers to more than a single speedometer and tachometer. For questions regarding simultaneous connection, or connection of additional devices to these drivers contact Caterpillar. Caterpillar requests device specifications, a sample of the intended additional device, a connection diagram for vehicle installation, and sufficient lead time to evaluate this request.

8.4 Speedometer and Tachometer Output Accuracy

8.4.1 Speedometer Signal Accuracy

The engine control processes the vehicle speed input signal using the pulses per mile as determined by the customer programmable Vehicle Speed Calibration parameter. It is then scaled for the speedometer driver at 30,000 pulses per mile. The most likely source of error for the output signal is incorrectly programming the ECM or speedometer pulses per mile, and drive line variations such as tire wear.

There are five sources of signal processing error of the vehicle speed by the ECM:

1) ECM input resolution is ± 2 µsec.

2) Vehicle Speeds less than 1.5 miles per hour are ignored.

3) Rounding error due to division (scaling from pulses-in to pulses-out per mile).

4) ECM output resolution is ± 2 µsec.

5) ECM sampling of the vehicle speed occurs every 30 mS.

8.4.2 Tachometer Signal Accuracy

The tachometer driver accuracy is ± 5 rpm.

9.0 Lamp Outputs

The ECM provides four lamp outputs that can be used in a variety of ways depending upon Customer Parameter programming. The Check Engine Lamp is the only required lamp. The Check Engine Lamp is a yellow lamp that indicates an active diagnostic code or alerts the driver to impending idle / PTO shutdown. An optional Warning Lamp is required if the Engine Monitoring feature is used. The Warning Lamp indicates an active problem with one of the monitored conditions such as high coolant temperature. A flashing Warning Lamp indicates the engine is derating power.

The programmable Engine Monitoring Lamps parameter provides the option of using a single Warning Lamp for all monitored conditions, or discrete lamps for each monitored condition. If the Engine Monitoring Lamps parameter is programmed to Warning Lamp, then J1/P1 terminal-29 is used for connection of a single Warning Lamp. If the Engine Monitoring Lamps parameter is programmed to Option 1, then J1/P1 terminal-29 is used to connect a Low Oil Pressure Warning Lamp and J1/P1 terminal-31 is used to connect a High Coolant Temperature Lamp. If an optional Coolant Level Sensor is also installed (Coolant Level Sensor parameter programmed to 4-Pin) then J1/P1 terminal-30 is used to connect a Low Coolant Level Lamp.

If a Coolant Level Sensor is not installed (Coolant Level Sensor parameter programmed to No) or the Engine Monitoring Lamps parameter is programmed to Warning Lamp, then J1/P1 terminal-30 will function as a PTO Switch On Lamp output. Refer to “14.1 Dedicated PTO Operation” on page 53 for more information on the PTO functions

9.1 Electrical Specifications

Electrical characteristics of the ECM Lamp outputs are as follows:

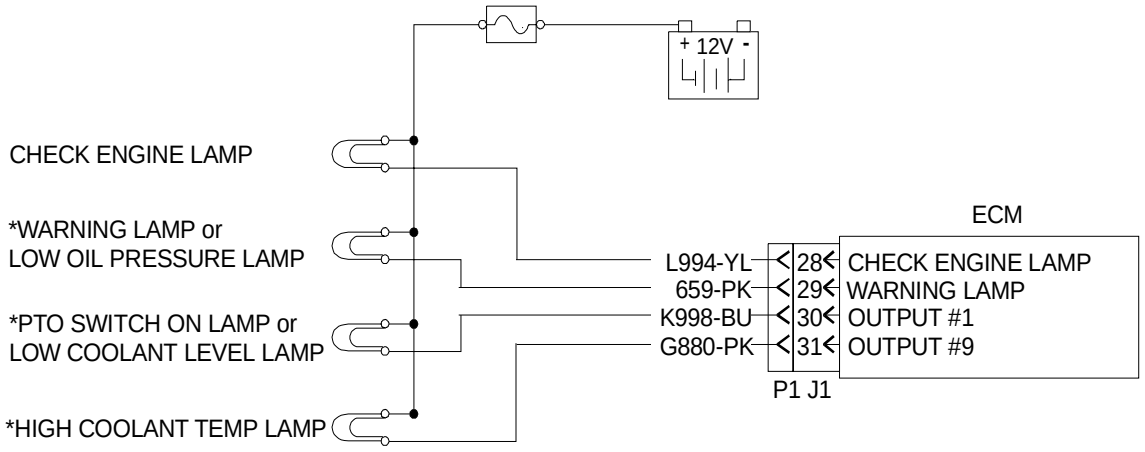
Maximum Current: 0.30 Amperes

Maximum Leakage Current in OFF State: 100 μA

The lamp circuits are low side drivers—the ECM provides a path to ground to activate the load. Caterpillar does not request dedicated circuit protection for this circuit. The engine control has not implemented diagnostic codes for these circuits.

ECM Lamp Output Terminal Assignments	**ECM Terminal Usage (Parameter Programming Dependent)**	
	Engine Monitoring Lamps programmed to **Warning Lamp**	Engine Monitoring Lamps programmed to **Option 1**
Terminal 28	Check Engine Lamp	Check Engine Lamp
Terminal 29	Warning Lamp	Low Oil Pressure Lamp
Terminal 30	PTO Switch On Lamp	*PTO Switch On Lamp or Low Coolant Level Lamp
Terminal 31	Unused	High Coolant Temp Lamp

*If the Coolant Level Sensor parameter is programmed to “4-Pin” and the Engine Monitoring Lamps parameter is programmed to “Option 1”, then J1/P1 terminal 30 is used for a Low Coolant Level Lamp. Otherwise, it can used as a PTO Switch On Lamp.



Wiring Diagram 7 - Lamp Output Wiring Diagram

9.2 Check Engine Lamp Operation

An OEM installed yellow Check Engine Lamp is required to indicate a control system malfunction (diagnostic condition) to the driver, for diagnosing control system component failures, and for indicating the Idle or PTO Shutdown Timer is within 90 seconds of shutting down the engine. When a diagnostic code alert is active the Check Engine Lamp will flash ON and OFF.

On power up (key ON, engine OFF), the Check Engine Lamp will come ON for five seconds and turn off indicating the lamp circuit is functional. Any time there is an Active diagnostic code the lamp will flash ON five seconds, blink off, flash ON five seconds, blink off, etc.

9.2.1 Viewing Diagnostic Flash Codes

Caterpillar's proprietary two-digit diagnostic flash codes can be prompted from the Check Engine Lamp. Active or Logged Codes (occurring since ECM power up) may be viewed on the Check Engine Lamp as follows:

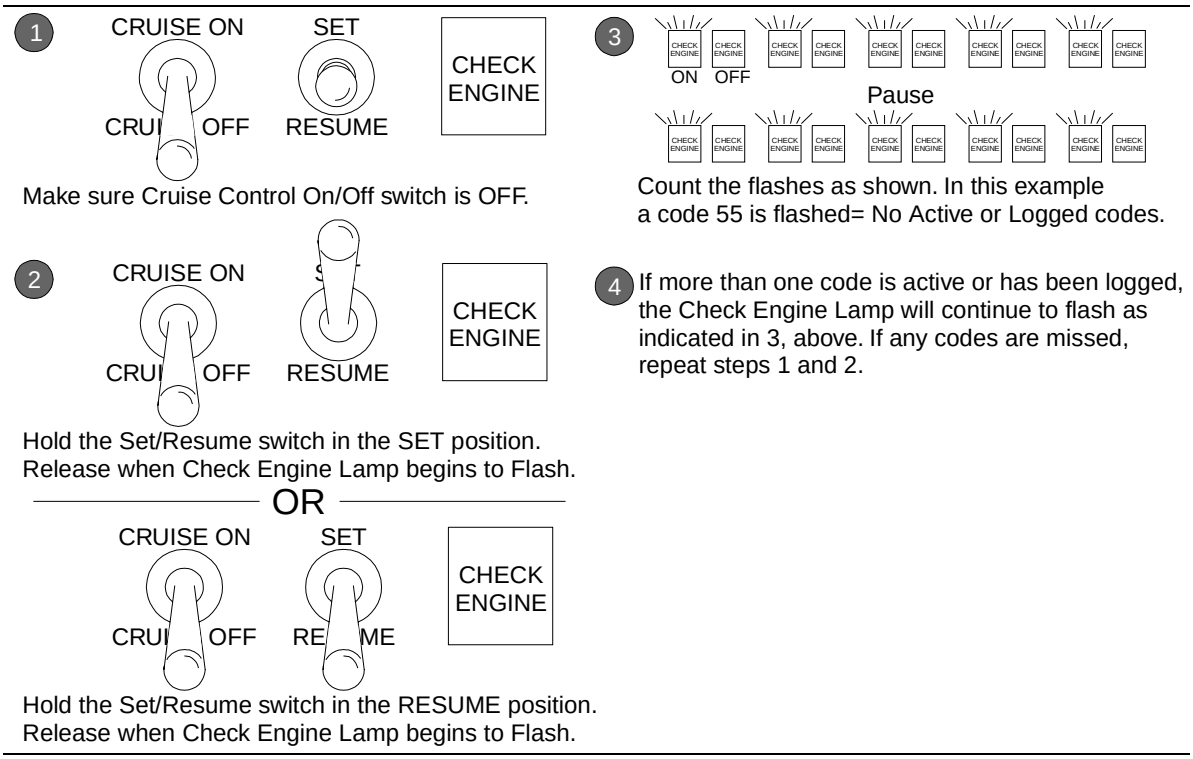


Figure 29 - Viewing Diagnostic Flash Codes

Note: It is suggested the Diagnostic Flash Codes only be used to indicate the nature of a diagnostic code occurrence, not to perform detailed troubleshooting. Troubleshooting should be performed using SAE J1587 PID/FMI Diagnostic Codes obtained via an electronic service tool.

9.2.2 Viewing Diagnostic Flash Codes using the Diagnostic Enable Input

Diagnostic flash codes can also be prompted using a Diagnostic Enable switch. The Diagnostic Enable parameter must be programmed to J1/P1:46, and a switch connected between ECM Vehicle Harness Connector J1/P1 terminal-46 and Sensor Common. Refer to "13.7 Diagnostic Enable" on page 50 for details.

To initiate the flash codes, depress the momentary Diagnostic Enable switch until the Check Engine Lamp begins to flash. The codes should flash out as indicated above.

9.3 Warning Lamp Operation

Engine Monitoring requires an additional OEM installed red warning lamp(s) to alert the driver to an engine problem detected by the ECM. The Warning Lamp also alerts the driver to the level of action the ECM is taking to respond to the condition. The lamp is ON continuously while the engine is in the warning mode. Warning mode indicates the ECM has detected a problem, but the ECM is not altering engine performance to force driver action. The Warning Lamp flashes when in the derate mode, indicating the ECM has begun to force driver action and is reducing available horsepower and the maximum vehicle speed. During warning and derate the Check Engine Lamp will flash because of the active diagnostic code.The Warning Lamp(s) will come on for two seconds following engine start-up to check the lamp and circuit function. Refer to "9.0 Lamp Outputs" on page 39 for additional information on the warning lamp options.

9.4 Output #1

Output #1 can be used as a PTO Switch On Lamp or a Low Coolant Level Lamp, depending upon Customer Parameter programming. If the Engine Monitoring Lamps parameter is programmed to the “Warning Lamp” option, Output #1 is used as a PTO Switch On Lamp. The ECM will turn Output #1 ON when the PTO On/Off Switch circuit (Input #1) is ON and the PTO Configuration parameter is programmed to Cab Switches, Remote Switches or Remote Throttle. Refer to Wiring Diagrams 15 through 20 on page 56 through page 63 for PTO wiring diagrams and additional information regarding PTO operation.

If the Engine Monitoring Lamps parameter is programmed to “Option 1” and the Coolant Level Sensor parameter is programmed to “4-Pin” (OEM installed Coolant Level Sensor used), Output #1 is used as a Low Coolant Level Lamp. If the Engine Monitoring Mode parameter is programmed to Warning, Derate, or Shutdown and a loss of coolant is detected, the ECM will turn on the Low Coolant Level Warning Lamp as described in “1.5 Engine Monitoring” on page 7.

9.5 Output #9

Output #9 is used as a High Coolant Temperature Lamp when the Engine Monitoring Lamps parameter is programmed to “Option 1”. If the Engine Monitoring Lamps parameter is programmed to the “Warning Lamp” option, Output #9 is not used. If the Engine Monitoring Mode parameter is programmed to Warning, Derate, or Shutdown and a high coolant temperature is detected, the ECM will turn on the High Coolant Temp Warning Lamp as described in “1.5 Engine Monitoring” on page 7.

10.0 Engine Monitoring and OEM Requirements

The OEM is responsible for providing and installing the Coolant Level Sensor and a Warning Lamp. The coolant level sensor is the only individually selectable sensor for the Engine Monitoring feature. It is programmed through a Customer Programmable Parameter, with a default factory setting of NO. A four wire sensor (such as the RobertShaw RS-805B) can be installed. Refer to “1.5 Engine Monitoring” on page 7 for details on Engine Monitoring.

OEM provided and installed components required:

1) Warning lamp.

2) For Coolant Level sensing with a four wire sensor, the RS-805B (C85927-C1) coolant level sensor or similar sensor refer to “11.3 Four Pin Coolant Level Sensor Electrical Specifications” on page 43.

Customer Parameter programming required:

1) If Coolant Level is monitored Coolant Level Sensor should be programmed to “4-pin”.

2) Engine Monitoring should be programmed to Warning, Derate, or Shutdown for engine monitoring.

11.0 Coolant Level Sensor

A four pin coolant level sensor such as the RobertShaw RS-805B can be used. The sensor operates as a coolant loss sensor. A Customer Parameter “Coolant Level Sensor” is used to enable the feature.

11.1 Coolant Level Sensor Environmental Compatibility

The OEM should determine worst case mechanical, electrical, and electromagnetic field environments for the coolant level sensor and verify the selected coolant level sensor will function properly and reliably under worst case conditions.

NOTE: If engine monitoring is programmed OFF or Coolant Level Sensing is Disabled through the Customer Programmable option, it is not necessary to jumper any connector terminals on the OEM connector. The ECM will ignore the coolant level inputs.

The vehicle harness for the Coolant Level Sensor should not be connected to the ECM when a sensor is not installed.

11.2 Coolant Level Sensor Mounting Guidelines

To insure proper operation of the coolant level sensor, the following mounting guidelines should be followed:

A. The sensor is supplied with thread sealant applied to the threads. No other tape or sealant should be applied when mounting.

B. **For the liquid present signal**, the sensor must be mounted in a position completely immersing the sensing tube and mounting thread.

C. **For the liquid absent signal,** the sensor must be mounted in a position with no fluid contacting the entire sensing tube and mounting thread.

D. The output signal is indeterminate when only a portion of the sensing tube is immersed in fluid.

E. The sensor should be mounted low enough in the tank to operate correctly under all slosh, tilt, and roll conditions.

F. Preferred sensor mounting is horizontal.

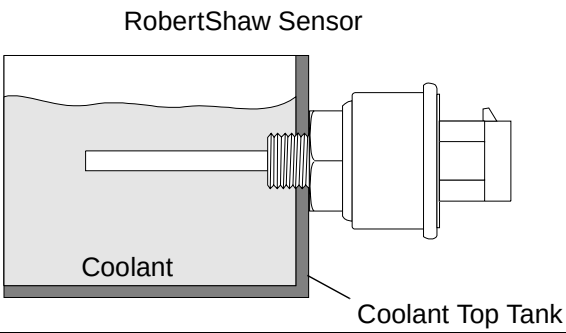
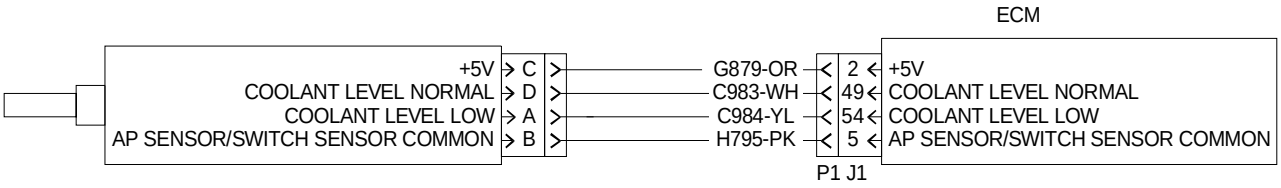


Figure 30 - Coolant Level Sensor Installation

11.3 Four Pin Coolant Level Sensor Electrical Specifications

The four pin coolant level sensor specification is shown below.

11.3.1 Coolant Level Sensor Connections



Wiring Diagram 8 - 4 Pin RobertShaw Coolant Level Sensor Wiring Diagram

Sensor Terminal Assignment	ECM Terminal Assignment	Terminal Description
Terminal A	Terminal 54	Coolant Level Low
Terminal B	Terminal 5	AP Sensor/Switch Sensor Common
Terminal C	Terminal 2	+5V
Terminal D	Terminal 49	Coolant Level Normal

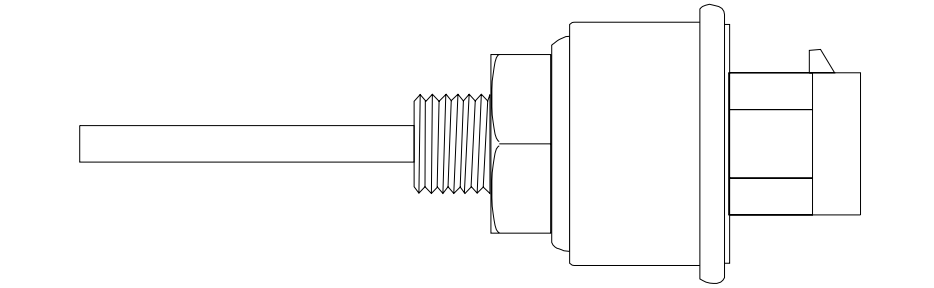


Figure 31 - 4 Pin RobertShaw (RS-805B) 85927-C1 Coolant Level Sensor

11.3.2 Coolant Level Sensor Power Supply

The sensor must operate off the ECM regulated power supply of 5.0 ± 0.25 Vdc. Total current draw by the sensor at the +5V terminal must not exceed 20 mA under any conditions.

11.3.3 Coolant Level Sensor Outputs

(All voltages are DC and referenced to AP Sensor/Switch Sensor Common at the ECM Connector J1/P1)

I. Coolant Level Low

A. Fluid Present

Output voltage = 0.5V MAXIMUM when sinking 10 mA or less.

B. Fluid Absent

Output voltage = 4.1V MINIMUM when sourcing 1 mA or less. (The outputs must be able to tolerate a 20 kΩ or greater resistance pulled up to 13V).

II. Coolant Level Normal

A. Fluid Present

Output voltage = 4.1V MINIMUM when sourcing 1 mA or less. (The outputs must be able to tolerate a 20 kΩ or greater resistance pulled up to 13V).

B. Fluid Absent

Output voltage = 0.5V MAXIMUM when sinking 10 mA or less.

11.3.4 Coolant Level Sensor Response Time

Sensor outputs must change states in less than 2 seconds when subjected to an immersion-removal transition. Cool Level Low must change states within ±1.0 millisecond of a Cool Level Normal state change.

11.3.5 Coolant Level Sensor Diagnostic

If the ECM Coolant Level Circuit indicates the sensor outputs are at the same voltage for at least two seconds, a diagnostic code is triggered.

OEM provided and installed components required:

1) Coolant Level sensor meeting this specification.

2) Engine Monitoring Warning Lamp.

Customer Parameter programming required:

1) Coolant Level Sensor Customer Parameter programmed to 4 Pin.

12.0 Idle Shutdown and Ambient Air Temperature Sensor Installation

12.1 Idle Shutdown Timer

To conserve fuel, the control system can be programmed to shut down the engine. The engine will shutdown if it operates under reduced load with the vehicle stationary for a customer defined period of time. This feature does not shut off vehicle electrical power. An Engine Shutdown Output is available to shut down the vehicle power when the idle shutdown timer expires, refer to“16.3 Engine Shutdown Output” on page 74.

Ninety seconds before the programmed time expires, the Check Engine Lamp will begin to flash. If the Allow Idle Shutdown Override parameter is programmed to allow the driver to override the Shutdown Timer, the operator can move the clutch or service brake during this 90 seconds and override the timer. When the timer is overridden a diagnostic code is logged. To reset the Idle Shutdown Timer, the ECM must detect the vehicle has moved.

If the Idle Shutdown Timer Maximum RPM parameter is programmed to a value below the Top Engine Limit, the timer can be reset by increasing engine rpm above the programmed limit.

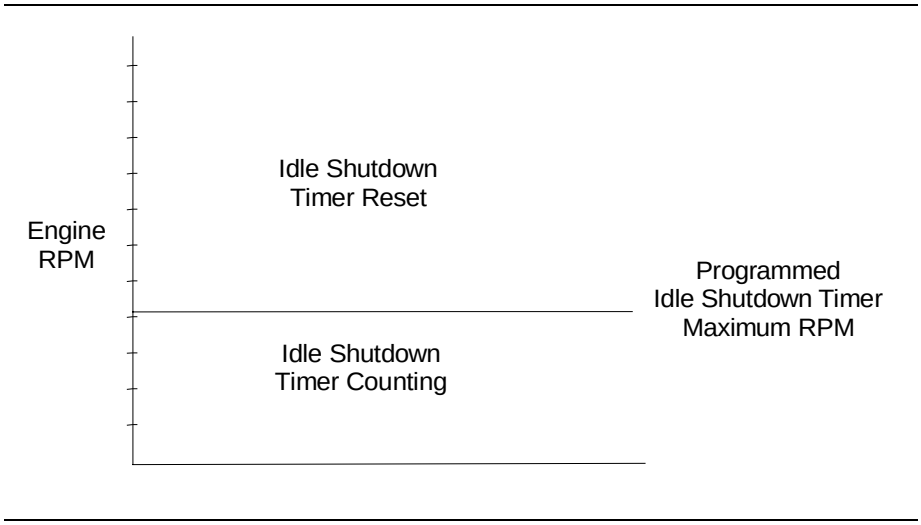


Figure 32 - Idle Shutdown Timer Maximum RPM Graph

OEM provided and installed components required:

1) Vehicle speed source.

2) Check Engine Lamp.

3) Service Brake Pedal Position Switch.

4) Clutch Pedal Position Switch.

5) Transmission Neutral Switch (Automatic Transmissions Style parameter programmed to Automatic Option 3 or Automatic Option 4).

Customer Parameter programming required:

1) Idle Shutdown Time programmed in the 3 - 1440 minutes range.

2) Vehicle Speed Calibration.

3) Allow Idle Shutdown Override (Optional)

4) Idle Shutdown Timer Maximum RPM (Optional)

12.2 Ambient Air Temperature Sensor

An optional Caterpillar Ambient Air Temperature Sensor is available. The sensor should be mounted in a location providing the most accurate measurement of ambient (outside) air temperature. Recommended locations are inside the battery box or on the frame rail near the front bumper. The sensor is used on applications that monitor outside air temperature in order to allow an Idle Shutdown Override when the outside air temperature is below a minimum or above a maximum programmed range. The two wire sensor is available from Caterpillar (part number 130-9811), and is identical to the factory installed Coolant, Fuel and Intake Manifold Air Temperature Sensors. The sensor is only used when the Allow Idle Shutdown Override parameter is programmed to Outside Temp Based. Refer to " Allow Idle Shutdown Override" on page 129 for more information.

NOTE: If ambient air temperature is broadcast over the SAE J1587 datalink, the engine ECM can be programmed to use this data instead of this sensor. Refer to " Allow Idle Shutdown Override" on page 129 for more information.

OEM provided and installed components required:

1) Ambient Air Temperature Sensor and connector wiring harness.

Customer Parameter programming required:

1) Idle Shutdown Time programmed in the 3 - 1440 minutes range.

2) Allow Idle Shutdown Override programmed to Outside Temp Based.

3) Minimum Idle Shutdown Outside Temp programmed to a value between -40 and 49°C (-40 and 120°F).

4) Maximum Idle Shutdown Outside Temp programmed to a value between -40 and 49°C (-40 and 120°F).

12.2.1 Ambient Air Temperature Sensor Connections

NOTE: INPUT SENSOR COMMON #2 (TERMINAL-3) MAY BE USED IN PLACE OF INPUT SENSOR COMMON #1 (TERMINAL-18).

Wiring Diagram 9 - 130-9811 Ambient Air Temperature Sensor Wiring Diagram

13.0 OEM Installed Switch Inputs

The ECM has 18 switch inputs. Three are switched to positive battery, and 15 are switched to ground (sensor common)

13.1 Switch to Ground Electrical Specifications

Applied voltage to switches by the control will normally not exceed 11.5 Volts DC. Contact plating should not corrode or oxidize. Gold plated contacts are recommended. Normal current draw through the switches by the control will not exceed 6.5 mA.

Contact chatter and momentary opening or closing should not exceed 100 milliseconds in duration. The switches should not open or close due to vibration or shock normally found in the application.

ECM internal pull-ups force the respective input to 11.5 Volts DC when a switch contact is opened or the harness is open circuited. Closure of an OEM installed switch must short circuit the input to the Sensor Common (terminal-3, terminal-5 or terminal 18) of the ECM OEM connector P1.

Voltage thresholds measured at ECM:

Voltage-In-Low < 0.9 Volts DC - With any switch contacts closed, ground potential differences, switch voltage drops, and wiring harness voltage drops must be such that a switch closure results in less than 0.9 Volts DC between the respective control inputs and Sensor Common terminal.

Voltage-In-High > 4.0 Volts DC - With the switch contacts open, ground potential differences, switch voltage drops, and wiring harness voltage drops must be such that a switch opening results in greater than 4.0 Volts DC between the control input and Sensor Common terminal.

13.2 Sensor Common Connections

Three Sensor Common terminals are available to ground inputs connected to the ECM. If additional Sensor Common connections are required, please contact Caterpillar.

OEM installed components used as inputs to the ECM must not be connected to the vehicle or cab ground, and must not be case grounded. OEM installed switches must be grounded to an ECM Sensor Common via a dedicated return line to the ECM.

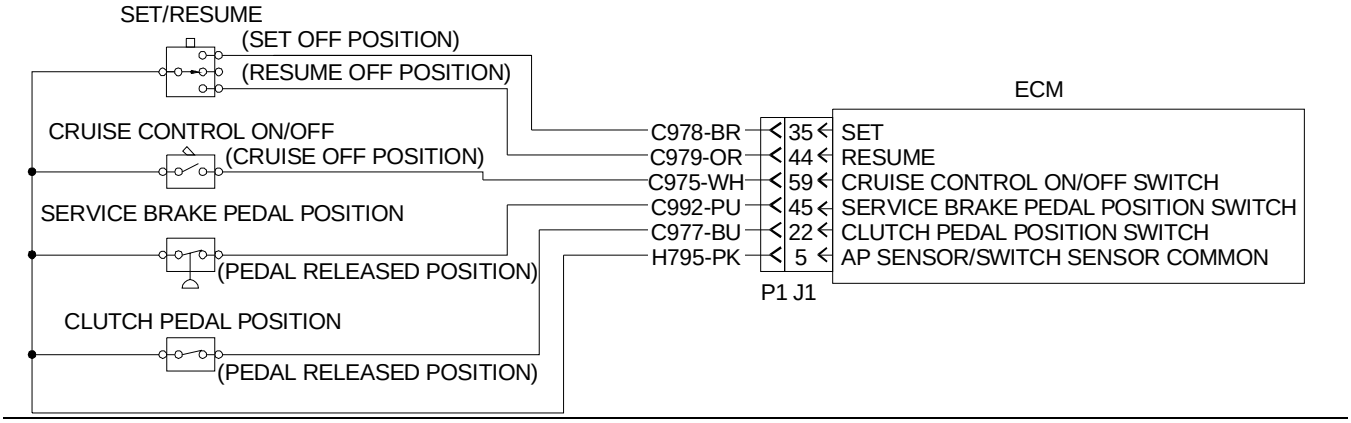
Terminal Description	ECM Terminal Assignment
AP Sensor/Switch Sensor Common	Terminal 5
Input Sensor Common #1	Terminal 18
Input Sensor Common #2	Terminal 3

13.3 Preset Switch to Ground Inputs

The function of five of the switch to ground inputs are preset from the factory to function as described in the table below.

Terminal Description	ECM Terminal Assignment
Cruise Control On/Off	Terminal 59
Cruise Control Set	Terminal 35
Cruise Control Resume	Terminal 44
Clutch Pedal Position Switch	Terminal 22
Service Brake Pedal Position Switch	Terminal 45

Cruise control operation requires the following OEM installed switches: ON/OFF, Set/Resume, Service Brake Pedal Position Switch #1, Service Brake Pedal Position Switch #2 (option for automatic transmissions only), and Clutch Pedal Position Switch.



Wiring Diagram 10 - Preset Switches Wiring Diagram

13.4 Cruise Control

Vehicle speed control is a standard feature available from the control system. It allows setting cruise control vehicle speed via OEM installed On/Off and Set/Resume switches. Cruise Control vehicle speed is maintained at the set speed until the OEM installed Service Brake Pedal Position or Clutch Pedal Position switches are actuated or Cruise Control ON/OFF is switched off.

OEM provided and installed components required:

1) Cruise Control On/Off switch.

2) Vehicle speed source.

3) Clutch Pedal Position Switch (for Manual and Eaton Top 2 Transmissions Style).

4) Service Brake Pedal Position Switch.

5) Set /Resume switch.

6) Transmission Neutral switch (If Transmission Style parameter is programmed to Automatic Option 3 or Automatic Option 4).

Customer Parameter programming required:

1) Vehicle Speed Calibration.

2) Low Cruise Control Speed Set Limit.

3) High Cruise Control Speed Set Limit.

4) Transmission Style.

13.5 Factory Preset Cruise Control Switches Operation

13.5.1 Cruise Control On/Off Switch

The On/Off switch is a two position switch. The On/Off input enables the cruise control or extended idle function. When the On/Off switch input is toggled to the ON position the cruise control or extended idle function is enabled, and the switch contacts are closed (a short circuit).

13.5.2 Set/Resume Switch

The Set/Resume switch is a three position switch biased to a neutral position. The ECM inputs are Customer programmable determining the Accel/Decel function of the Set and the Resume input. The factory default is Set/Accel and Resume/Decel.

If the Set/Resume switch is toggled to the Set position the control will enter vehicle or engine speed into memory for use in control of vehicle speed in the cruise control mode or engine speed in the idle mode. Once the control is in either cruise control or extended idle mode, momentary toggling the Set/Resume switch to the Accel position will increase vehicle speed by 1 MPH in cruise control mode or engine speed by a Customer Parameter programmed RPM in idle mode. Holding the Set/Resume switch in the Accel position for more than one second will ramp up vehicle speed in cruise control mode or ramp up engine speed in idle mode. Note that the High Cruise Control Speed Set Limit and Idle RPM Limit will not be exceeded using the switches as outlined above.

If the Cruise Control On/Off Switch is in the ON position, but the engine control is not in cruise control mode (i.e., the brake or clutch has been depressed to disengage a Cruise Control set speed), and the Set/Resume switch is toggled to the Resume position the control will return the vehicle or engine speed to the previous set point. Once the control is in either cruise control or idle mode, momentarily toggling the Set/Resume switch to the Decel position will decrease vehicle speed by 1 MPH in cruise control mode or decrease engine speed by a Customer Programmable Parameter “Idle/PTO Bump RPM” determined value in idle mode. Holding the Set/Resume switch in the Decel position for more than 1 second will ramp down vehicle speed in cruise control mode or ramp down engine speed in idle mode. The Idle/PTO Engine Speed Ramp rate is selectable from 5 to 1000 RPM/sec (default is 50 RPM/sec).This selection applies to both the Accel and Decel modes, as well as the Resume mode for idle operation.

The Cruise Control set speed must be set following power up of the control. Turning the Ignition Key Switch OFF (connector P1, Terminal 70) loses the previously set Cruise Control speed, whereas turning the Cruise Control On/Off switch OFF does not lose a previously set speed. If the operator has not set the Cruise Control Set speed since the engine control power up, and he attempts to Resume to a speed that has not been previously set (cruise control switch in the ON position), the engine control will use the vehicle speed at the time the Resume switch is pressed as the Cruise Control Set speed.

If the High Cruise Control Speed Set Limit is programmed to a value greater than the Vehicle Speed Limit, the Cruise Switches can be used to exceed the programmed Vehicle Speed Limit. If the set speed is then terminated using the brake or clutch, the vehicle can be returned to the set speed by toggling the Resume switch.

13.5.3 Service Brake Pedal Position Switch Function

The Service Brake Pedal Position Switch is required for all applications. This switch must be an open circuit when the service brake pedal is depressed. The control will deactivate either cruise control, idle, or PTO (depending on PTO programming) when the Service Brake Pedal Position Switch is an open circuit. A change in state (depressing a released pedal, or releasing a depressed pedal) of the Service Brake in the last 90 seconds while the Idle Shutdown Timer is counting also overrides the Idle Shutdown Timer if the Customer Parameter “Allow Idle Shutdown Override” is programmed to Yes (default). Refer to “13.12 Service Brake Pedal Position Switch #2 Function” on page 52.

13.5.4 Clutch Pedal Position Switch Function

The Clutch Pedal Position Switch is required if a Manual Transmission is installed or if an automated transmission that uses a clutch is installed. This switch must be an open circuit when the clutch pedal is depressed. The control will deactivate either the cruise control or Cab PTO when the Clutch Pedal Position Switch is an open circuit. Remote PTO is not affected by the Brake and Clutch Pedal Position Switches. Adjustment of the Clutch Pedal Position Switch is critical to proper system performance. A change in state (depressing a released pedal, or releasing a depressed pedal) of the Clutch in the last 90 seconds while the idle shutdown timer is counting also overrides the Idle Shutdown Timer, if the ECM is programmed to allow Idle Shutdown Override.

13.5.5 Clutch Pedal Position Switch with Automatic Transmissions

If the parameter Transmission Style is programmed to Automatic Option 1, Automatic Option 2, Automatic Option 3, or Automatic Option 4 the Clutch Switch can be omitted. Refer to “ Transmission Style Parameter Switch Input Table” on page 85 for details.

13.5.6 Parking Brake Switch

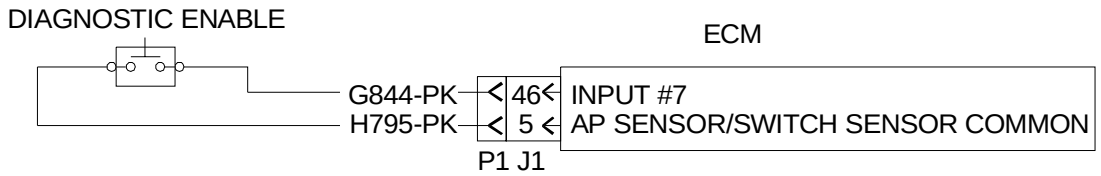
A Parking Brake Switch is not used to trigger the Idle Shutdown Timer feature. A Parking Brake Switch can be installed in series with the PTO On/Off Switch as an interlock to prevent PTO operation unless the vehicle is stationary. The ECM does not have a dedicated input for a parking brake switch.

13.6 Additional Switch to Ground Inputs

Several additional Switch to Ground Inputs are provided for connection to a Fan Override switch, Retarder Solenoid Low/Hi switch, Retarder Solenoid Med/Hi switch, PTO On/Off switch, Remote PTO Set/Resume switch, Diagnostic Enable switch, Ignore Brake/Clutch switch, Torque Limit switch, Two-Speed Axle switch, Starting Aid On/Off switch, PTO Engine RPM Set Speed A switch, PTO Engine RPM Set Speed B switch.

13.7 Diagnostic Enable

A Diagnostic Enable input is available to prompt the ECM for flashing Diagnostic Flash Codes. ECM Input #7 is available for this feature. The Diagnostic Enable parameter must be programmed to J1/P1:46 (Input #7) to enable this feature. A momentary normally open switch is required. The ECM will begin flashing and continue to flash out codes while the input is shorted to the ECM AP Sensor/Switch Sensor Common.



Wiring Diagram 11 - Diagnostic Enable Circuit

OEM provided and installed components required:

1) Normally open momentary switch.

Customer Parameter programming required:

1) Program Diagnostic Enable parameter to J1/P1:46 (Default is None).

