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Application and Installation

DDEC® IV

DETROIT DIESEL
CORPORATION

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CALIFORNIA
Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

ATTENTION

This document is a guideline for qualified personnel. It is intended to be used by vehicle manufacturers and contains Detroit Diesel Corporation's recommendations for the ancillary systems supporting the Detroit Diesel engines covered by this document. The vehicle manufacturer is responsible for developing, designing, manufacturing and installing these systems, including component qualification. The vehicle manufacturer is also responsible for furnishing vehicle users complete service and safety information for these systems. Detroit Diesel Corporation makes no representations or warranties regarding the information contained in this document and disclaims all liability or other responsibility for the design, manufacture or installation of these ancillary systems, or the preparation or distribution to vehicle users of appropriate information regarding these systems. The information contained in this document may not be complete and is subject to change without notice.

DDEC IV APPLICATION AND INSTALLATION MANUAL

ABSTRACT

Detroit Diesel Corporation has produced electronically controlled engines for nearly two decades. DDEC IV, the fourth generation electronic engine controller, offers improved engine control and a more extensive range of engine and vehicle options.

The detail provided will facilitate the following:

- ☐ The selection of features and settings, based on individual applications
- ☐ The fabrication and installation of a vehicle interface harness, based on individual applications
- ☐ The communication of messages & data between sensors and various electronic control modules within the installation
- ☐ The use of industry standard tools to obtain engine data and diagnostic information, as well as to reprogram key parameters

The manual is arranged as follows:

- ☐ The initial portion covers the installation, beginning with an overview and safety precuations, followed by hardware and wiring requirements, inputs and outputs, and available features.
- ☐ The second portion covers communication protocol.
- ☐ The third portion covers the tools capable of obtaining engine data and diagnostic information from the Electronic Control Module, as well as reprogramming of its key parameters.
- ☐ The fourth portion covers application specific recommendations.
- ☐ The final portion summarizes detailed information on codes and kit availability.

This manual does not cover the installation of the engine itself into various applications. For this, the reader should refer to the specific engine application and installation manual.

This manual is intended for those with an electrical background. A simple installation may require a basic understanding of electrical circuits while a more comprehensive electrical/electronics background is required to access all the capability of DDEC IV.

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1 INTRODUCTION

The Detroit Diesel Electronic Control System (DDEC®) is an advanced electronic fuel injection and control system that can be integrated into many applications. DDEC provides the customer value throughout the life of the unit and at time of resale.

DDEC IV provides three industry standard serial data links: SAE Standards J1587, J1922, and J1939. SAE Standard J1587 provides two way communications for the diagnostic equipment and vehicle displays. SAE Standards J1922 and J1939 provide control data to other vehicle systems such as transmissions and traction control devices.

FEATURES

DDEC IV offers significant operating advantages over traditional mechanically governed engines. The following features can be tailored to achieve specific customer preferences:

- Cruise Control operation
- Vehicle speed limit control
- Variable speed governing
- Fast Idle operation
- Idle Shutdown control
- Crank and throttle inhibiting
- Device controlling power take-off (PTO) is both in-cab and remotely operable
- Application specific safety features, such as door interlock
- Application specific control features
- A customer security/reprogramming password
- Fan control

ADVANTAGES

DDEC IV offers significant operating advantages over traditional mechanically governed engines offering end users:

- ☐ State-of-the-art fuel management and economy, including compensation for changing environmental conditions and user preferences
- ☐ EPA and CARB smoke and emissions compliance (nonroad and on-highway applications)
- ☐ Total system integration including the availability of SAE Standards J1587, J1922, and J1939 data links
- ☐ Application specific features to meet customer needs
- ☐ Multi-level password protected security and reprogramming flexibility
- ☐ Proven reliability and durability that customers demand
- ☐ Easily accessible components, reducing maintenance time and simplifying troubleshooting
- ☐ Integrated engine protection features with lights for visual awareness
- ☐ Easily retrievable historical fault codes for diagnostic capability
- ☐ Operating statistics are tracked, fuel consumed, miles traveled (hours used), for accurate unit and fleet management

TYPICAL INSTALLATION

A typical installation includes:

- ☐ A fused ignition wire to the ECM
- ☐ A Power Harness that supplies 12 or 24 volts to the ECM.
- ☐ (Series 4000 requires 24V)
- ☐ An Engine Sensor Harness from the engine-mounted sensors to the ECM and to the injector solenoids
- ☐ An OEM supplied Vehicle Interface Harness (VIH) from the remaining sensors, switches, throttle device, and other components attached to the SAE 1587 Data Link back to the ECM
- ☐ A Communication Harness that connects the ECM's J1922 and J1939 ports to other vehicle systems such as traction control devices and transmissions
- ☐ Display devices (lights, tachometer, etc.)

The schematic for a typical on-highway installation is shown in the following illustration (see see Figure 1-1).

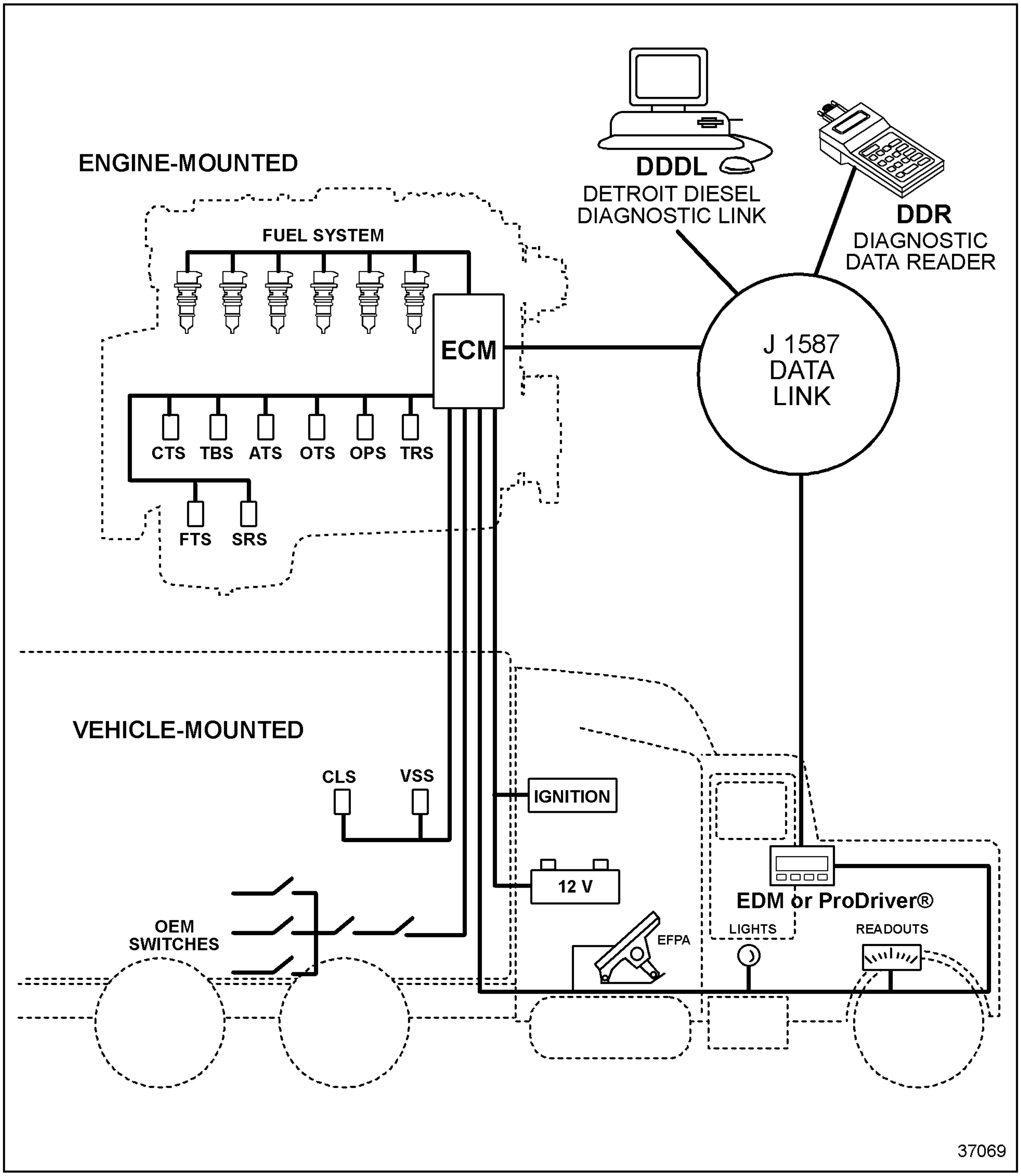


Figure 1-1 The DDEC IV System, On-highway Application - Series 60 Engine

The schematic for a typical construction and industrial installation is shown in the following illustration (see Figure 1-2).

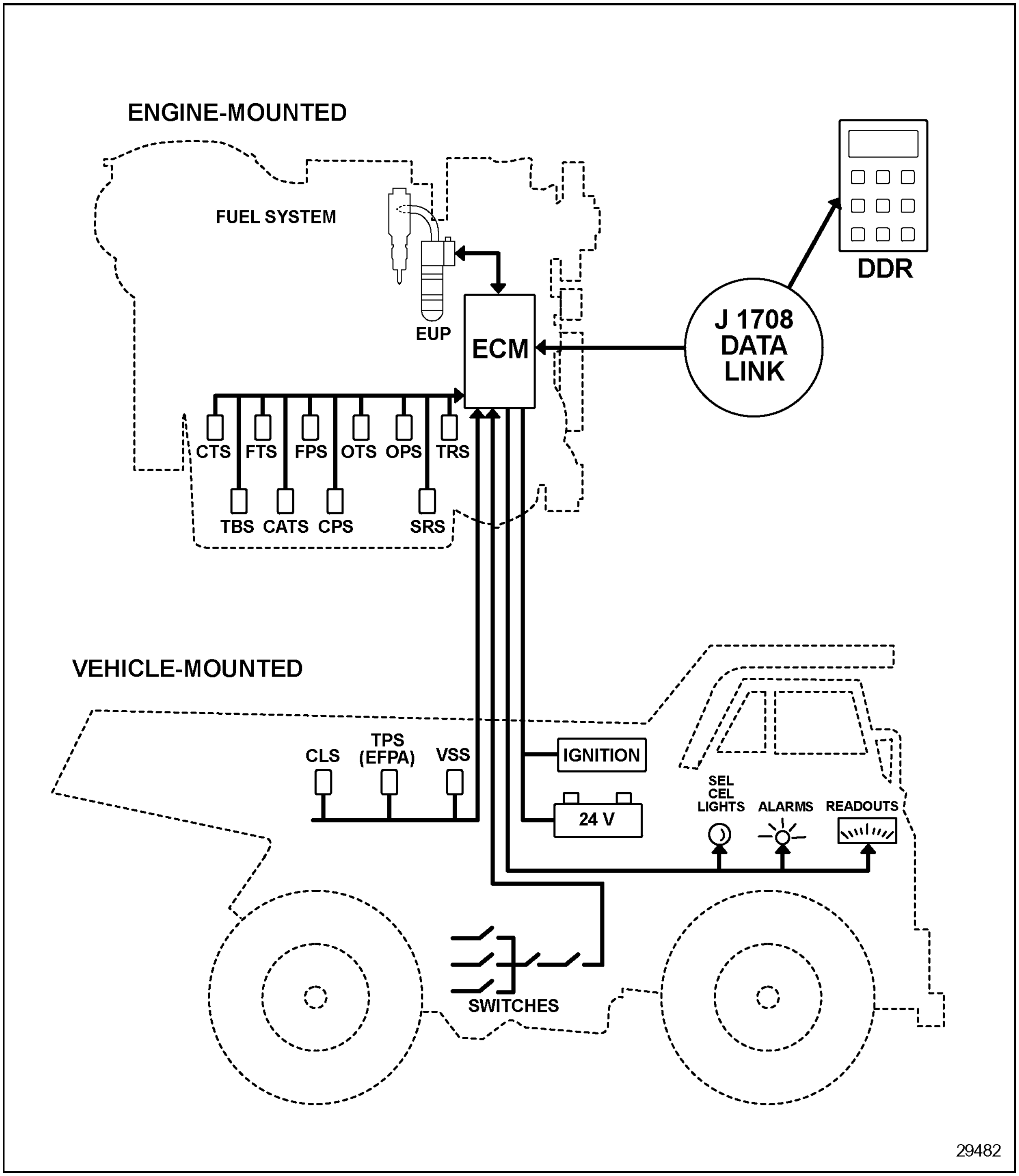


Figure 1-2 The DDEC IV System, Construction and Industrial Application - Series 2000 Engine

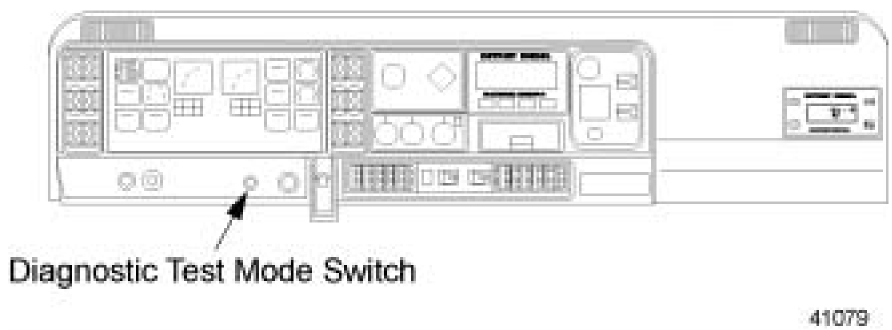
APPLICATION FLEXIBILITY

DDEC IV can be tailored to operate and/or interact with various systems, drivelines, and driven devices including:

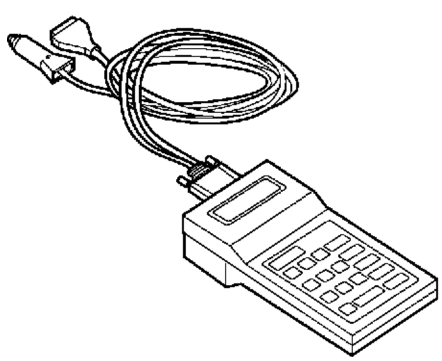
- ☐ Manual, automatic, and electronically controlled transmissions
- ☐ Electronically controlled transmission retarders and other engine retarders
- ☐ Various types of single or dual throttle devices like foot- and hand-actuated, in-cab and remote controlled devices
- ☐ PTOs
- ☐ A Pressure Sensor Governor
- ☐ Air compressors
- ☐ Anti-lock brakes and automatic traction control
- ☐ Electronic speedometers, tachometers, and instruments and displays, such as the Electronic Display Module, ProDriver® and Electronic Fire Commander™

DIAGNOSTICS AND TOOLS

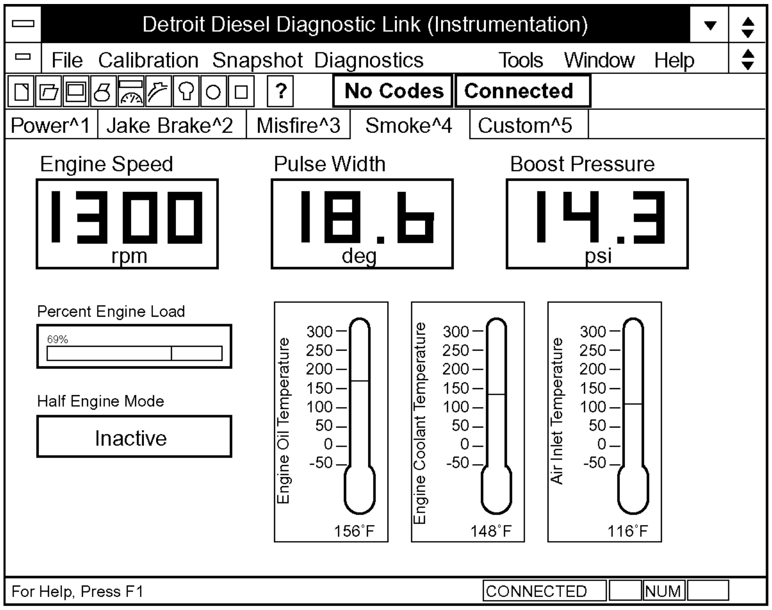
Diagnostic and other fleet management tools offer additional flexibility and convenience. Pressing a panel-mounted Data Request Button retrieves active and inactive (historic) codes.



A hand-held Diagnostic Data Reader (DDR) obtains the same codes, performs self-checks, collects snapshot data, and reprograms certain features.



The Detroit Diesel Diagnostic Link™ (DDDL) is a sophisticated software package supporting the set up, maintenance and repair of engines using DDEC. Used as a diagnostic tool DDDL can be used to change the engine rating, view an audit trail of ECM and injector calibration change, monitor fault codes as they occur, snap shot recording, and set the ECM output functions to particular values to support troubleshooting.

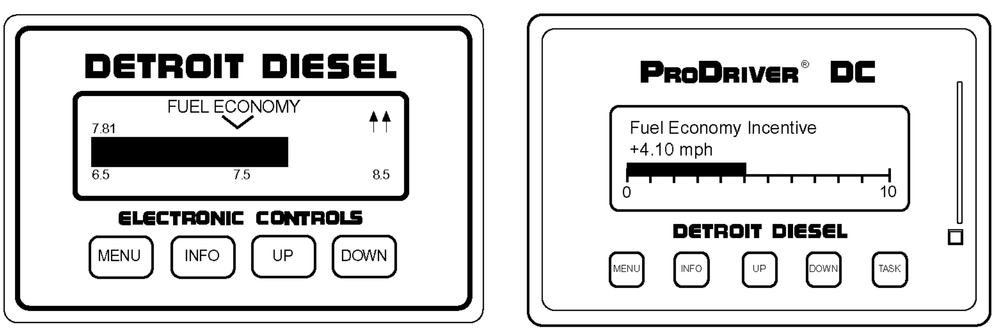


41080

ELECTRONIC DISPLAYS

DDEC IV SAE J1587 Data Link is used to transmit and display sensor and engine data to other vehicle modules including electronic dashboard displays.

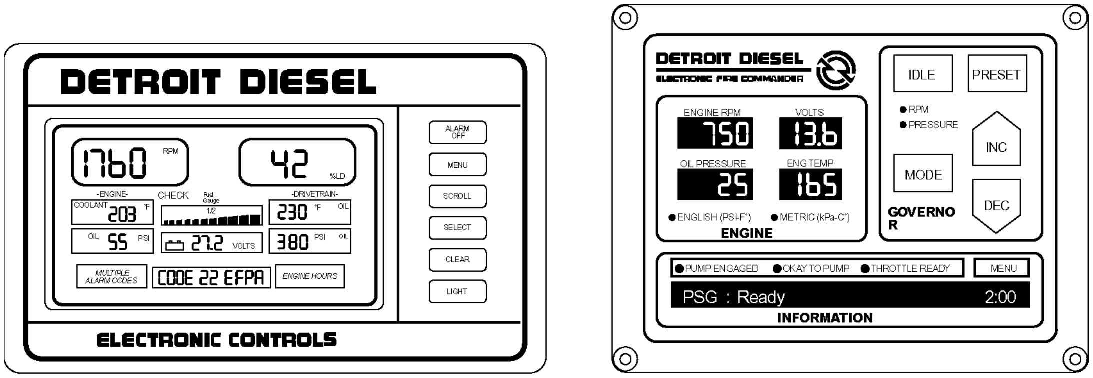
A panel-mounted ProDriver or ProDriver DC display shows operational data such as instantaneous fuel economy and idle time.



ProDriver ProDriver DC

41081

Electronic Display Module (EDM) is an electronic display system which displays engine and equipment parameters. Electronic Fire Commander (EFC) is a complete pressure governor control unit which displays engine speed, battery voltage, engine oil pressure, and either engine oil temperature or engine coolant temperature (programmable).

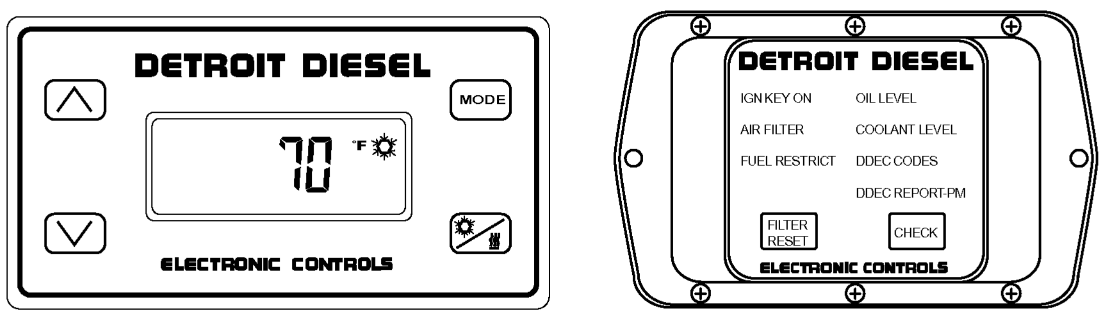


ELECTRONIC DISPLAY MODULE

ELECTRONIC FIRE COMMANDER

41082

Optimized Idle® automatically stops and restarts the engine to keep the engine oil temperature between factory set limits, keep the battery charged, and keep the vehicle interior at the desired temperature (using the optional thermostat). Engine idle time is reduced, there is an overall reduction in exhaust emissions and noise, and improved starter and engine life. The system also reduces dead batteries due to electrical loads, such as refrigerators or satellite systems.



OPTIMIZED IDLE

MAINTENANCE ALERT SYSTEM

41083

The Maintenance Alert System (MAS) monitors engine fluid levels and filter restrictions and notifies the driver and/or technician when maintenance is required.

THE BASICS

The ECM can be considered the most important component of the DDEC system, as it controls the engine operation and acts as an interface with the other subsystems and devices, via the SAE J1587, J1922, or J1939 data links.

In these roles, the ECM adjusts engine speed and torque by transmitting output signals to the electronic unit injectors or electronic unit pumps via the Injector Harness and interacts with the other subsystems by:

- ☐ Monitoring system status
- ☐ Transmitting engine status
- ☐ Receiving sensor input

- ☐ Receiving system requests

The ECM adjusts engine speed and torque after:

- ☐ Receiving input signals, diagnostic information, and requests from sensors and other subsystems and devices
- ☐ Conditioning input signals
- ☐ Performing calculations
- ☐ Determining output signals necessary to achieve operating goals

The ECM also monitors and reacts to various situations as detailed below:

- ☐ Certain ambient conditions can result in fuel rate and timing adjustments to control smoke during starting
- ☐ Certain barometric conditions can result in fuel rate and timing adjustments to compensate for altitude
- ☐ Certain oil temperatures require changes to compensate for differences in oil viscosity, reducing fuel injection variation
- ☐ Engine speed and cranking time is monitored to determine if crank inhibiting is necessary
- ☐ Vehicle speed is monitored and compared to user settings and instantaneous preferences specified by input switches to meet cruise control requirements
- ☐ Requirements for driven devices like PTOs, air compressors, and pumps are monitored and compared to user settings, monitored conditions, and instantaneous preferences specified by input switches to achieve in-cab or remotely controlled PTO operation requirements

The ECM also:

- ☐ Performs self-checks and retains fault codes within its memory
- ☐ Monitors operating conditions and either signals the user with a light or cuts back fuel in an attempt to control overtemperature and abnormal pressure conditions for engine protection
- ☐ Monitors operations to signal the user of an impending service interval
- ☐ Broadcasts operational and diagnostic information over the data link

2 SAFETY PRECAUTIONS

The following safety measures are essential when installing DDEC IV in a vehicle equipped with a Detroit Diesel engine.

CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- **Always start and operate an engine in a well ventilated area.**
- **If operating an engine in an enclosed area, vent the exhaust to the outside.**
- **Do not modify or tamper with the exhaust system or emission control system.**

2.1 STANDS

Use safety stands in conjunction with hydraulic jacks or hoists. Do not rely on either the jack or the hoist to carry the load.

2.2 GLASSES

Select appropriate safety glasses for the job. Safety glasses *must* be worn when using tools such as hammers, chisels, pullers and punches.

2.3 WELDING

Consider the consequences of welding.

NOTICE:
When welding, the following must be done to avoid damage to the electronic controls or the engine: ☐ Both the positive (+) and negative (-) battery leads must be disconnected before welding. ☐ Ground cable must be in close proximity to welding location - engine must never be used as a grounding point. ☐ Welding on the engine or engine mounted components is NEVER recommended.

Wear welding goggles and gloves when welding or using an acetylene torch.

CAUTION:
To avoid injury from fire, check for fuel or oil leaks before welding or carrying an open flame near the engine.

Insure that a metal shield separates the acetylene and oxygen which must be chained to a cart.

2.4 WORK PLACE

Organize your work area and keep it clean.

CAUTION:
To avoid injury from slipping and falling, immediately clean up any spilled liquids.

Eliminate the possibility of a fall by:

- ☐ Wiping up oil spills
- ☐ Keeping tools and parts off the floor

A fall could result in a serious injury.

After installation of the engine is complete:

CAUTION:
To avoid injury from rotating belts and fans, do not remove and discard safety guards.

- ☐ Reinstall all safety devices, guards or shields
- ☐ Check to be sure that all tools and equipment used to install the engine are removed from the engine

2.5 CLOTHING

Wear work clothing that fits and is in good repair. Work shoes must be sturdy and rough-soled. Bare feet, sandals or sneakers are not acceptable foot wear when installing an engine.

CAUTION:
To avoid injury when working near or on an operating engine, remove loose items of clothing, jewelry, tie back or contain long hair that could be caught in any moving part causing injury.

2.6 ELECTRIC TOOLS

Improper use of electrical equipment can cause severe injury.

CAUTION:
To avoid injury from electrical shock, follow OEM furnished operating instructions prior to usage.

Check power tools before using.

2.7 AIR

Use proper shielding to protect everyone in the work area.

CAUTION:

To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

2.8 FLUIDS AND PRESSURE

Be extremely careful when dealing with fluids under pressure.

CAUTION:

To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).

Fluids under pressure can have enough force to penetrate the skin.

CAUTION:

To avoid injury from penetrating fluids, do not put your hands in front of fluid under pressure. Fluids under pressure can penetrate skin and clothing.

These fluids can infect a minor cut or opening in the skin. See a doctor at once, if injured by escaping fluid. Serious infection or reaction can result without immediate medical treatment.

2.9 BATTERIES

Electrical storage batteries give off highly flammable hydrogen gas when charging and continue to do so for some time after receiving a steady charge.

CAUTION:

To avoid injury from battery explosion or contact with battery acid, work in a well-ventilated area, wear protective clothing, and avoid sparks or flames near the battery. Always establish correct polarity before connecting cables to the battery or battery circuit. If you come in contact with battery acid:

- **Flush your skin with water.**
- **Apply baking soda or lime to help neutralize the acid.**
- **Flush your eyes with water.**
- **Get medical attention immediately.**

Always disconnect the battery cable before working on the Detroit Diesel Electronic Controls system.

2.10 FIRE

Keep a charged fire extinguisher within reach. Be sure you have the correct type of extinguisher for the situation. The correct fire extinguisher types for specific working environments are listed in Table 2-1.

Fire Extinguisher	Work Environment
Type A	Wood, Paper, Textile and Rubbish
Type B	Flammable Liquids
Type C	Electrical Equipment

Table 2-1 The Correct Type of Fire Extinguisher

2.11 DIAGNOSTIC DATA READER

For mobile applications, the Diagnostic Data Reader (DDR) must be used by personnel other than the vehicle operator.

CAUTION:
To avoid injury from loss of vehicle/vessel control, the operator of a DDEC equipped engine must not attempt to use or read the Diagnostic Data Reader when the vehicle/vessel is moving.

The vehicle operator must maintain control of the vehicle while an assistant performs the diagnostic evaluations.

2.12 DETROIT DIESEL DIAGNOSTIC LINK

For mobile applications, Detroit Diesel Diagnostic Link (DDDL) must be used by personnel other than the vehicle operator.

CAUTION:
To avoid injury from loss of vehicle/vessel control, the operator of a DDEC equipped engine must not use or read any diagnostic tool while the vehicle/vessel is moving.

The vehicle operator must maintain control of the vehicle while an assistant performs the diagnostic evaluations.

2.13 PAINT

NOTICE:
Do not apply paint to the ECM or EFC. The application of paint may affect the performance of the ECM and EFC.

Mask off the ECM and EFC, prior to applying any paint.

2.14 FLUOROELASTOMER (VITON)

Fluoroelastomer (Viton) parts such as O-rings and seals are perfectly safe to handle under normal design conditions.

CAUTION:

To avoid injury from chemical burns, wear a face shield and neoprene or PVC gloves when handling fluoroelastomer O-rings or seals that have been degraded by excessive heat. Discard gloves after handling degraded fluoroelastomer parts.

A potential hazard may occur if these components are raised to a temperature above 600°F (316°C) (in a fire for example). Fluoroelastomer will decompose (indicated by charring or the appearance of a black, sticky mass) and produce hydrofluoric acid. This acid is extremely corrosive and, if touched by bare skin, may cause severe burns (the symptoms could be delayed for several hours).