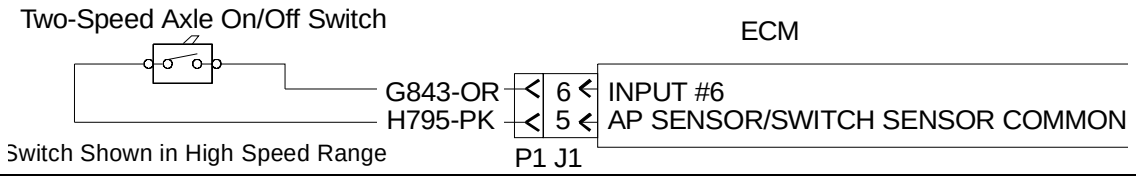
13.8 Two-Speed Axle On/Off Switch

A Two-Speed Axle On/Off switch input is available when a two-speed axle is used. ECM Input #6 is available for this feature. A normally open switch is required. When a two-speed axle is used, the change in gear ratios from the high speed range to the low speed range alters the calibration of the vehicle speed signal. With this system, the ECM will automatically adjust the vehicle speed calibration when the switch is ON. This will ensure an ECM driven speedometer and ECM stored information correctly reflect the actual vehicle speed. The Low Speed Range Axle Ratio and High Speed Range Axle Ratio parameters must be programmed. The Two Speed Axle parameter must be programmed to J1/P1:6 (Input #6). When the switch is shorted to the ECM AP Sensor/Switch Sensor Common (ON) the ECM will use the following equation to calculate the actual vehicle speed:

$$\frac{\text{High Speed Range Axle Ratio}}{\text{Low Speed Range Axle Ratio}} \text{ X calculated vehicle speed = actual vehicle speed}$$

Where the calculated vehicle speed is the vehicle speed calculated using the programmed vehicle speed calibration (pulse per mile). This adjusted vehicle speed will be used to determine idle, PTO, and Fast Idle kick out speeds as programmed. The data link broadcast vehicle speed and the ECM speedometer output vehicle speed will reflect the adjustment. If the Two Speed Axle parameter is not programmed to J1/P1:6 (Input #6), the ECM does not use either axle ratio to determine the actual speed.

NOTE: The Two Speed Axle parameter should be locked out to prevent tampering.



Wiring Diagram 12 - 2-Speed Axle On/Off Switch Circuit

OEM provided and installed components required:

1) Switch to close when the low speed range is used.

Customer Parameter programming required:

1) Two Speed Axle parameter must be programmed to J1/P1:6 when a two-speed axle is used (default is NONE).

2) High Speed Range Axle Ratio and Low Speed Range Axle Ratio must be programmed or the feature is disabled.

3) Lock out the parameter with an Electronic Service Tool or VEPS.

13.9 Switch-to-Battery Electrical Specifications

Contact plating should not corrode or oxidize. Gold plated contacts are recommended. Normal current draw through the Input #12 and Input #13 by the control is 6.0 mA at 12 Volts DC. Normal current draw through the Ignition Key Switch by the control is 1.2 mA at 12 Volts DC.

Contact chatter and momentary opening or closing should not exceed 100 milliseconds in duration. The switches should not open or close due to vibration or shock normally found in the application.

Each of these ECM inputs is pulled to ground eliminating the need for external termination. Closure of an OEM installed switch must short circuit the input to the vehicle positive battery.

Voltage thresholds measured at ECM:

Switch Open < 0.9 Volts DC - With the switch contacts open, ground potential differences, switch voltage drops, and wiring harness voltage drops, the ECM must detect less than 0.9 Volts DC between the control input and the ECM negative battery connection.

Switch Closed > 9.0 Volts DC - With the switch contacts closed, ground potential differences, switch voltage drops, and wiring harness voltage drops, the ECM must detect a switch closure resulting in greater than 9.0 Volts DC between the control input and the ECM negative battery connection.

13.9.1 Switch-to-Battery Circuit Protection

Circuit protection for these inputs should be 20 Amperes maximum. These circuits do not require dedicated circuit protection.

13.10 Ignition Key Switch to Positive Battery

The Ignition Key Switch input is factory preset. When the ECM detects the input is switched to vehicle battery (Ignition Key Switch ON), the ECM will be powered. The ECM will then control the injectors allowing the engine to start. The ECM remains powered if Vehicle Speed > 0, regardless of the state of the Ignition Keyswitch Input.

Terminal Description	ECM Terminal Assignment
Ignition Key Switch	Terminal 70

Refer to Wiring Diagram 1 - “ECM and Engine Stud Battery Connections” on page 19 for a wiring diagram of the Ignition Key Switch circuit.

OEM provided and installed components required:

1) Switch to close when the ignition is ON.

13.11 Programmable Switch to Positive Battery Inputs

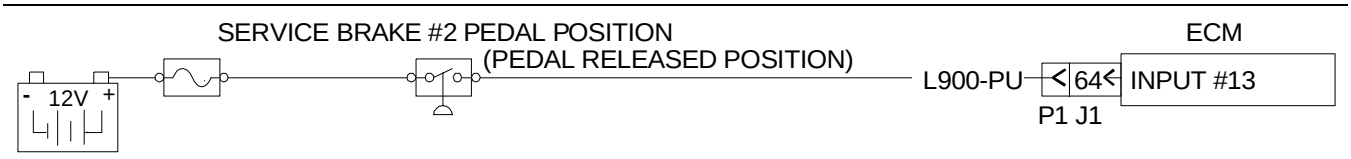
Two additional switch to positive battery inputs are available. Input #13 is used as Service Brake Pedal Position Switch #2 if the Transmission Style is programmed to Automatic Option 2 or Automatic Option 3. Input #12 is used as a Transmission Neutral Switch when the Transmission Style is programmed to Automatic Option 3 or Automatic Option 4.

Terminal Description	ECM Terminal Assignment
Input #12	Terminal 62
Input #13	Terminal 64

13.12 Service Brake Pedal Position Switch #2 Function

Service Brake Pedal Position Switch #2 is required if the Transmission Style is programmed to Automatic Option 2 or Automatic Option 3. Input #13 is used as the Service Brake Switch #2 input. Refer to “ Transmission Style Parameter Switch Input Table” on page 85.

This switch must be a short circuit when the service brake pedal is depressed. The control will deactivate either cruise control, Cab Switches PTO Configuration, Fast Idle, or idle when the Service Brake Pedal Position Switch #2 is a short circuit. Remote Switches or Remote Throttle PTO Configuration is not affected by the Brake or Clutch Pedal Position Switches. A change in state (depressing a released pedal, or releasing a depressed pedal) of the Service Brake in the last 90 seconds while the Idle Shutdown Timer is counting can also override the Idle Shutdown Timer, if the ECM is programmed to allow Idle Shutdown Override.



Wiring Diagram 13 - Service Brake Pedal Position Switch #2 Circuit

OEM provided and installed components required:

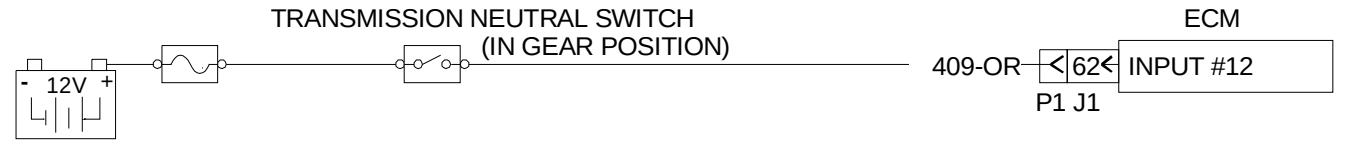
1) Switch to close when service brakes are applied.

Customer Parameter programming required:

1) Customer Parameter Transmission Style programmed to Automatic Option 2 or Automatic Option 3.

13.13 Transmission Neutral Switch

This switch is used to indicate when the transmission is in neutral, allowing Cab Switches PTO Configuration and idle to be used. The switch is required if the Transmission Style Parameter is programmed to Automatic Option 3 or Automatic Option 4 or if the Battery Monitor and Engine Speed Control feature is used. Refer to “ Battery Monitor and Engine Control Voltage” on page 131 for details.



Wiring Diagram 14 - Transmission Neutral Switch

OEM provided and installed components required:

1) Switch to close when the transmission is in neutral.

Customer Parameter programming required:

1) Customer Parameter Transmission Style programmed to Automatic Option 3 or Automatic Option 4 (if an automatic transmission is installed).

NOTE: If the Battery Monitor and Engine Speed Control feature is used, the ECM will monitor the Neutral Switch Input at all times for the Battery Monitor and Engine Speed Control purposes, regardless of Transmission Style parameter programming.

14.0 PTO Engine Governor and Idle Speed Control

Several options are available to control engine rpm either as an isochronous engine governor or for setting an idle speed above the programmed low idle setting. The Cab Cruise Control On/Off and Set/Resume switches can be used to set an idle rpm, or a dedicated PTO On/Off switch can be installed to control PTO mode operation.

If the Cruise Control On/Off switch is used to set an idle speed, engine rpm is maintained at the set speed until the OEM installed Brake or Clutch Pedal Position Switches are actuated (open circuit) or the Cruise Control On/Off

switch is switched OFF (open circuit). The Cab Switches PTO Configuration can also use the Cruise Set/Resume switch to adjust engine rpm, but required a dedicated PTO On/Off switch instead of the Cruise On/Off switch.

Dedicated PTO operation also provides the ability to use preset speeds or additional switches and throttles to control engine speed. Remote PTO applications allows setting engine rpm via OEM or chassis body builder installed On/Off and Set/Resume switches and the Cab Switches and Accelerator are ignored. Refer to “Dedicated PTO Operation” on page 53 for further details.

OEM provided and installed components required:

1) Cruise Control On/Off switch.
2) Vehicle speed source.
3) Clutch Pedal Position switch (for Manual and Eaton Top 2 Transmission Style).
4) Service Brake Pedal Position switch.
5) Transmission Neutral switch (automatic transmissions with Transmission Style parameter programmed Automatic Option 3 or Automatic Option 4).
6) Cruise Control Set/Resume Switch.
7) PTO On/Off Circuit (for PTO Operation).
8) PTO Set/Resume Switch (for Remote Switches PTO Operation).
9) PTO Remote Accelerator Position Sensor (for Remote Throttle PTO Operation).
10) PTO Switch On Lamp.

Customer Parameter programming required:

1) For Dedicated PTO operation the PTO Configuration must be programmed to Cab Switches, Remote Switches, or Remote Throttle.

14.1 Dedicated PTO Operation

Engine PTO operation requires some or all of the following OEM installed switches: PTO ON/OFF, Set/Resume (for speed adjustment only), Service Brake Pedal Position #1, Service Brake Pedal Position #2, Transmission Neutral, and Clutch Pedal Position. Refer to “Wiring Diagram 10 - Preset Switches Wiring Diagram” on page 48, “Wiring Diagram 13 - Service Brake Pedal Position Switch #2 Circuit” on page 52, and “13.13 Transmission Neutral Switch” on page 52.

The following options are available for applications requiring control of engine speed from inside or outside of the cab. These options are available to enhance the engine’s capability for these applications. The system can be configured to operate the engine at specific programmable engine speeds, with a second set of PTO On/Off and Set/Resume switches, or with a second accelerator pedal position sensor. The cab accelerator pedal position sensor can be disabled or limited. A programmable torque limit is also available.

There are four programmable PTO Configurations available:

1) Off.
2) Cab Switches.
3) Remote Switches.
4) Remote Throttle.

The Remote/PTO features should provide enough functional capability to cover any typical application: Bulk Hauler, Fire Truck, Cement Mixer, Refuse Packer, Crane, Bucket Truck, etc. These inputs will allow the OEM or body-builder to add the necessary switches, ground, or accelerator pedal sensor reducing the amount of splicing and disturbance of the cab wiring.

Caterpillar requires all switches, and all components used in these circuits meet the specifications as outlined in this document (refer to “13.1 Switch to Ground Electrical Specifications” on page 47, “Sensor Common Connections” on page 21, “13.9 Switch-to-Battery Electrical Specifications” on page 51, and “Accelerator Pedal Position Sensor Electrical Specifications” on page 31). Caterpillar recommends the OEM provide a customer access connector in an easily accessible location to aid installation of these features.

14.2 Advantages of PTO Configurations

1) Reduction or elimination of the amount alteration to cab wiring.

2) Unnecessary to ground accelerator pedal position sensor to disable cab accelerator pedal.

3) Provides an optional torque limit for temporary protection of equipment.

4) Provides an optional PTO Top Engine Limit to allow maximum use of engine speed to protect speed sensitive equipment.

5) Provides optional PTO Set Speeds for those applications where preset speeds above low idle are required.

6) Whenever the PTO On/Off circuit is ON the Exhaust Retarder is disabled.

7) Disabling of Idle Shutdown whenever the PTO On/Off circuit is ON.

8) Cooling fan can be programmed to turn ON and remain ON while the PTO On/Off switch is ON.

14.3 Inputs

Seven inputs are available. Adding these inputs will allow the aftermarket body-builder to add necessary components without altering the cab cruise control switch wiring.

14.3.1 Input Electrical Specifications

Electrical specifications for Inputs #1, #2, #3, #4, #5, #6 and #7 are located in “13.1 Switch to Ground Electrical Specifications” on page 47. Electrical specifications for the remote accelerator pedal position sensor are located in “6.4 Remote Accelerator Position Sensor PWM Input, Input #8” on page 33.

14.4 Sensor Common for PTO Applications

ECM Vehicle Harness Connector J1/P1 terminal-3 (Input Sensor Common #2) is designated as the Sensor Common connection for PTO additions. Caterpillar requires this connection be reserved for components connected to the engine to control engine speed for PTO applications only. It should only be used when PTO wiring is or will be required on the vehicle. The PTO Components can also use J1/PI terminal-5 (AP Sensor / Switch Sensor Common) or Terminal-18 (Input Sensor Common #1) as a common connection if required. Devices not interfacing to the ECM for use with the Inputs must not be connected to Input Sensor Commons. All switches connected to the Input Sensor Commons must also meet the specifications indicated in “Sensor Common Connections” on page 21 of this document.

14.5 PTO On/Off Switch Operation

This input is the trigger for the system when PTO Configuration is programmed to Cab Switches, Remote Switches, and Remote Throttle. Whenever this switch is “ON”, PTO operation is assumed.The PTO On/Off switch is connected to the ECM input labeled Input #1 (Connector P1, terminal 56). When this input is ON it can trigger several types of operation depending on the Customer Parameter Dedicated PTO programming. For PTO Operation, an OFF to ON transition of the PTO On/Off switch is required. If the vehicle is started with the switch left in the ON position, PTO operation will not be enabled.

14.6 PTO Switch On Lamps

Output #1 can be used to connect a PTO Switch On Lamp. The output is automatically selected for this feature unless the Engine Monitoring Lamps feature is programmed to Option 1 and a Coolant Level Sensor is installed. Refer to“9.0 Lamp Outputs”“9.0 Lamp Outputs” on page 39 for details. If the output is unavailable, a double pole / double throw PTO On/Off Switch can be used to connect a PTO Switch ON Lamp between +Battery and Ground. If a Remote PTO configuration is used, a lamp should be installed in the cab and at the remote operations station.

14.7 PTO Interlocks

The switches labeled PTO Interlock in the wiring diagrams are redundant switches that should be added to insure the engine is put in PTO mode only when the vehicle is ready and prepared for PTO operation. These switches may be parking brake switches or whatever interlock is required for the application.

14.8 PTO Customer Access Connector

Caterpillar recommends the OEM provide a customer access connector for those chassis' frequently used in vocational applications. This connector should provide wiring from the ECM to a connector easily located and identified on the vehicle. Caterpillar recommends the circuits listed in the following table be provided at this connector.

Terminal Description	ECM Terminal Assignment	Parameter
Input #1	Terminal 56	PTO On/Off Switch
Input #2	Terminal 58	Remote PTO Set Switch
Input #3	Terminal 60	Remote PTO Resume Switch
Input Sensor Common #2	Terminal 3	
Output #1	Terminal 30	PTO Switch On Lamp
Input #8	Terminal 68	Remote Throttle

Additional circuits such as positive and negative battery should also be considered (these circuits must be separate from the engine ECM battery circuits).

14.9 PTO Configurations

The table below outlines the operating differences for each of the PTO Configurations. The table shows each inputs affect on the engine rpm when the PTO On/Off switch is ON for each configuration. For the following table, an "✗ " means the input can return the engine to low idle from a set speed, a "✔" means the input can adjust engine rpm, and "P" means the input function is programmable to a limit.

PTO Configuration	Cruise On/Off	Cruise Set	Cruise Resume	Cab Accelerator	Remote Throttle	Service Brake	Clutch	Neutral	PTO Set	PTO Resume	PTO Engine RPM Set Speed Input A	PTO Engine RPM Set Speed Input B
Off	✔	✔	✔	✔		✗	✗	✗				
Cab Switches		✔	✔	P		✗	✗	✗			✔	✔
Remote Switches									✔	✔	✔	✔
Remote Throttle					✔				✔	✔	✔	✔

14.9.1 PTO Configuration - Cab Switches, Remote Switches, or Remote Throttle Operation

When the PTO On/Off switch is turned to the ON position:.

1) The PTO Top Engine Limit is activated. This PTO TEL can be programmed to exceed the programmed Top Engine Limit.

2) A torque limit is activated if programmed.

3) The engine will proceed directly to the PTO Engine RPM Set Speed if programmed.

4) The engine will proceed directly to PTO Engine RPM Set Speed A if switch A is ON and a valid RPM is programmed.

5) The engine will proceed directly to PTO Engine RPM Set Speed B if switch B is ON, switch A if OFF, and a valid RPM is programmed.

6) The Engine Retarder is disabled.

14.9.2 PTO Configuration - Cab Switches Operation Differences

1) The cruise control Set/Resume switch can be used to adjust engine speed.

2) The cab accelerator pedal position sensor can be limited to Low Idle, Top Engine Limit, or the PTO Top Engine Limit.

14.9.3 PTO Configuration - Remote Switches Operation Differences

1) The remote Set/Resume (not the Cruise Control Set/Resume switch) switch can be used to adjust engine speed.

2) The cab accelerator pedal position sensor, cab cruise control, brake, clutch and neutral switches are ignored.

14.9.4 PTO Configuration - Remote Throttle Operation Differences

1) The remote accelerator pedal input is available to adjust engine speed.

2) The cab accelerator pedal position sensor, cab cruise control, brake, clutch and neutral switches are ignored.

14.10 PTO Configuration - Cab Switches

The Cab Switches Configuration utilizes a dedicated PTO On/Off circuit (connected to ECM Connector P1/J1, terminal-56), a PTO Switch On Lamp (programming dependent), and can use the cruise control Set/Resume inputs for both Cruise Control / Idle operation (when the PTO On/Off circuit is OFF) and PTO operation (when the PTO On/Off circuit is ON).

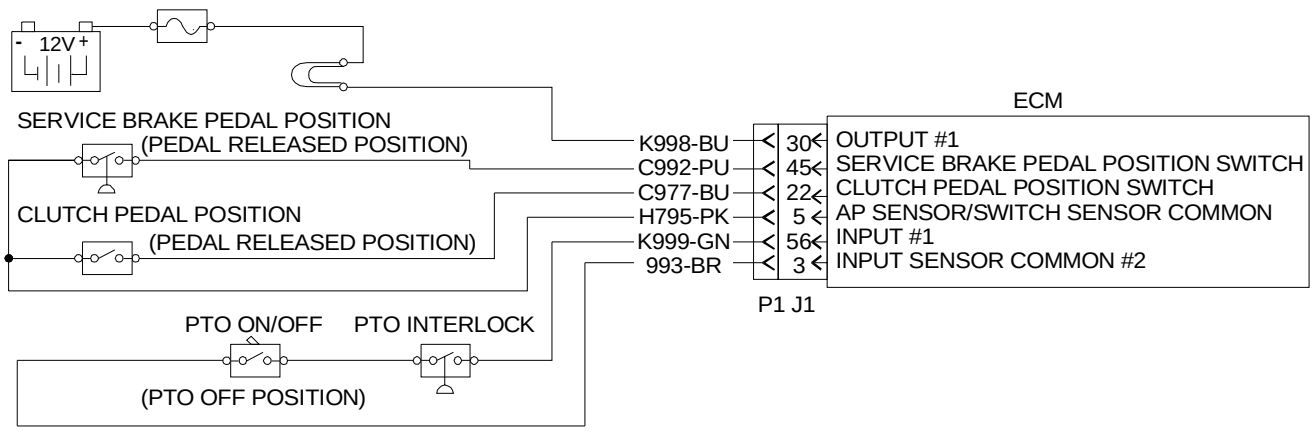
14.10.1 One Speed Above Low Idle with PTO Switched On

Wiring Diagram 15 - “PTO Configuration Cab Switches with One Speed Above Idle Circuit” on page 56 is for applications requiring only one rpm above low idle. With PTO to Set Speed programmed to Yes, the ECM will ramp up to the pre-programmed PTO Engine RPM Set Speed when the PTO On/Off switch is turned ON. If the PTO Top Engine Limit is set to the same value as the PTO Engine RPM Set Speed, the engine will not exceed this rpm.

The Service Brake Pedal Position, and Clutch Pedal Position circuits are included because they will interrupt a set rpm using the Cab Switches configuration. The cab accelerator pedal position sensor can be limited to low idle, PTO Top Engine Limit, or Top Engine Limit using the PTO Cab Throttle RPM Limit parameter.

Parameter settings for PTO Configuration Cab Switches with One Speed Above Idle Circuit

Customer Parameter	PTO Configuration	PTO Cab Throttle RPM Limit	PTO TEL	PTO Engine RPM Set Speed	PTO to Set Speed
Parameter Setting	Cab Switches	Desired Limit	700 - TEL	Desired RPM	Yes
Input/Output	Input #1	Output #1			
Connection	PTO On/Off Circuit	PTO Switch On Lamp			



Wiring Diagram 15 - PTO Configuration Cab Switches with One Speed Above Idle Circuit

If cab accelerator pedal limiting is required before the preset speed activates, after the PTO On/Off switch is ON, and the activating switch is a Set/Resume type toggle switch, refer to “14.10.2 One Speed Above Low Idle after PTO Switched On, Using Cruise Set /Resume”.

14.10.2 One Speed Above Low Idle after PTO Switched On, Using Cruise Set /Resume

These diagrams provide cab accelerator pedal limiting before the rpm ramps up, and allow the one speed above idle to be controlled from the Cruise Set/Resume switches. Wiring Diagram 16 - “PTO Configuration Cab Switches with One Speed Above Idle Circuit” is for applications requiring only one rpm above low idle. If the PTO to Set Speed parameter is programmed to NO, the ECM will not go to the programmed PTO Engine rpm Set Speed until the Set (rpm increase) switch is toggled. If the PTO Top Engine Limit is set to the same value as the PTO Engine rpm Set Speed, the engine will not exceed this rpm. If the PTO Top Engine Limit is set above the PTO Engine rpm Set Speed, the engine rpm can be adjusted between the idle rpm, PTO Engine rpm Set Speed, and PTO Top Engine Limit using the Set (rpm increase) and Resume (rpm decrease).

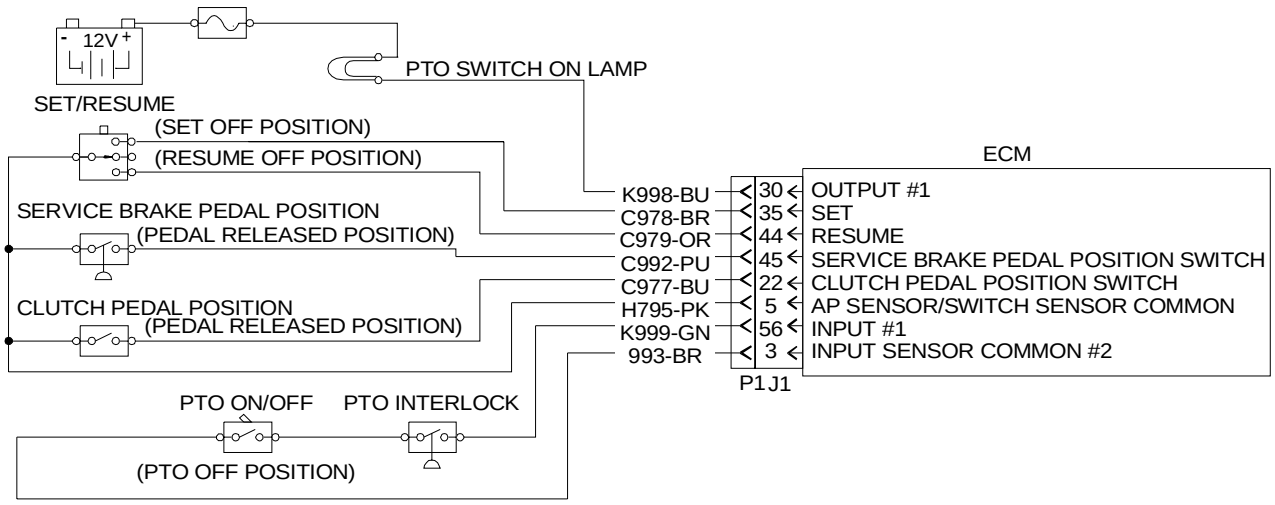
If the PTO to Set Speed parameter is programmed to NO, the ECM will not go to the programmed PTO Engine rpm Set Speed until the Set (rpm increase) switch is toggled.

The Cruise Set/Resume, Service Brake, and Clutch circuits are included because they will interrupt a set rpm using the Cab Switches configuration. The cab accelerator pedal position sensor can be limited to low idle, PTO Top Engine Limit, or Top Engine Limit using the PTO Cab Throttle RPM Limit parameter.

NOTE: If the PTO Engine RPM Set Speed is programmed to 0 rpm, the Set/Resume switch can be used to bump (increment) engine speed up and down by a pre-defined increment. The Idle / PTO Bump RPM parameter provides the ability to program the desired bump rate.

Parameter settings for PTO Configuration Cab Switches with One Speed Above Idle Circuit

Customer Parameter	PTO Configuration	PTO Cab Throttle RPM Limit	PTO TEL	PTO Engine RPM Set Speed	PTO to Set Speed
Parameter Setting	Cab Switches	Desired Limit	700 - TEL	Desired RPM	No
Input/Output	Input #1	Output #1			
Connection	PTO On/Off Circuit	PTO Switch on Lamp			



NOTE: INPUT SENSOR COMMON #1 (TERMINAL-18) MAY BE USED IN PLACE OF INPUT SENSOR COMMON #2 (TERMINAL-3)

Wiring Diagram 16 - PTO Configuration Cab Switches with One Speed Above Idle Circuit

14.10.3 PTO Configuration - Cab Switches Programmable Options

The following list includes all of the programmable options available for the PTO Configuration Cab Switches:

1) Cruise/Idle/PTO Switch Configuration - determines the function of the Set and Resume inputs when held in position or toggled. The two options are Set-Accel, Resume - Decel or Set -Decel, Resume-Accel. This applies to cruise control, idle, and PTO modes of operation. If any PTO Engine RPM Set Speeds are programmed, the Set switch is an RPM increase switch and Resume is an RPM decrease switch for PTO.

2) PTO Vehicle Speed Limit - determines the vehicle speed operating range of the PTO inputs. If vehicle speed exceeds this limit the engine will either not allow an engine speed to be set, or disengage a set PTO speed. The PTO On/Off circuit has priority over Cruise Control On/Off.

3) Idle/PTO RPM Ramp Rate - determines the rate of engine speed acceleration/deceleration for the Resume, Accel, and Decel operation. Applies to both PTO and Idle engine speed control.

4) Idle/PTO Bump RPM- determines the amount of rpm increase/decrease when the Set/Resume switch is toggled in the Accel/Decel position. If a PTO Engine RPM Set Speed has been programmed this parameter applies to Idle only, where engine speed is set using the cruise control On/Off circuit. If PTO Engine RPM Set Speed has not been programmed this parameter applies to engine speed control using the cruise control On/Off and PTO On/Off circuit.

5) PTO Top Engine Limit - Top RPM Limit of the engine when the PTO On/Off circuit is ON.

   For applications requiring one PTO engine speed above low idle this parameter should be programmed to the same value as the PTO Engine RPM Set Speed parameter.

   For operation limiting PTO engine speed to two engine speeds above low idle with a toggle adjustment switch this parameter can be programmed to the top or second engine speed.

6) PTO Engine RPM Set Speed - program this parameter only if one or two specific engine speed points above low idle are desired. The parameter is bounded by the programmed low idle and PTO Top Engine Limit.

   Program this parameter above low idle but less than the PTO Top Engine limit to get three discrete engine speeds. With the PTO circuit ON, toggling the Set switch once advances engine speed to this programmed value. Toggle the Set switch again and the engine speed proceeds to the PTO Top Engine Limit. Toggle the Resume switch and the engine speed is reduced to the next lower operating speed.

   Program this parameter to the same RPM as the PTO Top Engine Limit if only two discrete engine speeds are desired.

7) PTO to Set Speed - program this parameter only if the application requires the engine speed to ramp up to the PTO Engine RPM Set Speed whenever the PTO On/Off circuit is turned ON.

8) PTO Cab Throttle RPM Limit - program this parameter if the operation requires limiting engine speed to protect equipment. If programmed to Low Idle, this parameter has the affect of ignoring/disabling the accelerator pedal position sensor when the PTO On/Off circuit is ON.

   If programmed to PTO TEL the accelerator pedal position sensor can be used to control the engine speed up to the programmed PTO TEL when the PTO On/Off circuit is ON.

9) Torque Limit - program this parameter if a lower than rated torque limit is desired in order to temporarily protect equipment used for PTO operation. The torque limit will apply whenever the Torque Limit switch is ON.

10) PTO Engine RPM Set Speed A - This parameter can be programmed to a desired set speed that can be attained by turning on a dedicated switch during PTO operation. The PTO Engine RPM Set Speed Input A parameter must be programmed to one of the available switch input options and an additional switch installed for this feature to function.

11) PTO Engine RPM Set Speed B - This parameter can be programmed to a desired set speed that can be attained by turning on a dedicated switch during PTO operation. The PTO Engine RPM Set Speed Input B parameter must be programmed to one of the available switch input options and an additional switch installed for this feature to function.

14.11 PTO Configuration - Remote Switches

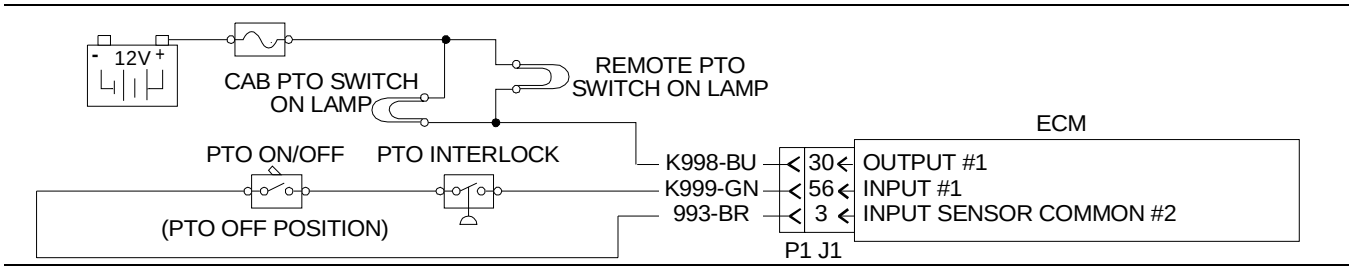
The Remote Switches Configuration utilizes a dedicated PTO On/Off circuit (connected to ECM Connector P1/J1, terminal 56), and an optional pair of PTO Switch On Lamps connected to terminal-30 (one in cab, the other out of the cab at the remote location - programming dependent).

14.11.1 One Speed Above Low Idle with PTO Switched On

Wiring Diagram 17 - “PTO Configuration Remote Switches with One Speed Above Idle Circuit” on page 59 is for applications requiring only one rpm above low idle. With PTO to Set Speed programmed to Yes, the ECM will ramp up to the pre-programmed PTO Engine rpm Set Speed when the PTO On/Off switch is ON. The engine will not exceed the PTO Engine rpm Set Speed with the PTO On/Off Switch ON. The Service Brake Pedal Position switch, Clutch Pedal Position switch, and cab accelerator pedal position sensor circuits are ignored whenever the PTO On/Off switch is ON.

Parameter settings for PTO Configuration Remote Switches with One Speed Above Idle Circuit

Parameter	PTO Configuration	PTO Cab Throttle RPM Limit	PTO TEL	PTO Engine RPM Set Speed	PTO to Set Speed
Setting	Remote Switches	Not Used	700 - TEL	Desired RPM	Yes
Input/Output	Input #1	Output #1			
Connection	PTO On/Off Circuit	PTO Switch On Lamp			



Wiring Diagram 17 - PTO Configuration Remote Switches with One Speed Above Idle Circuit

If the preset speed must not come ON until after the PTO On/Off switch is ON and the activating switch is a Set/Resume type toggle switch, refer to “14.11.2 One Speed Above Low Idle after PTO Switched On, Using PTO Set / Resume”.

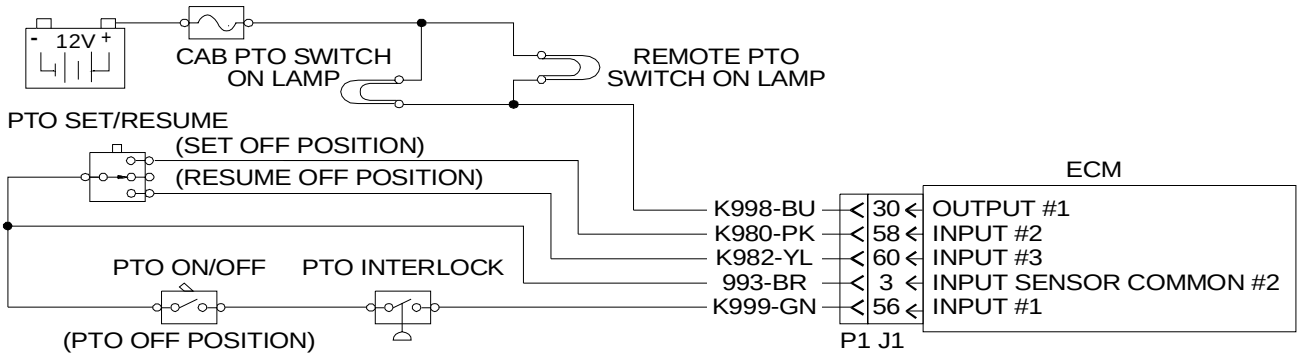
14.11.2 One Speed Above Low Idle after PTO Switched On, Using PTO Set /Resume

Wiring Diagram 18 - “PTO Configuration Remote Switches with One Speed Above Idle Circuit” on page 60 is for applications requiring only one rpm above low idle. If the PTO to Set Speed parameter is programmed to NO, the ECM will not go to the programmed PTO Engine rpm Set Speed until the Set (rpm increase) switch is toggled. If the PTO Top Engine Limit is set to the same value as the PTO Engine rpm Set Speed, the engine will not exceed this rpm. If the PTO Top Engine Limit is set above the PTO Engine rpm Set Speed, the engine rpm can be adjusted between the idle rpm, PTO Engine rpm Set Speed, and PTO Top Engine Limit using the Set (rpm increase) and Resume (rpm decrease).

The service brake pedal position and clutch pedal position switches, and the cab accelerator pedal position sensor circuits are ignored whenever the PTO On/Off switch is ON.

Parameter settings for PTO Configuration Remote Switches with One Speed Above Idle Circuit

Customer Parameter	PTO Cab Throttle RPM Limit	PTO Configuration	PTO TEL	PTO Engine RPM Set Speed	PTO to Set Speed
Parameter Setting	Not Used	Remote Switches	700 - TEL	Desired RPM	No
Input/Output	Output #1	Input #1	Input #2	Input #3	
Connection	PTO Switch On Lamp	PTO On/Off Circuit	PTO Set Switch	PTO Resume Switch	



NOTE: INPUT SENSOR COMMON #1 (TERMINAL-18) MAY BE USED IN PLACE OF INPUT SENSOR COMMON #2 (TERMINAL-3)

Wiring Diagram 18 - PTO Configuration Remote Switches with One Speed Above Idle Circuit

14.11.3 PTO Configuration - Remote Switches Programmable Options

The following list includes all of the programmable options available for the PTO Configuration Remote Switches. The options listed below are nearly identical to those for the Cab Switches Configuration. Differences include the inability to disable PTO in response to all cab inputs (Cruise, Set/Resume, accelerator pedal position sensor, service brake pedal position, transmission neutral, and clutch pedal position switches) when the PTO On/Off circuit is ON.

1) Cruise/Idle/PTO Switch Configuration - only affects Remote Switches if a Remote Set and Remote Resume are installed, and PTO Set Speeds are not programmed. If PTO Set Speeds are programmed, the PTO Set is always RPM increases, the PTO Resume is always a RPM decrease.
2) PTO Vehicle Speed Limit - determines the vehicle speed operating range of the PTO inputs. If vehicle speed exceeds this limit the engine will either not allow an engine speed to be set, or disengage a set PTO speed. The PTO On/Off circuit has priority over Fast Idle and Cruise Control On/Off circuits. The PTO Switch On Lamp will reflect this.
3) Idle/PTO RPM Ramp Rate - determines the rate of engine speed acceleration/deceleration for the PTO and Idle engine speed control.
4) Idle/PTO Bump RPM- determines the amount of rpm increase/decrease if a PTO Set/Resume switch is toggled in the Accel/Decel position. If a PTO Engine RPM Set Speed has been programmed this parameter does not apply to PTO.
5) PTO Top Engine Limit - Top RPM Limit of the engine when the PTO On/Off circuit is ON.
6) PTO Engine RPM Set Speed - program this parameter only if one or two specific engine speed points above low idle are desired. The parameter is bounded by the programmed low idle and PTO Top Engine Limit.