2.15 PRESSURE SENSOR GOVERNOR INSTALLATION

The Vehicle Interface Harness requires unique additional circuits to accommodate the Pressure Sensor Governor (PSG).

The OEM must supply a series of interlock switches to insure the vehicle is in the specified state in order to activate the PSG.

CAUTION:

To avoid injury from the vehicle moving while in either Pressure or RPM Mode, the required interlock switches must be engaged.

Interlock switches may include but are not limited to the following:

- ☐ Parking brake
- ☐ Transmission state - in neutral (PTO pump) or engaged (midship pump)
- ☐ Pump mechanically engaged

2.16 OPTIMIZED IDLE

Optimized Idle enhances the DDEC Idle Shutdown feature. Optimized Idle will automatically stop and restart the engine when required in order to keep the engine temperature above 60°F, the battery charged, and/or the vehicle interior at the desired temperature.

CAUTION:

To avoid injury from an accidental startup of an engine equipped with the Optimized Idle® system, remove the starter relay from the relay holder.

3 HARDWARE AND WIRING

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3.1 SUPPLIED HARDWARE

Hardware supplied by the Original Equipment Manufacturer (OEM) and DDC is required to install DDEC IV. The following sections list the minimum hardware required.

3.1.1 OEM-SUPPLIED HARDWARE

The minimum OEM-supplied hardware required is listed in Table 3-1.

Hardware	Description
Ignition Switch (refer to section 3.4.4)	Switched 12 or 24 volt ignition source
Vehicle Interface Harness (VIH) (refer to section 3.4)	Connects the vehicle functions to the ECM.
Communication Harness (refer to section 3.5)	Connects the ECM's SAE J1922 and SAE J1939 data links to other vehicle systems.
Power Harness (refer to section 3.7)	Single-ECM Applications only - Connects battery power (12/24 volts) and ground to the ECM and includes fuse(s) or circuit breaker(s).
Vehicle Power Harness (refer to section 3.7.6)	Multi-ECM Applications only - Connects battery (12/24 V) and ground to ECMs and includes fuses and/or critical breakers.
Diagnostic Connector (refer to section 3.10.7)	Cab-mounted diagnostic connector
Throttle Input Device (refer to section 3.15)	An electronic foot pedal assembly (EFPA), hand throttle, or alternative throttle device
Coolant Level Sensor (CLS) (refer to section 3.14.19)	A radiator top tank or remote surge tank mounted sensor
Check Engine Light (CEL) (refer to section 3.16.1)	A panel mounted yellow indicator light.
Stop Engine Light (SEL) (refer to section 3.16.2)	A panel mounted red indicator light.

Table 3-1 OEM-supplied Hardware

3.1.2 DDC-SUPPLIED HARDWARE

The minimum DDC-supplied hardware required is listed in Table 3-2.

Hardware	Description
Engine Sensor Harness (refer to section 3.3)	Factory installed harness that facilitates the receipt of inputs and outputs signals, controlling the fuel injection process and engine speed.
Engine Interface Harness (refer to section 3.4.3)	Multi-ECM Applications - Factory installed, interface between ECM and VIH.
Injector Harness (refer to section 3.6)	Factory installed harness that is connect to the injection unit and the ECM(s).
Engine Power Harness (refer to section 3.7.5)	Multi-ECM Applications - Factory installed, interface between ECM and OEM Vehicle Power Harness.

Table 3-2 Minimum DDC Supplied Hardware

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3.2 ELECTRONIC CONTROL MODULE

The engine-mounted ECM includes control logic to provide overall engine management. The ECM continuously performs self diagnostic checks and monitors other system components. System diagnostic checks are made at ignition-on and continue throughout all engine operating modes. See Figure 3-1.

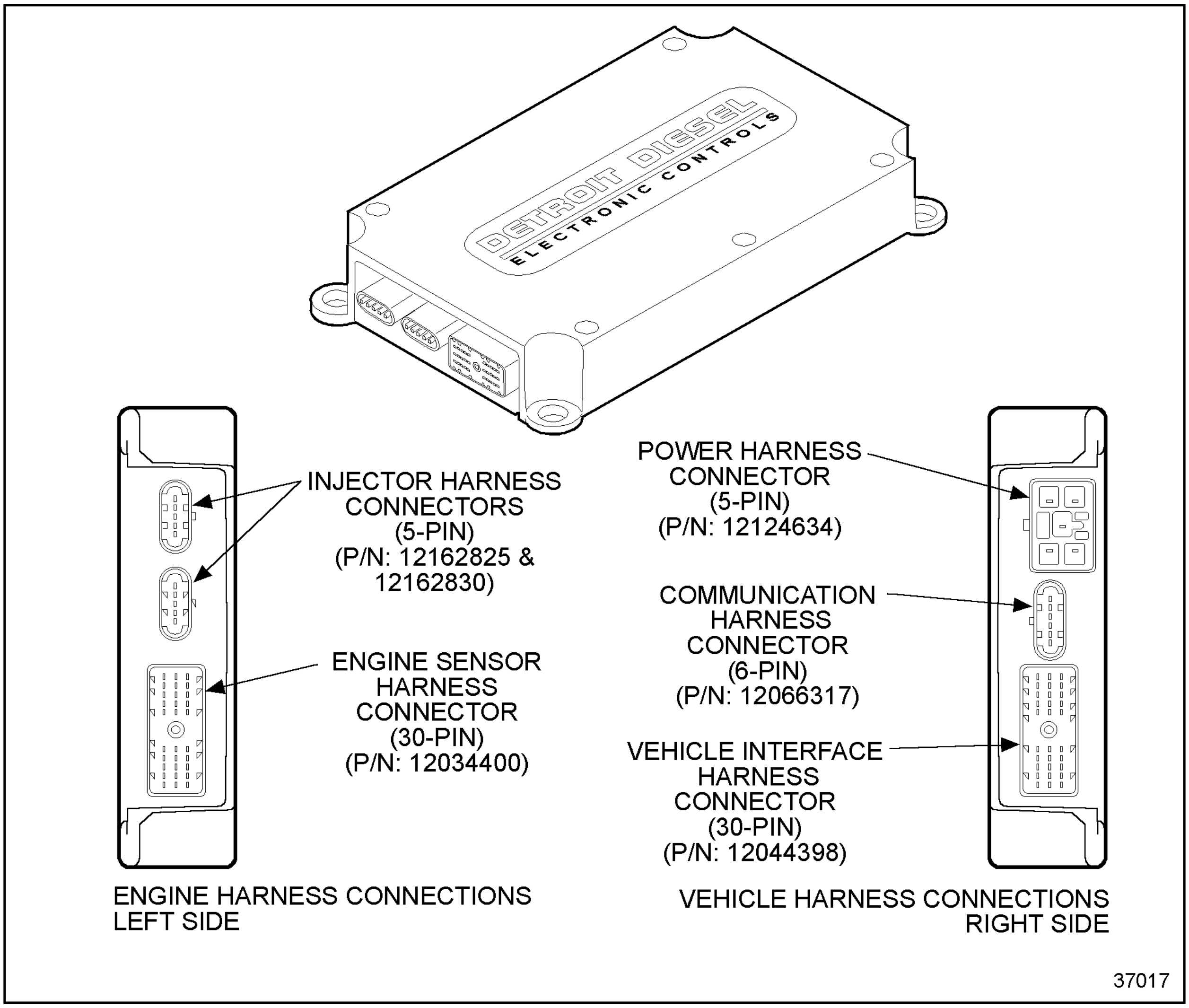

Figure 3-1 The Electronic Control Module

The ECM contains an Electronically Erasable Programmable Read Only Memory (EEPROM). The EEPROM controls the basic engine functions, such as rated speed and power, timing of fuel injection, engine governing, torque shaping, cold start logic, transient fuel delivery, diagnostics, and engine protection. The control logic determines duration and timing of fueling, which results in precise fuel delivery and improved fuel economy.

3.2.1 MULTI-ECMS

Engines with more than eight cylinders operate with multiple ECMs. One ECM is called the master, while the others are referred to as receivers. The master ECM is the primary controller of the engine. It receives input from the various sensors, determines proper timing and communicates this information to the injectors that the master ECM controls. The master ECM sends this information to the receiver ECM. The receiver ECM instructs its injectors to operate in the same manner. Capability exists to enable independent operation of each portion of the engine in the unlikely event that the communications fail between the master and receiver ECMs.

3.2.2 ECM PART NUMBERS

Part numbers for DDEC III and IV ECMs are listed in Table 3-3.

Part Number	Description	Voltage	No. of Cylinders
23518645*	DDEC III - Standard On-highway ECM	12/24 V	6
23518743	DDEC III - Universal ECM	12/24 V	8
23518744	DDEC III - Series 4000 ECM only	24 V	8
23519307	DDEC IV - Standard On-highway ECM	12 V	6
23519308	DDEC IV - Universal ECM	12/24 V	8
23519309	DDEC IV - Series 4000 ECM only	24 V	8

* Does not have SAE J1939, all other ECMs are SAE J1939 compatible

Table 3-3 ECM Part Numbers for DDEC III and DDEC IV

NOTE:
All DDEC IV ECMs are compatible with SAE J1939.

The part numbers for the ECM connectors are listed in Table 3-4.

Description	Part Number
Injector Harness Connectors (5-pin) (2 connectors)	12162825
	12162830
Engine Sensor Harness Connector (30-pin)	12034400
Power Harness Connector (5-pin)	12124634
Communication Harness Connector (6-pin)	12066317
Vehicle Interface Harness Connector (30-pin)	12044398

Table 3-4 ECM Connectors

For more information on the ECM connectors, refer to section 3.10.

3.2.3 ENVIRONMENTAL CONDITIONS

The following environmental conditions must be considered.

Temperature

The ambient operating temperature is – 40°F (-40°C) minimum and 221°F (105°C) maximum.

Atmospheric Pressure

The engine mounted ECM can withstand atmospheric pressures ranging from 62.0 to 120.0 kPa absolute that result from altitude and weather changes in the operating and non-operating conditions.

Water Intrusion

The ECM can be exposed to steam cleaning and pressure washing. Care should be taken not to pressure spray the connectors.

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3.3 ENGINE SENSOR HARNESS

The Engine Sensor Harness (ESH) is installed at the factory and is delivered connected to all engine sensors and the ECM. See Figure 3-2 for an illustration of a typical on-highway ESH. Refer to Appendix B for a harness schematic.

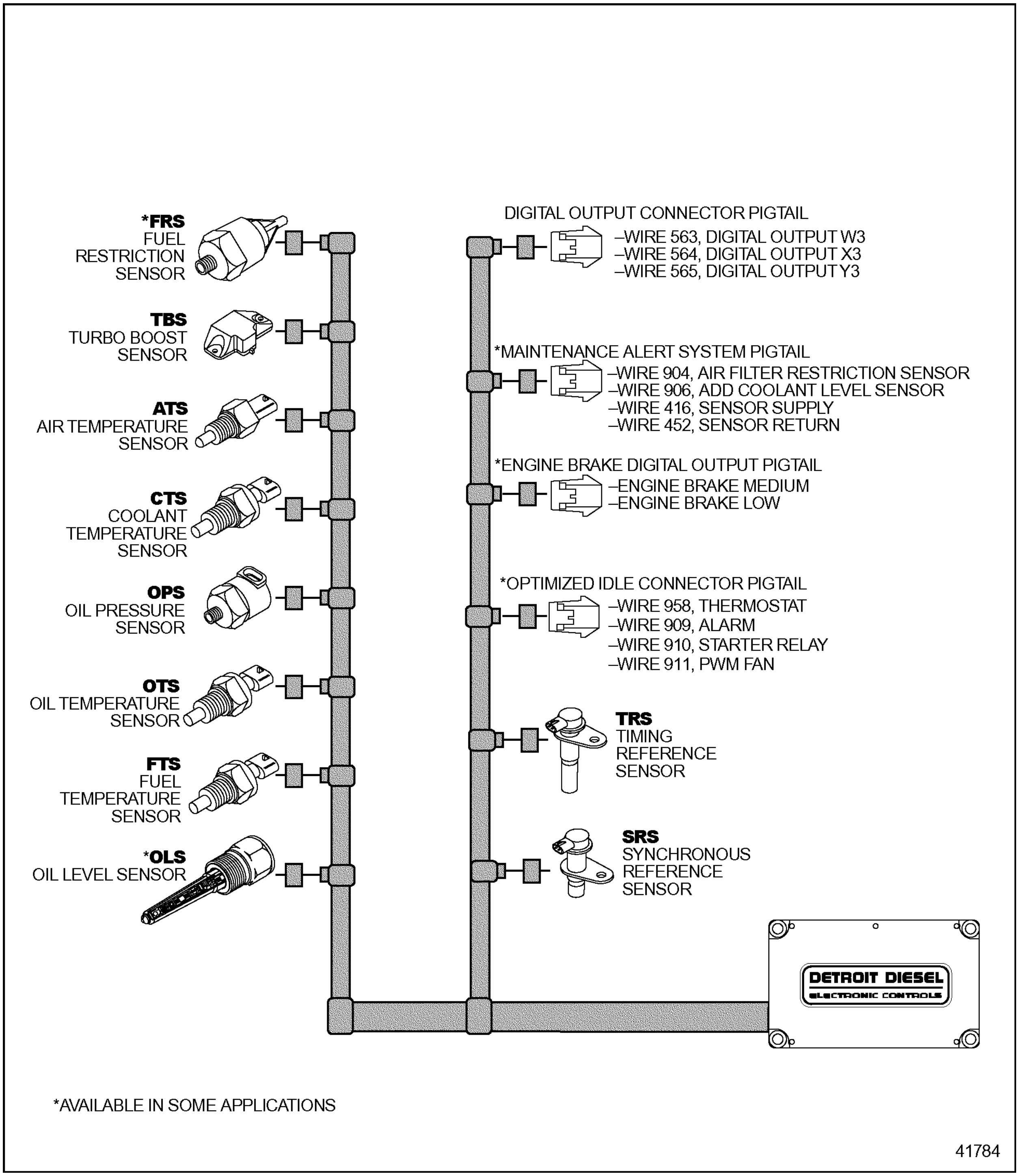

Figure 3-2 A Typical On-highway Engine Sensor Harness

See Figure 3-3 for an illustration of a Series 60 construction and industrial ESH.

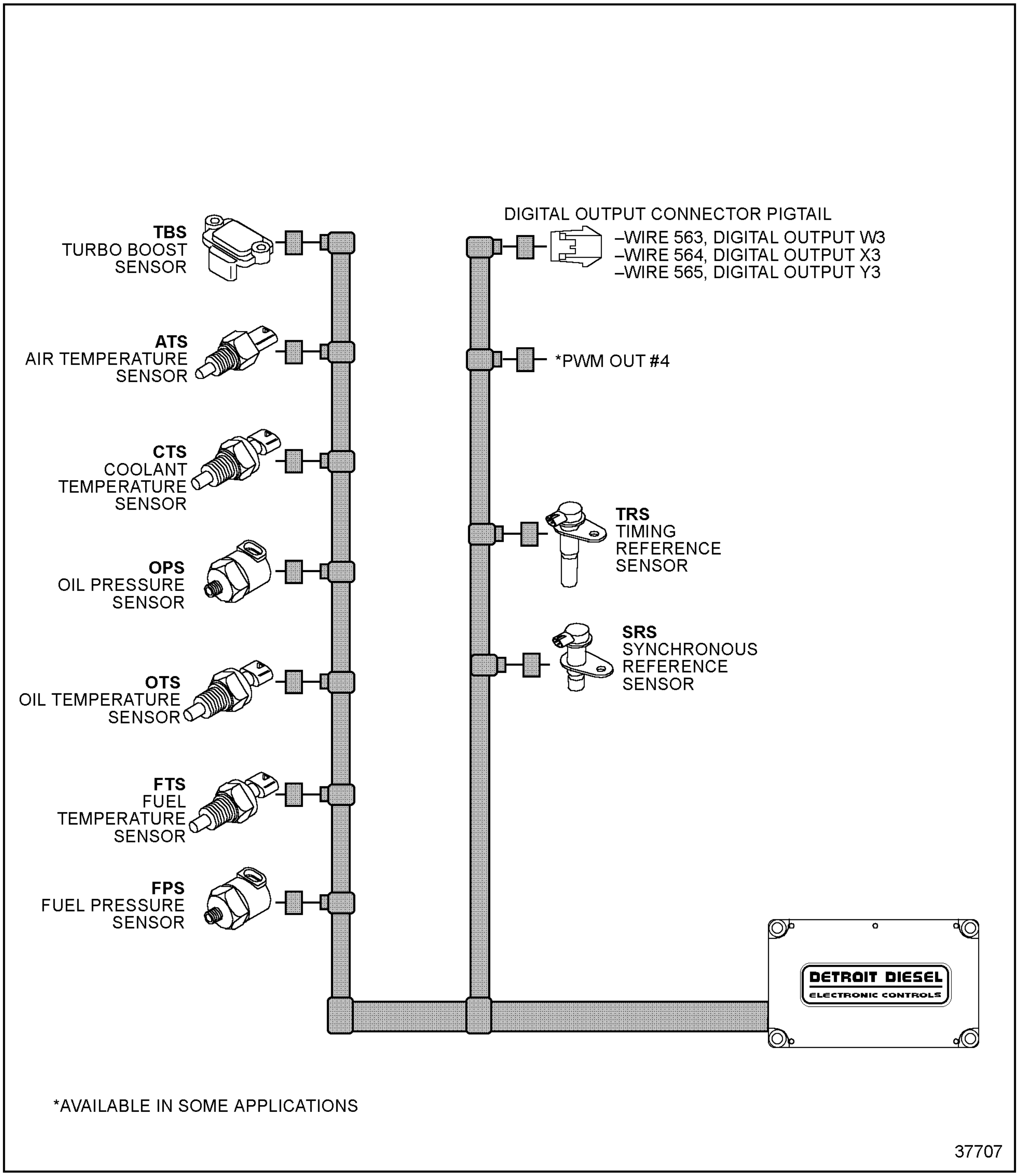

Figure 3-3 A Typical Series 60 Construction and Industrial Engine Sensor Harness

See Figure 3-4 for an illustration of a Series 2000 construction and industrial ESH. Refer to Appendix B for a harness schematic.

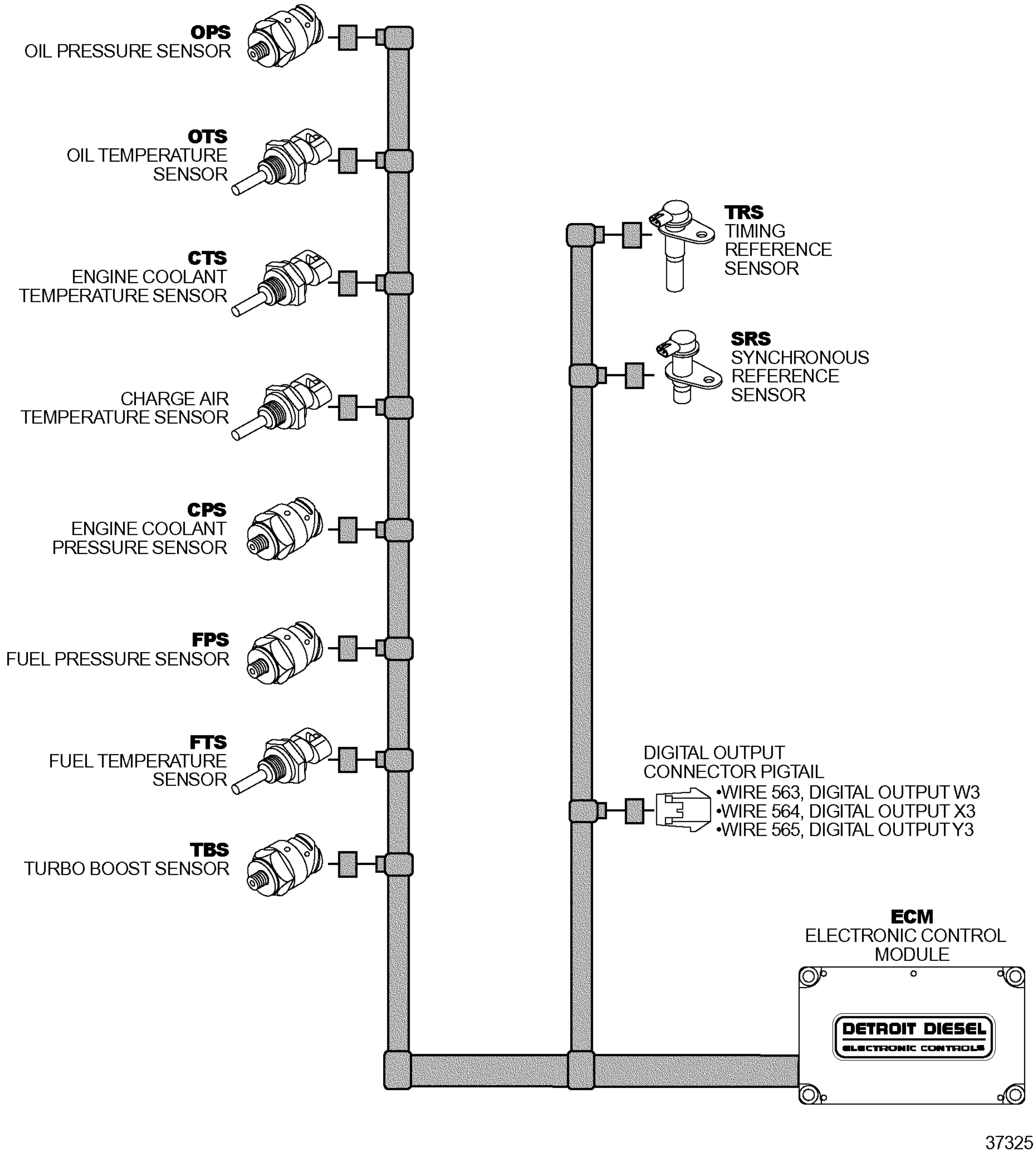

Figure 3-4 A Typical Series 2000 Single-ECM Construction and Industrial Engine Sensor Harness

See Figure 3-5 for an illustration of a Series 2000 generator set ESH. Refer to Appendix B for a harness schematic.

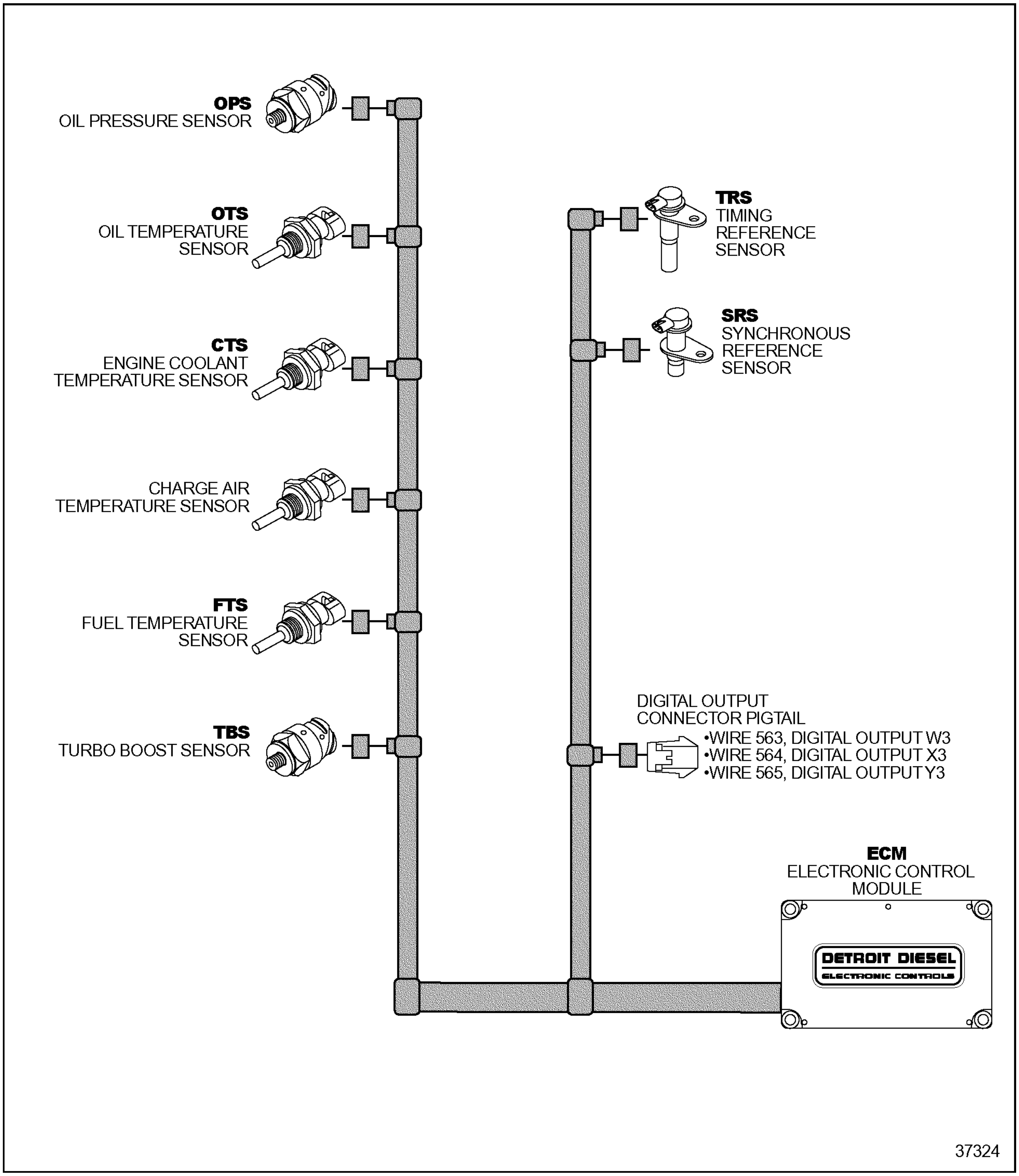

Figure 3-5 Series 2000 Single ECM Genset Engine Sensor Harness

3.3.1 ENGINE SENSOR HARNESS FOR MULTI-ECM ENGINES

Multi-ECM engines operate with more than one Electronic Control Module. The controlling ECM is referred to as the master ECM, while one receiver is referred to as the first receiver and the other, if required, is the second receiver.

The Engine Sensor Harness is installed at the factory and is delivered connected to all sensors and all ECMs. This harness contains the following:

- ☐ SAE J1939 communication link between the ECMs
- ☐ A Turbo Boost Sensor for each ECM
- ☐ The Timing Reference Sensor (TRS) and Synchronous Reference Sensor (SRS) are shared by the ECMs

See Figure 3-6 for an illustration of the Series 4000 multi-ECM Sensor Harness and see Figure 3-7 for an illustration of the Series 2000 multi-ECM Sensor Harness. Refer to Appendix B for a harness schematic.