   Program this parameter above low idle but less than the PTO Top Engine limit to get two discrete engine speeds above idle. With the PTO circuit ON, toggling the Set switch once advances engine speed to this programmed value. Toggle the Set switch again and the engine speed proceeds to the PTO Top Engine Limit.

   Toggle the Resume switch and the engine speed is reduced to the next lower operating speed.

   Program this parameter to the same RPM as the PTO Top Engine Limit if only one engine speed above idle is desired.
7) PTO to Set Speed - program this parameter only if the application wants the engine speed to ramp up to the PTO Engine RPM Set Speed whenever the PTO On/Off circuit is turned ON.
8) PTO Cab Throttle RPM Limit- this parameter has no affect on operation for the PTO Configuration Remote Switches- the Cab Throttle RPM Limit is always low idle when the PTO On/Off circuit is ON.
9) Torque Limit - program this parameter if a lower than rated torque limit is desired in order to temporarily protect equipment used for PTO operation. The torque limit will apply whenever the Torque Limit switch is ON.
10) PTO Engine RPM Set Speed A - This parameter can be programmed to a desired set speed that can be attained by turning on a dedicated switch during PTO operation. The PTO Engine RPM Set Speed Input A parameter must be programmed to one of the available switch input options and an additional switch installed for this feature to function.
11) PTO Engine RPM Set Speed B - This parameter can be programmed to a desired set speed that can be attained by turning on a dedicated switch during PTO operation. The PTO Engine RPM Set Speed Input B parameter must be programmed to one of the available switch input options and an additional switch installed for this feature to function.

14.12 PTO Configuration - Remote Throttle

The Remote Throttle Configuration utilizes a dedicated PTO On/Off circuit (connected to ECM Connector P1/J1, terminal 56), an optional pair of PTO Switch On Lamps (one in cab the other out of the cab at the remote location, connected to ECM Connector P1/J1, terminal 30 - programming dependent), and uses a second, additional PTO Accelerator Pedal Position Sensor (when the PTO On/Off circuit is ON, connected to ECM Connector P1/J1, terminal-68).

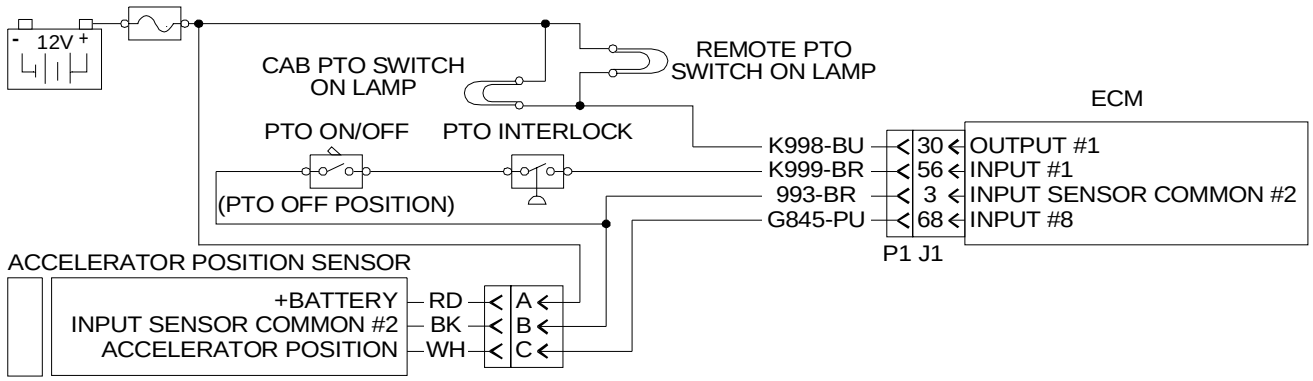
14.12.1 Remote Accelerator Pedal Sensor without Set and Resume

Wiring Diagram 19 - “PTO Configuration Remote Throttle” on page 62 is for applications requiring a remote accelerator pedal without Set/Resume capability. The engine will not exceed the PTO Top Engine Limit with the PTO On/Off Switch ON.

The Service Brake Pedal Position, Clutch Pedal Position switch, and cab accelerator pedal position sensor circuits are ignored whenever the PTO On/Off switch is ON.

Parameter settings for PTO Configuration Remote Throttle with One Speed Above Idle Circuit

Customer Parameter	PTO Configuration	PTO to Set Speed	PTO Cab Throttle RPM Limit	PTO TEL	PTO Engine RPM Set Speed
Parameter Setting	Remote Throttle	Not Used	Not Used	700 - TEL	Not Used
Input/Output	Input #1	Input #8	Output #1		
Connection	PTO On/Off Circuit	Remote Accelerator Position Sensor	PTO Switch On Lamp		



NOTE: INPUT SENSOR COMMON #1 (TERMINAL-18) MAY BE USED IN PLACE OF INPUT SENSOR COMMON #2 (TERMINAL-3)

Wiring Diagram 19 - PTO Configuration Remote Throttle

If the Set/Resume capability is required refer to “14.12.2 Remote Throttle Sensor with Set and Resume”.

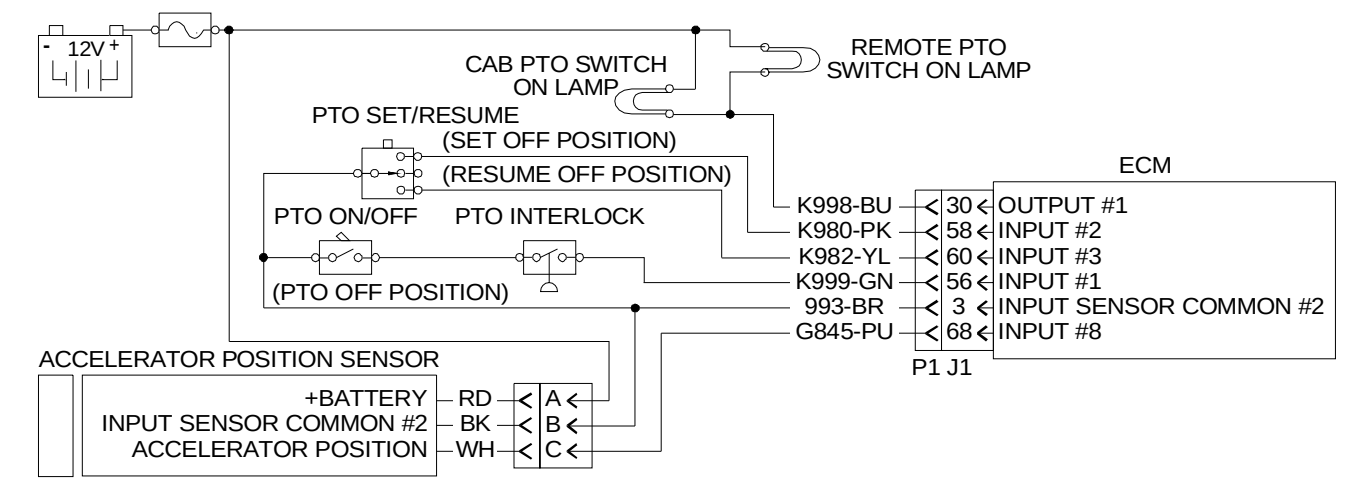
14.12.2 Remote Throttle Sensor with Set and Resume

Wiring Diagram 20 - “PTO Configuration Remote Throttle with Set/Resume” on page 63 is for applications requiring a remote accelerator pedal without Set/Resume capability. The engine will not exceed the PTO Top Engine Limit with the PTO On/Off Switch ON.

The Service Brake Pedal Position, Clutch Pedal Position switch, and cab accelerator pedal position sensor circuits are ignored whenever the PTO On/Off switch is ON.

Parameter settings for PTO Configuration Remote Throttle with Set/Resume

Customer Parameter	PTO Configuration	PTO TEL	PTO Engine RPM Set Speed	PTO to Set Speed	PTO Cab Throttle RPM Limit
Parameter Setting	Remote Throttle	700 - TEL	Not Used	Not Used	Not Used
Input/Output	Input #1	Input #2	Input #3	Input #8	Output #1
Connection	PTO On/Off Circuit	PTO Set Switch	PTO Resume Switch	Remote Accelerator Position Sensor	PTO Switch On Lamp



Wiring Diagram 20 - PTO Configuration Remote Throttle with Set/Resume

14.12.3 PTO Configuration - Remote Throttle Programmable Options

The following list includes all of the programmable options available for the PTO Configuration Remote Throttle. The disabling of ECM response to cab inputs (Cruise Control On/Off, Set/Resume, service brake pedal position and clutch pedal position switches, cab accelerator pedal sensor) occurs when the PTO On/Off circuit is ON.

1) Cruise/Idle/PTO Switch Configuration - determines the function of the Set and Resume inputs when held in position or toggled. The two options are Set-Accel, Resume - Decel or Set -Decel, Resume Accel. This applies to cruise control, PTO, and idle modes of operation.

2) PTO Vehicle Speed Limit - determines the vehicle speed operating range of the PTO inputs. If vehicle speed exceeds this limit the engine will either not allow an engine speed to be set, or disengage a set PTO speed. This parameter also applies to the Idle circuit if using the Cruise Control On/Off switch instead of the PTO On/Off circuit. The PTO On/Off circuit has priority over Fast Idle and Cruise Control On/Off.

3) Idle/PTO RPM Ramp Rate - determines the rate of engine speed acceleration/deceleration for the resume, accel, and decel operation. Applies to both PTO and Idle engine speed control.

4) Idle/PTO Bump RPM- determines the amount of rpm increase/decrease when the Set/Resume switch is toggled in the Accel/Decel position. For the Remote Throttle configuration this parameter applies to engine speed control using the cruise control On/Off and PTO On/Off circuit.

5) PTO Top Engine Limit - Top RPM Limit of the engine when the PTO On/Off circuit is ON.

6) PTO Engine RPM Set Speed - this parameter is not available if the PTO Configuration is Remote Throttle.

7) PTO to Set Speed - this parameter is not available if the PTO Configuration is Remote Throttle.

8) PTO Cab Throttle RPM Limit - programming this parameter has no affect for the PTO Configuration Remote Throttle.

9) PTO Switch On Lamp - program this parameter to turn on a lamp when the PTO On/Off Switch is in the ON position.

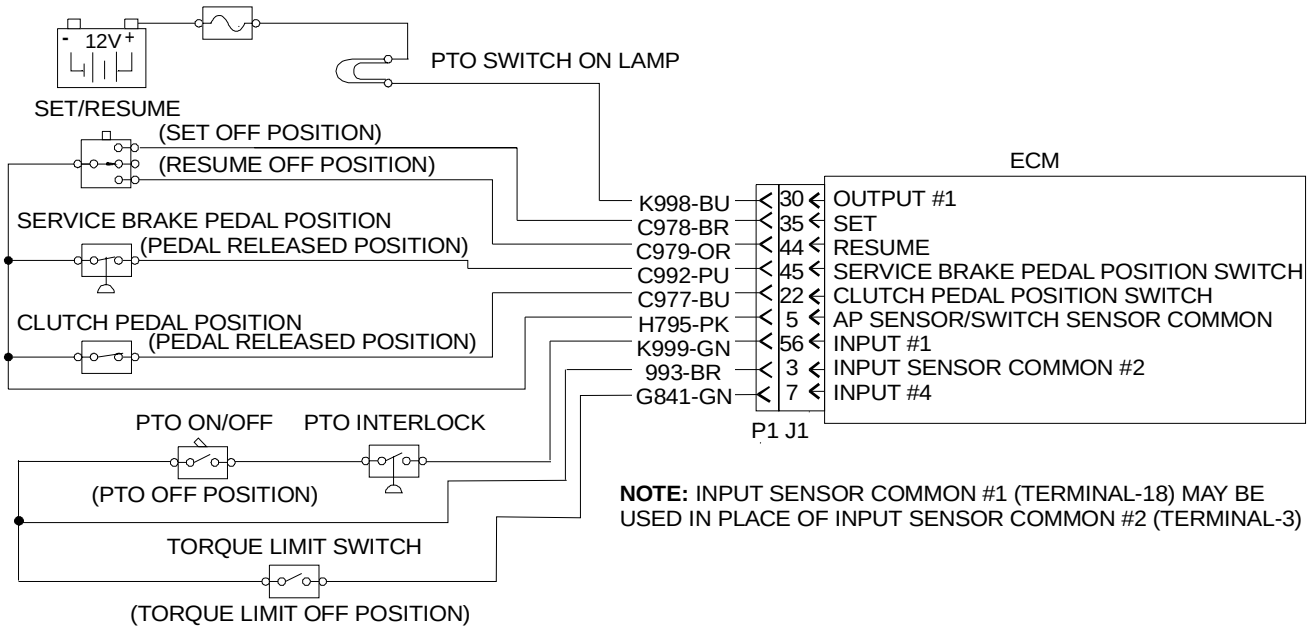
10) Torque Limit - program this parameter if a lower than rated torque limit is desired in order to temporarily protect equipment used for PTO operation. The torque limit will apply whenever the Torque Limit switch is ON.

11) PTO Engine RPM Set Speed A - This parameter can be programmed to a desired set speed that can be attained by turning on a dedicated switch during PTO operation. The PTO Engine RPM Set Speed Input A parameter must be programmed to one of the available switch input options and an additional switch installed for this feature to function.

12) PTO Engine RPM Set Speed B - This parameter can be programmed to a desired set speed that can be attained by turning on a dedicated switch during PTO operation. The PTO Engine RPM Set Speed Input B parameter must be programmed to one of the available switch input options and an additional switch installed for this feature to function.

14.13 PTO Configuration - Cab Switches with Torque Limiting

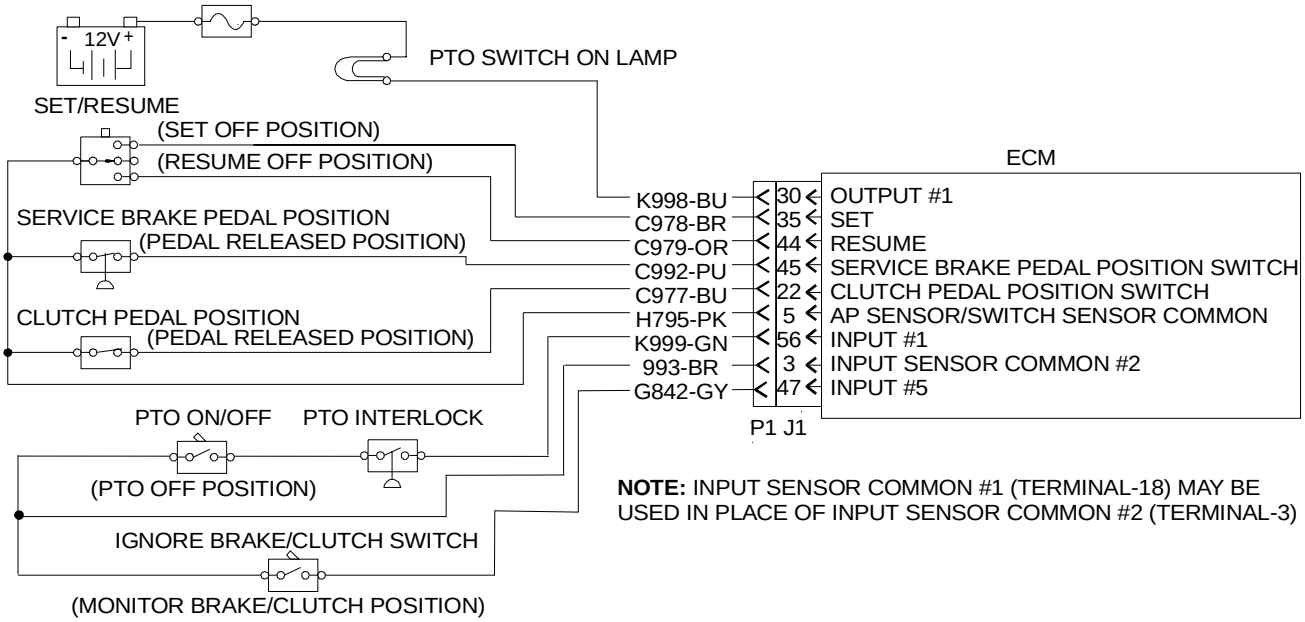
This configuration is identical to the configuration outlined in “PTO Configuration - Cab Switches” on page 56 with the addition of a Torque Limit Switch. If a Torque Limit is programmed it ONLY applies when the Torque Limit Switch is in the ON position. This configuration allows the use of a torque limit switch connected to ECM Input #4 (ECM Connector P1/J1, pin 7) if Torque Limiting is required when during PTO operation or when the PTO On/Off Switch is in the OFF position. Torque Limiting should only be used for temporary protection of equipment. The programmable parameter Torque Limit Switch must be programmed to J1/P1:7 (Input #4) to enable this feature (Default is None). The wiring diagram for this configuration is also shown in PTO Installation and Application Special Instruction.



Wiring Diagram 21 - Cab Switches With Torque Limiting

14.14 PTO Configuration - Cab Switches with Ignore Brake/Clutch Switch

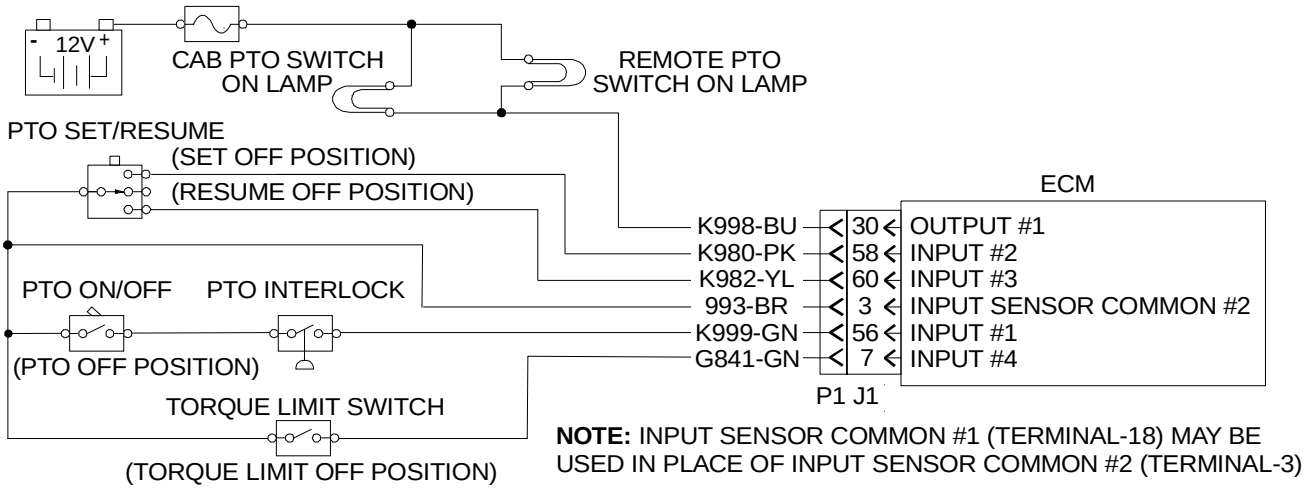
This configuration is identical to the configuration outlined in “PTO Configuration - Cab Switches” on page 56 with the addition of an Ignore Brake/Clutch Switch connected to ECM Input #5 (ECM Connector J1/P1, pin 47). The Ignore Brake/Clutch Switch is intended for applications requiring mobile use of the vehicle with a set engine rpm that does **NOT** require the Brake or Clutch to disengage the engine rpm set speed. This is useful for applications such as a cement truck pouring curbs/roads, or a fire truck pumping water where vehicle speed is adjusted using the clutch or brakes but engine speed remains constant for proper pump operation. The programmable parameter Ignore Brake/Clutch Switch must be programmed to J1/P1:47 (Input #5) to enable this feature (Default is None). The wiring diagram for this configuration is also shown in PTO Installation and Application Special Instruction.



Wiring Diagram 22 - Cab Switches with Ignore Brake/Clutch Switch

14.15 PTO Configuration - Remote Switches with Torque Limiting

This configuration is identical to the configuration outlined in “PTO Configuration - Remote Switches” on page 59 with the addition of a Torque Limit Switch. If a Torque Limit is programmed it ONLY applies when the Torque Limit Switch is in the ON position. This configuration allows the use of a torque limit switch connected to ECM Input #4 (ECM Connector P1/J1, pin 7) if Torque Limiting is required during PTO operation or when the PTO On/Off Switch is in the OFF position. Torque Limiting should only be used for temporary protection of equipment. The programmable parameter Torque Limit Switch must be programmed to J1/P1:7 (Input #4) to enable this feature (Default is None). The wiring diagram for this configuration is also shown in PTO Installation and Application Special Instruction.

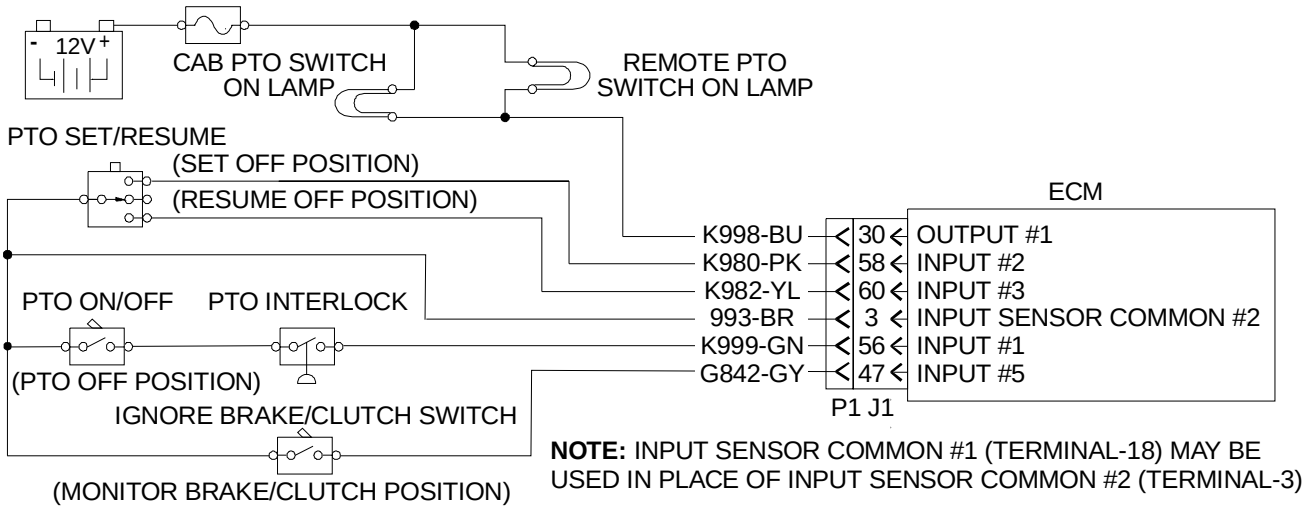


Wiring Diagram 23 - Remote Switches With Torque Limiting Switch

14.16 PTO Configuration - Remote Switches with Ignore Brake/Clutch Switch for Idle Control

This configuration is identical to the configuration outlined in “PTO Configuration - Remote Switches” on page 59 with the addition of an Ignore Brake/Clutch Switch connected to ECM Input #5 (ECM Connector J1/P1, pin 47). The Ignore Brake/Clutch Switch is intended for applications requiring mobile use of the vehicle with a set engine idle rpm that does **NOT** require the Brake or Clutch to disengage the engine rpm set speed. This is useful for applications such as a cement truck pouring curbs/roads, or a fire truck pumping water where vehicle speed is adjusted using the clutch or brakes but engine speed remains constant for proper pump operation. The programmable parameter Ignore Brake/Clutch Switch must be programmed to J1/P1:47 (Input #5) to enable this feature (Default is None). If the PTO On/Off Switch is **OFF**, the ECM considers connection of ECM Vehicle Harness Connector J1/P1 terminal-47 to J1/P1 terminal-3 (Input #5 to Input Sensor Common #2) as a request to prevent the disengagement of an Idle Set Speed (set using cruise switches).

NOTE: This feature only applies when the vehicle speed is below the programmable Idle Vehicle Speed Limit and an engine rpm is set. When the PTO On/Off Switch is ON the Ignore Brake/Clutch Switch is not required to ignore inputs from the Brake or Clutch. The Remote Switches PTO Configuration Automatically ignores all cab switch inputs. The wiring diagram for this configuration is also shown in PTO Installation and Application Special Instruction.



Wiring Diagram 24 - Remote Switches With Ignore Brake/Clutch Switch

14.17 Multiple Speed PTO Operation

14.17.1 Multiple Speed PTO Operation using Dedicated Switch Inputs to Control Engine RPM

Multiple Speed PTO operation can be utilized for all three PTO Configurations available (Cab Switches, Remote Switches or Remote Throttle). This feature provides a simple means to add one or two additional set speeds that can be actuated by turning on a dedicated switch(es) for the programmed speed(s). The“Wiring Diagram 25 - Cab Switches PTO Configuration with Multiple Speed Operation” on page 70 illustrates a multiple speed PTO installation for the Cab Switches configuration. However, the installation of the dedicated PTO Engine RPM Set Speed Input Switches (A and B) is identical for all three configurations.

For multiple speed PTO operation the PTO Engine RPM Set Speed Input A parameter can be programmed to use either J1/P1:6, J1/P1:46, J1/P1:58 or J1/P1:60. The corresponding PTO Engine RPM Set Speed A parameter can be programmed to the desired operating speed. When the switch between the selected input and sensor common is closed, the engine will proceed to the programmed speed for that input while operating in Dedicated PTO Mode (PTO On/Off Switch ON).

For an additional set speed input, the PTO Engine RPM Set Speed Input B parameter can be programmed to use any of the other three inputs not selected for the choices mentioned above. The corresponding PTO Engine RPM Set Speed B parameter to the desired speed. When the switch between the selected input and sensor common is closed, the engine will proceed to the programmed speed for that input while the engine is operating in Dedicated PTO Mode (PTO On/Off Switch ON), and the PTO Engine RPM Set Speed Input A is OFF.

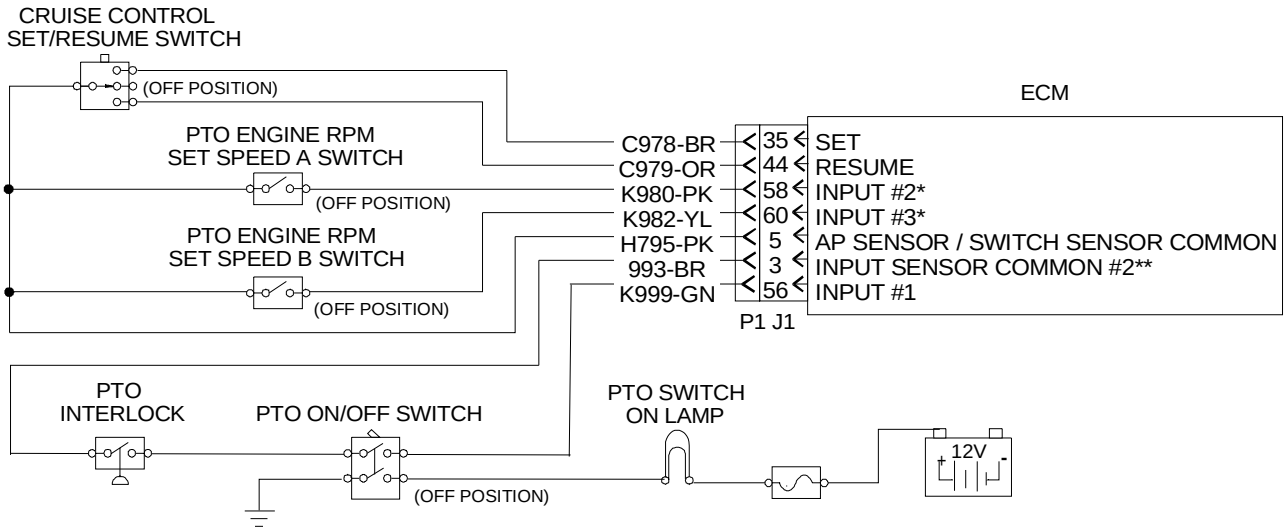
When the PTO On/Off Switch is turned ON and a PTO Engine RPM Set Speed Input Switch (A or B) is already ON or then turned ON, the engine will proceed to the corresponding rpm programmed for that switch. If both switches are ON, the engine will proceed to PTO Engine RPM Set Speed A because the PTO Engine RPM Set Speed Input A has **priority** over PTO Engine RPM Set Speed Input B. If switch A is then turned OFF, the engine will proceed to the programmed PTO Engine RPM Set Speed B. If switch A is then turned ON again, the engine will proceed back to PTO Engine RPM Set Speed A. If both switches are turned OFF the engine will then return to Low Idle.

The PTO Engine RPM Set Speeds A and B can be used with, and have priority over, all other PTO features used to control engine rpm with the exception of conditions that disable PTO operation or cause a “kickout”. For Example, the Cab Throttle, Remote Throttle, Cruise Set/Resume, and Remote Set/Resume Inputs as well as the PTO to Set Speed feature are all ignored when either PTO Engine RPM Set Speed Input Switch (A or B) is ON. When the switch is turned OFF, normal control is returned.

NOTE: The PTO to Set Speed feature is only available for Cab Switches and Remote Switches configurations. If the PTO to Set Speed parameter is programmed to YES and a PTO Engine RPM Set Speed is programmed, the engine will automatically go to that programmed speed when the PTO On/Off Switch is turned ON. However, if either PTO Engine RPM Set Speed Input Switch (A or B) is ON, the engine will operate at the corresponding rpm programmed for that switch. When the A or B switch is turned OFF, the engine will proceed to the PTO Engine RPM Set Speed. If the PTO to Set Speed parameter is programmed to NO, the engine will return to Low Idle when the PTO Engine RPM Set Speed Input Switch (A or B) is turned OFF.

Parameter settings for PTO Configuration Cab Switches with One Speed Above Idle Circuit

Customer Parameter	PTO Configuration	PTO Engine RPM Set Speed Input A	PTO Engine RPM Set Speed A	PTO Engine RPM Set Speed Input B	PTO Engine RPM Set Speed B
Parameter Setting	Cab Switches	J1/P1:58	Desired RPM	J1/P1:60	Desired RPM
Input/Output	Input #1	Input #2	Input #3	Output #1	
Connection	PTO On/Off Circuit	Set Speed A Switch Circuit	Set Speed B Switch Circuit	PTO Switch on Lamp	



* INPUTS ARE SELECTABLE THROUGH CUSTOMER PARAMETER PROGRAMMING

** INPUT SENSOR COMMON #1 (TERMINAL-18) MAY BE USED IN PLACE OF INPUT SENSOR COMMON #2 (TERMINAL-3)

Wiring Diagram 25 - Cab Switches PTO Configuration with Multiple Speed Operation

15.0 Engine Retarder

15.1 Engine Retarder Control

The ECM can directly drive the solenoids for a Caterpillar factory installed compression type engine retarder and also provide an auxiliary brake signal based upon engine rpm, throttle position, clutch and brake engagement, and the cruise control On/Off switch setting. The retarder output signals prevent ECM initiated retarder operation while the engine is being fueled.

15.1.1 Engine Retarder Solenoid Output

The engine retarder solenoid output provides four levels of retarding; OFF, LOW, MED, and HIGH.

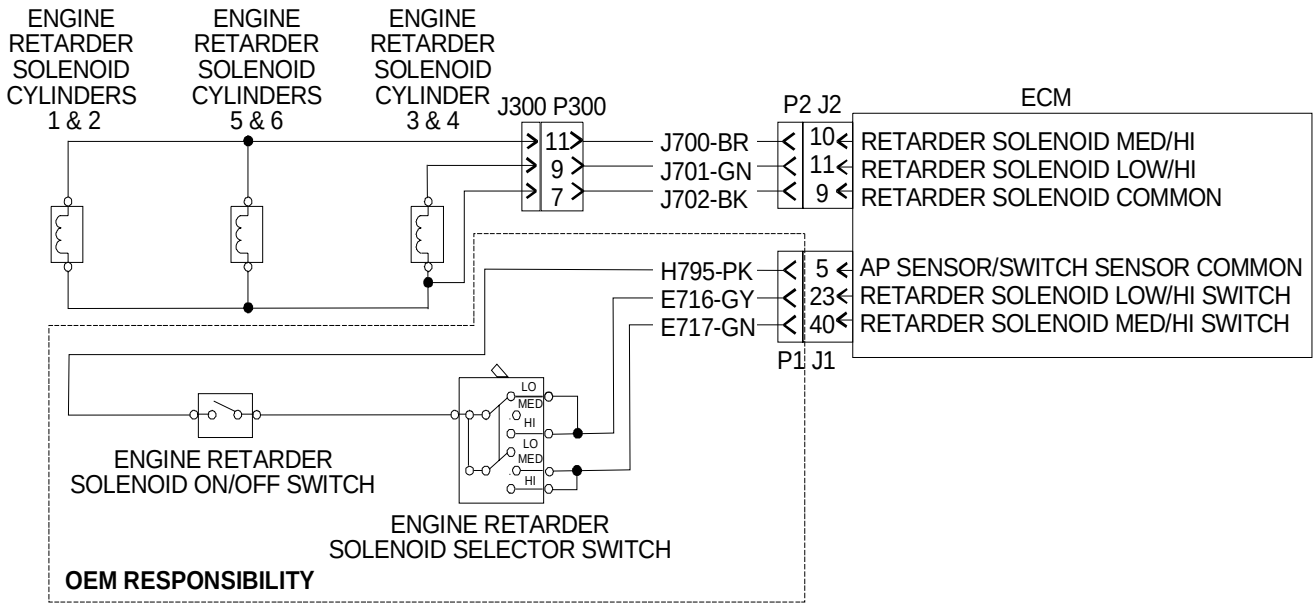
OEM provided and installed components required:

1) Cab switch(es).

15.2 Engine Retarder Solenoid Selector Switch

Engine Retarder Solenoid operation requires OEM switches providing logic input to the control indicated in the following table for proper operation. A short circuit in the following table is a connection to ECM Connector P1, terminal 5 (AP Sensor/Switch Sensor Common.

Level	Low/High- Terminal 23	Med./High - Terminal 40
Off	Open Circuit	Open Circuit
Low	Short Circuit	Open Circuit
Med	Open Circuit	Short Circuit
High	Short Circuit	Short Circuit



Wiring Diagram 26 - Engine Retarder Wiring Diagram

15.3 Retarder Solenoid Operation

In order to assure proper retarder operation the following conditions must be met, regardless of the Customer Parameter settings for the Engine Retarder, Auto Retarder in Cruise, Engine Retarder Minimum Vehicle Speed, Engine Retarder Minimum VSL Type, and Engine Retarder Delay parameters:

Engine rpm is above 800 rpm

AND

Accelerator Pedal Position≤ 7%

AND

Clutch pedal released

15.3.1 Engine Retarder Mode

Additional operating requirements must be met if the Cruise Control On/Off Switch is in the ON position, or the engine is in Cruise Control, or when the vehicle is moving due to Customer Specified Parameters - Engine Retarder, Auto Retarder in Cruise, Engine Retarder Minimum VSL Type, Engine Retarder Minimum Vehicle Speed, and Engine Retarder Delay.

The engine retarder is disabled if the vehicle speed is above 0 mph (0 km/h) but less than the programmed Engine Retarder Minimum Vehicle Speed (program this parameter to 0 mph (0 km/h) to disable vehicle speed regulation of the retarder). The engine retarder is also disabled whenever the PTO On/Off switch is ON if the customer parameter PTO Configuration is programmed to Cab Switches, Remote Switches, or Remote Throttle.

Cruise Control Switch in the ON position:

With the Cruise Control Switch ON three special retarder options allow the engine retarder to operate only after the driver steps on the service brake. The three customer programmable modes of operation are:

1) The Coast mode engages the engine retarder when the driver presses the service brake. The retarder disengages when the driver's foot is removed from the service brake.
2) The Latch mode engages the retarder when the driver presses the service brake. The retarder remains engaged until the control detects a change in a control input, such as depressing the throttle pedal, clutch pedal, or the engine rpm drops below 800 rpm. Release of the service brake does not necessarily turn OFF the retarder like the Coast mode.
3) The Manual mode causes the retarder to operate the same whether the Cruise Control switch is ON or OFF - depressing the service brakes is not necessary to initiate the retarder as for the Latch and Coast options.

NOTE: The Customer programmable modes Latch, Coast, and Manual determine Engine Retarder operation only when the Cruise Control Switch is ON - not when the engine is active in cruise control (Latch and Coast modes require service brake initiation before acting - service brake action disengages cruise control).

15.4 Auto Retarder in Cruise

The Auto Retarder in Cruise option allows the engine retarder to come on while the engine is active in cruise control in order to attempt to maintain the cruise control set speed. The Auto Retarder in Cruise option still requires the engine retarder switches to be in the ON position, and will only activate the retarder to the level at which the switches indicate operation should occur. The Auto Retarder in Cruise parameter programs a vehicle speed above the cruise control set speed at which the retarder will begin engaging the engine retarder. At this vehicle speed the engine retarder will come on at the "low" level. The Auto Retarder in Cruise Increment determines the incremental mph for the medium and high braking levels (assuming the engine retarder switches are ON above the low level).

NOTE: The Auto Retarder in Cruise parameter does not operate the Auxiliary Brake Output while in cruise control. The Auto Retarder in Cruise applies to the engine retarder solenoids driven directly from the ECM Engine Harness Connector P2, terminals 9, 10, and 11.