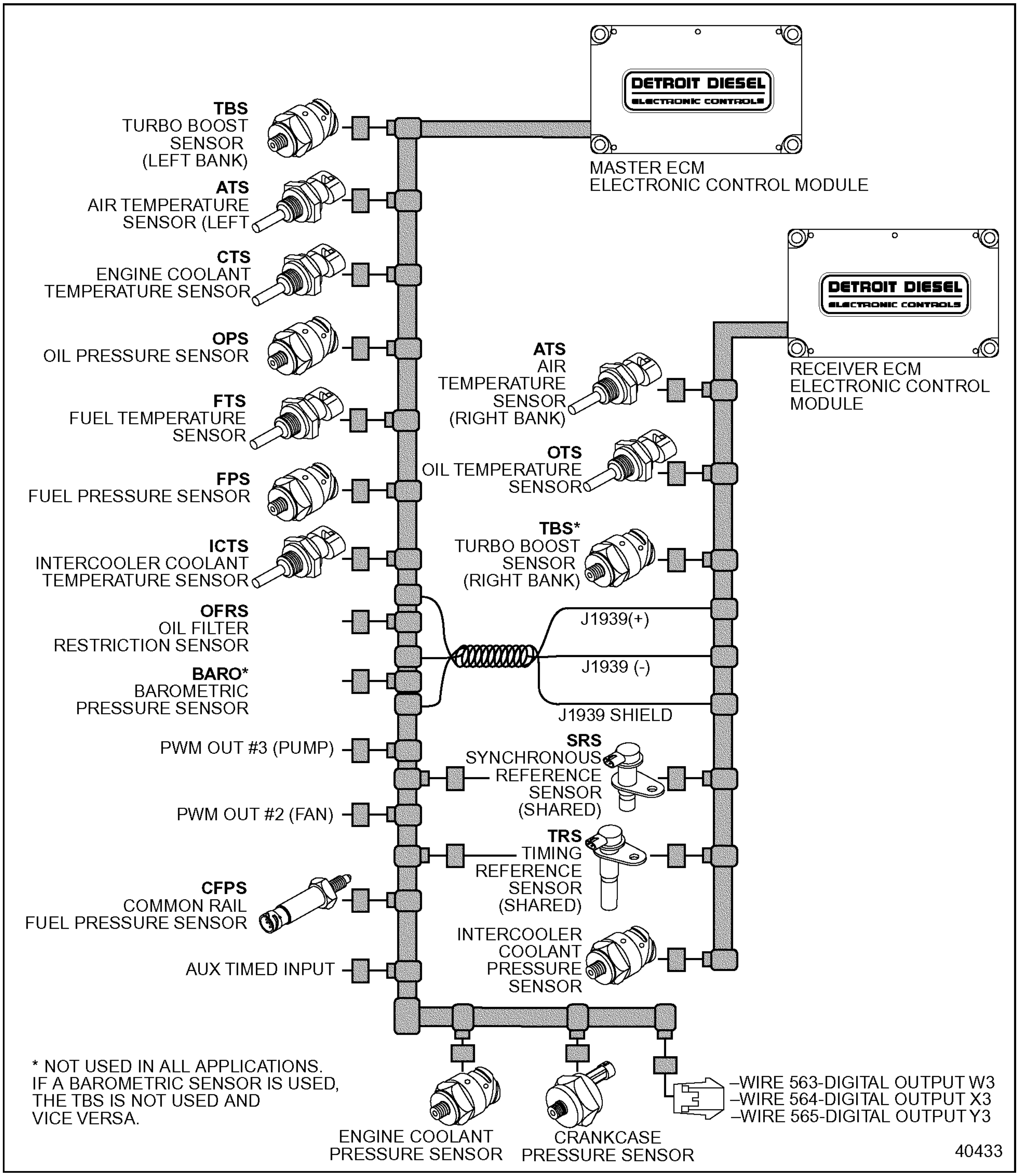

Figure 3-6 A Typical Series 4000 Multi-ECM Engine Sensor Harness

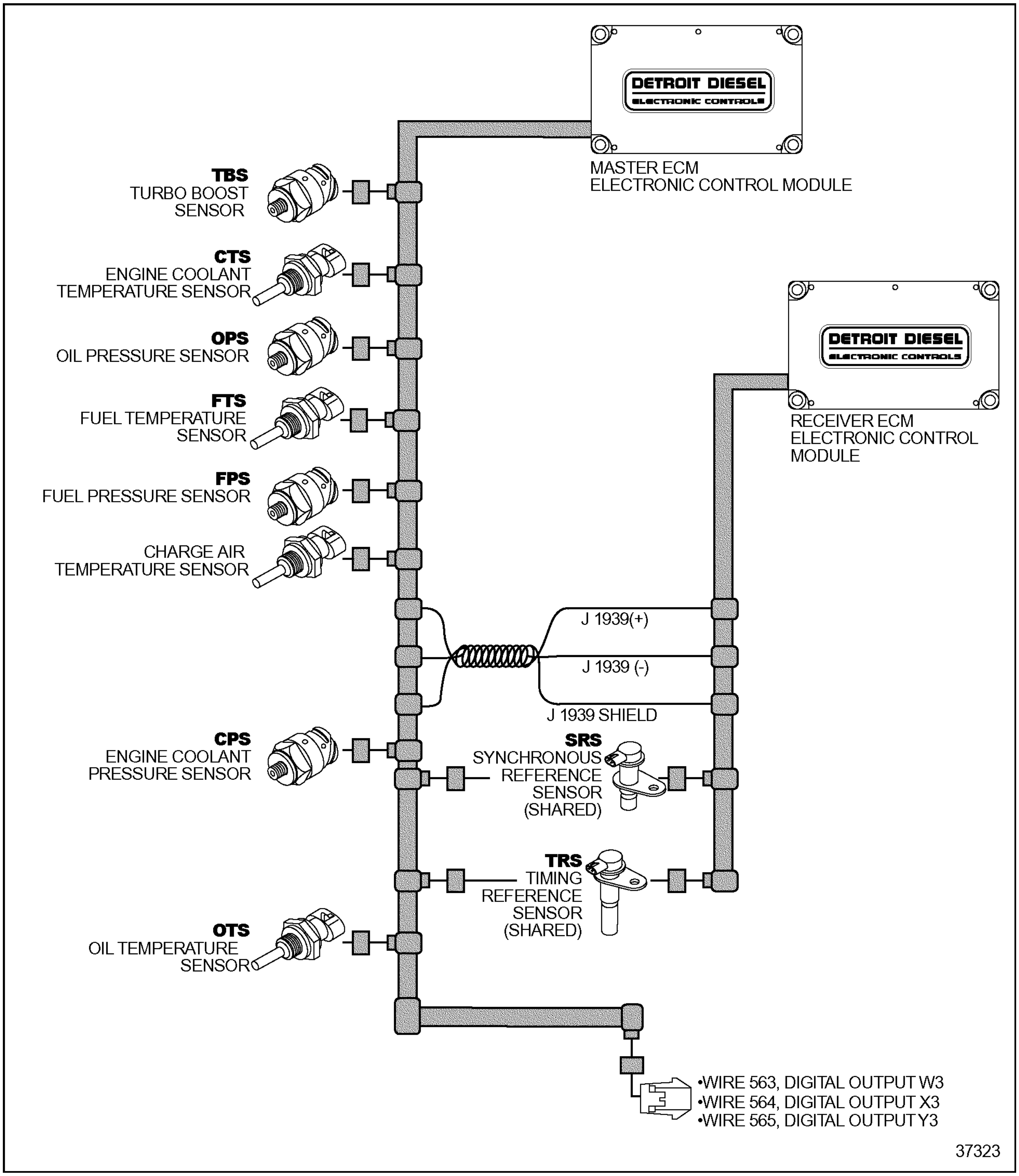

Figure 3-7 A Typical Series 2000 Multi-ECM Engine Sensor Harness

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3.4 VEHICLE INTERFACE HARNESS

The OEM supplied Vehicle Interface Harness (VIH) connects the ECM to other vehicle systems as shown in the VIH illustrations. See Figure 3-8 and Figure 3-9. Refer to Appendix B for a harness schematic.

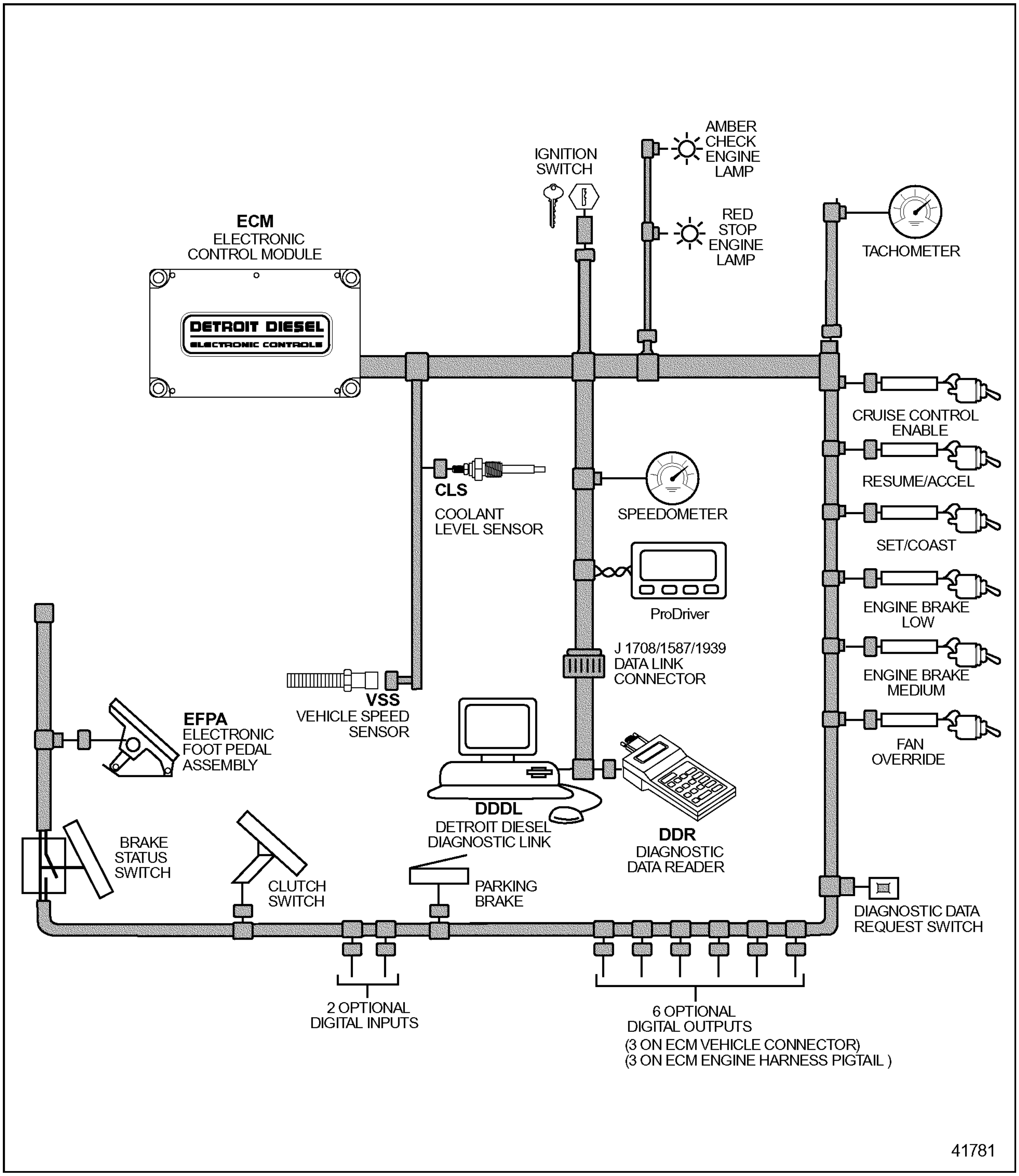

Figure 3-8 Typical On-highway Vehicle Interface Harness

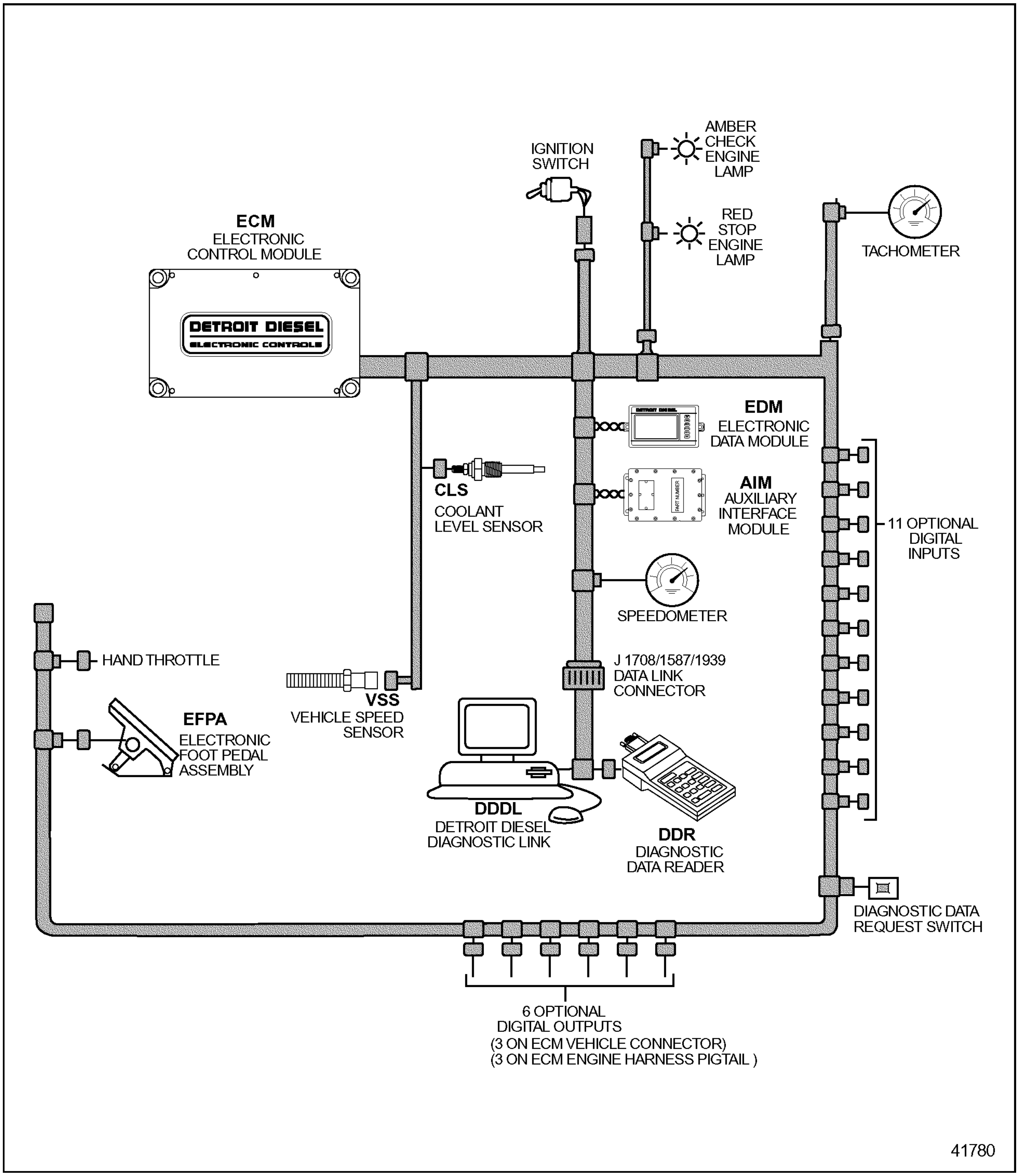

Figure 3-9 Typical Construction and Industrial Vehicle Interface Harness

3.4.1 VIH DESIGN

The following criteria are to be used when designing the VIH.

Criteria: VIH Design

The VIH 30-pin connector is designed to accept 18 gage (0.75 - 0.80 mm^2) standard wall thickness cable only.

The acceptable cable insulations are Teflon (EFTE), cross-link polyethylene (XLPE) or any equivalent self-extinguishing insulation such as GXL having a minimum rating of -40°C to 125°C. An equivalent insulation must meet the acceptable cable diameters from 2.00 - 2.42 mm.

The conductor must be annealed copper, not aluminum, and must comply with the industry standard SAE J1128 document.

Detroit Diesel Corporation recommends color coding and hot stamping wire numbers in contrasting colors at intervals of four inches or less.

NOTE:
Avoid renumbering DDC circuits since all troubleshooting guides reference the circuit numbers shown in the schematic. DDC suggests including a prefix or suffix with the DDC circuit numbers when conflicts exist.

NOTE:
The Vehicle Speed Sensor (VSS) circuits 556 and 557 and the Data Link circuits 900 and 901 (SAE J1587) must be twisted pairs. The twists are a minimum of 12 turns per foot (305 mm) and are required to minimize electromagnetic field coupling.

NOTE:
The maximum length for the SAE J1708/J1587 Data Link is 40 m (130 ft). The maximum length for the SAE J1939 Data Link is 40 m (130 ft).

3.4.2 VIH INSTALLATION

The following concepts have proven to be effective in installing the VIH.

Provide maximum physical separation of the VIH from other vehicle electrical systems. Other electrical system cables should ideally be at least three feet away from the VIH and should not be parallel to the VIH. This will eliminate coupling electromagnetic energy from other systems into the VIH.

Do not route the harness near any vehicle moving parts, exhaust or any high heat source.

Use a protective sheath to prevent wires from being cut or frayed when weaving harness through the frame.

The 30-pin VIH-to-ECM connector assembly (12034398) center screw must be torqued to 7-13 in.·lbs (0.79 - 1.47 Nm).

Adhere to industry standards for relief length and maximum wire bend radius at the connectors.

3.4.3 VEHICLE INTERFACE HARNESS FOR MULTI-ECM ENGINES

Multi-ECM engines operate with more than one engine mounted ECM. The controlling ECM is referred to as the master ECM, while one receiver is referred to as the first receiver and, if required, the other is the second receiver.

The VIH is similar to the VIH used for single-ECM engines with the following exceptions:

- ☐ The Series 149 engine has a single SEL and a single CEL for each ECM.

  The Stop Engine Override Switch operates all ECMs with the engine running and acts as a diagnostic code flashing switch on the CEL and SEL for the master ECM only when the engine is not running.
- ☐ The Stop Engine Override/Diagnostic Request Switch is used to flash codes on the CEL and SEL from the master ECM when the engine is not running or the engine is at idle.
- ☐ All receiver ECMs have a separate Diagnostic Request Switch that cannot enable the Stop Engine Override function.

Engine Interface Harness

The Engine Interface Harness used in multi-ECM applications is usually installed at the factory and delivered connected to all ECMs. The factory installed Engine Interface Harness (see Figure 3-10), normally terminates with a quick disconnect connector.

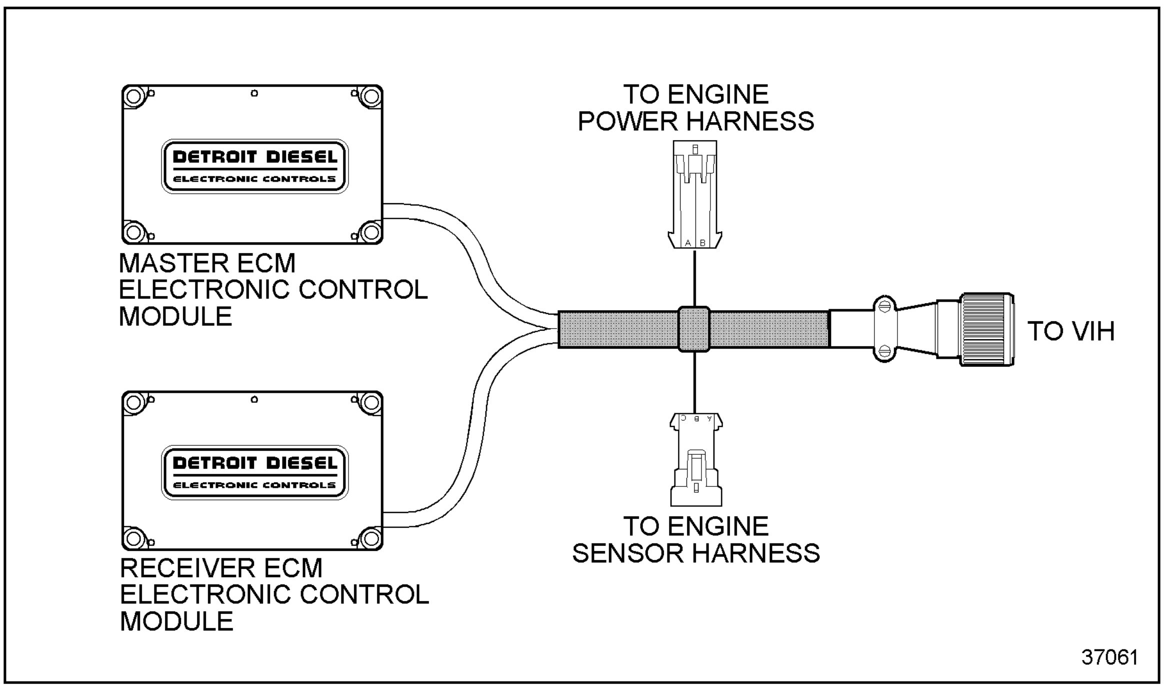

Figure 3-10 A Typical Multi-ECM Engine Interface Harness

The OEM Vehicle Interface Harness connects to the quick disconnect connector (see Figure 3-11 and Figure 3-12). Refer to Appendix B for a harness schematic.

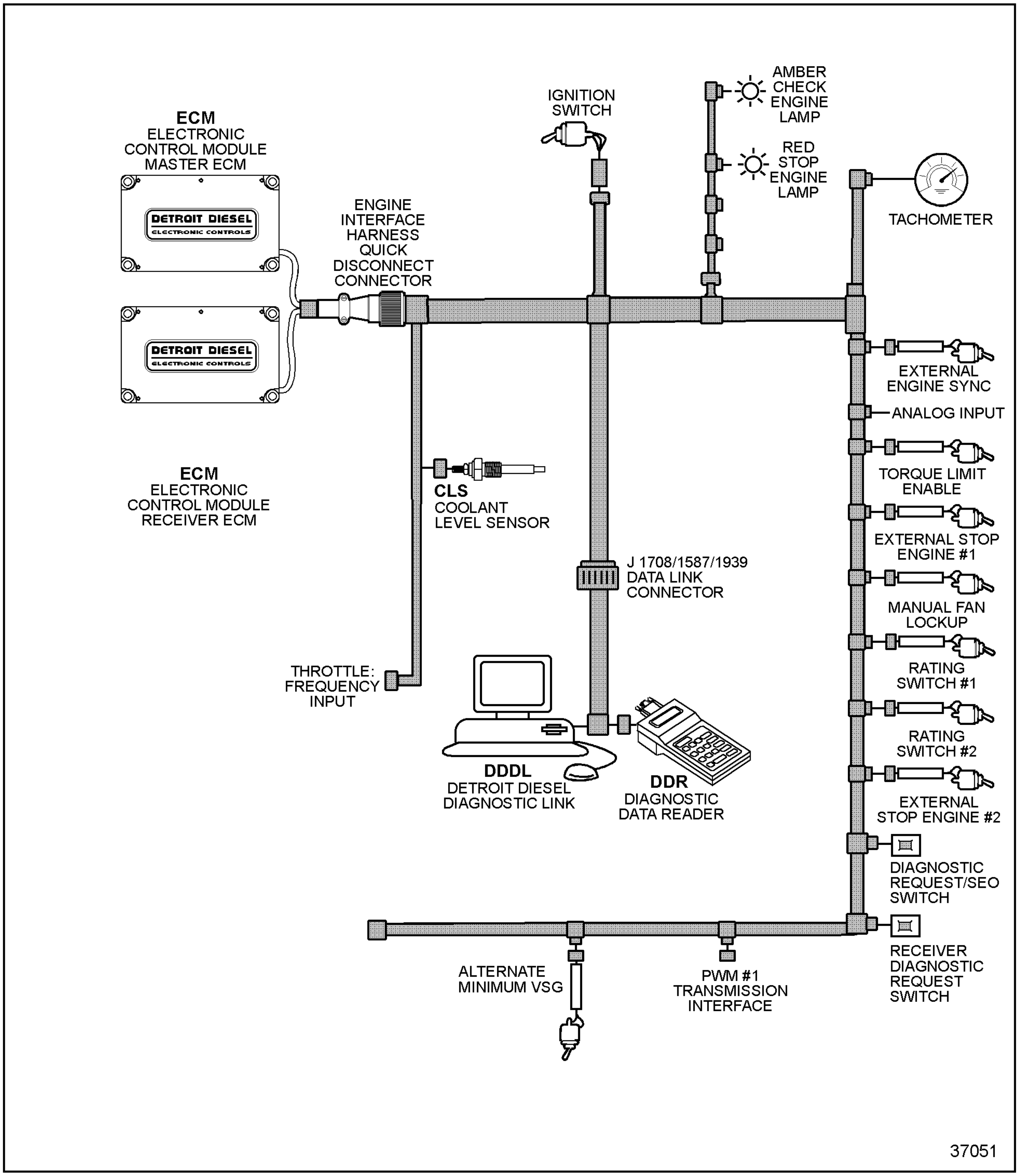

Figure 3-11 Typical Multi-ECM Construction and Industrial Vehicle Interface Harness Schematic - Series 4000

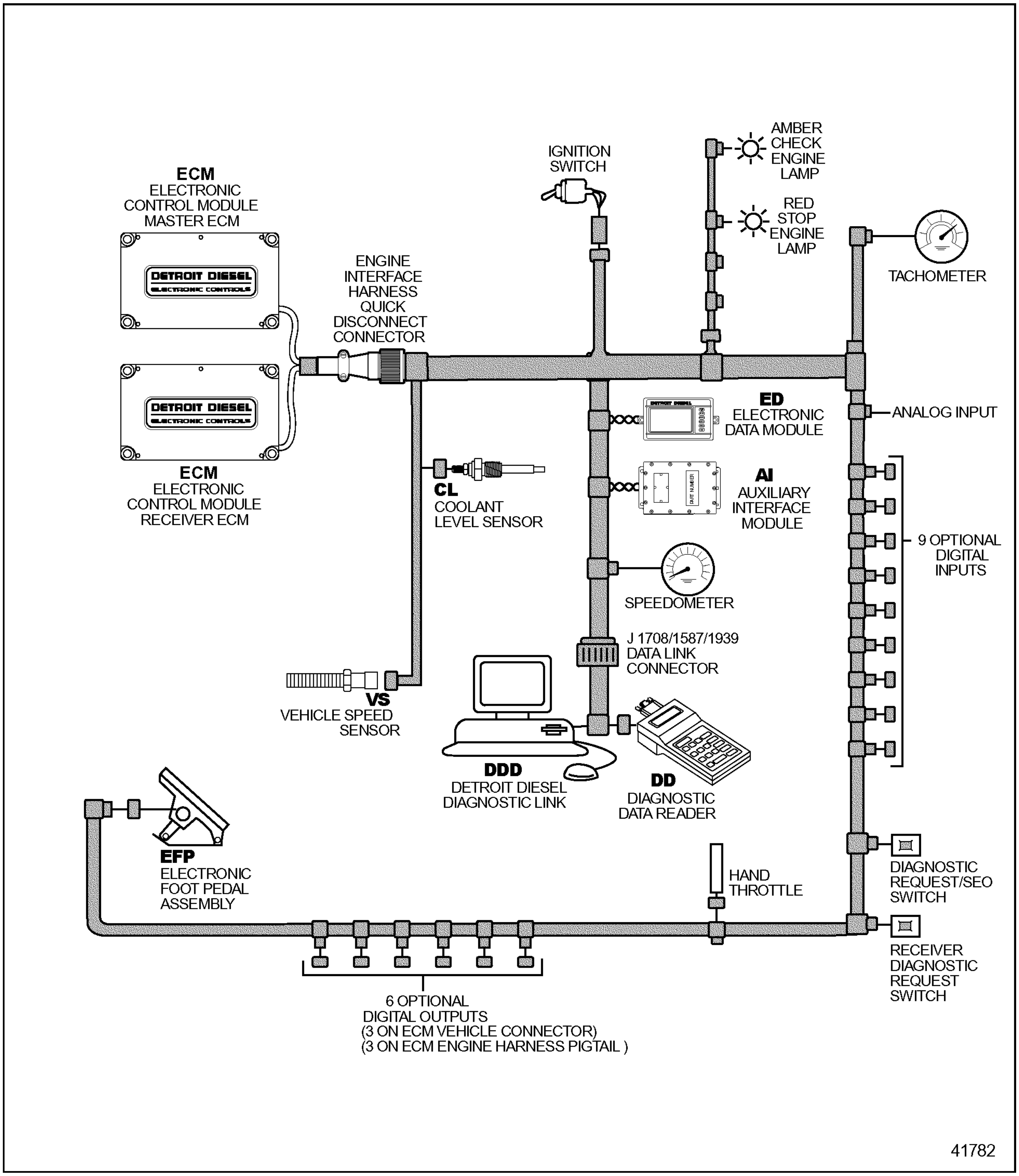

Figure 3-12 Typical Multi ECM Construction and Industrial Vehicle Interface Harness Schematic - Series 2000

3.4.4 HARNESS DESIGN GUIDELINES

The electrical characteristics of some of the system elements including the ECM are described in the following sections. This information is useful for harness design.

NOTE:
All output loads (PWM and digital outputs), ignition, and ECM power must be powered by the same battery voltage.

Pulse Width Modulated Port (PWM #1, 2, 4)

The output of this port is capable of providing 50 to 1000 Hz modulation between 0% and 100% duty cycle with a resolution of less than or equal to 0.1% duty cycle and an accuracy of less than or equal to 20 µsec.

Output Characteristics:

Output On:	E_{out} is less than or equal to 0.8 volts with respect to ECM ground. I_{sink} is less than or equal to 5 mA.
Output Off:	$I_{leakage}$ (I_{sink}) is less than or equal to 1.0 mA while $0 \le E_{out} \le V_{battery}$.

Load Drive Capabilities:

Resistance:	Capable of driving a resistance greater than or equal to 32 ohms for a 12 volt ignition. Capable of driving a resistance greater than or equal to 64 ohms for a 24 volt ignition.
Inductance:	Capable of connecting to an inductance less than or equal to 60 mH at 100 Hz.
I_{sink}:	Capable of sinking an average current of 3 A or less and peak current of 6 A or less.

Digital Output Ports

The digital output ports are: 419, 509, 988, 555, 499, 563, 564, and 565. Wire numbers 419 and 509 are reserved for the CEL and SEL, respectively. Refer to section 4.2, "Digital Outputs" for additional information.

Output Characteristics:

Output On:	E_{out} is less than or equal to 0.8 volts with respect to ECM ground (#150). $I_{sink}$is less than or equal to 1.5 A.
Output Off:	$I_{leakage}$ (I_{sink}) is less than or equal to 1.0 mA while $0 \le E_{out} \le V_{battery}$.

Load Drive Capabilities:

Resistance:	Capable of driving a resistance greater than or equal to 11 Ω for a 12 volt ignition. Capable of driving a resistance greater than or equal to 21 Ω for a 24 volt ignition.
Inductance:	Capable of connecting to an inductance less than or equal to 85 mH. If load is >85 mH then external clamping is required.
I_{sink}:	Capable of sinking less than or equal to 1.5 A.