15.5 Engine Retarder Delay

The Engine Retarder Delay parameter provides a lag between when conditions are actually met for the Retarder or Auxiliary Brake and the time they come ON.

Trucks equipped with SAE J1922 or SAEJ1939 systems may also control the Engine Retarder when necessary. For ABS systems not using J1922 or J1939 with the Engine Retarder Solenoids it will be necessary to connect a relay as shown in "Wiring Diagram 33 - ABS Connection for Engine Retarder or Auxiliary Brake without SAE J1922 or J1939 Communications" on page 77 to disable the retarder.

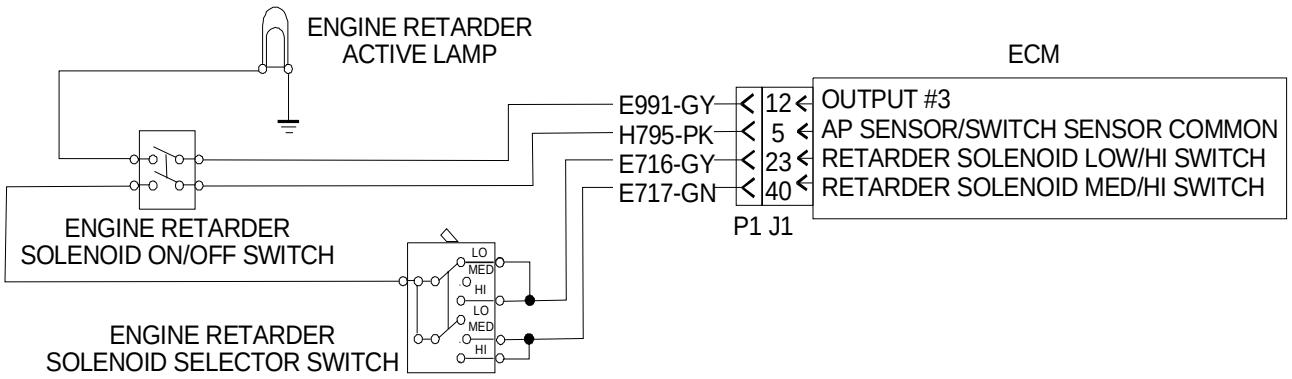
15.5.1 ABS Engine Retarder Relay Specification

This normally closed relay must be capable of operating reliably with the low 5 mA current through the contact side.

15.5.2 Installing an Engine Retarder Active Lamp

In some applications it may be desirable to provide a dash lamp or operate the brake lamps to indicate when the engine retarder is ON. “Wiring Diagram 27 - Installation Diagram for Engine Retarder Active Lamp” provides this option with one exception. The lamp will not illuminate when the retarder solenoids are on due to Auto Engine Retarder in Cruise operation.

NOTE: The lamp is driven from the ECM Output #3 (if Auxiliary Brake parameter is programmed to J1/P1:12) of ECM Connector P1/J1terminal 12. The Auxiliary Brake output used is a 1.5 Amp high side output. This option is not available if this output is used to drive a second ECM controlled braking device.



Wiring Diagram 27 - Installation Diagram for Engine Retarder Active Lamp

16.0 Programmable Outputs

Output #2 can be used for an Engine Running Output, an Engine Shutdown Output or a Starting Aid Output. Output #3 can be used for an Auxiliary Brake, Engine Running Output, Engine Shutdown Output or a Starting Aid Output. Output #4 can be used for an Engine Running Output, Engine Shutdown Output, Starting Aid Output or a Second Fan Driver Output (if the Fan Control Type is programmed to Horton 3-Speed) refer to“17.0 Cooling Fan” on page 78.

16.1 Output #2, Output #3, and Output #4 Electrical Specifications

Electrical characteristics of these high side outputs are as follows:

Minimum “ON” Output Voltage	Maximum “ON” Output Voltage	Maximum Current Draw	Off State
Battery - 2.0 volts	Battery	1.5 A (12 V or 24 V)	High Impedance

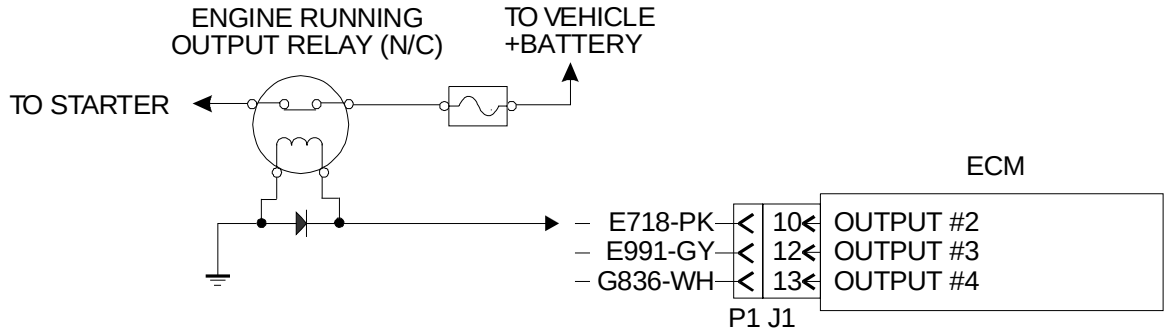
These outputs can be connected to the coil side of a relay or directly to a solenoid (if the maximum current draw for the solenoid is less than 1.5 amps). If connected to a relay, the contact side of the relay should be connected to “+Battery” and the appropriate solenoid. Regardless if the output is used to connect to a solenoid or relay coil, Caterpillar recommends transient suppression be used on the inductive load in addition to the ECM internal protection. ***Circuit protection for the contact side of the relay and its grounding (when powering a relay) is left to the OEM’s discretion. Do not ground the relay or solenoid to the ECM Sensor Common connections.***

Connections for Output #2, #3 and #4:

Terminal Description	ECM P1/J1Terminal Assignment
Output #2	Terminal 10
Output #3	Terminal 12
Output #4	Terminal 13

16.2 Engine Running Output

An Engine Running Output is available to indicate the engine is running. The Engine Running Output parameter can be programmed to use Output #2, Output #3 or Output #4 by programming the Engine Running Output parameter to J1/P1:10, J1/P1:12, or J1/P1:13 respectively. The ECM uses a 1.5 amp output to drive a relay. This can be used to disable the starter or other devices. This will be a normally closed relay so that cranking can be achieved immediately at power up. During cranking, the ECM will energize the relay once the engine rpm reaches 50 rpm below the low idle rpm. The relay will be de-energized if engine rpm falls 100 rpm below the programmed low idle (600-750 rpm is low idle range). A normally closed relay is recommended because the ECM could see insufficient battery voltage during cranking, preventing the ECM from providing sufficient battery voltage to energize the relay.



NOTE: OUTPUT #2, #3 OR #4 MAY BE USED. ENGINE RUNNING OUTPUT PARAMETER MUST BE PROGRAMMED TO THE OUTPUT SELECTION.

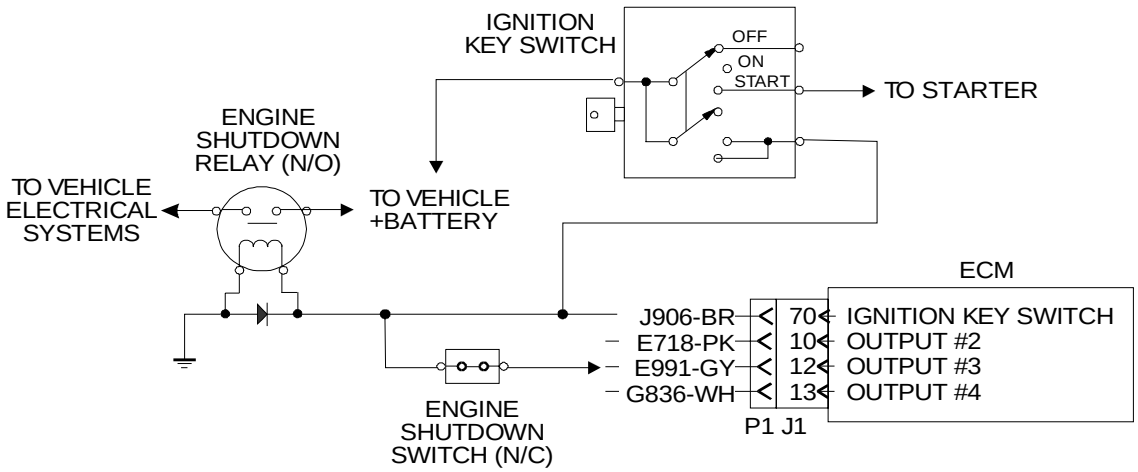
Wiring Diagram 28 - Engine Running Outputs

16.3 Engine Shutdown Output

An Engine Shutdown Output is available to shut down the vehicle electrical system after the idle shutdown timer expires. The Engine Shutdown Output parameter can be programmed to use Output #2, Output #3 or Output #4 by programming the Engine Shutdown Output parameter to J1/P1:10, J1/P1:12, or J1/P1:13 respectively. The ECM uses a 1.5 amp output to drive a relay.

This feature can provide the vehicle operator with the ability to remove the ignition key from the truck and leave the vehicle, relying on the Engine Shutdown Output to remove power from the vehicle electrical system after the engine shuts down when the idle shutdown timer expires. The operator may also shut down the vehicle immediately by turning the key OFF and opening the Shutdown Switch. This requires a normally closed OEM installed switch and a normally open OEM installed relay. Refer to “Wiring Diagram 29 - Engine Shutdown Outputs” on page 75.

NOTE: If the wiring is configured as shown, the Electronic Service Tool Ignition Key Switch Status will display ON whenever the Engine Shutdown Output Relay is ON, even if the ignition key switch has been turned to the OFF position.



NOTE: OUTPUT #2, #3 OR #4 MAY BE USED. ENGINE SHUTDOWN OUTPUT PARAMETER MUST BE PROGRAMMED TO THE OUTPUT SELECTION.

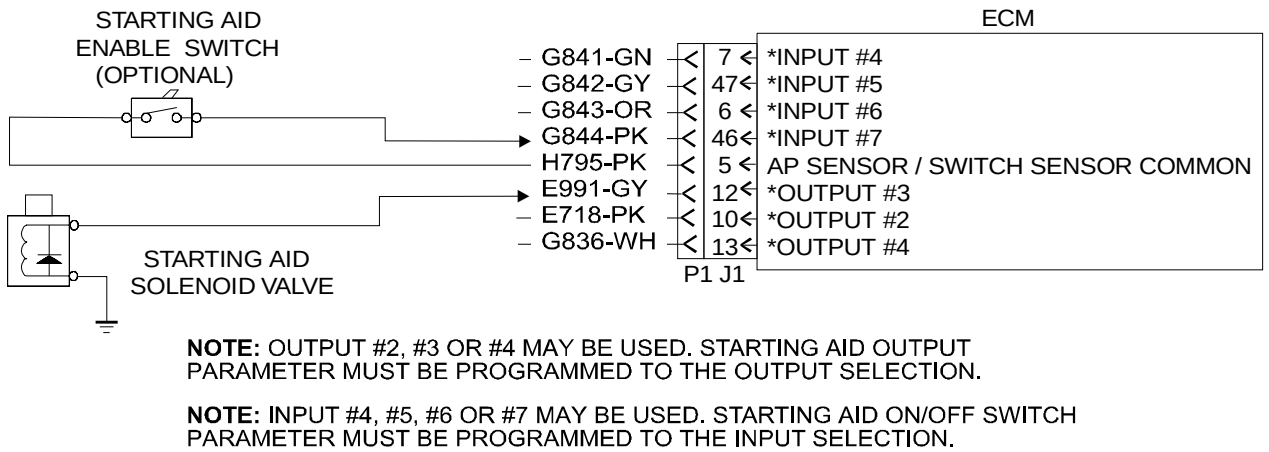
Wiring Diagram 29 - Engine Shutdown Outputs

16.4 Starting Aid Output

A Starting Aid Output parameter is available to connect to a relay and/or solenoid to control a Continuous Flow Starting Aid System. The Starting Aid Output parameter can be programmed to use Output #2, Output #3 or Output #4 by programming the Starting Aid Output parameter to J1/P1:10, J1/P1:12, or J1/P1:13 respectively. The ECM uses a 1.5 amp output to drive the relay and/or solenoid.

Typical Starting Aid Systems inject ether into the intake manifold to aid engine starting during cold weather operation. The output can be automatically controlled by the ECM, or an optional switch can be added to the system to provide a means for the operator to disable the system if desired. If a switch is installed the Starting Aid On/Off Switch parameter must be programmed to the corresponding switch input. When the switch is in the ON position, the Starting Aid System will automatically enable the Starting Aid Output when conditions require the use of a starting aid. When the switch is in the OFF position, the Starting Aid System will not function. If the Starting Aid On/Off Switch parameter is programmed to None (default), this feature is not used. If it is programmed to one of the available input options (J1/P1:7, J1/P1:47, J1/P1:6, J1/P1:46) the feature is available and the switch circuit should be connected to the input option specified.

The Intake Manifold Air Temperature reading is used to determine if conditions require use of the Starting Aid. If a fault condition exists with the Intake Manifold Air Temperature sensor circuit, the Coolant Temperature Sensor reading will be used. If the temperature reading is below 0°C (32°F) and an attempt is made to start the engine, the Starting Aid Output will be enabled for up to 30 seconds while the engine is cranking. If the engine starts or a condition occurs that prevents fuel from being injected, the Staring Aid Output will be disabled.



Wiring Diagram 30 - Starting Aid Output

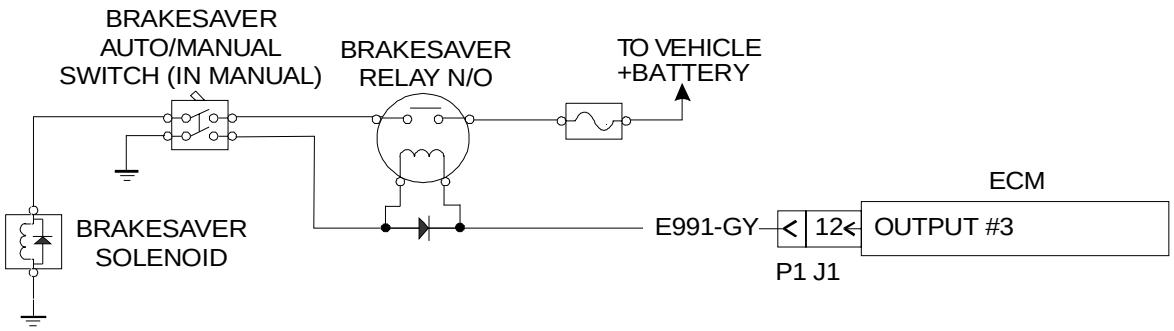
16.5 Auxiliary Brake

Output #3 can be used for the Caterpillar BrakeSaver or other brakes not installed by Caterpillar by programming the Auxiliary Brake parameter to J1/P1:12 (Output #3). The output circuit sends out the enable (high +Battery) signal when turning the braking device ON. A relay with normally open contacts must be used with the Auxiliary Brake for proper operation. Caterpillar recommends simultaneously switching both the contact and coil side of the relay. Simultaneous switching also provides additional failure mode protection in case the relay contacts stick, because the switch is in both the coil and contact side of the relay.

16.5.1 Caterpillar BrakeSaver Installation

To enable the Caterpillar BrakeSaver automatic mode with the C-15 and C-16 engine, install as shown in Wiring Diagram 31 - “Caterpillar BrakeSaver Connection Diagram” on page 76.

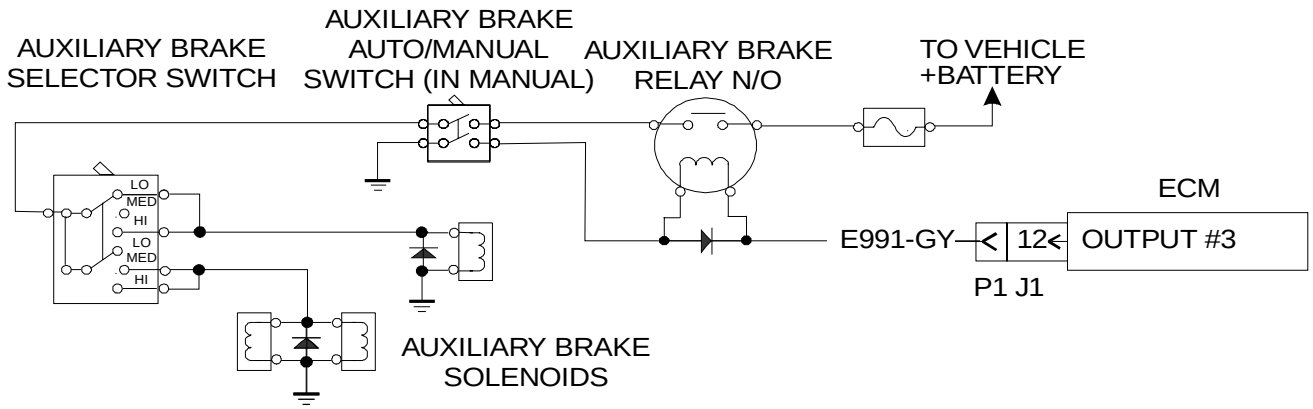
For C-15 and C-16 engines equipped with Caterpillar Engine Monitoring and a Caterpillar BrakeSaver, the SHUTDOWN mode for engine monitoring is not available. For any engine retarder rejecting heat to the engine cooling system the SHUTDOWN mode of engine monitoring must not be used.



Wiring Diagram 31 - Caterpillar BrakeSaver Connection Diagram

16.5.2 OEM Installed Auxiliary Brake

Caterpillar recommends simultaneously switching both the contact and coil side of the relay. Simultaneous switching also provides additional failure mode protection in case the relay contacts stick, because the switch is in both the coil and contact side of the relay.

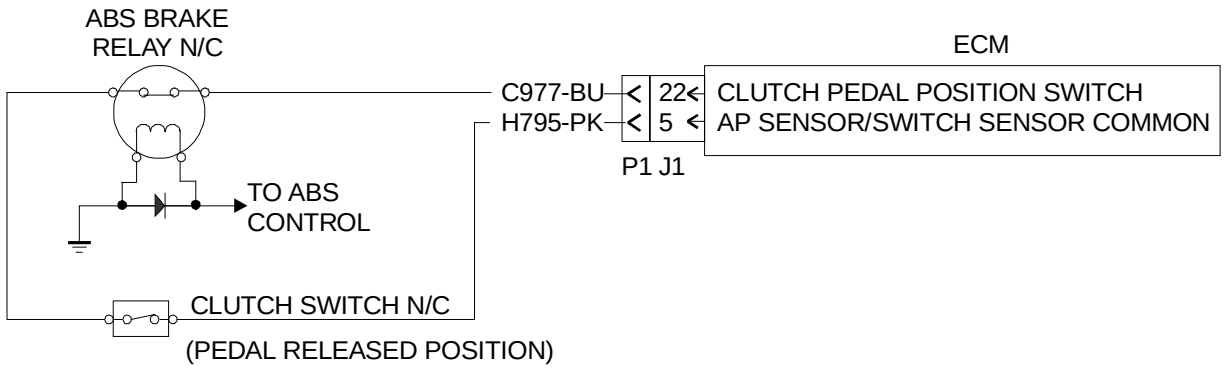


Wiring Diagram 32 - OEM Installed Auxiliary Brake Connection Diagram

NOTE: The Auxiliary Brake circuit operates identically to the ENGINE RETARDER SOLENOID circuit except it does not read the dash switches, and will not come ON in cruise control mode for the Auto Retarder in Cruise Customer Parameter option.

16.5.3 ABS Auxiliary Brake Specification

Wiring Diagram 33 - “ABS Connection for Engine Retarder or Auxiliary Brake without SAE J1922 or J1939 Communications” on page 77 shows connection of ABS systems not using SAE J1922 communications.



Wiring Diagram 33 - ABS Connection for Engine Retarder or Auxiliary Brake without SAE J1922 or J1939 Communications

17.0 Cooling Fan

The ECM provides a cooling fan disable signal (ECM output = high for fan OFF) for On/Off control of the cooling system fan based on coolant temperature, engine retarder operation, engine rpm, and intake manifold air temperature. Optional control based on an OEM installed air conditioning high pressure switch or a manual Fan Override switch can also be selected. The parameter Fan Control Type determines how the ECM controls a fan.The Fan Control Type programmable options are On-Off, Three Speed Fan and NONE (default). Program this parameter to None if the ECM is not connected to the Cooling Fan circuit. This will aid the service technician for troubleshooting purposes if correctly programmed.

To prevent unnecessary cooling fan cycling due to reduced voltage levels during engine cranking, the ECM turns the output(s) OFF (fan ON). Because an electrical open circuit is the most likely failure mode, Caterpillar recommends a normally open circuit(s).

17.0.1 Output #5 Electrical Specifications

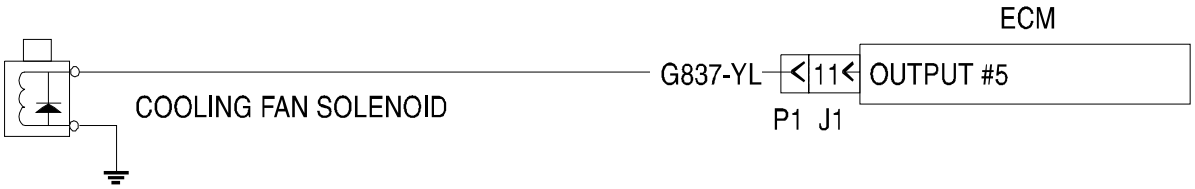
Electrical characteristics of the fan control high side driver is as follows:

Minimum “ON” Output Voltage	Maximum “ON” Output Voltage	Maximum Current Draw	OFF State
Battery - 2.0 Volts DC	Battery	1.5 A (12 V or 24 V)	High Impedance

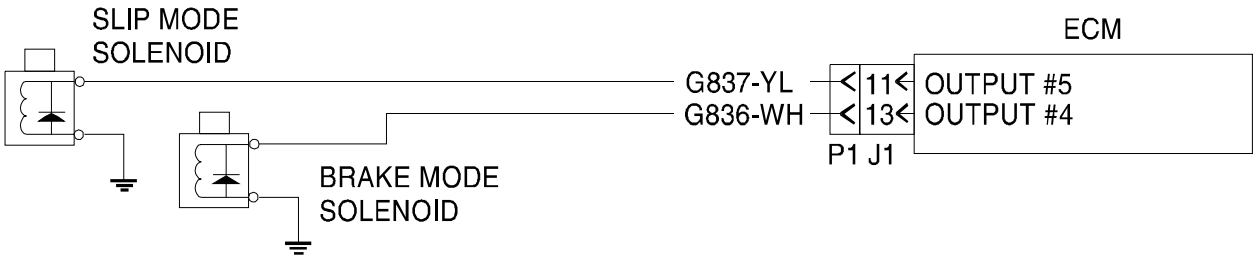
The drivers are intended for connection to the cooling fan solenoids. Caterpillar recommends transient suppression be used on the inductive load in addition to the ECM’s internal protection.

Connection for these output:

Terminal Description	ECM Terminal Assignment
Output #4	Terminal 13
Output #5	Terminal 11



Wiring Diagram 34 - On-Off Cooling Fan Circuit



Wiring Diagram 35 - Three Speed Cooling Fan Circuit

17.1 Cooling Fan Output Operation with Fan Control Type Programmed to On-Off

Program Fan Control Type to On-Off to have the ECM provide control of an ON-OFF fan clutch. The Cooling Fan circuit sends out a high signal to turn the fan OFF. The fan comes ON in the event of an output circuit failure such as an open circuit. This requires a relay with normally open contacts (if powering the coil side of a relay), or a solenoid valve that deactivates the fan when it receives the disable (high) signal. Refer to “Wiring Diagram 34 - On-Off Cooling Fan Circuit” on page 78. Additional switching devices in the circuit should cause an open circuit to turn the fan ON. This circuit is designed to withstand a short circuit to “+Battery” voltage and will not be adversely affected if other devices are connected to this line when directly driving a solenoid. When driving a relay, connection of other devices to the Cooling Fan Output should not be necessary.

OEM provided and installed components required:

1) Solenoid or Solenoid and Relay.

Customer Parameter programming required:

1) Cooling Fan Type programmed to On-Off Fan.

NOTICE

Caterpillar requires the OEM to install a warning sticker near the fan indicating the fan is automatically controlled and may come ON at any time.

The ECM will turn the cooling fan **ON** under **any** of the following conditions if engine rpm is less than 2250 rpm:

Conditions to turn Fan ON for C-15 and C-16	Conditions to turn Fan ON for C-10 and C-12
Engine Not Running	Engine Not Running
During Engine Cranking	During Engine Cranking
Coolant Sensor Temperature > **216°F (102°C)**	Coolant Sensor Temperature > **205°F (96°C)**
Active Coolant Temperature Sensor Diagnostic	Active Coolant Temperature Sensor Diagnostic
Intake Manifold Air Temperature > **189°F (87°C)**	Intake Manifold Air Temperature > **189°F (87°C)**
Intake Manifold Air Temperature > **162°F (72°C)** with Boost Pressure > 10 psi (70 kPa)	Intake Manifold Air Temperature > **162°F (72°C)** with Boost Pressure > 10 psi (70 kPa)
*Engine Retarder ON in high mode > 2 seconds, when Fan With Engine Retarder in High Mode is programmed to YES	*Engine Retarder ON in high mode > 2 seconds, when Fan With Engine Retarder in High Mode is programmed to YES
*A/C High Pressure Switch Input is Open or ECM is Counting	*A/C High Pressure Switch Input is Open or ECM is Counting
*PTO On/Off Switch in ON position, when PTO Activates Cooling Fan parameter is programmed to Continuous	*PTO On/Off Switch in ON position, when PTO Activates Cooling Fan parameter is programmed to Continuous
*Manual Fan Override Switch is ON, when the Fan Override Switch parameter is programmed to a selected input.	*Manual Fan Override Switch is ON, when the Fan Override Switch parameter is programmed to a selected input.

*These items are dependent upon programming of Customer Parameters.

NOTE: The ECM will turn the cooling fan OFF for 10 seconds during an engine shutdown.

The fan will remain on for a minimum of 30 seconds following ECM initiated activation except following engine start up, or if the A/C Pressure Switch Fan On Time is programmed less than 30 seconds. During engine start up, the ECM will keep the fan ON for 2 seconds after the engine has reached the programmed low idle (700 - 750 rpm). This is done because unstable vehicle battery voltage during cranking may cause the fan to cycle.

The fan will be turned **OFF** by the control (after being turned ON) if engine rpm exceeds 2300 rpm or when **all** the following circumstances are met.

Conditions to turn Fan OFF for C-15 and C-16	Conditions to turn Fan OFF for C-10 and C-12
Coolant Sensor Temperature < **208°F (98°C)**	Coolant Sensor Temperature < **198°F (92°C)**
The fan has been ON for at least 30 seconds	The fan has been ON for at least 30 seconds
Intake Manifold Air Temperature < **151°F (66°C)**	Intake Manifold Air Temperature < **151°F (66°C)**
Engine Retarder ON Strategy is not Active	Engine Retarder ON Strategy is not Active
A/C High Pressure Switch not Active	A/C High Pressure Switch not Active
PTO On/Off Switch in OFF position	PTO On/Off Switch in OFF position
Manual Fan Override Switch in OFF position	Manual Fan Override Switch in OFF position
Key Switch turned OFF with Engine Speed Present	Key Switch turned OFF with Engine Speed Present

NOTE: The ECM will turn the cooling fan OFF for 10 seconds during an engine shutdown.

17.2 Cooling Fan Output Operation with Fan Control Type Programmed to Three Speed Fan

The Three Speed Fan operates in three modes: brake, slip and direct (full speed). Two solenoids are required for three speed fan control. Refer to “Wiring Diagram 35 - Three Speed Cooling Fan Circuit” on page 78.The fan comes ON in direct mode in the event of an output circuit failure such as an open circuit. This requires relays with normally open contacts (if powering the coil side of a relay), or solenoid valves that deactivate the fan when it receives the disable (high) signal. Additional switching devices in the circuit should cause an open circuit to turn the fan ON. This circuit is designed to withstand a short circuit to “+Battery” voltage and will not be adversely affected if other devices are connected to this line when directly driving a solenoid. When driving relays, connection of other devices to the Cooling Fan Outputs should not be necessary.

When the fan is in Brake Mode both output drivers are ON (Fan OFF). In Slip Mode Output #4 driver is OFF and Output #5 driver is ON. During Direct Mode both output drivers are OFF (Fan ON full speed).

OEM provided and installed components required:

1) Two solenoids or two relays and two solenoids.

Customer Parameter programming required:

1) Cooling Fan Type programmed to Three Speed Fan.

NOTICE

Caterpillar requires the OEM to install a warning sticker near the fan indicating the fan is automatically controlled and may come ON at any time.

17.2.1 Direct Mode Operation (Fan ON full speed) will occur under any of the following conditions if engine rpm is less than 2250 rpm:

Direct Mode Operation for C-15 and C-16	Direct Mode Operation for C-10 and C-12
Engine Not Running.	Engine Not Running.
During Engine Cranking.	During Engine Cranking.
Coolant Sensor Temperature increasing > **217°F (103°C).** **NOTE:** If the cooling fan is operating in Direct Mode the fan will continue to operate in Direct Mode until coolant sensor temperature is < **207°F (97°C).**	Coolant Sensor Temperature increasing > **203°F (95°C).** **NOTE:** If the cooling fan is operating in Direct Mode the fan will continue to operate in Direct Mode until coolant sensor temperature is < **198°F (92°C).**
Active Coolant Temperature Sensor Diagnostic.	Active Coolant Temperature Sensor Diagnostic.
Intake Manifold Air Temperature increasing > **178°F (81°C).** **NOTE:** If the cooling fan is operating in Direct Mode the fan will continue to operate in Direct Mode until intake manifold sensor air temperature is < **127°F (53°C).**	Intake Manifold Air Temperature increasing > **178°F (81°C).** **NOTE:** If the cooling fan is operating in Direct Mode the fan will continue to operate in Direct Mode until intake manifold sensor air temperature is < **127°F (53°C).**
Intake Manifold Air Temperature increasing > **149°F (65°C)** if Boost Pressure > 70 kPa (10 psi). **NOTE:** If the cooling fan is operating in Direct Mode the fan will continue to operate in Direct Mode until intake manifold sensor air temperature is < **127°F (53°C).**	Intake Manifold Air Temperature increasing > **149°F (65°C)** if Boost Pressure > 70 kPa (10 psi). **NOTE:** If the cooling fan is operating in Direct Mode the fan will continue to operate in Direct Mode until intake manifold sensor air temperature is < **127°F (53°C).**
*Engine Retarder ON in high mode > 3 seconds, when Fan With Engine Retarder in High Mode is programmed to YES.	*Engine Retarder ON in high mode > 3 seconds, when Fan With Engine Retarder in High Mode is programmed to YES.
*PTO On/Off Switch in ON position, when PTO Activates Cooling Fan parameter is programmed to Continuous.	*PTO On/Off Switch in ON position, when PTO Activates Cooling Fan parameter is programmed to Continuous.
*Manual Fan Override Switch is ON, when the Fan Override Switch parameter is programmed to a selected input.	*Manual Fan Override Switch is ON, when the Fan Override Switch parameter is programmed to a selected input.

*These items are dependent upon programming of Customer Parameters.

The fan will remain on for a minimum of 20 seconds in direct mode following ECM initiated activation and a minimum of 3 seconds in slip speed mode except following engine start up, or if the A/C Pressure Switch Fan On Time is programmed less than 20 seconds. During engine start up, the ECM will keep the fan ON for 2 seconds after the engine has reached the programmed low idle (700 - 750 rpm). This is done because unstable vehicle battery voltage during cranking may cause the fan to cycle

17.2.2 Slip Mode Operation will occur under the following conditions:

Slip Mode Operation for C-15 and C-16	Slip Mode Operation for C-10 and C-12
Coolant Sensor Temperature increasing > **194°F (90°C)**. **NOTE:** If the cooling fan is operating in Slip Mode the fan will continue to operate in Slip Mode until coolant sensor temperature is < **178°F (81°C).**	Coolant Sensor Temperature increasing > **194°F (90°C)**. **NOTE:** If the cooling fan is operating in Slip Mode the fan will continue to operate in Slip Mode until coolant sensor temperature is < **178°F (81°C).**
Intake Air Sensor Temperature increasing > **127°F (53°C)**. **NOTE:** If the cooling fan is operating in Slip Mode the fan will continue to operate in Slip Mode until intake air sensor temperature is < **34°F (1°C).**	Intake Air Sensor Temperature increasing > **127°F (53°C)**. **NOTE:** If the cooling fan is operating in Slip Mode the fan will continue to operate in Slip Mode until intake air sensor temperature is < **34°F (1°C).**
*A/C High Pressure Switch Input is Open or ECM is Counting.	*A/C High Pressure Switch Input is Open or ECM is Counting.

17.2.3 Brake Mode Operation (Fan OFF) will occur if engine rpm exceeds 2300 rpm or when all of the following conditions are met:

Brake Mode Operation for C-15 and C-16	Brake Mode Operation for C-10 and C-12
Coolant Sensor Temperature < **196°F (91°C)**. **NOTE:** If the cooling fan is operating in Slip Mode the fan will not transition to Brake Mode until the coolant sensor temperature decreases to < **178°F (81°C)**.	Coolant Sensor Temperature < **196°F (91°C)**. **NOTE:** If the cooling fan is operating in Slip Mode the fan will not transition to Brake Mode until the coolant sensor temperature decreases to < **178°F (81°C)**.
The fan has been ON for at least 20 seconds.	The fan has been ON for at least 20 seconds.
Intake Manifold Air Temperature < **129°F (54°C).** **NOTE:** If the cooling fan is operating in Slip Mode the fan will not transition to Brake Mode until the coolant sensor temperature decreases to < **34°F (1°C).**	Intake Manifold Air Temperature < **129°F (54°C).** **NOTE:** If the cooling fan is operating in Slip Mode the fan will not transition to Brake Mode until the coolant sensor temperature decreases to < **34°F (1°C).**
Engine Retarder ON Strategy is not Active.	Engine Retarder ON Strategy is not Active.
A/C High Pressure Switch not Active.	A/C High Pressure Switch not Active.
PTO On/Off Switch in OFF Position.	PTO On/Off Switch in OFF Position.
Manual Fan Override Switch in OFF position	Manual Fan Override Switch in OFF position

17.3 Air Conditioning High Pressure Switch

Input #11 to the ECM is available for connection of a normally closed high pressure A/C switch. The ECM has a timer available to prevent excessive cycling of the cooling fan clutch due to successive cycling of the A/C switch input. The timer is programmable from 0 to 600 seconds, with 0 seconds indicating the feature is OFF (the default). Typical programming is 30 seconds, with 1 second recommended for systems connecting this input to other controls with their own built in timers.

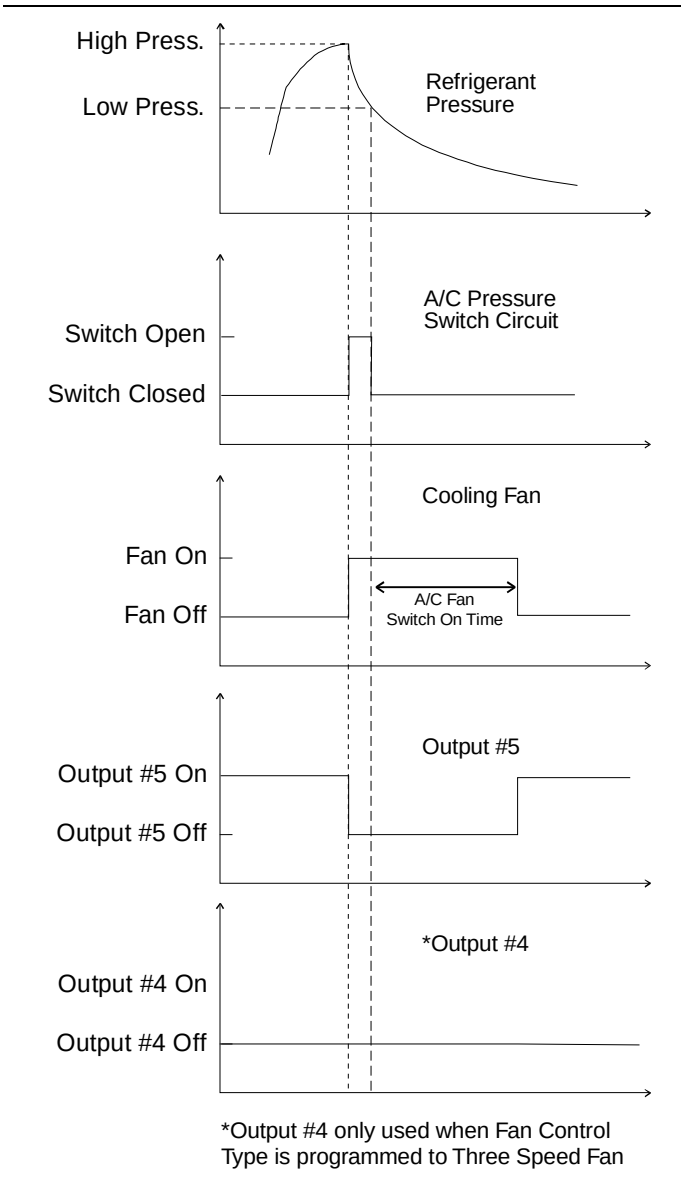


Figure 33 - A/C High Pressure Switch Operation

OEM provided and installed components required:

1) Normally closed high pressure A/C switch.

2) Cooling fan connection to Output #5, and Output #4 (if Fan Control Type is programmed to On-Off or Three Speed Fan).

Customer Parameter programming required:

1) Fan Control Type programmed to On-Off or Three Speed Fan.

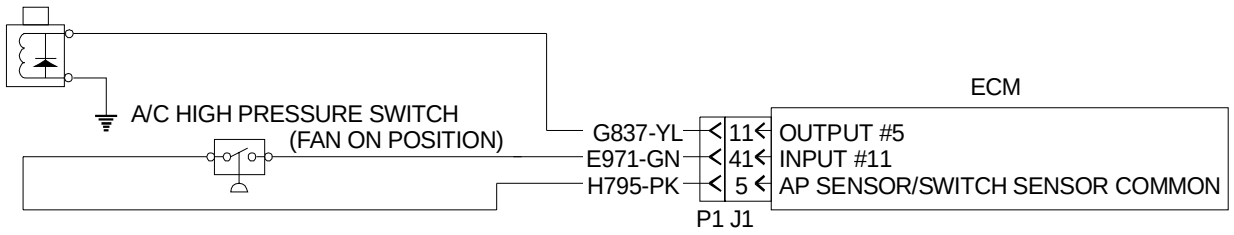
2) A/C Pressure Switch Fan-On Time programmed in the 1 - 600 second range (0 = disabled).

17.3.1 A/C High Pressure Switch Operation

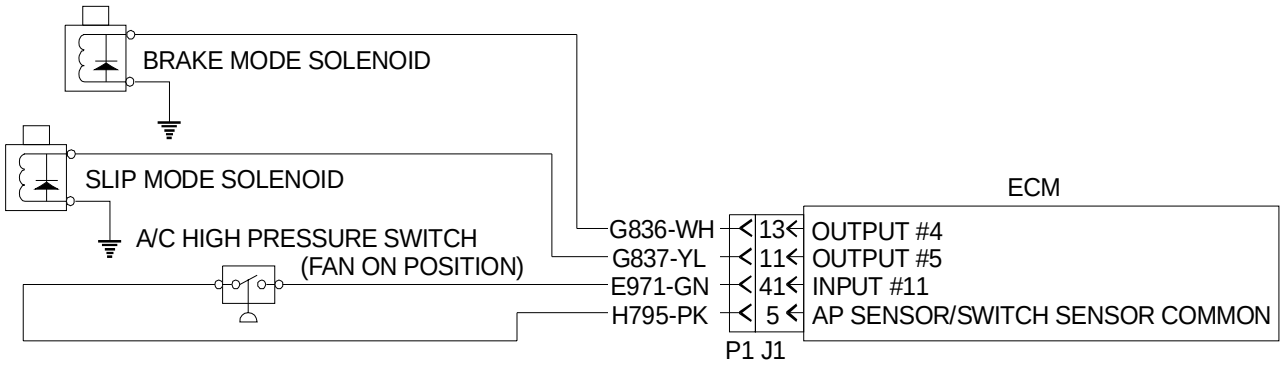
This switch must be a normally closed switch, opening when the refrigerant pressure exceeds the desired level. The ECM input is monitored only if the Customer Programmable Parameter for A/C Pressure Fan On Time is programmed in the 1-600 second range. Figure 33 illustrates the fan operation due to this input. The A/C Pressure Switch Fan-On Time is programmable from 0 to 600 seconds. If the Parameter is at 0 seconds, the ECM will not respond to the input. Figure 33 - “A/C High Pressure Switch Operation” indicates the ECM A/C High Pressure Switch operation.

17.4 Input #11 Connection

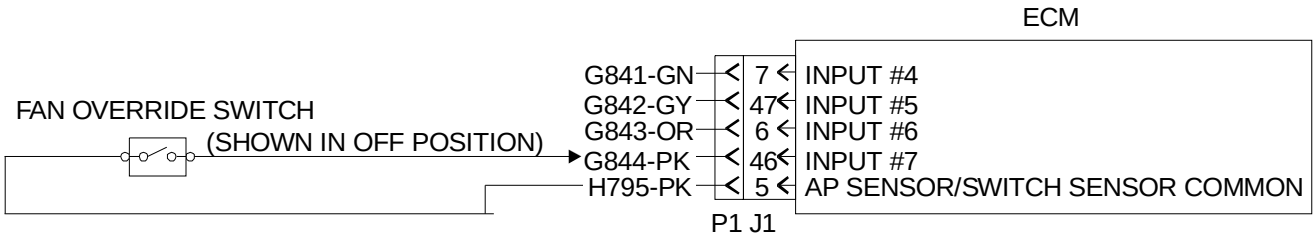
Terminal Description	ECM Terminal Assignment
Input #11	Terminal 41



Wiring Diagram 36 - Cooling Fan and A/C High Pressure Switch Circuit for On-Off Fan Type



Wiring Diagram 37 - Cooling Fan and A/C High Pressure Switch Circuit for Three Speed Fan Type



NOTE: INPUT #4, #5, #6 OR #7 MAY BE USED. THE FAN OVERRIDE SWITCH PARAMETER MUST BE PROGRAMMED TO THE INPUT SELECTION.

Wiring Diagram 38 - Manual Fan Override Switch

18.0 Transmissions

Caterpillar C-10, C-12, C-15 and C-16 engines can be connected to a variety of transmissions. Caterpillar provides the Customer Parameter Transmission Style including the available options of Manual, Automatic Option 1, Automatic Option 2, Automatic Option 3, Automatic Option 4 and Eaton Top 2. This selection should be based on the type of transmission and whether a neutral switch or a second separate service brake pedal position switch is used. Correct programming is required to provide proper cruise control, PTO, and Extended Idle operation. Refer to “13.13 Transmission Neutral Switch” on page 52 for more information.

Transmission Style Parameter Switch Input Table

Transmission Style Parameter Setting	Service Brake #1	Service Brake #2	Clutch	Transmission Neutral	ECM Connection
Manual	✔		✔		J1/P1, terminal 22
Automatic Option 1	✔				
Automatic Option 2	✔	✔			J1/P1, terminal 64
Automatic Option 3	✔	✔		✔	J1/P1, terminal 62 J1/P1, terminal 64
Automatic Option 4	✔			✔	J1/P1, terminal 62
Eaton Top 2	✔		✔		J1/P1, terminal 22

NOTE: All options require a Service Brake Pedal Position Switch circuit connected to the ECM Connector J1/P1, terminal 45.

Transmission Style Options Table

Transmission Installed	Acceptable Transmission Style Programming Options	Data Link Used
Allison WTEC*	Automatic Option 1, Automatic Option 2, Automatic Option 3, Automatic Option 4	J1587 or J1939
Allison ATEC*	Automatic Option 1, Automatic Option 2, Automatic Option 3, Automatic Option 4	J1587 or J1939
Eaton Top 2	Eaton Top 2	None
Manual	Manual	None
Eaton Autoshift	Manual	J1939
Eaton Lightning	Manual	J1939
Meritor ESS	Manual	J1939
Meritor SureShift	Manual	J1939

*Where more that one option is listed, the Transmission Style parameter is dependent upon the particular switch installation. Refer to “ Transmission Style Parameter Switch Input Table” on page 85 for details.

18.0.1 Spicer Automate-2 10 Speed Electronically Automated Transmission

The C-10, C-12, C-15 and C-16 engines have not been developed to be compatible with the Spicer Automate-2 transmission. Please contact Caterpillar regarding application of this transmission.

18.1 Allison ATEC Series

The Allison ATEC requires connection to either the SAE J1587/J1708 or J1939 data link to communicate to the ECM.

OEM provided and installed components required:

1) SAE J1587 or J1939 Data link connection to the Allison transmission control.

2) Connection to ECM Service Brake #2 and Neutral Switch Input as per " Transmission Style Parameter Switch Input Table" on page 85.

18.2 Allison WTEC Series

The Allison WTEC requires connection to the SAE J1587/J1708 or J1939 data link to communicate to the ECM.

OEM provided and installed components required:

1) SAE J1587 or J1939 Data link connection to the Allison transmission control.

2) Connection to ECM Service Brake #2 and Neutral Switch Input as per " Transmission Style Parameter Switch Input Table" on page 85.

Customer Parameter programming required:

1) Transmission Style programmed to match components connected to ECM Service Brake #2 and Neutral Switch Inputs.

18.3 Allison AT/MT/HT Series

Caterpillar 3126B engines provide Transmission Style parameter options that use an output to control a Shift Interface Relay for AT/MT/HT non-electronic transmissions. The C-10, C-12, C15 and C-16 engines require a special additional interface component (not supplied by Caterpillar) to be compatible with Allison AT/MT/HT Transmissions. This component connects to the ECM SAE J1587/J1708 data link and controls Shift Modulation. Please contact Allison regarding availability of these components.

OEM provided and installed components required:

1) SAE J1587 Data link connection to the Interface Kit.

2) Connection to ECM Service Brake #2 and Neutral Switch Input as per " Transmission Style Parameter Switch Input Table" on page 85.

Customer Parameter programming required:

1) Transmission Style programmed to match components connected to ECM Service Brake #2 and Neutral Switch Inputs.

18.4 Eaton CEEMAT

The C-10, C-12, C-15 and C-16 engines have not been developed to be compatible with the CEEMAT transmission. Please contact Caterpillar regarding application of this transmission.

18.5 Eaton Autoshift

Caterpillar provides capability for connection with an Eaton 10 Speed or 18 Speed Autoshift transmission using SAE J1939 communications.

NOTE: The Eaton Autoshift is an automated manual transmission and requires a clutch switch.

NOTE: The Eaton Autoshift transmission is not currently compatible with a Brakesaver equipped engine. Changes to the SAE J1939 broadcast will make this combination compatible in the future.

OEM provided and installed components required:

1) SAE J1939 Data link connection to the Eaton transmission control.

2) Clutch Switch.

Customer Parameter programming required:

1) Powertrain Data Link parameter programmed to J1939, or J1922 & J1939 (only if SAE J1939 and SAE J1922 are both used on the vehicle).

2) Transmission Style programmed to Manual.

18.6 Eaton Top 2 Transmissions

The Caterpillar ECM operates two solenoids to control the shifting between the top two gears of an Eaton Top 2 Transmission. This requires programming of four Customer Parameters and additional wiring. Caterpillar recommends Locking each of these parameters following their programming for Eaton Top 2. Each of the parameters must be correctly programmed for the system to operate correctly.

OEM provided and installed components required:

1) Connection to ECM J1/P1 terminal-20 to a Shift Solenoid and to J1/P1 terminal-19 to a Lockout Solenoid.

Customer Parameter programming required:

1) Transmission Style parameter programmed to Eaton Top 2.

2) Top Gear Ratio.

3) Top Gear Minus One Ratio.

4) Top Gear Minus Two Ratio.

18.6.1 Output #6 and Output #7 Electrical Specifications

Electrical characteristics of these high side drivers are as follows:

Minimum “ON” Output Voltage	Maximum “ON” Output Voltage	Maximum Current Draw	OFF State
Battery - 2.0 Volts DC	Battery	1.0 A	High Impedance

These driver are intended for connection to a solenoid. Caterpillar recommends transient suppression be used on the inductive load in addition to the ECM’s internal protection. ***Circuit protection is left to the OEM’s discretion.***

Connection for this output:

Terminal Description	ECM Terminal Assignment
Output #6	Terminal 19
Output #7	Terminal 20

18.6.2 Lockout Solenoid Operation

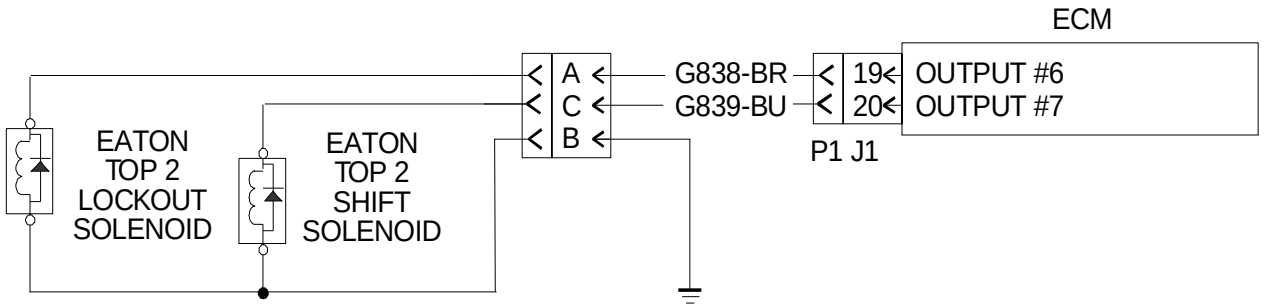
The Lockout Solenoid uses Output #6 when the Transmission Style is programmed to Eaton Top 2.This output will be ON when the ECM detects an Eaton Top 2 transmission is in the programmed Top Gear Minus One Ratio and OFF under all other conditions. A 54-05 Output #6 Open Circuit (66) diagnostic code will be active if the Transmission Style is programmed to Eaton Top 2 without connection to the solenoid or if a fault condition exists for the Lockout Solenoid.

18.6.3 Shift Solenoid Operation

The Shift Solenoid uses Output #7 when the Transmission Style is programmed to Eaton Top 2. This output will be ON when the ECM detects an Eaton Top 2 transmission is in the programmed Top Gear Ratio and OFF under all other conditions. A 55-05 Output #7 Open Circuit (67) diagnostic code will be active if the Transmission Style is programmed to Eaton Top 2 without connection to the solenoid or if a fault condition exists for the Shift Solenoid.

18.6.4 Eaton Top 2 Installation Requirements

Eaton Top 2 transmissions require a wiring harness to connect the Lockout Solenoid to Output #6 and Shift Solenoid to Output #7. The ground connection for the solenoids should be connected to the engine ground stud. Refer to “Wiring Diagram 39 - Eaton Top 2 Circuit Diagram” on page 88.



Wiring Diagram 39 - Eaton Top 2 Circuit Diagram

18.7 Meritor Engine Syncro Shift (ESS) Transmissions

Caterpillar provides capability for connection with an Meritor ESS transmission using SAE J1939 communications.

NOTE: The Meritor ESS is an automated manual transmission and requires a clutch switch.

NOTE: The Meritor ESS transmission is not currently compatible with a Brakesaver equipped engine. Changes to the SAE J1939 broadcast will make this combination compatible in the future.

OEM provided and installed components required:

1) SAE J1939 Data link connection to the Eaton transmission control.

2) Clutch Switch.

Customer Parameter programming required:

1) Powertrain Data Link parameter programmed to J1939, or J1922 & J1939 (only if SAE J1939 and SAE J1922 are both used on the vehicle).

2) Transmission Style programmed to Manual.

18.8 Meritor SureShift Transmissions

Caterpillar provides capability for connection with an Meritor SureShift transmission using SAE J1939 communications.

NOTE: The Meritor SureShift is an automated manual transmission and requires a clutch switch.

NOTE: The Meritor SureShift transmission is not currently compatible with a Brakesaver equipped engine. Changes to the SAE J1939 broadcast will make this combination compatible in the future.

OEM provided and installed components required:

1) SAE J1939 Data link connection to the Eaton transmission control.

2) Clutch Switch.

Customer Parameter programming required:

1) Powertrain Data Link parameter programmed to J1939, or J1922 & J1939 (only if SAE J1939 and SAE J1922 are both used on the vehicle).

2) Transmission Style programmed to Manual.

19.0 ABS and Traction Control

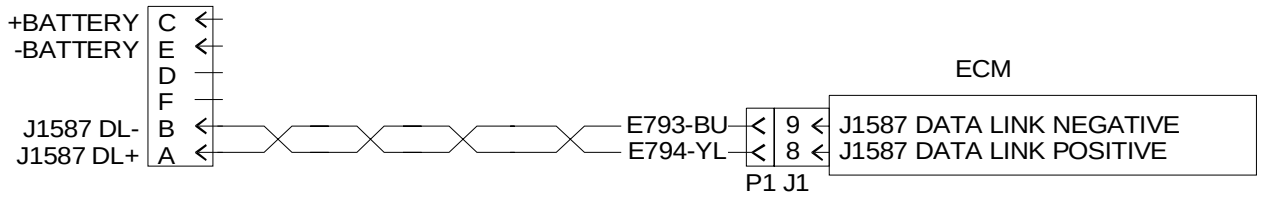
The ECM can communicate with ABS and ABS with Traction Control using the SAE J1939 or the SAE J1922 data link. Refer to “23.0 SAE J1939 Data Link Supported Parameters” on page 102 for supported messages. Caterpillar’s ECM will respond to commands from Anti-Lock Brake Systems (ABS) using SAE J1922 or J1939 communication for Engine Retarder control. This eliminates a relay for ABS systems using SAE J1922 or J1939 communications. This does require connection to the engine control SAE J1922 or J1939 Data Link. Those ABS systems not using J1922 or J1939 communications will still require relays.

20.0 Data Links

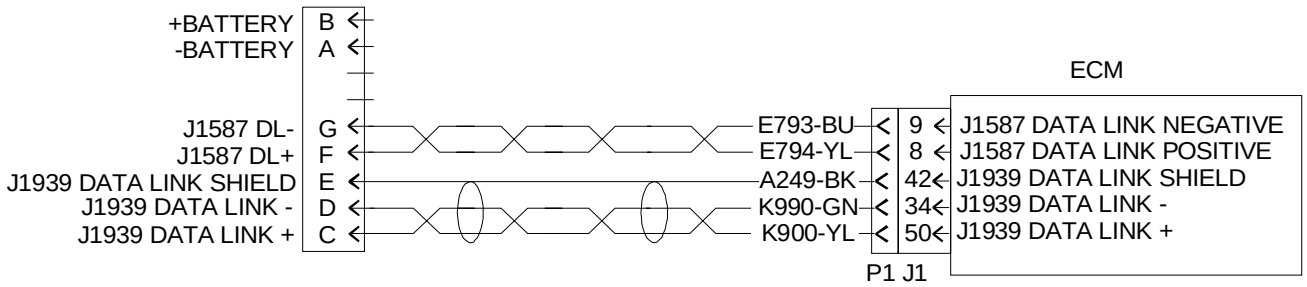
20.1 SAE J1587/J1708 Data Link

The control system has a standard data link available for communicating with electronic service tools, dash displays, and certain transmissions. The ATA (American Trucking Association), SAE J1587/SAE J1708 Data Link is standard on all Caterpillar Truck Engines. The ATA data link can reduce duplication of engine and vehicle sensors by allowing other control systems to share sensor information. The ATA data link can also communicate with Caterpillar or MPSI Pro-Link (with Caterpillar Cartridge) service tools. Refer to “Wiring Diagram 40 - J1587 Data Link Circuit with 6-Terminal Diagnostic Connector” on page 89 and “Wiring Diagram 41 - J1587 Data Link Circuit with 9-Terminal J1939 Diagnostic Connector” on page 89 for data link wiring details. The ATA data link does not require a Customer Parameter to activate. The data link follows SAE recommended practice J1708 for hardware and SAE recommended practice J1587 for the communication protocol.

An OEM installed wiring harness and cab connector are necessary to allow for accessing the data link with a service tool. There is not a data link connector supplied in the engine harness. Caterpillar requests the vehicle OEM install a data link connector at the engine for those applications where the cab data link connector is too far away for practical service of the engine. For engine mounted data link connectors Caterpillar recommends grounding the engine data link connector directly to the engine ground stud through a splice into either “-Battery” wire (Connector P1, terminal 65 or 67). It must not be grounded to ECM Sensor Common connections. An example application for an engine installed data link connector would be found on a bus or RV with a rear mounted engine. The diagrams below represent the ATA data link installed in to a 6-terminal and 9-terminal dash connectors.



Wiring Diagram 40 - J1587 Data Link Circuit with 6-Terminal Diagnostic Connector



Wiring Diagram 41 - J1587 Data Link Circuit with 9-Terminal J1939 Diagnostic Connector

20.2 Service Tools and Diagnostics

The control system has built-in diagnostics to verify system components are operating properly. In the event of a component failure, the driver is alerted to the condition via an OEM installed “Check Engine” or diagnostic lamp, or from a message transmitted over the SAE J1587 data link. Intermittent faults are logged and stored in the memory of the ECM and can be retrieved using an Electronic Service Tool.

The recommended electronic service tool for the C-10, C-12, C-15 and C-16 engine is Caterpillar Electronic Technician (ET). ET is a software based service tool used to diagnose and repair Caterpillar products. It is designed to run on a personal computer using the Windows® 95 or Windows® NT operating system. Another Caterpillar service tool that can be used but is no longer supported, is the Electronic Control Analyzer and Programmer (ECAP).

Caterpillar is also compatible with the MPSI Pro-Link service tool (requires Caterpillar cartridge). The following table outlines the capabilities of the electronic service tools mentioned. Note that the table outlines features as of the publication date. The MPSI Pro-Link Caterpillar cartridge allows all printable characters available on ET or ECAP except the following: ~, \, and _ characters. Therefore, for existing passwords containing these characters, ET or ECAP must be used. The Caterpillar ET or ECAP service tool allows the use of any printable character available on the keyboard. **It is important when considering Customer passwords to make sure the service tool normally used to access these parameters can input all the necessary characters.**

Service Tool Features	ET	ECAP	Pro-Link[1]
WinFlash Program Personality Module Software	Yes	No	No
Read/Change Customer Parameters	Yes	Yes[2]	Yes[2]
Read/Change Factory Parameters	Yes	Yes	No
Lock/Unlock Parameters	Yes	Yes	No
Display Engine Status Parameters / Groups	Yes	Yes	Yes[2]
Display/Clear Diagnostic Codes	Yes	Yes	Yes[3]
Calibrate Engine Speed/Timing	Yes	Yes	Yes
Automated Cylinder Cutout Tests	Yes	No	No
Cylinder Cutout Test	Yes	Yes	Yes
Special Tests	Yes	Yes[2]	Yes[2]
Data Logger	Yes	No	No
Real Time Graphing	Yes	No	No
Driver Reward Programming	Yes	No	No
Display Current Totals	Yes	No	No
Display Trip Totals and Histograms	Yes	No	No
Snapshot Recorder & Viewer	Yes	No	No
Copy Configuration - ECM Replacement	Yes	No	No
Rating History	Yes	No	No
SIS Integrated Guided Diagnostics	Yes	No	No

[1] MPSI Pro-Link with the Caterpillar Truck Engine Cartridge 1.09

[2] Limited Support available

[3] MPSI Pro-Link will not clear diagnostic codes that require factory passwords.

OEM provided and installed components required:

1) Data link connector, following The Maintenance Council RP1202.

2) Check Engine Lamp.

Customer Parameter programming required:

1) Availability of some diagnostic codes is influenced by parameter programming, such as Engine Monitoring.

The Caterpillar service tool connector uses a 9-terminal Deutsch HD series connector to connect to the vehicle. Caterpillar offers a variety of adapter cables to connect various cab / engine datalink connectors to the standard 9-pin connector found on the 139-4166 or 160-0141 Service Tool cable. The following list identifies some of those adapter cables commonly used on various applications.

• 7X-1686 - Connects 9-terminal Service Tool Cable (139-4166 or 160-0141) to GM ALDL Cab Connector

• 7X-1714 - Connects 9-terminal Service Tool Cable (139-4166 or 160-0141) to a 6-terminal Cab Connector

• 157-4829 - Connects 9-terminal Service Tool Cable (139-4166 or 160-0141) to a 9-terminal J1939 Cab Connector

20.3 ECM Software Changes

ECM software changes (uprates, updates) require a personal computer, a Caterpillar approved communication adapter, and either Caterpillar Electronic Technician (ET) or the LEXT3037 PC Program software.

20.4 Information Available Via SAE J1587/J1708 Using SAE J1587 Escape Parameter

Trip data and Maintenance Indicator data are available only via the SAE J1587 Data Link escape parameter. Accessing this information requires Caterpillar to provide the communication protocol. Please contact Caterpillar Engineering if you are interested in accessing this data. A description of the available data follows.

20.5 Engine Totals

The ECM maintains current totals for the following information.

ECM Maintained Total Data

Total Time	Total Distance	Total Idle Fuel
Total PTO Time	Total Fuel	Total Max Fuel
Total Idle Time	Total PTO Fuel	Average Load Factor

Average Load Factor is calculated using actual fuel used, maximum fuel possible, and idle fuel:

$$\text{Average Load Factor} = \frac{\text{(actual fuel - idle fuel)}}{\text{(maximum fuel- idle fuel)}}$$

All data is stored in metric form except distance (miles), and vehicle speed (mph). Conversion to other formats are be performed by the Electronic Service Tool.

20.6 Trip Data

Included under the heading of Trip Segment is a Fleet Trip Segment and Driver Trip Segment. These two data segments are independent—resetting one does not affect the other.The fleet trip segment also includes a 3-dimensional histogram (engine rpm, vehicle speed, and engine hours), two 2-dimensional histogram (one for engine rpm - hours, the other for vehicle speed - hours), and five sets of Fleet Segment Custom Data. The 2-dimensional histograms are a subset of the 3-dimensional histogram.

A segment is defined as the difference from the current instantaneous Engine Totals data and the Engine Totals stored at the previous reset of the data. When a reset occurs, the ECM stores the current ECM Engine Totals value in place of the old value for the respective Trip Data information. The ECM maintains only the data reset values for the Fleet Trip Data or Driver Trip Data segments, and Maintenance Indicator segment. The ECM does not calculate actual trip data for these trip segments. It does however, calculate the data for the Fleet Trip Data Histograms and Fleet Segment Custom data. The Fleet Trip Segment can be further divided into two driver trip segments tagged by the Driver ID, and also into state segments. Driver ID and State crossing data requires a Caterpillar Driver Information Display to enter Driver ID’s and State crossings.

20.6.1 Fleet Trip Segment

The Fleet Trip Segment maintains the following Engine Totals information, recorded at the time of reset:

Fleet Trip Segment Data

Time (Engine Hours)	Idle Fuel	Average Driving Speed
Driving Time	Percent Idle Time	Max Vehicle Speed
Distance	PTO Time	Max Engine Speed
Fuel	PTO Fuel	Start Timer
Overall Fuel Economy	Percent PTO Time	End Time
Driving Fuel Economy	Average Load Factor	Start Odometer
Idle Time	Average Vehicle Speed	End Odometer

A reset occurs via a data link message only.

20.6.2 Fleet Trip Histograms

The ECM maintains the histograms tracking Engine Hours at specific Engine Speed and Vehicle Speed ranges. The RPM data points and vehicle speed ranges are broken down into various ranges such as 0-4, 5-9, 10-14 mph or 0-599, 600-699, 700-799 rpm. A reset occurs via a data link message only.

20.6.3 Fleet Segment Custom Data

The Fleet Segment Custom Data records data determined from a specific list of customer defined options. The basic structure of the data is as follows:

xxxx WHEN yyyy IS range^{Y} AND zzzz is range^{Z}.

For Example:

fuel burned WHEN cruise IS on AND vehicle speed IS BETWEEN 65 and 90 mph.

Variable xxxx	Range xxxx
Engine Hours	131,000
Distance Traveled	1,677,720
Fuel Burned	8,192
Occurrences	4,294,967,296

Variables yyyy & zzzz	Range yyyy & zzzz
Engine Speed	0 - 3000
Vehicle Speed	0 - 127.5
Fuel Rate	0 - 40
Load Factor	0 - 100
Coolant Temperature	0 - 248 (^{o}F)
Oil Pressure	0 - 100 (psi)
Fuel Temperature	0 - 248 (^{o}F)
Intake Manifold Air Temp	0 - 248 (^{o}F)
Cruise	ON or OFF
PTO	ON or OFF
Engine Retarder	Active or Not Active
Throttle Position	0 - 100 Percent
Brake	ON or OFF

20.6.4 Driver Trip Segment Data

The Driver Trip Segment maintains the following Engine Total Data recorded at the time of reset:

Driver Trip Segment Data

Time (Engine Hours)	Idle Fuel	Average Driving Speed
Driving Time	Percent Idle Time	Max Vehicle Speed
Distance	PTO Time	Max Engine Speed
Fuel	PTO Fuel	Start Timer
Overall Fuel Economy	Percent PTO Time	End Time
Driving Fuel Economy	Average Load Factor	Start Odometer
Idle Time	Average Vehicle Speed	End Odometer

A reset occurs via a data link message only.

20.7 Customer Parameter Cross Check

Caterpillar FIS (Fleet Information Software) can set up a template for Customer Parameters. This template can then be checked against the parameters in trucks, exceptions noted and then corrected. No ECM Customer Parameters are required to enable this feature. It is available only from the FIS.

20.8 ECM Wireless Communication Enable

This parameter is used to configure the ECM for use with a remote communications device such as a HIGHWAY MASTER® wireless network or a QUALCOMM OmniTRAC® satellite network. Remote communications are used to program parameters and transfer ECM data. Factory Level Passwords are required to support this feature.

This parameter is defaulted to NO (OFF). It can only be enabled by obtaining Factory Passwords from Caterpillar. This feature can only be enabled after the truck has been delivered to the customer.

20.9 Economy Model

Using FIS (Fleet Information Software) installed on a PC, a customer can set up scoring parameters to rate driver and vehicle performance. The parameters include: average engine rpm, average vehicle speed, shifting technique, power demand, and idle time. These parameters are weighted to determine a score. No ECM Customer Parameters are required to enable this feature. It is available only from the FIS software.

20.9.1 Driver Reward

The driver reward feature automatically adjusts the Vehicle Speed Limit as a reward to the driver for operating a truck in a manner meeting the truck owner's specifications. Several parameters are monitored in order to evaluate a drivers operating habits. Weighting factors can be applied to the parameters reflecting the desired and expected operating habits. If operating habits meet or exceed the owner's specifications, the VSL is automatically increased as a reward. The VSL will decrease when operating habits do not meet owner specifications. The Driver Reward Enable parameter provides a means to Disable and Lockout this feature if regulations require a fixed vehicle speed limit.

The CAT ID can be used to monitor parameters affecting the Driver Incentive, allowing the driver to adjust operating techniques as required.

20.10 Maintenance Indicator Data

The ECM maintains Maintenance information for three levels of maintenance; PM1, Coolant Flush/Fill, and PM2. PM1 is defined as oil and filter service, and PM2 is an engine inspection/clean-up. Stored information is last maintenance performed (PM1, PM2, Coolant Flush/Fill), and PM1 interval. The information is available in either engine hours or miles. For further information about PM1, PM2, and Coolant Flush/Fill, see the Operation and Maintenance Manuals for the respective engine.

20.10.1 PM1 Maintenance

PM1 can be determined from a user-specified interval, or from the ECM based on fuel. The Maintenance Indicator Programmable Parameters for Maintenance Indicator Mode, Interval, and Sump Capacity all influence the Maintenance Interval. The ECM provides PM1 maintenance interval and last maintenance information.

20.11 Engine Snapshot Recorder

The ECM stores engine operating parameters when diagnostic codes occur. An Electronic Service Tool or the Cruise Set/Resume switch can also be used to manually trigger a snapshot. The Set/Resume switch must be toggled to the Set then the Resume position within one second to trigger the snapshot recorder. The ECM can store up to two Diagnostic Code Triggered snapshots, two Externally triggered snapshots, and one Quick Stop Snapshot. Each type is stored in a "circular buffer". When a new snapshot is taken, the oldest one in the buffer will be replaced.

20.11.1 Engine Snapshot Recorder Records

Each diagnostic record contains 27 frames of information; frame 20 is the diagnostic code occurrence, 19 frames before, 7 frames following the code. Each frame is separated by 0.48 seconds. Each switch activated record contains 54 frames; frame 40 is the switch activation trigger, 39 frames before, 14 frames after the switch trigger. Time between frame is 0.24 seconds for the switch activated record.

20.11.2 Data Stored In Engine Snapshot Recorder Frames

Each frame of the snapshot stores the Status Parameter data.

20.12 Quick Stop Recorder

A snapshot can also be stored for a Quick Stop occurrence if the Customer Parameter is programmed. The ECM stores the number of occurrences of the Quick Stop Events, as well as a snapshot of the latest occurrence.

20.12.1 Engine Snapshot Recorder Records

Each Quick Stop record contains 60 frames of information; frame 45 is the Quick Stop occurrence, 44 frames before, 15 frames following the code. Each frame is separated by 1.0 second.

20.12.2 Data Stored In Quick Stop Recorder Frames

Each frame of the snapshot record stores the following data;

ECM Snapshot Frame Data

Engine rpm	Vehicle Speed
Throttle Position	Cruise Status
Clutch Switch	Brake Switch

20.13 SAE J1587 Data Link Broadcast Parameters

SAE J1708/J1587 data link parameters, parameter identifiers (PID's), size, scaling, and broadcast period for the C-10, C-12, C-15 and C-16 engines are as follows:

Message Identifier (MID) - 128 [engine control MID]

Broadcast Period	Parameter Name	PID	Size (bytes)	Scaling per bit
0.1 sec	Road Speed	84	1	0.5 mph
*	Cruise Control Set Speed	86	1	0.5 mph
	Percent Accelerator Pedal Position	91	1	0.4 percent
	Percent Engine Load	92	1	0.5 percent
*	Power Take Off Set Speed	187	2	0.25 rpm
	Engine Speed	190	2	0.25 rpm
0.2 sec	Engine Status	2	1	Bit Code
	Cruise Control Status	85	1	Bit Code
	Engine Retarder Status**	121	1	Bit Code
	Fuel Rate	183	2	4.34x10-6 gal/s
	Instantaneous Fuel Economy	184	2	1/256 mpg
1.0 sec	Idle Shutdown Status	71	1	Bit Code
	Road Speed Limit Status	83	1	Bit Code
	Power Take Off Status	89	1	Bit Code
	Engine Oil Pressure	100	1	0.5 PSI
	Boost Pressure	102	1	0.125 PSI
	Intake Manifold Temperature	105	1	1 °F
	Coolant Temperature	110	1	1 °F
	ECM Battery Voltage	168	2	0.05 V
(optional)	Ambient Air Temperature	171	2	0.025 °F
	Fuel Temperature	174	2	0.025 °F
(Inferred)	Engine Oil Temperature	175	2	0.025 °F
(active only)	Engine Diagnostic	194	Variable	PID/SID & FMI

* Cruise and PTO set speeds are sent at 0.1 second intervals only when they are changing.
** Engine Retarder status is for ECM Solenoid Retarder, controlled via OEM installed switches. This may differ from the Auxiliary Brake, which the ECM operates without OEM switch inputs.

Broadcast Period	Parameter Name	PID	Size (bytes)	Scaling per bit
10.0 sec	Cruise Control Set Speed	86	1	0.5 mph
(not all ratings)	Atmospheric Pressure	108	1	0.0625 PSI
	Average Fuel Economy	185	2	1/256 mpg
	Power Take Off Set Speed	187	2	0.25 rpm
	Total Miles	245	4	0.1 miles
On Request	Road Speed Limit	74	1	0.5 mph
	High Cruise Control Speed Set Limit	87	1	0.5 mph
	Low Cruise Control Speed Set Limit	88	1	0.5 mph
	Rated Horsepower	166	2	1.0 BHP
	Engine Idle RPM Speed	188	2	0.25 rpm
	Engine Rated RPM Speed	189	2	0.25 rpm
	Software Identification (Caterpillar P/N)	234	16	ASCII Char.
	Total Idle Hours	235	4	0.05 hours
	Total Idle Fuel Consumption	236	4	0.125 gal
	Vehicle Identification	237	17	ASCII Char.
	Total Miles	245	4	0.1 miles
	Total Engine Hours	247	4	0.05 hours
	Total Engine PTO Hours	248	4	0.05 hours
	Total Fuel Consumption	250	4	0.125 gal
	Real Time Clock - Time	251	3	Char 1: 0.25 sec Char 2: 1.0 min Char 3: 1.0 hour
	Real Time Clock - Date	252	3	Char 1: 0.25 day Char 2: 1.0 month Char 3: 1.0 year

Broadcast Period	Parameter Name	PID	Size (bytes)	Scaling per bit
On Request (Sent as multi-packet message)	Component Identification **Message #1** Byte 1- MID = 128 Byte 2- PID for multi-packet message = 192 Byte 3- number of characters following = 16 Byte 4- Requested PID 243 = 243 Byte 5- Last and current section number = 16 Byte 6- Byte count of total data portion = 21 Byte 7-19 - PID 243 data portion = 128, ASCII Characters = CTRPL*C-10, CTRPL*C-12, CTRPL*C-15 or CTRPL*C-16 Byte 29 - Checksum **Message #2** Byte 1- MID = 128 Byte 2- PID for multi-packet message = 192 Byte 3- number of characters following = 11 Byte 4- Requested PID 243 = 243 Byte 5- Last and current section number = 17 Byte 6- Byte count of total data portion = 8 Byte 7-14 - PID 243 data portion = 128, ASCII Characters = 6NZ12345 (C-15), 7CZ12345 (C-16), 3CS12345 (C-10) or 2KS12345 (C-12) Byte 15- Checksum	243	21	ASCII Char.
On Request	Clock	251	3	Character 1 = 0.25 sec/bit Character 2 = 1 min/bit Character 3 = 1 hr/bit
	Date	252	3	Character 1 = 0.25 day/bit Character 2 = 1 month/bit Character 3 = 1 year/bit

20.14 Bit Code Definitions

Status Definition:	Parameter Name	Indication	Indication
Engine Status Code Definitions (PID 2):			
Bit 7	Low Oil Pressure	0 = not active	1 = active
Bit 6	Powertrain Data Link	0 = not active	1 = active
Bit 5	undefined	0 = not active	1 = active
Bit 4	undefined	0 = not active	1 = active
Bit 3	Cold Mode	0 = not active	1 = active
Bit 2	Road Speed Limit	0 = not active	1 = active
Bit 1	Top Engine Limit	0 = not active	1 = active
Bit 0	Engine Shutdown	0 = not active	1 = active

Bit code definitions for Cruise Control Status (PID 85), Engine Brake Status (PID 121), Parking Brake Switch (PID 70), Idle Shutdown Status (PID 71), Road Speed Limit Status (PID 83), and Power Take Off Status (PID 89) are as per SAE J1587 definitions.