The digital output ports are capable of driving a #168 bulb (three candlepower lamp) in a 12 volt system or a # 313 bulb (three candlepower lamp) in a 24 volt system. See Figure 3-13.

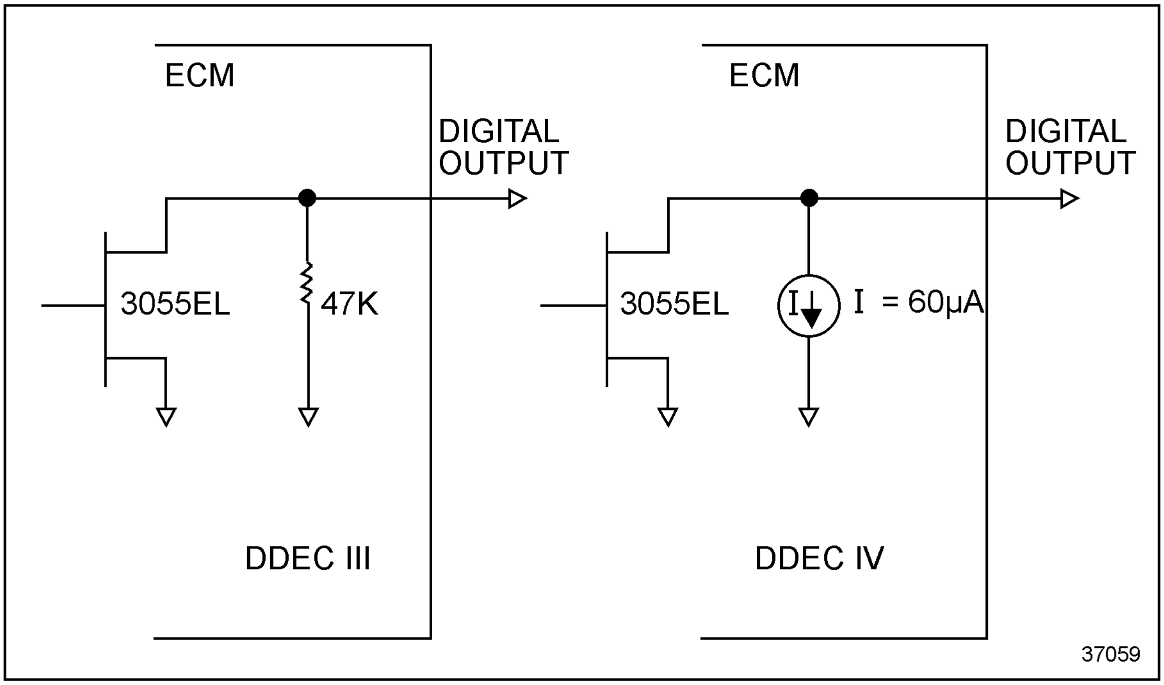

Figure 3-13 DDEC III and DDEC IV Internal Digital Output Circuits

Digital Input Ports

The digital input ports are: 451, 542, 528, 523, 541, 544, 543, 524, 531, 583, 545 and 979. Refer to section 4.2, "Digital Inputs" for additional information.

Input Requirements:

High State:	32 volts > E_{in} > 4 volts at less than 0.2 mA leakage current. The ECM has an internal 1kΩ pull-up to 5 volts.
Low State:	E_{in}< 1.0 volts.
I_{source}:	Capable of sourcing up to 5 mA.

NOTE:
Use switches that will not oxidize with the passage of time and environmental factors due to the low source current.

A DDEC IV digital input circuit may be seen in the next illustration (see Figure 3-14).

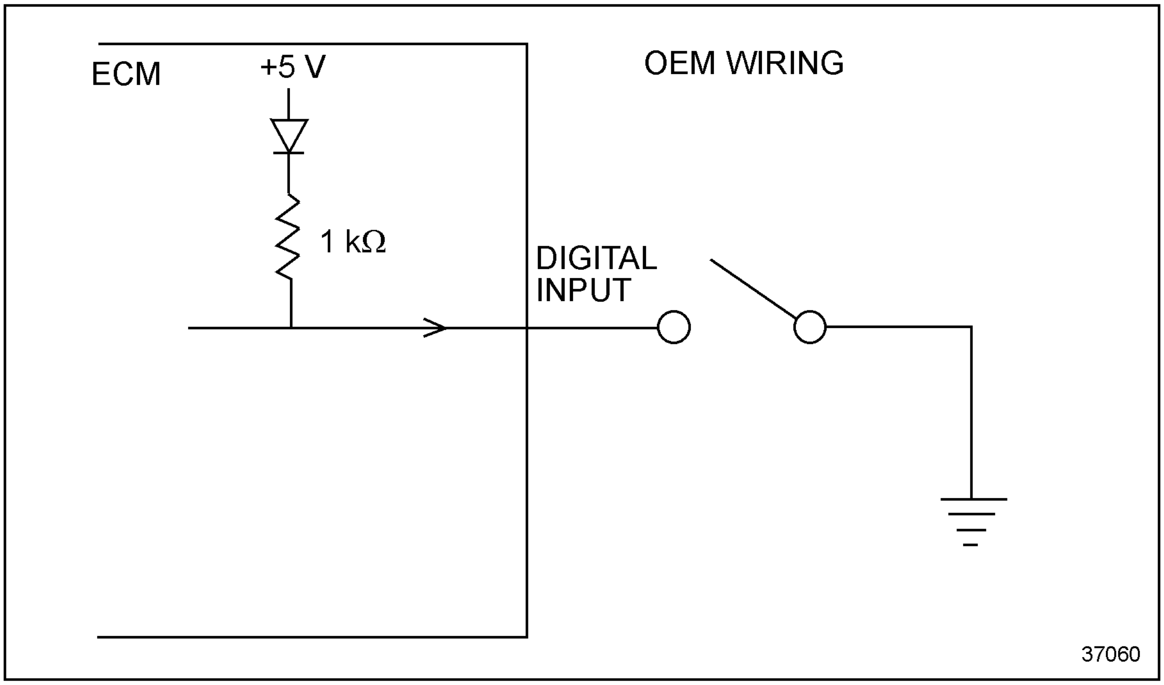

Figure 3-14 DDEC IV Digital Input Circuit

Switch Ground

Switch ground (circuit 953) must only be used to provide ground for DDEC components (i.e. digital inputs) and must be sourced directly from the negative battery or bus bar terminal; refer to section 3.7, "Power Harness."

NOTE:
This circuit can not be used to provide ground for non-DDEC OEM-supplied electronics.

Ignition

The ignition source may be either 12 or 24 volts depending on the ECM configuration. The DDEC ignition must be an independent input sourced directly from the battery post via a 5 amp weatherproof blade type fuse, circuit breaker, or equivalent. Fuse holders for blade type fuses may be purchased from the DDC Parts Distribution Center. Part numbers are listed in Table 3-5.

Part	Part Number
Fuse Holder	12033769
Cover	12033731
Terminals	12066614

Table 3-5 Fuse Holder Part Numbers

Ignition voltage must be continuously provided in the crank and run modes.

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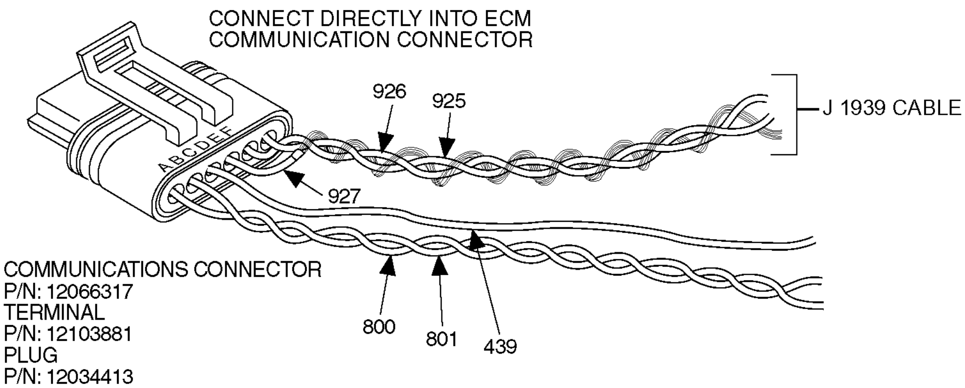
3.5 COMMUNICATION HARNESS

The OEM-supplied Communication Harness connects the ECM ports for SAE J1922 and SAE J1939 to other vehicle systems such as traction control devices, transmissions, braking systems, and retarders as shown in the communication harness schematic; see Figure 3-15.



LABEL	WIRE NO.	COMMUNICATION CONNECTOR CAVITY	WIRE COLOR
CAN_H/J 1939 (+) CONTROL DATA LINK	925	F	DK BLU
CAN_L/J 1939 (-) CONTROL DATA LINK	926	E	DK BLU/WHT
CAN_SHLD/J 1939 SHIELD	927	D	WHT/BLU
IGNITION	439	C	PNK
J 1922 (-) DATA LINK	801	B	TAN

NOTE: CIRCUIT 927 MUST USE A SHORT LENGTH (APPROX.) 6 in. OF STANDARD GAUGE GXL IN CAVITY D OF THE CONNECTOR, SPLICED TO THE NON-INSULATED SHIELD WIRE OF THE J 1939 COMMUNICATIONS CABLE. THE SPLICE MUST BE WRAPPED OR COVERED WITH A MATERIAL SUITABLE TO PREVENT DAMAGE TO THE OTHER WIRES. THE ENTIRE ASSEMBLY MUST BE COVERED WITH A GLUE LINED HEAT SHRINK.

NOTE: THE IGNITION WIRE IS OPTIONAL IF THE OEM HAS INSTALLED IGNITION ON THE 30-PIN VEHICLE INTERFACE HARNESS.

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Figure 3-15 Communication Harness

Both SAE J1922 and SAE J1939 provide for the interchange of interactive control data between vehicle systems and eliminate the need for redundant sensors. SAE J1922 runs at 9.6K baud while SAE J1939 runs at 250K baud.

3.5.1 DESIGN GUIDELINES

The design guidelines for the Communication Harness are as follows:

SAE J1922:	The SAE J1922 wire pairs (800 & 801) must be twisted a minimum of 12 turns per foot (305 mm). Twisting this wire pair will minimize the electromagnetic coupling effects.
SAE J1939:	The SAE J1939 wiring must follow the SAE J1939 wiring guidelines including termination resistors. The SAE J1939 wires (925, 926, and 927) must be twisted at nine turns per foot (305 mm). Refer to SAE J1939-11 for further details.

The following list of SAE documents covering the SAE J1939:

- J1939 - Top Layer (Overview)
- J1939-11 Physical Layer
- J1939-21 Data Link
- J1939-71 Application Layer
- J1939-01 Recommended Practice for Control and Communications Network for On-highway Equipment

The SAE document that covers the SAE J1922 Data Link is "Powertrain Control Interface for Electronic Controls Used in Medium and Heavy Duty Diesel On-Highway Vehicle Applications."

To obtain a copy of the SAE documents for SAE J1922 and SAE J1939, contact the Society of Automotive Engineers (SAE).

SAE International
400 Commonwealth Drive
Warrendale, PA 15096
Attention: Publications
Phone: (412) 776-4970

For a list of messages supported by DDEC, refer to Chapter 5, "Communication Protocols."

3.6 INJECTOR HARNESS AND INJECTION SYSTEMS

The injector harnesses (see Figure 3-16) are installed at the factory and are delivered completely connected to the injection units and the ECMs.

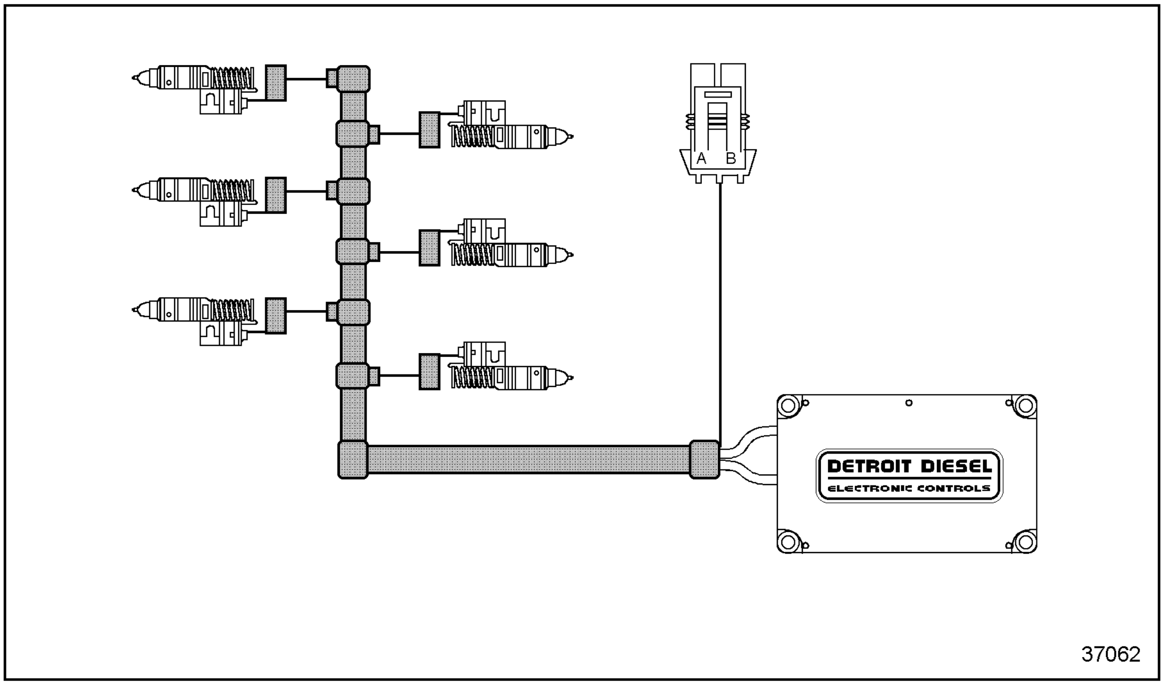

Figure 3-16 Typical On-highway Injector Harness

Injector harness schematics for various engine series and applications may be found in the Appendix (refer to Appendix B).

3.6.1 ELECTRONIC UNIT INJECTORS

The Electronic Unit Injector (EUI) (see Figure 3-17) operates on the same basic principle as the Mechanical Unit Injector (MUI) which has been incorporated in Detroit Diesel engines for over fifty years.