NOTE: The Caterpillar service tools follow the SAE/ATA J1587 and J1708 standards in all communications. Service tool interfacing is done using the escape provision defined in SAE J1587. The escape information is considered proprietary and is, therefore, not described here.

21.0 SAE J1922/J1708 Data Link

For C-10, C-12, C-15 and C-16 engines the SAE J1922 capability is standard. The J1922 data link is intended to communicate control parameters between the engine, transmission, and ABS/traction control systems. Use of the data link requires activation via a programmable parameter. Refer to “SAE J1587 Data Link Broadcast Parameters” on page 95 for data link parameter details.

OEM provided and installed components required:

1) Data link connection to traction control or transmission control.

Customer Parameter programming required:

1) Powertrain Data Link parameter programmed to J1922, or J1922 & J1939.

21.1 SAE J1922 Data Link Broadcast Parameters

SAE J1708/J1922 data link parameters, parameter identifiers (PID's), size, scaling, and broadcast period are as follows:

Broadcast Period	Byte	Parameter Name	Size (bytes)	Scaling per bit
50 msec				
	0	Message ID = 69	1	
	1	Percent Torque	1	1 percent
	2	Percent Accelerator Position	1	0.4 percent
	3	Status Byte (see table)	1	Bit Code
	4	Desired Engine RPM (Broadcast 0)	1	16 rpm
	5	Desired RPM Asymmetry Adjustment (Broadcast 0)	1	
	6	Checksum	1	

21.2 SAE J1922 Status Definitions

Status Definition:	Parameter Name	Indication	Indication
Bit 7	Not Implemented		
Bit 6	Not Implemented		
Bit 5	Acceleration Pedal Low Idle Switch	0 = Throttle Position > 6% pedal position	1 = Throttle Position < 7% pedal position
Bit 4	Acceleration Pedal Kick Down Switch	0 = Throttle Position < 95% pedal position	1 = Throttle Position > 94% pedal position
Bit 3	Retarder Control Status	0 = Not Enabled*	1 = Enabled
Bit 2	Road Speed Limiting Status	0 = Inactive	1 = Active
Bit 1	PTO Control Status	0 = Inactive	1 = Active
Bit 0	Cruise Control Status	0 = Inactive	1 = Active

* Engine Retarder Enable Signal can be activated even if an engine retarder is not installed, indicates conditions are met for retarder activation.

Broadcast Period	Byte	Parameter Name	Size (bytes)	Scaling per bit
On Request	0	Message ID = 70	1	
	1, 2	Engine Speed At Idle	2	.0625 rpm
	3	% Of Peak Torque At Idle (Not Implemented, always 0)	1	1 percent
	4, 5	Rated Engine Speed	2	.0625 rpm
	6	% Of Peak Torque At Rated Speed (Not Implemented, always 0)	1	1 percent
	7, 8	Engine Speed Point 3 (Not Implemented, always 0)	2	.0625 rpm
	9	% Of Peak Torque At Point 3 (Not Implemented, always 0)	1	1 percent
	10, 11	Engine Speed Point 4 (Not Implemented, always 0)	2	.0625 rpm
	12	% Of Peak Torque At Point 4 (Not Implemented, always 0)	1	1 percent
	13, 14	Engine Speed Point 5 (Not Implemented, always 0)	2	.0625 rpm
	15	% Of Peak Torque At Point 5 (Not Implemented, always 0)	1	1 percent
	16, 17	Engine Speed At Peak Torque	2	.0625 rpm
	18	Peak Torque Of Engine	1	10 lb.-ft.
	19, 20	Engine Speed At High Idle	2	.0625 rpm
	21	Maximum Engine Override Speed	1	16 rpm
	22	Checksum	1	

21.3 SAE J1922 Override Modes:

21.3.1 ABS/Traction Control:

Mode 11, Engine Percent Torque Limit.

21.3.2 Transmission Control:

Mode 01, Desired Engine Speed Override.

Mode 11, Engine Speed/Torque Limit.

21.3.3 SAE J1922 Application Notes

1) Default to normal engine operation if no message received from other Control Modules every 0.4 seconds.

2) Accept torque limit commands from -127 to 127, but any negative torque is the same as zero.

3) Require other Control Modules to respond to an Engine Control Initialization Request Message. It is used for diagnostic purposes when a Caterpillar electronic service tool is used.

4) The engine will not drop below programmed low idle engine rpm. If torque limit commands limit torque below what engine needs to run at low idle, the engine will run at the higher torque value to keep the engine rpm at low idle.

5) Engine Retarder can be disabled in all modes.

6) Engine Control will respond to Traction Control and Transmission Control Initialization Request Message

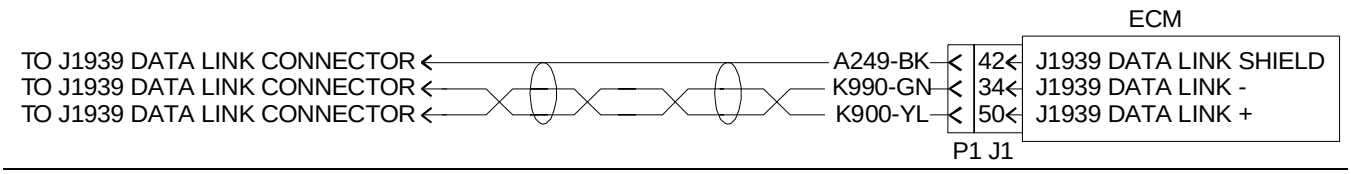
7) Transmission Control Modes override ABS/Traction Control Modes

8) Engine Speed Limit and Engine Speed Override Values outside Low to High Idle range are accepted, but engine will only go to these limits.

9) During Speed Override Mode, engine power is limited to low horsepower map (approximately 160 hp). If engine rpm request is higher than driver input desired speed for 5 seconds, then ignore command until it drops below driver input desired speed or mode is inactivated.

22.0 SAE J1939 Data Link

The SAE J1939 datalink is standard on all Caterpillar On-Highway Truck Engines. It is available for communications with transmission, anti-lock brake (ABS) and traction control (TC) systems, as well as instrument clusters and other devices that use that use SAE J1939 communications protocol. Contact Caterpillar Engineering for new application assistance. Refer to “23.0 SAE J1939 Data Link Supported Parameters” on page 102 for data link parameter details.



Wiring Diagram 42 - J1939 Data Link Circuit

OEM provided and installed components required:

1) Data link connection to power train components.

Customer Parameter programming required:

1) Powertrain Data Link parameter programmed to J1939, or J1922 & J1939.

The Powertrain Data Link parameter should be programmed to match the configuration of the vehicle. Programmable options are None (default), J1939, J1922 & J1939. Caterpillar recommends programming the Powertrain Data Link parameter to None if the J1939 Data Link is not being used to avoid unnecessary diagnostics.

Caterpillar electronic service tools have the capability to temporarily disable the Powertrain Data Links for dynamometer or other diagnostic testing purposes.

23.0 SAE J1939 Data Link Supported Parameters

The following table lists all J1939 messages currently supported. The ECM Powertrain Data Link Parameter must be programmed to J1939.

23.1 SAE J1939 Broadcast Messages

PGN Parameter Group Number	Parameter Name and Configuration	Transmission Repetition Rate	Byte or Field	Data Length	Data Page	PDU Format	PDU Specific	Default Priority
61,440 $F0000_{16}$	**Electronic Retarder Controller #1: ERC1**	100 msec		8	0	240	000	6
	Source Addresses Used: 41							
	Status_ERC1 bits 8 &7 retarder enable - shift assist switch (set to 01) bits 6 & 5 retarder enable - brake assist switch (retarder on/off switch) bits 4-1 engine/retarder torque mode (not supported)		1					
	Actual retarder percent torque (not speed dependent)		2					
	Not defined		3-8					
61,443 $F003_{16}$	**Electronic Engine Controller #2: EEC2**	50 msec		8	0	240	3	3
	Source Addresses Used: 0							
	Status_EEC2 bits 8-5 not defined bits 4-3 AP kickdown switch (not supported) bits 2-1 AP low idle switch (not supported)		1					
	Accelerator pedal (AP) position		2					
	Percent load at current speed (heavily filtered)		3					
	Not defined		4-8					

23.1 SAE J1939 Broadcast Messages (Continued)

PGN Parameter Group Number	Parameter Name and Configuration	Transmission Repetition Rate	Byte or Field	Data Length	Data Page	PDU Format	PDU Specific	Default Priority
61,444 $F004_{16}$	**Electronic Engine Controller #1: EEC1**	30 msec		8	0	240	4	3
	Source Addresses Used: 0							
	Status_EEC1 bits 8-5 not defined bits 4-1 engine/retarder torque mode, (only modes 000 - 1001 supported)		1					
	Drivers demand engine percent torque		2					
	Actual engine percent torque		3					
	Engine speed		4 & 5					
	Not defined		6-8					
65, 247 $FEDF_{16}$	**Electronic Engine Controller #3: EEC3**	250 msec		8	0	254	223	6
	Source Addresses Used: 0							
	Nominal friction percent torque		1					
	Engine’s desired operating speed (not supported)		2 & 3					
	Engine’s operating speed asymmetry adjustment (not supported)		4					
	Not Defined		5-8					

23.1 SAE J1939 Broadcast Messages (Continued)

PGN Parameter Group Number	Parameter Name and Configuration	Transmission Repetition Rate	Byte or Field	Data Length	Data Page	PDU Format	PDU Specific	Default Priority
65, 251 $FEE3_{16}$	**Engine Configuration**	5 sec		28	0	254	227	6
	Source Addresses Used: 0							
	Engine speed at idle, point 1		1 & 2					
	Percent torque at idle, point 1		3					
	Engine speed at point 2		4 & 5					
	Percent torque at point 2		6					
	Engine speed at point 3		7 & 8					
	Percent torque at point 3		9					
	Engine speed at point 4		10 & 11					
	Percent torque at point 4		12					
	Engine speed at point 5		13 & 14					
	Percent torque at point 5		15					
	Engine speed at high idle, point 6		16 & 17					
	Gain (KP) of end speed governor (not supported)		18 & 19					
	Reference engine torque		20 & 21					
	Maximum momentary engine override speed, point 7 = Programmed TEL + 200 rpm		22 & 23					
	Maximum momentary engine override time limit = 5 seconds		24					
	Requested speed control range lower limit (not supported)		25					
	Requested speed control range upper limit (not supported)		26					
	Requested torque control range lower limit (not supported)		27					
	Requested torque control range upper limit (not supported)		28					

23.1 SAE J1939 Broadcast Messages (Continued)

PGN Parameter Group Number	Parameter Name and Configuration	Transmission Repetition Rate	Byte or Field	Data Length	Data Page	PDU Format	PDU Specific	Default Priority
65, 259 $FEEB_{16}$	**Component Identification**	On req		Var	0	254	235	6
	Source Addresses Used: 0							
	Make		A					
	Model		B					
	Serial Number (not supported)		C					
	Unit Number (not supported)		D					
65, 261 $FEED_{16}$	**Cruise Control / Vehicle Speed Setup**	On req		8	0	254	237	6
	Source Addresses Used: 0							
	Maximum vehicle speed limit		1					
	Cruise control high set limit speed		2					
	Cruise control low set limit speed		3					
	Not defined		4-8					
65, 262 $FEEE_{16}$	**Engine Temperature**	1 sec		8	0	254	238	6
	Source Addresses Used: 0							
	Engine coolant temperature		1					
	Fuel temperature		2					
	Engine oil temperature (not supported)		3 & 4					
	Turbo oil temperature (not supported)		5 & 6					
	Engine intercooler temperature (not supported)		7					
	Not defined		8					

23.1 SAE J1939 Broadcast Messages (Continued)

PGN Parameter Group Number	Parameter Name and Configuration	Transmission Repetition Rate	Byte or Field	Data Length	Data Page	PDU Format	PDU Specific	Default Priority
65, 263 $FEEF_{16}$	**Engine Fluid Level / Pressure**	500 msec		8	0	254	219	6
	Source Addresses Used: 0							
	Fuel pressure (not supported)		1					
	Not defined		2					
	Engine oil level (not supported)		3					
	Engine oil pressure		4					
	Crankcase pressure (not supported)		5 & 6					
	Coolant pressure (not supported)		7					
	Coolant level (not supported)		8					

23.1 SAE J1939 Broadcast Messages (Continued)

PGN Parameter Group Number	Parameter Name and Configuration	Transmission Repetition Rate	Byte or Field	Data Length	Data Page	PDU Format	PDU Specific	Default Priority
65, 265 FEF1$_{16}$	**Cruise Control / Vehicle Speed**	100 msec		8	0	254	241	6
	Source Addresses Used: 0							
	Measured_SW1 bits 8-5 not defined, (set to 11) bits 4-3 park brake switch, (set to 11) bits 2-1 2-spd axle switch, (set to 11)		1					
	Wheel based vehicle speed		2 & 3					
	Measured_CC_SW1 bits 8-7 clutch switch bits 6-5 brake switch bits 4-3 cruise control enable switch bits 2-1 cruise control active		4					
	Measured_CC_SW2 bits 8-7 cruise control accel switch bits 6-5 cruise control resume switch bits 4-3 cruise control coast switch bits 2-1 cruise control set switch		5					
	Cruise control set speed		6					
	State_CC bits 8-6 cruise control state bits 5-1 PTO state		7					
	Measured_Idle_SW1 bits 8-7 shutdown override switch (not supported) bits 6-5 engine test mode switch (not supported) bits 4-3 idle decrement switch (not supported) bits 2-1 idle increment switch (not supported)		8					

23.1 SAE J1939 Broadcast Messages (Continued)

PGN Parameter Group Number	Parameter Name and Configuration	Transmission Repetition Rate	Byte or Field	Data Length	Data Page	PDU Format	PDU Specific	Default Priority
65, 266 $FEF2_{16}$	**Fuel Economy**	100 msec		8	0	254	242	6
	Source Addresses Used: 0							
	Fuel rate		1, 2					
	Instantaneous fuel economy (not supported)		3, 4					
	Average fuel economy		5, 6					
	Not defined (not supported)		7, 8					
65, 270 $FEF6_{16}$	**Inlet / Exhaust Conditions**	500 msec		8	0	254	246	6
	Source Addresses Used: 0							
	Particulate trap inlet pressure (not supported)		1					
	Boost pressure		2					
	Intake manifold temperature		3					
	Air inlet pressure (not supported)		4					
	Air filter differential pressure (not supported)		5					
	Exhaust gas temperature (not supported)		6, 7					
	Coolant filter differential pressure (not supported)		8					

23.2 SAE J1939 Received Messages

PGN Parameter Group Number	Parameter Name and Configuration	Transmission Repetition Rate	Byte	Data Length	Data Page	PDU Format	PDU Specific	Default Priority
0 0_{16}	**Torque/Speed Control #1: TSC1** **(Refer to page 112 for special notes.)** Source Addresses Recognized: 03 (transmission #1) and 11 (ABS/TC) Destination Addresses Recognized: 00 (engine #1), 15 (retarder - engine) and 41 (retarder, exhaust, engine #1) Control Bits bits 8-7 not defined bits 6-5 override control mode priority bits 4-3 requested speed control conditions (ignored) bits 2-1 override control modes Requested speed/Speed Limit Requested torque/Torque Limit Not defined	10 mses to engine 50 msec to the retarder	 1 2, 3 4 5-8	8	0	0	Destination address	3

23.2 SAE J1939 Received Messages (Continued)

PGN Parameter Group Number	Parameter Name and Configuration	Transmission Repetition Rate	Byte	Data Length	Data Page	PDU Format	PDU Specific	Default Priority
61,441 F001$_{16}$	**Electronic Brake Controller #1: EBC1**	100 msec		8	0	240	1	6
	Source Addresses Recognized: 11							
	Status_EBC1 bits 8-7 EBS brake switch (ignored) bits 6-5 ABS Active (ignored) bits 4-3 ASR brake control active (ignored) bits 2-1 ASR engine control active (ignored)		1					
	Brake pedal position (ignored)		2					
	Status_EBC1 bits 8-7 not defined bits 6-5 ASR “hill holder” switch (ignored) bits 4-3 ASR off road switch (ignored) bits 2-1 ASR off road switch (ignored)		3					
	Measured_aux_1 bits 8-7 remote accel enable (ignored) bits 6-5 aux engine shutdown (ignored) bits 4-3 engine derate switch (source codes 11 & 49 recognized) bits 2-1 accel interlock switch (ignored)		4					
	Engine retarder selection (ignored)		5					
	Not defined		6-8					

23.2 SAE J1939 Received Messages (Continued)

PGN Parameter Group Number	Parameter Name and Configuration	Transmission Repetition Rate	Byte	Data Length	Data Page	PDU Format	PDU Specific	Default Priority
61,442 $F002_{16}$	**Electronic Transmission Controller #1: ETC1** **(Refer to "23.2.3 Electronic Transmission Controller #1: ETC1" on page 112 for special notes.)** Source Addresses Recognized: 3 Status_ETC1 bits 8-7 not defined bits 6-5 Shift in process bits 4-3 Torque converter lockup bits 2-1 Driveline engaged (ignored) Output Shaft Speed (ignored) Percent Clutch Slip (ignored) Command_ETC1 bits 8-5 not defined bits 4-3 Progressive shift disable (ignored) bits 2-1 momentary engine overspeed enable Input shaft speed (ignored) Not defined	10 msec	 1 2, 3 4 5 6 & 7 8	8	0	240	2	3

23.2.1 Torque/Speed Control #1 from Transmission Control to Engine

This message is used by the transmission to control the engine. The three override modes have been implemented if the request is from a transmission control:

Mode 01: speed control

Mode 10: torque control

Mode 11: speed/torque limit control

There are a few restrictions placed on these override modes and these are:

1) Default to normal engine operation if no message received every 90 milliseconds

2) Accept torque limit commands from -127 to 127, but any negative torque commands is the same as zero.

3) The engine will not drop below programmed low idle engine rpm. If torque limit commands limit torque below what the engine needs to run at low idle, the engine will run at the higher torque value to keep the engine at low idle.

4) Engine speed limit and engine speed override values outside the low idle to top engine limit range are accepted, but engine will only go to these limits.

5) During speed override mode, engine power is limited to about 120 horsepower.

6) If an engine speed request is higher than driver requested for five seconds, then ignore command until it drops below driver input desired speed or mode 01 is inactivated.

23.2.2 Torque/Speed Control #1 from Transmission Control to Retarder

Caterpillar engine controls accept this message if our control is broadcasting the ERC1 message which indicates that an engine retarder is installed. If retarder is installed, then the following control mode has been implemented if the request comes from a transmission control:

Mode 10: torque control

There are a few restrictions placed on this override mode and these are:

1) Default to normal retarder operation if no message received every 200 milliseconds

2) Engine must not be firing injectors or command will be ignored. An example would be that transmission control is in speed mode overriding below actual engine speed which means fuel would be shut off.

3) Transmission control must be in an override mode of engine control or engine retarder will not be turned on.

4) The torque request must be between -100% and -20% to get any engine retarder effect.

23.2.3 Electronic Transmission Controller #1: ETC1

Caterpillar uses this message for a service tool to indicate a transmission control exists on the J1939 data link. If a transmission supplier uses J1939 to communicate to the engine, then Caterpillar requires this message be supported. This message is also used to indicate via data byte five that the momentary engine overspeed enable is requested. This status is used by the engine control to allow the transmission to override the top engine limit and use speed override requests up to override speed of 2700 rpm. Engine defaults to normal operation if the message has not been received before 300 milliseconds.

24.0 Customer Specified Parameters

Customer Specified Parameters allow the truck owner to influence how a driver operates the vehicle. Some parameters may affect engine operation in ways an inadequately trained driver does not expect. These parameters may lead to power or performance complaints, even when the engine is performing to specification.

Customer parameters may be changed repeatedly as a customer changes his operation or as new drivers are assigned to a truck. **Customer Passwords** are required to change these parameters.

The following is a brief description of the Customer Specified Parameters. Along with each are the available values for the parameter and the default value. The parameter value shown in **bold** is programmed setting to disable a feature.

The tables show values in an approximate range for metric (kilometers, km/h, liters) units, followed by the exact U.S. (or English) units (miles, mph, quarts). The exact range of the parameter in metric units depends upon the Service Tool used because each Tool may use slightly different conversion factors.

The “Customer Specified Parameter Table” on page 142 lists each parameter, the default value, the available options and the Parameter IDentifier (PID) used with a Vehicle Electronic Programming Station (VEPS). Refer to the Definition file included with the VCP (Vendor Component Program) for addition information on the available options / ranges that can be used for VEPS programming. The parameters and options listed are shown as they appear on the Electronic Service Tool display screen.

Customer Parameter Lockout

This feature is available to restrict access to changing some available parameters. Locking out a parameter may require Customer Passwords (if used). Once a parameter is locked out, Factory Passwords are required to change the parameter or unlock the parameter.

If a “lockable” parameter is not locked out, Factory Passwords are not required to change the programmable option setting. A locked out parameter restricts the parameter from being changed directly by the customer. This allows vehicle owners to prevent their operators from tampering with the parameter configuration by obtaining Customer Passwords.

The following Customer Parameters are available for lockout using an Electronic Service Tool or VEPS:

• A/C Switch Fan On-Time	• Soft Vehicle Speed Limit
• Driver Reward Enable	• Top Engine Limit
• Engine Monitoring Lamps	• Top Gear Minus One Ratio
• Engine Retarder Delay	• Top Gear Minus Two Ratio
• Fan Control Type	• Top Gear Ratio
• High Cruise Control Speed Set Limit	• Transmission Style
• High Speed Range Axle Ratio	• Vehicle Speed Calibration
• Low Speed Range Axle Ratio	• Vehicle Speed Limit
• Multi-Torque Ratio	• VSL Protection

Factory Passwords are required to change a parameter from “locked” to “unlocked”. Only one set of Factory Passwords is required to unlock one or all locked parameters. If the Parameter Lockout screen is exited before unlocking all parameters, a second set of Factory Passwords will be required to unlock the remaining parameters.

Selected Engine Rating

Rating Number

Rating number within a power family. The Personality Module defines the power family such as 448 kW (600 hp) and may contain only one or several ratings. The rating number defines which rating is used within the family.

Alternatives	Default	VEPS PID
Power Family Dependent	Highest Setting Available within Power Family	56

Multi-Torque Ratio

This parameter is used to select the desired Multi-Torque trip point. Multi-Torque ratings allow the engine to provide additional torque or additional horsepower and torque when the transmission is operating is higher gears. The additional torque allows the truck to crest a hill without downshifting, increases fuel economy, and reduce wear. The trip point is determined by a ratio of engine speed versus vehicle speed. The three programmable options represent the different trip point values listed below:

MT-4 ...turn on ratio is 71.5 rpm/mph & below (Top 4 Gears)

MT-2 ...turn on ratio is 37.6 rpm/mph & below (Top 2 Gears)

MT-1 ...turn on ratio is 27.9 rpm/mph & below (Top 1 Gear)

NOTE: This feature is not used with standard engine ratings, it is only available for Multi-Torque ratings.

Engine Rating Type	Alternatives	Default	VEPS PID
Standard Ratings	Unavailable	Unavailable	FCB1
Multi-Torque Ratings	MT-2, MT-1	MT-4	

ECM Identification Parameters

Vehicle ID

Identification of the vehicle assigned by the OEM or customer and used only for customer reference. Not required by the ECM. Up to seventeen alpha-numeric characters can be entered.

Alternatives	Default	VEPS PID
17 Digits, Available characters are Service Tool Dependent	all zero’s	60

Security Access Parameters

ECM Wireless Communication Enable

This parameter is used to configure the ECM for use with a remote communications device such as a HIGHWAY MASTER® wireless network or a QUALCOMM OmniTRAC® satellite network. Remote communications are used to program parameters and transfer ECM data. This feature can only be enable by a Caterpillar Dealer after the vehicle is built. Factory Level Passwords are required to enable this feature.

Alternative	Default	VEPS PID
Yes	**No**	FC43

Vehicle Speed Parameters

Vehicle Speed Calibration

The ECM uses this value to scale the vehicle speed signal into kilometers per hour (miles per hour). It is programmed in pulses per kilometer (ppkm) or pulses per mile (ppm). This parameter must be programmed or a Diagnostic Code 253-02 Check Customer or System Parameters (56) will occur. This parameter affects cruise control, the ECM speedometer signal, Trip Totals, and can affect PTO and Extended Idle operation.

Minimum	Maximum	Default	VEPS PID
2485 ppkm (4000 ppm)	93226 ppkm (150000 ppm)	8696 ppkm (14000 ppm)	FC5F

Vehicle Speed Limit (VSL)

Top vehicle speed the ECM will permit. The ECM will shut off fuel above this speed. An inexperienced driver may think something is wrong with the engine, because the engine will not fuel above this vehicle speed limit. Vehicle speed limiting allows implementation of a gear fast/run slow truck specification to further improve fuel economy while limiting top vehicle speed.

NOTE: The Driver Incentive Feature can be used to automatically adjust the VSL according to the drivers operating habits.

Minimum	Maximum	Default	VEPS PID
48 km/h (30 MPH)	204 km/h (127 MPH)	**204 km/h (127 MPH)**	61

VSL Protection

Maximum engine rpm when there is an ECM detected vehicle speed signal problem. The ECM limits to this engine rpm when it senses no vehicle speed signal, and the engine is loaded. This is a feature to deter tampering by running without a Vehicle Speed input to the ECM.

NOTE: When this parameter is programmed to TEL rpm, diagnostic codes 84-01 Loss Of Vehicle Speed Signal (31) and 84-10 Vehicle Speed Rate of Change (36) are disabled, and the VSL Protection can be exceeded by disconnecting the Vehicle Speed Sensor.

Minimum	Maximum	Default	VEPS PID
1300 rpm	TEL rpm	**TEL rpm**	66

Tachometer Calibration

The ECM uses this value to scale the engine speed signal into revolutions per minute for a tachometer. It is programmed in pulses per revolution (ppr). Programmable range is from 12.0 to 500.0 in 0.1 ppr increments.

Minimum	Maximum	Default	VEPS PID
12.0 PPR	500.0 PPR	113.0 PPR	C7

Soft Vehicle Speed Limit

This limit operates in conjunction with the Vehicle Speed Limit. It limits the vehicle speed from 4 km/h (2.5 mph) below the programmed Vehicle Speed Limit at full load, to 4 km/h (2.5 mph) above the selected Vehicle Speed Limit at no load.

Alternative	Default	VEPS PID
Yes	**No**	C2

Low Speed Range Axle Ratio

This parameter must be programmed when a Two-Speed Axle On/Off Switch is used by the ECM in order to adjust the vehicle speed calibration. When a two-speed axle is used, the change in gear ratios from the high speed range to the low speed range alters the calibration of the vehicle speed signal, which requires a calibration adjustment to ensure the ECM driven speedometer and ECM stored information correctly reflect the actual vehicle speed. This parameter should be programmed to the low speed range axle ratio. This parameter only requires programming when the Two-Speed Axle Switch parameter is enabled (programmed to J1/P1:7, J1/P1:47, J1/P1:6, or J1/P1:46).

Minimum	Maximum	Default	VEPS PID
1.00	19.99	**1.00**	FC5E

High Speed Range Axle Ratio

This parameter must be programmed when a Two-Speed Axle On/Off Switch is used by the ECM in order to adjust the vehicle speed calibration. When a two-speed axle is used, the change in gear ratios from the high speed range to the low speed range alters the calibration of the vehicle speed signal, which requires a calibration adjustment to ensure the ECM driven speedometer and ECM stored information correctly reflect the actual vehicle speed. This parameter should be programmed to the high speed range axle ratio. This parameter only requires programming when the Two-Speed Axle Switch parameter is enabled (programmed to J1/P1:7, J1/P1:47, J1/P1:6, or J1/P1:46).

Minimum	Maximum	Default	VEPS PID
1.00	9.99	**1.00**	FC5D

Cruise Control Parameters

Low Cruise Control Speed Set Limit

The lowest vehicle speed at which cruise control can be used. Programming this parameter to the maximum value disables cruise control.

Minimum	Maximum	Default	VEPS PID
24 km/h (15 MPH)	204 km/h (127 MPH)	**204 km/h (127 MPH)**	63

High Cruise Control Speed Set Limit

The highest vehicle speed at which cruise control can be set. If a driver attempts to set a vehicle speed higher than this limit, the High Cruise Control Speed Set Limit will be the cruise set speed. If the High Cruise Control Speed Set Limit is programmed to a value greater than the Vehicle Speed Limit, the Cruise Switches can be used to exceed the programmed Vehicle Speed Limit. If the set speed is then terminated using the brake or clutch, the vehicle can be returned to the set speed by toggling the Resume switch.

Minimum	Maximum	Default	VEPS PID
48 km/h (30 MPH)	204 km/h (127 MPH)	**204 km/h (127 MPH)**	62

Engine Retarder Mode

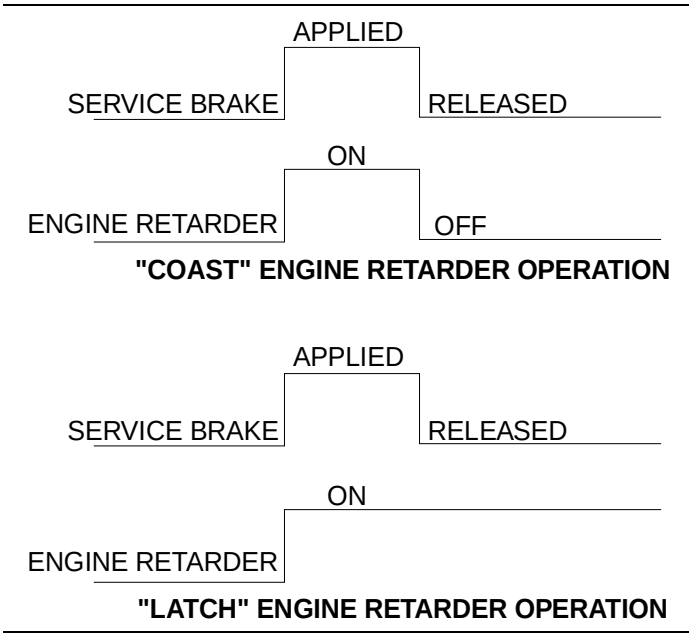


Figure 34 - Coast and Latch Engine Retarder Mode

Determines operation of the Auxiliary Retarder Output and Exhaust Retarder Output while the cruise control On/Off switch is in the ON position, but the engine is not in cruise control. This does not determine, or allow engine retarder operation while the engine is in cruise control.

Allowable options are Coast, Latch or Manual. When programmed to Coast, the retarder is enabled only while the service brakes are being applied. When programmed to Latch, the retarder stays enabled after the service brakes are released. A direct, immediate pressure on the brake pedal latches the retarder ON and it will remain on until the accelerator pedal is depressed.

If programmed to Manual, the retarder operates the same with the cruise control switch ON (but not in Cruise) as when it is OFF.

Refer to “15.1 Engine Retarder Control” on page 71 for more information on Engine Retarder operation.

Alternative	Default	VEPS PID
Coast, Latch	**Manual**	A1

Engine Retarder Minimum VSL Type

Provides two options, a Hard Limit and Soft Limit for the Engine Retarder Minimum Vehicle Speed option. If programmed to Hard Limit, below the programmed Engine Retarder Minimum Vehicle Speed the ECM disables the Retarder. The Soft Limit option allows the Engine Retarder to initiate activation above the programmed Engine Retarder Minimum Vehicle Speed Limit (just like Hard Limit), but allows Retarder operation to **continue** below the programmed minimum Engine Retarder Minimum Vehicle Speed Limit. The Soft Limit will not allow the Engine Retarder to **initiate** operation below the Engine Retarder Minimum Vehicle Speed Limit.

The following diagram illustrates Engine Retarder operation for both Engine Retarder Minimum Vehicle Speed Limit Type options. Engine Retarder parameter is programmed to MANUAL and Engine Retarder Minimum Vehicle Speed parameter is programmed to 30 MPH.

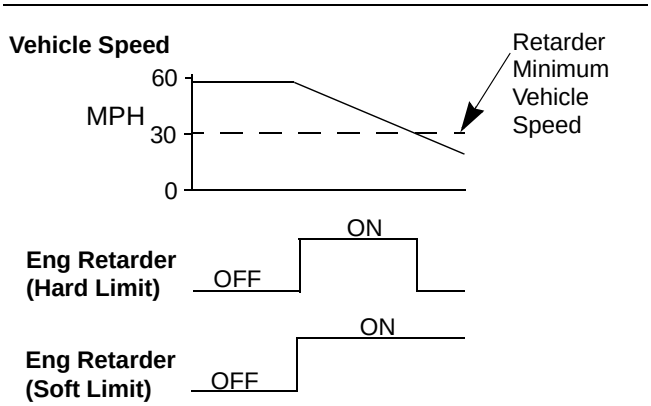


Figure 35 - Limit Type Engine Retarder Operation

If the Engine Retarder Minimum Vehicle Speed is programmed to 0 mph, programming this parameter has no affect on Engine Retarder Operation.

Alternative	Default	VEPS PID
Soft Limit	Hard Limit	FC3C

Engine Retarder Minimum Vehicle Speed

Determines the minimum vehicle speed limit for the engine retarder(s) to turn ON or remain ON. Below this vehicle speed the ECM will not turn ON the retarder unless the vehicle is stationary (vehicle speed = 0). If the vehicle is not moving, or if vehicle speed is 0 mph (because of a lost vehicle speed signal) the retarder can still operate. If programmed to zero the Retarder will operate at all vehicle speeds. This parameter affects both the Engine Retarder and any Auxiliary Retarder such as a BrakeSaver.

Minimum	Maximum	Default	VEPS PID
0 km/h (0 MPH)	204 km/h (127 MPH)	**0 km/h** **(0 MPH)**	FC16

Auto Retarder in Cruise

Auto Retarder in Cruise (0=OFF) determines the kilometers per hour (km/h) or miles per hour (mph) value above the cruise set speed the engine retarder (only the retarder driven through the Engine Harness) will come ON provided the engine retarder switch is ON and the vehicle speed exceeds the cruise set speed. Programming the parameter to zero disables this feature. This parameter applies while the engine is in cruise control.

Actual braking level is limited by the retarder switch settings. For example, the retarder will not come ON if the retarder is switched OFF.

The Medium and High braking levels will come on at the programmed Auto Retarder in Cruise Increment (see below) above the programmed Auto Retarder in Cruise value.

If SoftCruise Control is programmed to YES, the retarder will not come on until the vehicle speed is 5 km/h (3 mph) above the cruise set speed. An Electronic Service Tool will change an attempt to program 2 or 3 km/h (1 or 2 mph) for this parameter to 5 km/h (3 mph) if SoftCruise is programmed to YES.

Minimum	Maximum	Default	VEPS PID
0 km/h (0 MPH)	16 km/h (10 MPH)	**0 km/h** **(0 MPH)**	FC00

Auto Retarder in Cruise Increment

Requires the Auto Retarder in Cruise parameter programmed above 0 (0=OFF). Auto Retarder in Cruise Increment determines the kilometers per hour (km/h) or miles per hour (mph) increment when the Medium and High Engine Retarder levels will activate. Programming the parameter to zero will allow the retarder to come ON in the High mode when the programmed Auto Retarder in Cruise speed (above the cruise set speed) is reached.

This parameter applies while the engine is in cruise control. Actual braking level is limited by the retarder switch settings. For example, the retarder will not come ON if the retarder is switched OFF.

Minimum	Maximum	Default	VEPS PID
0 km/h **(0 MPH)**	8 km/h (5 MPH)	3 km/h (2 MPH)	FC1B

Cruise/Idle/PTO Switch Configuration

The configuration defines the function of Set/Resume Switch for ACCEL and DECEL modes. This parameter applies to cruise control, idle, and PTO modes.

Alternative	Default	VEPS PID
Set/Decel - Res/Accel	Set/Accel - Res/Decel	3C

Soft Cruise Control

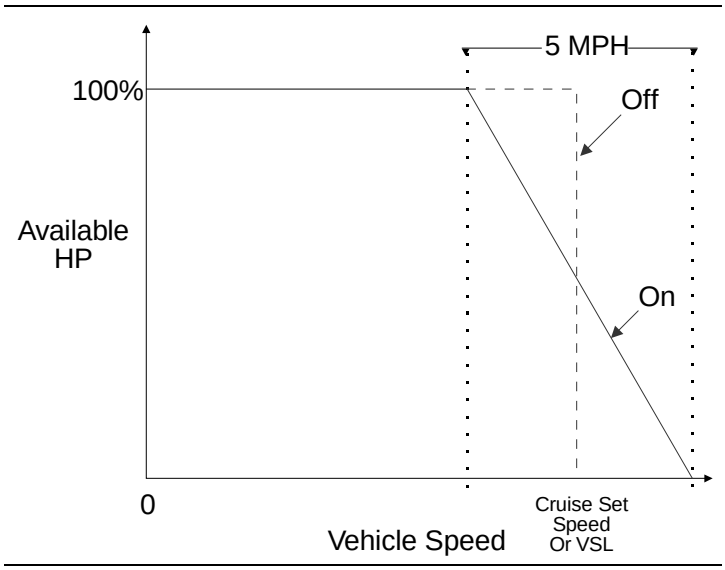


Figure 36 - SoftCruise Control and Soft Vehicle Speed Limit

Soft Cruise Control provides a 8 km/h (5 mph) operating range around the cruise control set speed to provide a smoother cruise control. It controls the cruise speed from 4 km/h (2.5 mph) below the set vehicle speed at full load to 4 km/h (2.5 mph) above the set vehicle speed at no load.

Alternative	Default	VEPS PID
No	Yes	C5

Idle Parameters

Idle Vehicle Speed Limit

Maximum vehicle speed for setting or maintaining a set engine rpm in idle mode. Idle mode is entered if the engine rpm is set using the cruise control On/Off switch along with Set/Resume. If the vehicle speed signal exceeds this value, the engine will not maintain the set engine rpm.

Minimum	Maximum	Default	VEPS PID
2 km/h (1 mph)	24 km/h (15 mph)	2 km/h (1 mph)	64

Idle RPM Limit

Maximum engine rpm in idle mode. Idle mode occurs if the engine rpm is set using the cruise control On/Off switch and the Set/Resume switch. The actual high limit of this parameter is determined by the programmed Top Engine Limit. The lower limit is determined by the programmed Low Idle Engine RPM.

Programming this parameter to 600 rpm will prevent the engine from idling at a constant rpm above the programmed Low Idle rpm.

Minimum	Maximum	Default	VEPS PID
600 rpm	TEL rpm	**TEL** rpm	65

Idle/PTO RPM Ramp Rate

This parameter determines engine rpm rate of increase/decrease. This parameter determines Accel, Decel, and Resume Idle or PTO Engine rpm rates of increase/decrease. The parameter can be set to a value between 5 rpm and 1000 rpm inclusively in one rpm increments.

NOTE: The parameter applies to both idle control (rpm set using cruise control On/Off switch and Set/Resume) and PTO control (rpm set using PTO On/Off switch and Set/Resume).

Minimum	Maximum	Default	VEPS PID
5 rpm/sec	1000 rpm/sec	50 rpm/sec	C4

Idle/PTO Bump RPM

Determines the rpm increment/decrement when the Accel/Decel switches are briefly toggled. It also applies to both dedicated PTO and idle. If a PTO Engine RPM Set Speed has been programmed the Idle/PTO Bump RPM applies only to engine rpm control initiated using the Cruise Control On/Off circuit not the PTO On/Off circuit.

Minimum	Maximum	Default	VEPS PID
5 rpm	500 rpm	20 rpm	F1

Dedicated PTO Parameters

PTO Configuration

Determines the features available and inputs used for Dedicated PTO applications. OFF (default) indicates the application does not use PTO. The remaining PTO programmable options require a PTO On/Off circuit connected to ECM Input #1. A PTO Switch On Lamp must also be connected to Output #1 (ECM J1/P1, terminal-30).

If programmed to Cab Switches the ECM will use the Cab Set (J1/P1, terminal-35) and Resume (J1/P1, terminal-44) switch inputs for PTO control and Cruise Control.

If programmed to Remote Switches the ECM will monitor programmed inputs such as the Remote Set and Remote Resume inputs. Inputs from the cab controls (brake, clutch, accelerator, cruise switches) will be ignored when the PTO On/Off circuit is ON.

If programmed to Remote Throttle, the ECM will monitor J1/P1, terminal-68 for the remote accelerator pedal. The ECM will monitor programmed inputs and ignore all cab controls when the PTO On/Off circuit is ON.

Alternative	Default	VEPS PID
Cab Switches, Remote Switches, Remote Throttle	**Off**	F3

PTO Top Engine Limit

The top engine limit available using a PTO On/Off circuit connected to Input # 1 of ECM Connector J1/P1. This parameter is limited by the programmed Top Engine Limit (TEL) parameter.

NOTE: PTO Configuration must be programmed to Cab Switches, Remote Switches, or Remote Throttle before this parameter can be programmed.

Minimum	Maximum	Default	VEPS PID
600	TEL rpm	**TEL** rpm	F0

PTO Engine RPM Set Speed

The engine rpm the ECM will control the engine to when the PTO On/Off circuit is turned ON (if PTO to Set Speed is programmed to the “Yes” option) or, after PTO is turned ON and the Set Switch is toggled (if PTO to Set Speed is programmed to the “NO” option).

If the PTO to Set Speed parameter is programmed to YES, the engine will automatically proceed to this speed whenever the PTO On/Off circuit is turned ON and the PTO Engine RPM Set Speed Input A & B Switches (if used) are OFF.

NOTE: PTO Configuration must be programmed to Cab Switches or Remote Switches for this parameter to function, it is not available for the Remote Throttle configuration.

This parameter must be programmed higher than the programmed Low Idle. If programmed to a higher value than the PTO Top Engine Limit, the Set Speed will be limited by the lower PTO Top Engine Limit.

For one rpm set speed operation above low idle, (low idle and PTO Engine RPM Set Speed) the PTO Top Engine Limit should be programmed to the same rpm as the PTO Engine RPM Set Speed.

For two rpm set speeds above low idle, program this parameter to some intermediate value between the low idle and the PTO Top Engine Limit. Place the PTO On/Off switch in the ON position. Toggle the Set switch once to cause rpm to advance from the Low Idle speed to the PTO Engine RPM Set Speed. Toggle the Set Switch again, and the engine advances to the PTO Top Engine Limit speed. Toggling the Resume Switch decreases the engine rpm to the previous set speed.

Minimum	Maximum	Default	VEPS PID
Low Idle rpm	PTO TEL rpm	**0 rpm**	F2

PTO Engine RPM Set Speed A

The engine rpm the ECM will control the engine to when the PTO On/Off circuit is ON and the PTO Engine RPM Set Speed Input A switch is ON. The RPM can be programmed to operate from Low Idle up to the PTO Top Engine Limit RPM. While operating at this set speed, all other speed control inputs are ignored (Cab and Remote Throttle, and the Set/Accel and Resume/Decel switches). This feature can also be used in conjunction with (and will override) the PTO to Set Speed and PTO Engine RPM Set Speed B features for multiple speed PTO operation.

Any time the PTO On/Off circuit is ON and the PTO Engine RPM Set Speed Input A switch is ON, the engine will only operate at this programmed speed, unless a condition is present to kickout PTO operation (brake or clutch pedal depressed, PTO Vehicle Speed Limit exceeded, etc.). In the event that the PTO operation is kicked out, the engine will return to low idle.

NOTE: The PTO Configuration parameter must be programmed to Cab Switches, Remote Switches or Remote Throttle and the PTO Engine RPM Set Speed Input A parameter must be programmed to a dedicated switch input (J1/P1:6, J1/P1:46, J1/P1:58, or J1/P1:60) for this feature to function.

Minimum	Maximum	Default	VEPS PID
Low Idle rpm	PTO TEL rpm	**0 rpm**	FC8B

PTO Engine RPM Set Speed B

The engine rpm the ECM will control the engine to when the PTO On/Off circuit is ON, the PTO Engine RPM Set Speed Input B switch is ON and the PTO Engine RPM Set Speed A switch if OFF. The RPM can be programmed to operate from Low Idle up to the PTO Top Engine Limit RPM. While operating at this set speed, all other speed control inputs are ignored (Cab and Remote Throttle, and the Set/Accel and Resume/Decel switches) except PTO Engine RPM Set Speed A. This feature can also be used in conjunction with (and will override) the PTO to Set Speed feature for multiple speed PTO operation.

Any time the PTO On/Off circuit is ON, the PTO Engine RPM Set Speed Input B switch is ON and the PTO Engine RPM Set Speed A switch if OFF, the engine will only operate at this programmed speed, unless a condition is present to kickout PTO operation (brake or clutch pedal depressed, PTO Vehicle Speed Limit exceeded, etc.). In the event that the PTO operation is kicked out, the engine will return to low idle.

NOTE: The PTO Configuration parameter must be programmed to Cab Switches, Remote Switches or Remote Throttle and the PTO Engine RPM Set Speed Input B parameter must be programmed to a dedicated switch input (J1/P1:6, J1/P1:46, J1/P1:58, or J1/P1:60) for this feature to function.

Minimum	Maximum	Default	VEPS PID
Low Idle rpm	PTO TEL rpm	**0 rpm**	FC8C

PTO to Set Speed

This parameter causes the ECM to proceed to the programmed PTO Engine RPM Set Speed when the PTO On/Off switch is ON. PTO Configuration must be programmed to Cab Switches or Remote Switches before this parameter can be programmed.

NOTE: This parameter is not available for PTO Configuration Remote Throttle.

Alternative	Default	VEPS PID
Yes	**No**	F6

PTO Cab Controls RPM Limit

Determines the engine rpm limit of the Cab Accelerator Pedal Position Sensor and Cab Set/Resume Switch when PTO Configuration is programmed to Cab Switches and the PTO On/Off circuit is ON. This parameter is intended to prevent engine overspeed while using dedicated PTO.

- If programmed to Low Idle, the Cab Controls are ignored.
- If programmed to TEL, the engine will operate to the programmed Top Engine Limit.
- If programmed to PTO TEL, the engine will operate to the programmed PTO Top Engine Limit.

NOTE: PTO Configuration must be programmed to Cab Switches for this parameter to take effect. If PTO Configuration is programmed to Remote Switches or Remote Throttle, the ECM will always ignore the Cab Controls when the PTO On/Off circuit is ON.

Alternative	Default	VEPS PID
Low Idle, TEL, PTO TEL	TEL	F4

PTO Vehicle Speed Limit

Maximum vehicle speed for setting or maintaining a set engine rpm in PTO mode. PTO mode is entered if the PTO On/Off switch is ON (uses Input #1). If the vehicle speed signal exceeds this value, the engine will not maintain the set engine rpm.

Minimum	Maximum	Default	VEPS PID
2 km/h (1 mph)	**204 km/h** **(127 mph)**	2 km/h (1 mph)	FC17

Torque Limit

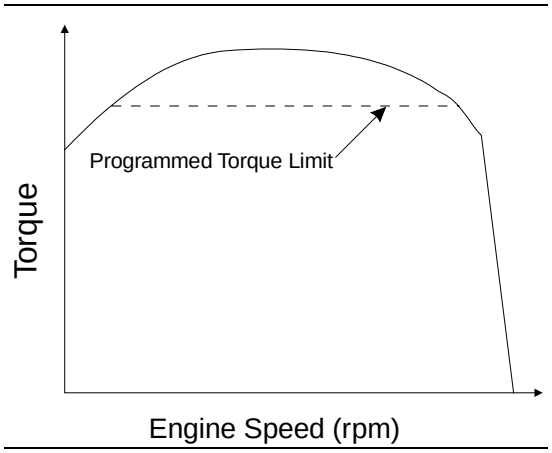


Figure 37 - Torque Limit Operation

Torque limit of the engine applies when the Torque Limit Switch circuit is ON, and the vehicle speed is less than the programmed Idle/PTO vehicle speed limit.

The maximum value is the Rated Torque of the engine. Programmable to N•m (lb-ft) of torque. Programming a value higher than the Rated Torque is limited by the ECM to Rated Torque. The torque limit is indicated by the dashed line in Figure 37.

Minimum	Maximum	Default	VEPS PID
270 N•m (200 lb-ft)	3400 N•m (2500 lb-ft)	**3400 N•m** **(2500 lb-ft)**	F7

PTO Shutdown Time

Time (in minutes) the engine will operate with the PTO On/Off circuit ON with no vehicle speed before shutting down. The timer will only count with no vehicle speed and the PTO On/Off circuit ON. The PTO Shutdown Timer will not begin counting if the engine is in Cold Mode. This parameter requires PTO Configuration programmed to Cab Switches, Remote Switches, or Remote Throttle for the timer to function.

NOTE: This feature does not shut down vehicle power, the ECM and vehicle remain powered.

Minimum	Maximum	Default	VEPS PID
3 minutes	1440 minutes	**0 minutes**	FC14

PTO Shutdown Timer Maximum RPM

This parameter can be used to reset of the PTO Shutdown Timer if engine speed goes above the programmed PTO Shutdown Timer Maximum RPM. Programming this parameter to 2120 rpm disables this feature and will not allow the PTO Shutdown Timer to be overridden by increasing engine rpm. If programmed to a value below 2120 rpm and the PTO Shutdown Timer is used, the timer will be reset whenever engine RPM exceeds the programmed value.

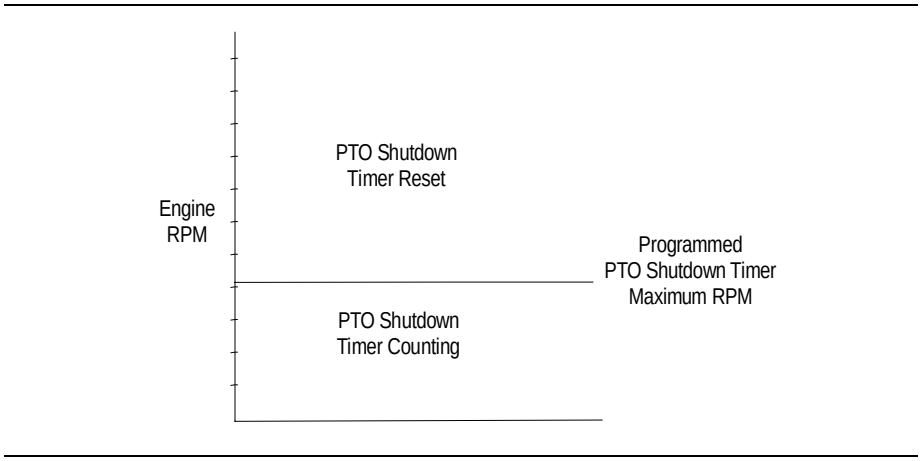


Figure 38 - PTO Shutdown Timer Maximum RPM Graph

Minimum	Maximum	Default	VEPS PID
600 rpm	2120 rpm	**2120 rpm**	FCB0

PTO Activates Cooling Fan

Requires use of the ECM cooling fan circuit. The ECM will signal the cooling fan to continuous operation when the PTO On/Off circuit is ON to reduce changes in load while being used for dedicated PTO applications. Setting this parameter to Normal (default) indicates the fan will operate the same (dependent upon coolant temperature, etc.) with the PTO On/Off circuit ON or OFF. PTO Configuration must be programmed to Cab Switches, Remote Switches, or Remote Throttle before this parameter can be programmed. Fan Control Type must also be programmed to On-Off or Three Speed Fan.

Alternatives	Default	VEPS PID
Continuous	**Normal**	F5

Engine/Gear Parameters

Lower Gears Engine RPM Limit

The engine will accelerate at a slower rate when this limit is exceeded under normal driving conditions. This is to encourage the driver to shift to the next highest gear. This parameter should remain at the factory default value when using an Automatic or Autoshift transmission, with the exception of the Eaton Top 2.

Minimum	Maximum	Default	VEPS PID
1100 rpm	TEL rpm	**TEL** rpm	6C

Lower Gears Turn Off Speed

Vehicle Speed where “Lower Gears Engine RPM Limit” is shut off. This must be matched with “Lower Gears Engine RPM Limit” to the specific drive train for best performance.This parameter should remain at the factory default value when using an Automatic or Autoshift transmission, with the exception of the Eaton Top 2.

Minimum	Maximum	Default	VEPS PID
5 km/h (3 mph)	48 km/h (30 mph)	5 km/h (3 mph)	69

Intermediate Gears Engine RPM Limit

Similar to “Lower Gears Engine RPM Limit”. The engine will accelerate at a slower rate when this limit is exceeded under normal driving conditions. Typically programmed to slightly higher rpm than the Lower Gears Engine RPM Limit. This parameter should remain at the factory default value when using an Automatic or Autoshift transmission, with the exception of the Eaton Top 2.

Minimum	Maximum	Default	VEPS PID
1100 rpm	TEL rpm	**TEL** rpm	6D

Intermediate Gears Turn Off Speed

Similar to “Lower Gears Turn Off Speed”. Typically programmed to a slightly higher vehicle speed than Low Gears Turn Off Speed. This parameter should remain at the factory default value when using an Automatic or Autoshift transmission, with the exception of the Eaton Top 2.

Minimum	Maximum	Default	VEPS PID
8 km/h (5 mph)	80 km/h (50 mph)	8 km/h (5 mph)	6A

Gear Down Protection RPM Limit

Engine RPM Limit when vehicle speed is above “Gear Down Protection Turn On Speed. This is a “hard” limit. The ECM will not allow fuel to the engine above this limit. This is to encourage the driver to shift into overdrive or top gear. This parameter should remain at the factory default value when using an Automatic or Autoshift transmission, with the exception of the Eaton Top 2.

Minimum	Maximum	Default	VEPS PID
1300 rpm	TEL rpm	**TEL** rpm	6E

Gear Down Protection Turn On Speed

Vehicle Speed where “Gear Down Protection RPM Limit” is ON. This must be matched to the specific drive train for best performance. Above this vehicle speed limit the engine rpm will be limited by the Gear Down Protection RPM Limit.

Minimum	Maximum	Default	VEPS PID
48 km/h (30 mph)	204 km/h (127 mph)	**204 km/h (127 mph)**	6B

Top Engine Limit (TEL)

Maximum engine rpm when the engine is under load. This parameter no longer provide a selectable range. The TEL rpm is fixed at 2120 rpm.

Minimum	Maximum	Default	VEPS PID
2120 rpm	2120 rpm	**2120***	67

*Excludes special ratings that offer 2150 Top Engine Limit.

Top Engine Limit with Droop

This parameter no longer provides the droop option. No is the fixed parameter value.

Maximum	Default	VEPS PID
No	**No**	C1

Low Idle Engine RPM

Minimum engine rpm.

Minimum	Maximum	Default	VEPS PID
600 rpm	750 rpm	600 rpm	6F

Transmission Style

Indicates to the ECM the type of transmission configuration installed in the vehicle. It is used by the ECM to determine how to read inputs (brake switch #2, clutch, and neutral switches).

If an automatic transmission is installed, this parameter should be programmed to Automatic Option 1, Automatic Option 2, Automatic Option 3, or Automatic Option 4.

The Manual selection requires a clutch pedal position switch connected to ECM Connector J1/P1, terminal 24. The transmission selections with a neutral switch require a transmission neutral switch connected to ECM Connector J1/P1, terminal-62 (Input #12).The transmission selections with two brake switches require a second brake switch connected to ECM Connector J1/P1 terminal-64 (Input #13). Refer to “ Transmission Style Parameter Switch Input Table” on page 85 for additional information.

The Eaton Top 2 transmission is a manual transmission and requires a clutch switch. The ECM operates two outputs to control shifting between the top two gears of an Eaton Top 2 transmission. A total of four parameters must be programmed for the system to operate correctly.

Alternative	Default	VEPS PID
Automatic Option 1, Automatic Option 2, Automatic Option 3, Automatic Option 4, Eaton Top 2	Manual	7B

Eaton Top 2 Override with Cruise Switch

If this parameter is programmed to YES the Cruise Control On/Off switch can be used to disable Top 2 mode. Turning the Cruise Control On/Off switch to the OFF position when the transmission is not in Top 2 mode will disable Top 2 mode (manual operation only). Turning the Cruise Control On/Off Switch to the ON position will enable the Top 2 mode and allow for automatic shifting in the Top 2 gears. When operating in one of the Top 2 gears and Top 2 mode is enabled, switching the Cruise Control On/Off switch to the OFF position will place the transmission in Hold mode (will not shift out of currently selected gear). Returning the switch to the ON position will return to Top 2 mode. Depressing the Clutch while in Hold mode will result in Manual mode (Top 2 disabled).

Alternative	Default	VEPS PID
Yes	**No**	FC89

Top Gear Ratio

Identifies the highest gear ratio for an Eaton Top 2 Transmission. For example, 10th gear for an Eaton Super 10 Top 2 transmission is the Top Gear. Programmable range is 0.000 to 3.750 in 0.001 increments. Default is 0.000. Refer to “Eaton Top 2 Transmission Gear Ratios Table” on page 129 for programmable values for each Eaton Top 2 transmission.

Note: This parameter must be precisely programmed to three decimal places to ensure proper operation of the Eaton Top 2 and Caterpillar engine drivetrain in the top two gears.

Minimum	Maximum	Default	VEPS PID
0.000	3.750	**0.000**	FC3D

Top Gear Minus One Ratio

Identifies the next to highest gear ratio for an Eaton Top 2 Transmission. For example, 9th gear for an Eaton Super 10 Top 2 transmission is Top Gear Minus One. Programmable range is 0.000 to 3.750 in 0.001 increments. Default is 0.000. Refer to “Eaton Top 2 Transmission Gear Ratios Table” on page 129 for programmable values for each Eaton Top 2 transmission.

Note: This parameter must be precisely programmed to three decimal places to ensure proper operation of the Eaton Top 2 and Caterpillar engine drivetrain in the top two gears.

Minimum	Maximum	Default	VEPS PID
0.000	3.750	**0.000**	FC3E

Top Gear Minus Two Ratio

Identifies the second to highest gear ratio for an Eaton Top 2 Transmission. For example, 8th gear for an Eaton Super 10 Top 2 transmission is Top Gear Minus Two. Programmable range is 0.000 to 3.750 in 0.001 increments. Default is 0.000. Refer to “Eaton Top 2 Transmission Gear Ratios Table” on page 129 for programmable values for each Eaton Top 2 transmission.

Note: This parameter must be precisely programmed to three decimal places to ensure proper operation of the Eaton Top 2 and Caterpillar engine drivetrain in the top two gears.

Minimum	Maximum	Default	VEPS PID
0.000	3.750	**0.000**	FC3F

Eaton Top 2 Transmission Gear Ratios Table

Transmission Model	Top Gear Minus Two Ratio	Top Gear Minus One Ratio	Top Gear Ratio
RTLO-XX610B-T2	1.352	1.000	0.741
RTLO-XX710B-T2	1.825	1.351	1.000
RTLO-XX713A-T2	1.000	0.856	0.730
RTLO-XX718B-T2	1.000	0.856	0.730

NOTE: XX appearing in Transmission Model number refers to (x) 100 = Nominal Torque Capacity. For example, RTLO-14613A has a Nominal Torque Capacity of 14 (x) 100 or 1400 lb ft.

Transmission model designation and other transmission identification information are stamped on the transmission tag. The tag is located on the lower left side near the front of the transmission.

Timer Parameters

Idle Shutdown Time

Time (in minutes) that engine will idle before shutting down. Engine will only shut down if the ECM senses low engine load and no vehicle speed. The Idle Shutdown Timer will not begin counting if the engine is in Cold Mode. If this parameter is programmed to zero, this feature is disabled and the engine will idle until the ignition key switch is in the OFF position.

NOTE: This feature does not shut down vehicle power. The ECM and vehicle remain powered.

Minimum	Maximum	Default	VEPS PID
3 minutes	1440 minutes	**0 minutes**	FC13

Idle Shutdown Timer Maximum RPM

This parameter can be used to reset of the Idle Shutdown Timer if engine speed goes above the programmed Idle Shutdown Timer Maximum RPM. Programming this parameter to 2120 rpm disables this feature and will not allow the Idle Shutdown Timer to be overridden by increasing engine rpm. If programmed to a value below 2120 rpm and the PTO Shutdown Timer is used, the timer will be reset whenever engine RPM exceeds the programmed value.

Minimum	Maximum	Default	VEPS PID
600 rpm	2120 rpm	**2120 rpm**	FCAF

Allow Idle Shutdown Override

Determines if the clutch or service brake can be used to override the idle shutdown timer during the driver alert (in the last 90 seconds when the Check Engine Lamp begins flashing). Requires Idle Shutdown Time (0=OFF) to be programmed to 3 or more minutes to take affect This parameter also provides the Outside Temperature Based option to Allow Idle Shutdown Override or the J1587 Outside Temperature Based to Allow Idle Shutdown Override.

If programmed to Outside Temperature Based or J1587 Outside Temperature Based, depressing the clutch or service brake in the last 90 seconds when the Check Engine Lamp begins flashing will override the timer (the engine will not shutdown) if the outside temperature is below the programmed Minimum Idle Shutdown Outside Temperature or above the Maximum Idle Shutdown Outside Temperature.

If the outside temperature is in between the Minimum Idle Shutdown Outside Temperature and the Maximum Idle Shutdown Outside Temperature the timer is not overridden and the engine will shutdown. If the Outside Temperature Based option is programmed, an Air Temperature Sensor must be installed to measure the outside temperature. If the sensor is not installed a 171-03 Outside Air Temperature Sensor Open Circuit diagnostic code will be active. If the J1587 Outside Temperature Based option is programmed and an active 171-11 No Ambient Air Temperature Data diagnostic code exists, the idle shutdown timer will be disabled.

Alternatives	Default	VEPS PID
No, Outside Temperature Based, J1587 Outside Temperature Based	Yes	4F

Minimum Idle Shutdown Outside Temp

Determines the lower outside temperature limit if the Allow Idle Shutdown Override parameter is programmed to Outside Temperature Based or J1587 Temperature Based.

Minimum	Maximum	Default	VEPS PID
-40°C (-40°F)	49°C (120°F)	49°C (120°F)	FC11

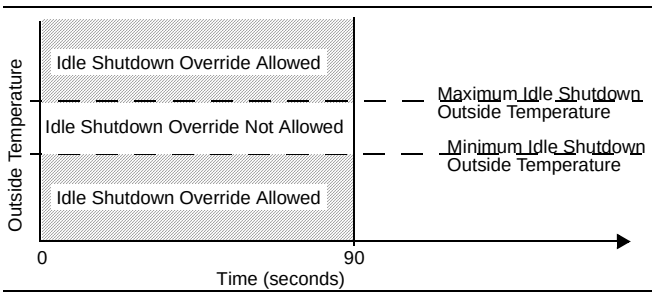


Illustration 39 - Allow Idle Shutdown Override Programmed to Outside Temperature Based or J1587 Temperature Based

Maximum Idle Shutdown Outside Temp

Determines the upper outside temperature limit if the Allow Idle Shutdown Override parameter is programmed to Outside Temperature Based or J1587 Temperature Based. “Illustration 39 - Allow Idle Shutdown Override Programmed to Outside Temperature Based or J1587 Temperature Based” on page 130 indicates the Idle Shutdown Override is allowed only during the final 90 seconds of timer counting with the outside temperature below the Minimum Idle Shutdown Outside Temperature or above the Maximum Idle Shutdown Outside Temperature.

Minimum	Maximum	Default	VEPS PID
-40°C (-40°F)	49°C (120°F)	49°C (120°F)	FC12

A/C Switch Fan On-Time

Input #11 to the ECM can be used for connection of a normally closed high pressure A/C switch. The ECM has a timer built in to prevent excessive cycling of the cooling fan clutch due to successive cycling of the A/C switch input. Programming this parameter to 0 disables the function. Programming depends upon refigerant and A/C system design as well use of the input. Program the timer to 1 second for connection of this input to another system also providing a time delay. This feature requires Fan Control Type programmed to On-Off or Three Speed Fan.

Minimum	Maximum	Default	VEPS PID
1 seconds	600 seconds	**0 seconds**	C0

Fan with Engine Retarder in High Mode

Fan with Engine Retarder in High Mode determines if the Cooling Fan will come ON when the Engine Brake has been active for at least two seconds. This feature requires the Fan Control Type programmed to On-Off or Three Speed Fan with an On-Off or Three Speed fan installed in order to function.

Alternatives	Default	VEPS PID
No	Yes	4E

Engine Retarder Delay

Engine Retarder Delay parameter provides a programmable delay after conditions to turn the retarder or brake ON are met.

Minimum	Maximum	Default	VEPS PID
0 seconds	3.0 seconds	**0 seconds**	FC3B

Smart Idle Parameters

Battery Monitor and Engine Control Voltage

This parameter is used to determine the voltage trip point below which the Battery Monitor and Engine Speed Control System will automatically elevate engine idle in order to maintain ideal battery system voltage. This feature is used to promote additional battery life. The engine idle will only be increased if the vehicle is stopped and the transmission is out of gear. If these conditions are not met, the engine idle will not be adjusted. This feature will not function when the engine is operating in dedicated PTO mode (PTO On/Off switch in the ON position).

The recommended setting is 12.2 Volts for a 12 Volt system, and 24.5 Volts for a 24 Volt system.

NOTE: This feature requires the installation of a Neutral Switch on J1/P1 terminal-62 (Input #12). Engine speed will only be elevated when the transmission is in Neutral. Refer to “13.13 Transmission Neutral Switch” on page 52 for details.

Minimum	Maximum	Default	VEPS PID
0 volts	25.5 Volts	**0 Volts**	FC8D

Engine Monitoring Parameters

Engine Monitoring Mode

Determines the level of action taken by the ECM in response to a potential engine damaging condition. The ECM reads the Caterpillar Coolant Temperature Sensor, and the OEM installed Coolant Level Sensor (if programmed).

Alternative	Default	VEPS PID
Off, Derate, Shutdown	Warning	7F

Engine Monitoring Lamps

This parameter determines the lamp requirements for the Engine Monitoring System. If programmed to the Warning Lamp option, J1/P1 terminal-29 is available for connection of a red Warning Lamp. The Warning Lamp is used to alert the operator that an engine problem is occurring, and indicate when the engine is being derated or shutdown is impending.

If programmed to Option 1, up to three discrete lamp outputs are available to indicate specific engine problems. Option 1 configures J1/P1 terminal-29 for connection of a Low Oil Pressure Warning Lamp and J1/P1 terminal-31 for connection of a High Coolant Temperature Warning Lamp. If the Coolant Level Sensor parameter is programmed to the 4-Pin option, then J1/P1 terminal-30 will also be available for connection of a Low Coolant Level Warning Lamp. If the Coolant Level Sensor parameter is programmed to OFF, then J1/P1 terminal-30 can be used to connect a PTO Switch On Lamp.

Alternative	Default	VEPS PID
Option 1	Warning Lamp	FCD2

Note: This Engine Monitoring System must be programmed to Warning, Derate or Shutdown in order for the Warning Lamp(s) to function.

Coolant Level Sensor

Determines if the ECM monitors the Coolant Level Sensor inputs. This feature requires Engine Monitoring Mode programmed to Warning, Derate, or Shutdown

Alternatives	Default	VEPS PID
4-Pin	**No**	7E

Maintenance Parameters

Maintenance Indicator Mode

The ECM records data related to vehicle maintenance. If Distance is selected (Manual - Distance or Automatic - Distance), then all maintenance indications (PM1, PM2, Coolant Flush/Fill) on the service tool will be displayed in Distance.

If Hours is selected (Manual - Hours or Automatic - Hours), then all maintenance indications (PM1, PM2, Coolant Flush/Fill) on the service tool will be in Hours. The ECM provides PM1 maintenance interval and last maintenance information.

Alternative	Default	VEPS PID
Man - Distance, Man- Hour, Auto - Distance, Auto - Hour	**Off**	C9

PM1 Interval (for Manual Maintenance Indicator Mode)
PM1 Interval allows a user-specified PM1 maintenance interval. This parameter (PM1 Interval) must be programmed only if Maintenance Indicator Mode is programmed to Manual - Distance or Manual - Hours.

Manual - Distance			
Minimum	**Maximum**	**Default**	**VEPS PID**
8050 km (5000 miles)	56325 km (35000 miles)	24140 km (15000 miles)	C8 CA

Manual - Hours			
Minimum	**Maximum**	**Default**	**VEPS PID**
100	750	300	C8 CB

Engine Oil Capacity (for Automatic Maintenance Indicator Mode)
PM1 Interval can be determined by the ECM based on fuel usage. This parameter must be programmed only if Maintenance Indicator Mode is programmed to Automatic - Distance or Automatic - Hours. Sump Capacity influences the Maintenance Interval.

Minimum	Maximum	Default	VEPS PID
19 liters (20 quarts)	57 liters (60 quarts)	see table below	C8 CC

Engine Model	Default
C-10, C-12	34 liters (36 quarts)
C-15, C-16	38 liters (40 quarts)
C-15, C-16 w/Rear Sump BrakeSaver	38 liters (40 quarts)
C-15, C-16 w/Front Sump BrakeSaver	38 liters* (40 quarts)

*C-15 & C-16 w/Front Sump BrakeSaver engines should be programmed to 49 liters (52 quarts).

Trip Parameters

Fuel Correction Factor

The fuel correction factor is available to fine tune all fuel data stored **in the future** by the ECM. Caterpillar recommends this factor be changed only after a significant operating interval with a comparison of actual tank fuel economy compared to ECM recorded fuel economy. The operating interval should also reflect a typical route. The Factor is a percentage, programmable in 0.5 percent increments.

Minimum	Maximum	Default	VEPS PID
-63.5	+63.5	**0**	D5

- Calculating Fuel Correction Factor

The following formula should be used to determine the new Fuel Correction Factor (NEW FCF).

$$\text{error} = \left(\frac{ECM - TANK}{TANK}\right)$$

$$\text{new fcf} = ((100 + \text{old fcf})\text{error}) + \text{old fcf}$$

Where OLD FCF is the Fuel Correction Factor currently in ECM, TANK is the actual fuel economy, and ECM is the fuel economy indicated in the ECM Trip Data.

Example

The Actual TANK fuel economy is determined to be 7.1 mpg, but the ECM Trip Data economy is 7.0 mpg over the same distance with an OLD FCF of -2.5.

$$\text{error} = \left(\frac{7.0 - 7.1}{7.1}\right) = -0.0141$$

$$\text{new fcf} = ((100 + \text{-}2.5) \times [-0.0141]) + (-2.5) = \text{-}3.9$$

-3.9 rounded off to the nearest 0.5, NEW FCF = -4.0

The following parameters (Change Fuel Correction Factor, PM1 Reset, and Fleet Trip Reset) establish security access for the Caterpillar Driver Information Display. **These parameters require a Caterpillar Driver Information Display for access.**

Dash - Change Fuel Correction Factor

Allows the driver to adjust the Fuel Correction Factor. An owner-operator would want driver access to this information, but a fleet operation might not.

Alternative	Default	VEPS PID
Yes	**No**	E0

Dash - PM1 Reset

Determines access for the driver to reset the PM1 Maintenance, when performed. Maintenance Indicator Mode cannot be programmed to OFF for the PM1 Reset parameter to take effect.

Alternative	Default	VEPS PID
Yes	**No**	E0

Dash - Fleet Trip Reset

Fleet Trip Reset sets access for the driver to reset the Fleet Trip Information

Alternative	Default	VEPS PID
Yes	**No**	E0

Dash - State Selection

Program to NO to disable this function of the Cat ID. The Cat ID will not show state selection as an option to the driver. If programmed to Yes (default) the Cat ID will provide the State Selection feature.

Programming this parameter to NO eliminates state crossing selection and therefore storage of State tagged trip data.

Alternative	Default	VEPS PID
No	Yes	E0

Theft Deterrent System Control

This feature can prevents the engine from starting or prevent vehicle use until the correct password has been entered via the CAT ID dash display. A Theft Deterrent Password must be programmed to use this feature.

If programmed to the YES option, the operator must first enter the password before the engine shuts off in order to enable the system, preventing engine starting without reentering the password on the next attempted start.

If programmed to the Auto-Enable option, the system will automatically enable each time the engine is shut down. The operator must then enter the password in order to start the engine.

The Secure Idle mode can be entered by bringing the engine to an idle condition and entering the password. If the engine is not shut down, it will only run at low idle until the password is reentered.

Alternative	Default	VEPS PID
Yes, Auto-Enable	**No**	FC08

Theft Deterrent Password

The password required by the ECM to disable the Theft Deterrent feature. The characters must all be upper case.

Alternatives	Default	VEPS PID
Four Characters, A-Z & 0-9	0000	FC09

Quick Stop Rate

Determines the rate of vehicle speed change the ECM uses to record a Quick Stop Event Code and Quick Stop Snapshot. Programmable from 5-24 km/h/s (3-15 mph/s) (0 = default = OFF). Each Quick Stop Snapshot contains 60 frames of information; frame 45 is the Quick Stop occurrence, 44 frames before, 15 frames following the code. Each frame is separated by 1.0 second.

ECM Snapshot Frame Data

Engine rpm	Vehicle Speed
Throttle Position	Cruise Status
Clutch Switch	Brake Switch

The most recent Quick Stop Snapshot is stored in the ECM memory. Each time another Quick Stop occurs the ECM replaces the old Snapshot with the new one. The ECM also logs a diagnostic event code (maximum of 255 occurrences stored) for each Quick Stop Occurrence.

Alternatives	Default	VEPS PID
5-24 km/h/s (3-15 mph/s)	**0 km/h/s** **0 mph/s**	FC0C

NOTE: Programming the Quick Stop Rate too low will cause an excessive number of Quick Stop Event Codes. The vehicle will be able to stop much more quickly without a load or trailer than with a heavy load. If too many Quick Stop Event Codes are being logged, the Quick Stop Rate should be increased to better detect the exceptions when they occur.

Vehicle Activity Report

Minimum Idle Time

The Vehicle Activity Report provides a chronological log of engine operation that records vehicle starts, stops, idle time, driving time and PTO time. The Minimum Idle Time parameter can be used to adjust the recorded idle time to filter out time spent stopped in traffic, switching in and out of PTO mode, and other brief periods of time the engine is operated at an idle condition. If the Minimum Idle Time is programmed to a value above 0 minutes (default), the previous mode of operation will be logged until the idle time exceeds the programmed limit.

Minimum	Maximum	Default	VEPS PID
0 minutes	1440 minutes	**0 minutes**	FCB3

Driver Reward

Driver Reward Enable

Driver Reward is a feature that allows a truck owner to place weighting factors on desired operating habits. If the vehicle is operated in a manner that exceeds the owner's specifications, the maximum vehicle speed limit can be automatically increased to a specified value as a reward to the driver. The Driver Reward Enable parameter provides a means to Disable and Lockout the Driver Reward feature using an Electronic Service Tool, for those areas with regulations that require a fixed maximum Vehicle Speed Limit.

Alternatives	Default	VEPS PID
Disabled	Enabled	N/A

Input Selections

Fan Override Switch

Input #4, Input #5, Input #6 or Input #7 can be used for connection of a Fan Override Switch. The Fan Override Switch parameter can be programmed to J1/P1:7, J1/P1:47, J1/P1:6, or J1/P1:46. This switch will allow the operator to turn ON the cooling fan at any time for improved engine retarding/braking and engine cooling.

Alternatives	Default	VEPS PID
J1/P1:7, J1/P1:47, J1/P1:6, J1/P1:46	**None**	FD01

Ignore Brake/Clutch Switch

Input #5 to the ECM can be used for connection of a Brake/Clutch Disable Switch for applications requiring mobile use of the vehicle with a set PTO engine rpm that does **NOT** require the Brake or Clutch to disengage the engine PTO operation. The Ignore Brake/Clutch Switch parameter must be programmed to J1/P1:47 to enable this feature.

Alternatives	Default	VEPS PID
J1/P1:47	**None**	FD05

Torque Limit Switch

Input #4 to the ECM can be used for connection of a Torque Limit Switch to limit engine torque to a programmable value. The Torque Limit Switch parameter must be programmed to J1/P1:7 to enable this feature.

Alternatives	Default	VEPS PID
J1/P1:7	**None**	FD09

Diagnostic Enable Switch

Input #7 can be used for connection of a diagnostic enable switch.The Diagnostic Enable Switch parameter must be programmed to J1/P1:46. Diagnostic flash codes can be prompted using the Diagnostic Enable switch. To initiate the flash codes, depress the momentary Diagnostic Enable switch until the Check Engine Lamp begins to flash. The codes should flash out as indicated above.

Alternatives	Default	VEPS PID
J1/P1:46	**None**	FD08

Remote PTO Set Switch

Input #2 can be used for connection of a Remote PTO Set Switch to be used when the PTO Configuration is programmed to Remote Switches and the PTO On/Off switch is in the ON position. The Remote PTO Set Switch parameter must be programmed to J1/P1:58.

Alternatives	Default	VEPS PID
None	J1/P1:58	FD0F

Remote PTO Resume Switch

Input #3 can be used for connection of a Remote PTO Resume Switch to be used when the PTO Configuration is programmed to Remote Switches and the PTO On/Off switch is in the ON position. The Remote PTO Resume Switch parameter must be programmed to J1/P1:60.

Alternatives	Default	VEPS PID
None	J1/P1:60	FD11

PTO Engine RPM Set Speed Input A

The PTO Engine RPM Set Speed Input A Switch can be connected to either J1/P1:6, J1/P1:46, J1/P1:58, or J1/P1:60. If the PTO Engine RPM Set Speed Input A parameter is programmed to the corresponding switch input option, the switch is used to control engine speed during PTO operation. The PTO Configuration parameter must be programmed to Cab Switches, Remote Switches or Remote Throttle and the PTO Engine RPM Set Speed A parameter must be programmed to a valid speed. Refer to “ PTO Engine RPM Set Speed A” on page 122 for additional information.

Alternatives	Default	VEPS PID
J1/P1:6, J1/P1:46, J1/P1:58, J1/P1:60	**None**	FD11

PTO Engine RPM Set Speed Input B

The PTO Engine RPM Set Speed Input B Switch can be connected to either J1/P1:6, J1/P1:46, J1/P1:58, or J1/P1:60. If the PTO Engine RPM Set Speed Input B parameter is programmed to the corresponding switch input option, the switch is used to control engine speed during PTO operation. The PTO Configuration parameter must be programmed to Cab Switches, Remote Switches or Remote Throttle and the PTO Engine RPM Set Speed B parameter must be programmed to a valid speed. Refer to “ PTO Engine RPM Set Speed B” on page 123 for additional information.

Alternatives	Default	VEPS PID
J1/P1:6, J1/P1:46, J1/P1:58, J1/P1:60	**None**	FD13

Starting Aid On/Off Switch

The Starting Aid On/Off Switch can be connected to either J1/P1:6, J1/P1:7, J1/P1:46, or J1/P1:47. The Starting Aid System does not require a switch for Automatic operation. A switch can be installed to allow the operator to override or disable the Automatic Starting Aid. If a switch is installed and the Starting Aid On/Off Switch parameter is programmed to the corresponding switch input, the switch will control the Starting Aid System. When the switch is in the ON position, the Starting Aid System will automatically enable the Starting Aid Output when conditions require the use of a starting aid. When the switch is in the OFF position, the Starting Aid System will not function.

Alternatives	Default	VEPS PID
J1/P1:6, J1/P1:7, J1/P1:46, J1/P1:47	**None**	FD21

Two Speed Axle Switch

Input #6 to the ECM can be used for connection of a Two-Speed Axle On/Off Switch. When a two-speed axle is used, the change in gear ratios from the high speed range to the low speed range alters the calibration of the vehicle speed signal. When the Two-Speed Axle On/Off Switch parameter is programmed to J1/P1:6 and the switch is in the ON position the ECM automatically adjusts the vehicle speed calibration. This will ensure the ECM driven speedometer and ECM stored information correctly reflect the actual vehicle speed. The High Speed Range Axle Ratio and Low Speed Range Axle Ratio must also be programmed for this feature to function correctly.

Alternatives	Default	VEPS PID
J1/P1:6	**None**	FD23

Cruise Control On/Off Switch

The Cruise Control On/Off Switch Input is available for connection of a Cruise Control On/Off Switch to ECM Connector J1/P1 terminal-59. The Cruise Control On/Off Switch parameter must be programmed to J1/P1:59. This switch is used to enable Cruise Control when the vehicle is moving or to control engine idle rpm when the vehicle is stationary.

Alternatives	Default	VEPS PID
	J1/P1:59	FD25

Cruise Control Set/Resume Switch

The Set and Resume Switch Inputs are available for connection of a Cruise Control Set/Resume Switch. The Cruise Control Set/Resume Switch parameter must be programmed to J1/P1:35 & 44. The Set input should be connected to J1/P1 terminal-35 and the Resume input to J1/P1 terminal-44. This switch is used in conjunction with the Cruise Control On/Off Switch to control cruise control operation while the vehicle is moving, to adjust engine idle rpm while the vehicle is stationary, and to enable Diagnostic Flash Codes on the Check Engine Lamp. The Cruise Control Set/Resume switch is also used with the PTO On/Off Switch (when the PTO Configuration is programmed to Cab Switches) to control engine rpm in PTO Mode operation.

Alternatives	Default	VEPS PID
	J1/P1:35 & 44	FD27

Clutch Pedal Position Switch

The Clutch Pedal Position Switch Input is available for connection of a Clutch Pedal Position Switch to ECM Connector J1/P1 terminal-22. The Clutch Pedal Position Switch parameter must be programmed to J1/P1:22. This input is used when the Transmission Style is programmed to Manual, which requires an input to determine the position of the clutch pedal.

Alternatives	Default	VEPS PID
	J1/P1:22	FD29

Retarder Off/Low/Medium/High Switch

The Retarder Solenoid Lo/Hi Switch and Retarder Solenoid Med/Hi Switch inputs are available for connection of a Engine Retarder Solenoid Selection Switch. The Lo/Hi Input should be connected to ECM Connector J1/P1 terminal- 23 and the Med/Hi Input to J1/P1 terminal-40. The Retarder Off/Low/Medium/Hi Switch parameter must be programmed to J1/P1:23 & 40. This switch controls the operation of the Engine Retarder Solenoids.

Alternatives	Default	VEPS PID
	J1/P1:23 & 40	FD2B

Service Brake Pedal Position Switch #1

The Service Brake Pedal Position Switch #1 Input is available for connection of a Service Brake Pedal Position Switch. The switch should be connector to ECM Connector J1/P1 terminal-45. The Service Brake Pedal Position Switch parameter must be programmed to J1/P1:45. The input is used to determine the position of the service brake pedal, which can affect Cruise, Idle, PTO, and Idle Shutdown operation.

Alternatives	Default	VEPS PID
	J1/P1:45	FD2D

Accelerator Pedal Position

The Accelerator Pedal Position Input is available for connection of an Accelerator Pedal Position Sensor. The Sensor signal line should be connected to ECM Connector J1/P1:66. The Accelerator Pedal Position Sensor parameter must be programmed to J1/P1:66. The input is used to determine the position of the Accelerator Pedal.

Alternatives	Default	VEPS PID
	J1/P1:66	FD35

Output Selections

Engine Running Output

Output #2, Output #3, or Output #4 is available for connection of an Engine Running Output Relay used to prevent starter engagement while the engine is running. The Engine Running Output can be programmed to J1/P1:10, J1/P1:12, or J1/P1:13. The Engine Running Output comes ON when the engine is running and turns OFF when the engine rpm = 0. The relay is normally closed so cranking can be achieved immediately at power up. During cranking, the ECM energizes the Engine Running Output once engine low idle rpm has been achieved. The relay is de-energized if engine speed falls 100 RPM below the programmed low idle (600-750 rpm is low idle range).

Alternatives	Default	VEPS PID
J1/P1:10, J1/P1:12, J1/P1:13	**None**	FD37

Engine Shutdown Output

Output #2, Output #3, or Output #4 is available for connection of an Engine Shutdown Output Relay used to shutdown the vehicle electrical system after the idle timer has expired. The Engine Shutdown Output can be programmed to J1/P1:10, J1/P1:12, or J1/P1:13. The Engine Shutdown Output comes ON after the engine is running for more than 3 seconds and turns OFF when the engine rpm is at least 100 rpm below low idle for more than 3 seconds.

Alternatives	Default	VEPS PID
J1/P1:10, J1/P1:12, J1/P1:13	**None**	FD4D

Auxiliary Brake

The Auxiliary Brake Output is for use with a BrakeSaver or other Aftermarket braking devices. Output #3 is available for connecting an Auxiliary Brake Relay. The Auxiliary Brake parameter must be programmed to J1/P1:12. Operation of the auxiliary brake and relay is inhibited during undesirable engine operating conditions (such as while the engine is being fueled).

Alternatives	Default	VEPS PID
J1/P1:12	**None**	FD39

Starting Aid Output

Output #2, Output #3, or Output #4 is available for connection of Starting Aid Output Relay/Solenoid. If a Starting Aid Switch is not used, the Starting Aid Output will turn on automatically when operating conditions require the use of a Starting Aid. If the Staring Aid On/Off Switch parameter is programmed and a switch connected to the corresponding switch input, the Starting Aid Output will not function when the switch is in the OFF position.)

Alternatives	Default	VEPS PID
J1/P1:10, J1/P1:12, J1/P1:13	**None**	FD4F

Fan Control Type

If the ECM is used to operate the cooling fan, this parameter must be programmed to On-Off or Three Speed Fan. Options are NONE (default), On-Off and Three Speed Fan. Refer to This parameter should be programmed to NONE if the ECM is not connected to/operating the cooling fan relay (or solenoid). When programmed to NONE the service technician can use an Electronic Service Tool to determine the ECM is not connected to the fan circuit.

Alternatives	Default	VEPS PID
On-Off, Three Speed Fan	**None**	FC18

Data Link Parameters

Powertrain Data Link

The data link parameter Powertrain Data Link determines if the ECM will communicate to a powertrain device using the SAE J1922 or J1939 data link. If the vehicle is not using the data link for communication to the powertrain (traction control systems, anti-lock brake systems, electronically controlled transmissions) this parameter should be programmed to NONE.

NOTE: A diagnostic code 231-11 J1939 Data Link Fault (58) will occur if the Powertrain Data Link parameter is set to either J1939 or J1922 & J1939 without another powertrain component ECU on the vehicle to communicate with the engine ECM.

Alternatives	Default	VEPS PID
Off, J1922, J1939, J1922 & J1939	**Off**	FC0D

24.1 Customer Specified Parameter Table

Customer Programmable Parameters			
Parameter	**Available Range/Options**	**Default**	**VEPS PID**
Selected Engine Rating			
Rating #	Engine Power Dependent		56
Multi-Torque Ratio	Unavailable (Standard Ratings) MT-1, MT-2, MT-4 (Multi-Torque Ratings)	Unavailable (Standard) MT-4 (Multi-Torque)	FCB1
ECM Identification Parameters			
Vehicle ID	17 Characters Available	all zero's	60
Security Access Parameters			
ECM Wireless Communications Enable	No, Yes	No	FC43
Vehicle Speed Parameters			
Vehicle Speed Calibration	4000 to 150000 pulses per mile	14000 ppm	FC5F
Vehicle Speed Limit	30 to 127 mph	127	61
VSL Protection	1300 to TEL rpm	TEL	66
Tachometer Calibration	12.0 to 500.0 pulse/revolution	113.0	C7
Soft Vehicle Speed Limit	Yes, No	No	C2
Low Speed Range Axle Ratio	1.00 to 19.99	1.00	FC5E
High Speed Range Axle Ratio	1.00 to 9.99	1.00	FC5D

Customer Programmable Parameters

Parameter	Available Range/Options	Default	VEPS PID
Cruise Control Parameters			
Low Cruise Control Speed Set Limit	15 to 127 mph	127	63
High Cruise Control Speed Set Limit	30 to 127 mph	127	62
Engine Retarder Mode	Coast, Latch, Manual	Manual	A1
Engine Retarder Minimum VSL Type	Hard Limit, Soft Limit	Hard Limit	FC3C
Engine Retarder Minimum Vehicle Speed	0 to 127 mph	0	FC16
Auto Retarder in Cruise	0 to 10, (0 = Off) mph	0	FC00
Auto Retarder in Cruise Increment	0 to 5 mph	2	FC1B
Cruise/Idle/PTO Switch Configuration	Set/Accel, Set/Decel	Set/Accel	3C
Soft Cruise Control	No, Yes	Yes	C5
Idle Parameters			
Idle Vehicle Speed Limit	1 to 15 mph	1	64
Idle RPM Limit	600 to TEL rpm	TEL	65
Idle/PTO RPM Ramp Rate	5 to 1000 rpm/second	50	C4
Idle/PTO Bump RPM	5 to 500 rpm	20	F1

Customer Programmable Parameters

Parameter	Available Range/Options	Default	VEPS PID
Dedicated PTO Parameters			
PTO Configuration	Off, Cab Switches, Remote Switches, Remote Throttle,	Off	F3
PTO Top Engine Limit	600 - TEL rpm	TEL	F0
PTO Engine RPM Set Speed	Low Idle - PTO TEL (0 = Off) rpm	0	F2
PTO Engine RPM Set Speed A	Low Idle - PTO TEL (0 = Off) rpm	0	FC8B
PTO Engine RPM Set Speed B	Low Idle - PTO TEL (0 = Off) rpm	0	FC8C
PTO to Set Speed	Yes, No	No	F6
PTO Cab Controls RPM Limit	Low Idle, TEL, PTO TEL	TEL	F4
PTO Vehicle Speed Limit	1 to 127 mph	1	FC17
Torque Limit	200 - Rated Torque lb-ft	2500	F7
PTO Shutdown Time	3 to 1440 (minutes, (0 = Off)	0	FC14
PTO Shutdown Timer Maximum RPM	600 - 2120 rpm	2120	FCB0
PTO Activates Cooling Fan	Normal, Continuous	Normal	F5

Customer Programmable Parameters

Parameter	Available Range/Options	Default	VEPS PID
Engine/Gear Parameters			
Lower Gears Engine RPM Limit	1100 to TEL rpm	2120	6C
Lower Gears Turn Off Speed	3 to 30 mph	3	69
Intermediate Gears Engine RPM Limit	1100 - TEL rpm	2120	6D
Intermediate Gears Turn Off Speed	5 to 50 mph	5	6A
Gear Down Protection RPM Limit	1300 to TEL rpm	2120	6E
Gear Down Protection Turn On Speed	30 to 127 mph	127	6B
Top Engine Limit	2120	2120	67
Top Engine Limit with Droop	No	No	C1
Low Idle Engine RPM	600 to 750	600	6F
Transmission Style	Manual, Automatic Option 1, Automatic Option 2, Automatic Option 3, Automatic Option 4, Eaton Top 2	Manual	7B
Eaton Top 2 Override with Cruise Switch	No, Yes	No	FC89
Top Gear Ratio	0.000 to 3.750	0.000	FC3D
Top Gear Minus One Ratio	0.000 to 3.750	0.000	FC3E
Top Gear Minus Two Ratio	0.000 to 3.750	0.000	FC3F

Customer Programmable Parameters

Parameter	Available Range/Options	Default	VEPS PID
Timer Parameters			
Idle Shutdown Time	3 to 1440 (minutes), (0 = Off)	0	FC13
Idle Shutdown Timer Maximum RPM	600 - 2120 rpm	2120	FCAF
Allow Idle Shutdown Override	Yes, No, Outside Temp Based, J1587 Outside Temp Based	Yes	4F
Minimum Idle Shutdown Outside Temp	-40 to 120°F	120	FC11
Maximum Idle Shutdown Outside Temp	-40 to 120°F	120	FC12
A/C Switch Fan On-Time	1 to 600 (seconds), (0 = Off)	0	C0
Fan with Engine Retarder in High Mode	Yes, No	No	4E
Engine Retarder Delay	0.0 to 3.0 seconds	0.0	FC3B
Smart Idle Parameters			
Battery Monitor and Engine Control Voltage	0 - 25.5 (0 = Off) volts	0	FCD8
Engine Monitoring Parameters			
Engine Monitoring Mode	OFF, Warning, Derate, Shutdown	Warning	7F
Engine Monitoring Lamps	Warning Lamp, Option 1	Warning Lamp	FCD2
Coolant Level Sensor	No, 4-Pin	No	7E

Customer Programmable Parameters

Parameter	Available Range/Options	Default	VEPS PID
Maintenance Parameters			
Maintenance Indicator Mode	Off, Man - Distance, Man - Hr, Auto - Distance, Auto - Hr.	Off	C9
PM1 Interval: (Manual))			C8
Miles	5000 to 35000	15000	CA
Hours	100 to 750	300	CB
Engine Oil Capacity (Automatic)	20 to 60 quarts	C-10: 36 C-12: 36 C-15/16 :40	CC
Trip Parameters			
Fuel Correction Factor	-63.5 to 63.5	0	D5
Dash- Change Fuel Correction Factor	Yes, No	No	E0
Dash- PM1 Reset	Yes, No	No	E0
Dash- Fleet Trip Reset	Yes, No	No	E0
Dash- State Selection	Yes, No	Yes	E0
Theft Deterrent System Control	Yes, No, Auto-Enable	No	FC08
Theft Deterrent Password	Four Characters		FC09
Quick Stop Rate	3 - 15 (0 = OFF) mph/s	0	FC0C
Vehicle Activity Report			
Minimum Idle Time	0 - 1440 minutes	0	FCB3
Driver Reward			
Driver Reward Enable	Enabled, Disabled	Enabled	N/A

Customer Programmable Parameters

Parameter	Available Range/Options	Default	VEPS PID
Input Selections			
Fan Override Switch	None, J1/P1:7, J1/P1:47, J1/P1:6, J1/P1:46	None	FD01
Ignore Brake/Clutch Switch	None, J1/P1:47	None	FD05
Torque Limit Switch	None, J1/P1:7	None	FD09
Diagnostic Enable	None, J1/P1:46	None	FD0B
Remote PTO Set Switch	J1/P1:58, None	J1/P1:58	FD0F
Remote PTO Resume Switch	J1/P1:60, None	J1/P1:60	FD11
PTO Engine RPM Set Speed Input A	J1/P1:6, J1/P1:46, J1/P1:58, J1/P1:60, None	None	FD13
PTO Engine RPM Set Speed Input B	J1/P1:6, J1/P1:46, J1/P1:58, J1/P1:60, None	None	FD15
Starting Aid On/Off Switch	J1/P1:7, J1/P1:47, J1/P1:6, J1/P1:46, None	None	FD21
Two Speed Axle Switch	None, J1/P1:6	None	FD23
Cruise Control On/Off Switch	J1/P1:59	J1/P1:59	FD25
Cruise Control Set/Resume Switch	J1/P1:35 & 44	J1/P1:35 & 44	FD27
Clutch Pedal Position Switch	J1/P1:22	J1/P1:22	FD29
Retarder Off/Low/Medium/High Switch	J1/P1:23 & 40	J1/P1:23 & 40	FD2B
Service Brake Pedal Position Switch #1	J1/P1:45	J1/P1:45	FD2D
Accelerator Pedal Position	J1/P1:66	J1/P1:66	FD35

Customer Programmable Parameters

Parameter	Available Range/Options	Default	VEPS PID
Output Selections			
Engine Running Output	None, J1/P1:10, J1/P1:12, or J1/P1:13	None	FD37
Engine Shutdown Output	None, J1/P1:10, J1/P1:12, or J1/P1:13	None	FD4D
Auxiliary Brake	None, J1/P1:12	None	FD39
Starting Aid Output	None, J1/P1:10, J1/P1:12, or J1/P1:13	None	FD4F
Fan Control Type	None, On/Off, Three Speed Fan	None	FC18
Passwords			
Customer Password #1	8 Digits, Available Characters Service Tool Dependent		45
Customer Password #2			46
Data Link Parameters			
Powertrain Data Link	None, J1922, J1939, J1922 & J1939	None	FC0D

24.2 Customer Parameter Worksheet

Selected Engine Rating

Rating Number ..... _____

Multi-Torque Ratio ..... _____

ECM Identification Parameters

Vehicle ID ..... _____

Security Access Parameters

ECM Wireless Communication Enable ..... _____

Vehicle Speed Parameters

Vehicle Speed Calibration ..... _____

Vehicle Speed Limit ..... _____

VSL Protection ..... _____

Tachometer Calibration ..... _____

Soft Vehicle Speed Limit ..... _____

Low Speed Range Axle Ratio ..... _____

High Speed Range Axle Ratio ..... _____

Cruise Control Parameters

Low Cruise Control Speed Set Limit ..... _____

High Cruise Control Speed Set Limit ..... _____

Engine Retarder Mode ..... _____

Engine Retarder Minimum VSL Type ..... _____

Engine Retarder Minimum Vehicle Speed ..... _____

Auto Retarder in Cruise ..... _____

Auto Retarder in Cruise Increment ..... _____

Cruise/Idle/PTO Switch Configuration ..... _____

Soft Cruise Control ..... _____

Idle Parameters

Idle Vehicle Speed Limit ..... _____

Idle RPM Limit ..... _____

Idle/PTO RPM Ramp Rate ..... _____

Idle/PTO Bump RPM ..... _____

Dedicated PTO Parameters

PTO Configuration ..... _____

PTO Top Engine Limit ..... _____

PTO Engine RPM Set Speed ..... _____

PTO Engine RPM Set Speed A ..... _____

PTO Engine RPM Set Speed B ..... _____

PTO to Set Speed ..... _____

PTO Cab Controls RPM Limit ..... _____

PTO Vehicle Speed Limit ..... _____

Torque Limit ..... _____

PTO Shutdown Time ..... _____

PTO Shutdown Timer Maximum RPM ..... _____

PTO Activates Cooling Fan ..... _____

Engine/Gear Parameters

Lower Gears Engine RPM Limit ..... _____

Lower Gears Turn Off Speed ..... _____

Intermediate Gears Engine RPM Limit ..... _____

Intermediate Gears Turn Off Speed ..... _____

Gear Down Protection RPM Limit ..... _____

Gear Down Protection Turn On Speed ..... _____

Top Engine Limit ..... _____

Top Engine Limit with Droop ..... _____

Low Idle Engine RPM ..... _____

Transmission Style ..... _____

Eaton Top 2 Override with Cruise ..... _____

Top Gear Ratio ..... _____

Top Gear Minus One Ratio ..... _____

Top Gear Minus Two Ratio ..... _____

Timer Parameters

Idle Shutdown Time (0=OFF) ..... _____

Idle Shutdown Timer Maximum RPM ..... _____

Allow Idle Shutdown Override ..... _____

Minimum Idle Shutdown Outside Temp ..... _____

Maximum Idle Shutdown Outside Temp ..... _____

A/C Switch Fan On-Time ..... _____

Fan with Engine Retarder in High Mode ..... _____

Engine Retarder Delay ..... _____

Smart Idle Parameters

Battery Monitor and Engine Control Voltage ..... _____

Engine Monitoring Parameters

Engine Monitoring Mode ..... _____

Engine Monitoring Lamps ..... _____

Coolant Level Sensor ..... _____

Maintenance Parameters

Maintenance Indicator Mode ..... _____

PM1 Interval ..... _____

Engine Oil Capacity ..... _____

Trip Parameters

Fuel Correction Factor ..... _____

Dash - Change Fuel Correction Factor ..... _____

Dash - PM1 Reset ..... _____

Dash - Fleet Trip Reset ..... _____

Dash - State Selection ..... _____

Theft Deterrent System Control ..... _____

Theft Deterrent Password ..... _____

Quick Stop Rate ..... _____

Vehicle Activity Report

Minimum Idle Time ..... _____

Driver Reward

Driver Reward Enable ..... _____

Input Selections

Fan Override Switch ..... _____

Ignore Brake/Clutch Switch ..... _____

Torque Limit Switch ..... _____

Diagnostic Enable ..... _____

Remote PTO Set Switch ..... _____

Remote PTO Resume Switch ..... _____

PTO Engine RPM Set Speed Input A ..... _____

PTO Engine RPM Set Speed Input B ..... _____

Starting Aid On/Off Switch ..... _____

Two Speed Axle Switch ..... _____

Cruise Control On/Off Switch ..... _____

Cruise Control Set/Resume Switch ..... _____

Clutch Pedal Position Switch ..... _____

Retarder Off/Low/Medium/High Switch ..... _____

Service Brake Pedal Position Switch #1 ..... _____

Accelerator Pedal Position ..... _____

Output Selections

Engine Running Output ..... _____

Engine Shutdown Output ..... _____

Auxiliary Brake ..... _____

Starting Aid Output ..... _____

Fan Control Type ..... _____

Passwords

Customer Password #1 ..... _____

Customer Password #2 ..... _____

Data Link Parameters

Powertrain Data Link ..... _____

25.0 ECM Date/Time Clock

The ECM date & time can be programmed using an Electronic Service Tool or VEPS. The Electronic Service Tool will display the programmed Date in Month/Day/Year format and the programmed Time in Hour:Minute:Second format. The Electronic Service 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 in the ECM and will not reset even if the Unswitched Battery connections are removed.

The real time clock is used to date/time stamp the following critical event codes: 84-00 Vehicle Overspeed Warning, 190-00 Engine Overspeed Warning, 110-11 Very High Coolant Temperature, 100-11 Very Low Oil Pressure, and 111-11 Very Low Coolant Level. ECM diagnostic snapshots, Quick Stop snapshots, and snapshots triggered using the Set/Resume switch are also time stamped.

25.0.1 Clock Accuracy

The ECM real time clock is accurate to within four minutes per month worst case. Typically the accuracy is similar to a personal computer real time clock.

Date	Time	VEPS PID
Month Day Year	hour:minute:second	FC1D

26.0 ECM Diagnostic Clock

The Diagnostic Clock should not be confused with the ECM Date/Time clock. The Diagnostic Clock records actual hours that the ECM has been powered (ignition key switch ON). The diagnostic 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. The Diagnostic Clock does not represent actual Engine Hours, it increments any time the ECM is powered regardless of whether the engine is running or not. Actual Engine Running hours (Total Time) can be obtained from the Current Totals menu of ET (Electronic Technician).

27.0 ECM Vehicle Harness Connector Terminal Assignments and Loads

Terminal	Wire ID	Wire	Signal	Assignment	Voltage	Current
1*	E721-WH	18 AWG	Data Link	J1922 Data Link	per J1922	
2	G897-OR	18 AWG	Supply	+5V: 4-Pin Coolant Level Sensor Supply	5 VDC	40 mA
3	993-BR	18 AWG	Common Gnd	Input Sensor Common #2: Used for PTO Applications		
4	C985-BU	18 AWG	Supply	+8V: Accelerator Pedal Sensor Supply	8 VDC	40 mA
5	H795-PK	18 AWG	Common Gnd	AP Sensor/Switch Sensor Common: Cruise, Brake, Clutch, Fast Idle, A/C High Pressure, and Diagnostic Enable Switches, Accelerator Pedal Position Sensor, etc.		
6*	G843-OR	18 AWG	Switch to Gnd	Input #6: Two Speed Axle Switch Fan Override Switch PTO Engine Set Speed A Switch PTO Engine Set Speed B Switch Starting Aid On/Off Switch	13 VDC	6.5 mA
7*	G841-GN	18 AWG	Switch to Gnd	Input #4: Torque Limit Switch Fan Override Switch Starting Aid On/Off Switch	13 VDC	6.5 mA
8	E794-YL	18 AWG	Data Link	J1587 Data Link Positive	5 VDC	100 mA
9	E793-BU	18 AWG	Data Link	J1587Data Link Negative	5 VDC	100 mA
10*	E718-PK	18 AWG	High Side	Output #2: Engine Running Output Driver Engine Shutdown Output Driver Starting Aid Output	Battery	1.5A
11*	G837-YL	18 AWG	High Side	Output #5: On-Off Cooling Fan Driver 3 Speed Fan - Slip Mode Driver	Battery	1.5A
12*	E991-GY	18 AWG	High Side	Output #3: Engine Running Output Driver Engine Shutdown Output Driver Auxiliary Brake Driver Starting Aid Output	Battery	1.5A
13*	G836-WH	18AWG	High Side	Output #4: Engine Running Output Driver Engine Shutdown Output Driver 3 Speed Fan - Brake Mode Driver Starting Aid Output	Battery	1.5A
14*	E720-PK	18 AWG	Data Link	J1922 Data Link	per J1922	
15				Not Used (Analog Input)		
16				Not Used (Analog Input)		
17				Not Used (Analog Input)		
18	L901-GY	18 AWG	Common Gnd	Input Sensor Common #1		

Terminal	Wire ID	Wire	Signal	Assignment	Voltage	Current
19*	G838-BR	18AWG		Output #6: Eaton Top 2 Lockout Solenoid		
20*	G839-BU	18 AWG	High Side	Output #7 Eaton Top 2 Shift Solenoid	13 VDC	1.0 A
21				Output #8 (Not Used)		
22*	C977-BU	18 AWG	Switch to Gnd	Clutch Pedal Position Switch	13 VDC	6.5 mA
23	E716-GY	18 AWG	Switch to Gnd	Retarder Solenoid Low/Hi Switch	13 VDC	6.5 mA
24				Not Used (Passive Speed+)		
25				Not Used (Passive Speed-)		
26*	C453-YL	18 AWG	Analog Input	Ambient Air Temp Sensor	13 VDC	0.6 mA
27				Not Used (Passive/Active Analog Input)		
28	L994-YL	18 AWG	Low Side	Check Engine Lamp	Battery	0.3 A
29*	659-PK	18 AWG	Low Side	Warning Lamp Low Oil Pressure Lamp	Battery	0.3 A
30*	K998-BU	18 AWG	Low Side	Output #1: PTO Switch On Lamp Low Coolant Level Lamp	Battery	0.3 A
31*	G880-PK	18 AWG	Low Side	Output #9: High Coolant Temperature Lamp	Battery	0.3 A
32	G808-BU	18 AWG	Differential Input	Vehicle Speed In +		
33	G809-GN	18 AWG	Differential Input	Vehicle Speed In -		
34*	K990-GN	18 AWG	Data Link	J1939 Data Link Negative	per J1939	
35	C978-BR	18 AWG	Switch to Gnd	Cruise Set	13 VDC	6.5 mA
36	C974-PU	18 AWG	Complementary	Speedometer+	10 Volts	4 mA
37	C973-GN	18 AWG	Complementary	Speedometer-	10 Volts	4 mA
38	450-YL	18 AWG	Complementary	Tachometer +	10 Volts	4 mA
39	451-BR	18 AWG	Complementary	Tachometer -	10 Volts	4 mA
40	E717-GN	18 AWG	Switch to Gnd	Retarder Solenoid Med/Hi Switch	13 VDC	6.5 mA
41*	E971-GN	18 AWG	Switch to Gnd	Input #11: A/C High Pressure Switch	13 VDC	6.5 mA
42*	A249-BK	18 AWG	Data Link	J1939 Data Link Shield	per J1939	
43				Not Used		
44	C979-OR	18 AWG	Switch to Gnd	Cruise Resume	13 VDC	6.5 mA
45	C992-PU	18 AWG	Switch to Gnd	Service Brake Position Switch #1	13 VDC	6.5 mA
46*	G844-PK	18 AWG	Switch to Gnd	Input #7: Diagnostic Enable Fan Override Switch PTO Engine Set Speed A Switch PTO Engine Set Speed B Switch Starting Aid On/Off Switch	13 VDC	6.5 mA

Terminal	Wire ID	Wire	Signal	Assignment	Voltage	Current
47*	G842-GY	18 AWG	Switch to Gnd	Input #5: Ignore Brake/Clutch Switch Fan Override Switch Starting Aid On/Off Switch	13 VDC	6.5 mA
48				Not Used (+Battery)		
49*	C983-WH	18 AWG	Analog Input	Coolant Level Normal (4-Pin Sensor)	13 VDC	0.6 mA
50*	K900-YL	18 AWG	Data Link	J1939 Data Link Positive	per J1939	
51				Not Used (PWM Output -)		
52	101-RD	14 AWG	Supply	Unswitched +Battery	Battery	20 A
53	101-RD	14 AWG	Supply	Unswitched +Battery	Battery	20 A
54*	C984-YL	18 AWG	Analog Input	Coolant Level Low (4-Pin Sensor)	13 VDC	0.6 mA
55				Not Used (+Battery)		
56*	K999-GN	18 AWG	Switch to Gnd	Input #1: PTO ON/OFF Switch	13 VDC	6.5 mA
57				Not Used (+Battery)		
58*	K980-PK	18 AWG	Switch to Gnd	Input #2: Remote PTO Set Switch PTO Engine Set Speed A Switch PTO Engine Set Speed B Switch	13 VDC	6.5 mA
59	C975-WH	18 AWG	Switch to Gnd	Cruise Control On/Off Switch	13 VDC	6.5 mA
60*	K982-YL	18 AWG	Switch to Gnd	Input #3: Remote PTO Resume Switch PTO Engine Set Speed A Switch PTO Engine Set Speed B Switch	13 VDC	6.5 mA
61				Not Used (-Battery)		
62*	G881-BU	18 AWG	Switch to +Battery	Input #12: Neutral Switch	Battery	6.0 mA
63				Not Used (-Battery)		
64*	G882-WH	18 AWG	Switch to +Battery	Input #13: Service Brake Position Switch #2	Battery	6.0 mA
65	229-BK	14 AWG	Supply	- Battery	Battery	20 A
66	C986-BR	18 AWG	PWM Input	Accelerator Pedal Position	5 VDC	40 mA
67	229-BK	14 AWG	Supply	-Battery	Battery	20 A
68*	G845-PU	18 AWG	PWM Input	Input #8: Remote PTO Accelerator Position	5 VDC	40 mA
69				Not Used		
70	J906-BR	18 AWG	Switch to +Battery	Ignition Key Switch	Battery	1.2 mA

*****Indicates items that are dependent upon Customer Parameter Programming

A

B

C

D

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