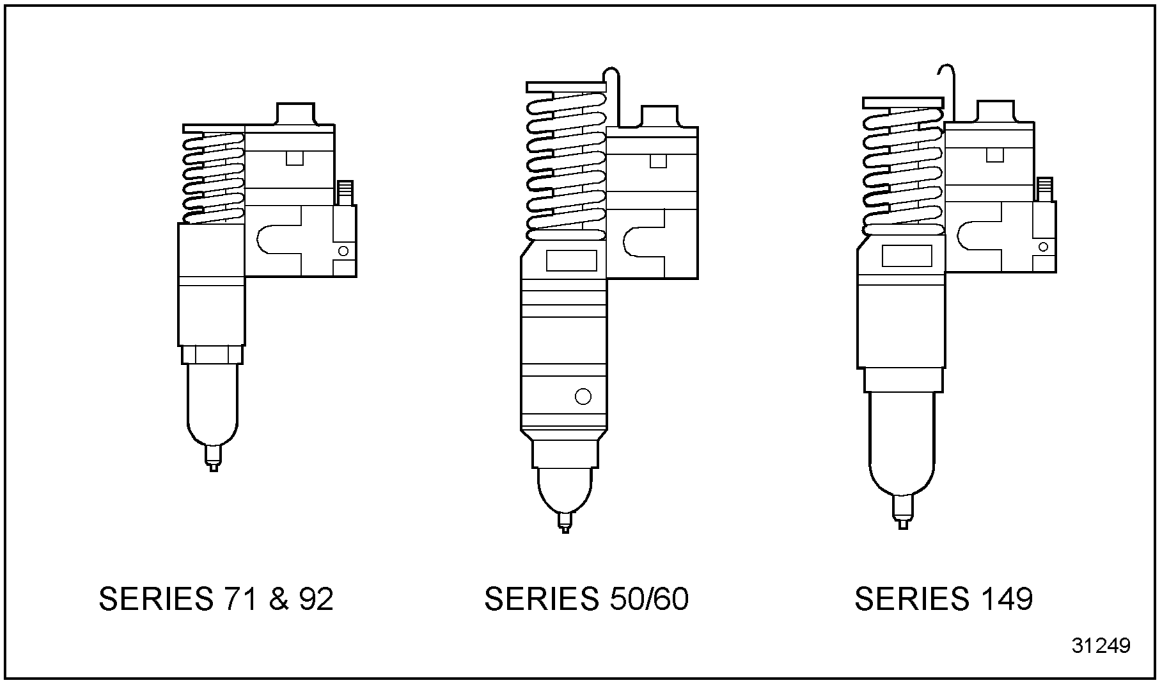

Figure 3-17 The Electronic Unit Injector

The EUI uses a solenoid operated valve to control injection timing and metering. The source for high pressure fuel delivery is the cam/rocker arm system. Fuel injection begins when the solenoid valve is closed. Opening the solenoid valve ends injection. The duration of valve closure determines the quantity of fuel injected.

3.6.2 COMMON RAIL ELECTRONICS

The Series 4000 common rail fuel injection system relies on a single high pressure fuel pump that provides a continuous supply of fuel, at injection pressure, to all of the injectors.

The ECM(s) receives data (such as engine temperatures and engine speed), analyzes this data, and modulates the fuel system accordingly to ensure efficient engine operation. The signals that the ECM(s) sends to the high pressure pump determines the timing and amount of fuel delivered to each cylinder.

3.6.3 ELECTRONIC UNIT PUMP

The Series 2000 Electronic Unit Pump (EUP) provides fuel to the fuel injector nozzle. The nozzle directs pressurized fuel directly into the combustion chamber. The EUP uses a solenoid operated valve to control injection timing and metering. The source for high pressure fuel delivery is the cam/rocker arm system. Fuel injection begins when the solenoid valve is closed. Opening the solenoid valve ends injection. The duration of valve closure determines the quantity of fuel injected. See Figure 3-18.

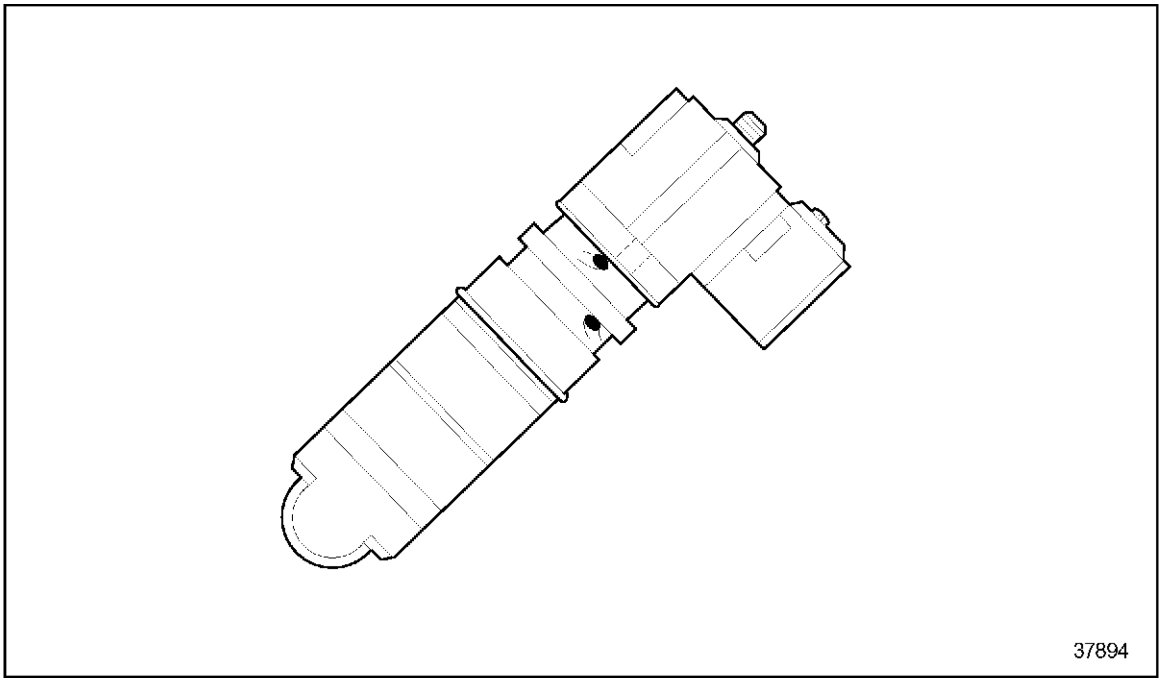

Figure 3-18 Electronic Unit Pump Assembly

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3.7 POWER HARNESS

The OEM-supplied Power Harness supplies either 12 or 24 volts depending on the ECM. The system must be sourced directly from the battery or bus bar.

3.7.1 DUAL-FUSE INSTALLATION

DDC's primary recommendation is a dual-fuse installation. This will provide redundancy on a critical circuit and prevent splicing of wire into fuse holders or power connectors. Dual-fuse installations have two lines wired in parallel. This configuration also allows for a greater distance from ECM to battery. See Figure 3-19.

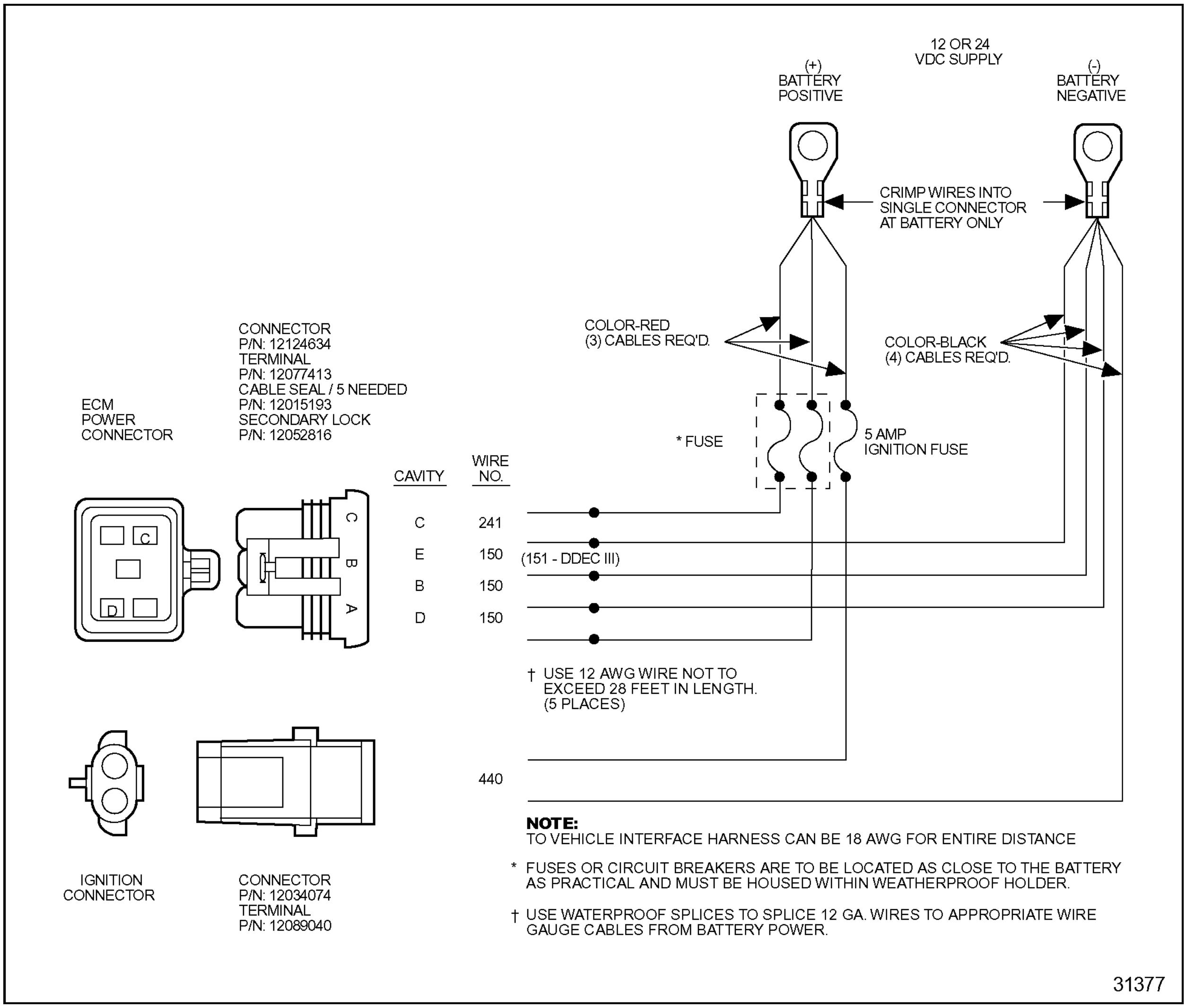


Figure 3-19 Power Harness - Single-ECM, Dual-Fuses

The resistance requirement is unchanged. The correct fuse size is listed in Table 3-6.

NOTICE:
Connection to reverse polarity will damage the system if not properly fused.

Number of Cylinders	Dual-Fuse or Circuit Breaker Size
6	2@ 15 A
8	2@ 20 A
12	4@ 15 A
16	4@ 20 A
20	4@ 15 A 2@ 20 A

Table 3-6 Fuse Size For Dual-Fuse Installations

To determine minimum cable gage based upon harness length from the battery source to the ECM, use the information listed in Table 3-7.

Length from ECM to Battery or Bus Bar		Minimum Wire Size		Total Resistance of Maximum Length	
U.S. (ft)	International (m)	U.S. (Ga.)	International (mm^2)	U.S. ($m\Omega$)	International ($m\Omega$)
0 to 28	0 to 6	12	2.5	24.8	22.8
28 to 44	6 to 10	10	4	24.57	23.55
44 to 70	10 to 14	8	6	24.58	21.98
70 to 110	14 to 26	6	10	24.7	23.66
110 to 178	26 to 40	4	16	25.0	23.2

Table 3-7 Power Harness Length Criteria for Dual Fuse Installations

NOTE:
For international wire sizes the harness length must be recalculated to meet the resistance requirement.

If larger than 12 AWG wire is required, it should be spliced to 12 AWG wire as close as possible to the connector (see Figure 3-20).

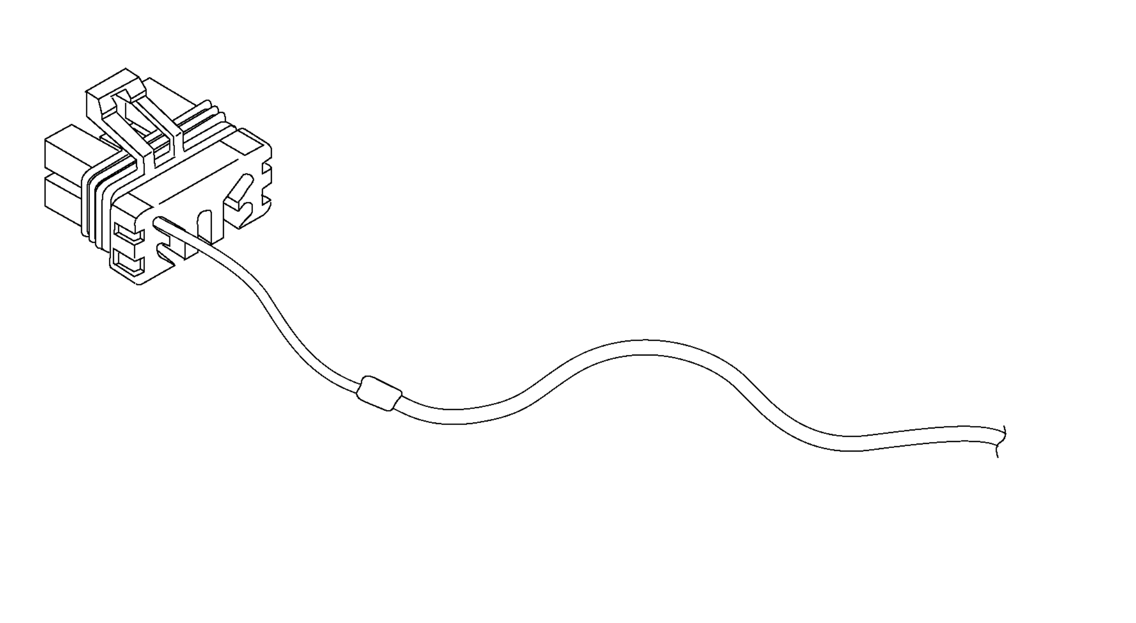


Figure 3-20 Spliced Power Connector Wire

These length and sizes are based on the use of stranded *annealed copper* not aluminum wire.

Splices must be soldered and sealed with a waterproof insulator. Alpha FIT-300, Raychem TAT-125 or any equivalent heat shrink - dual wall epoxy encapsulating adhesive polyolefin is required.

3.7.2 SINGLE-FUSE INSTALLATION

Single-fuse installations have one line from the battery to the ECM. The correct fuse size is listed in Table 3-8.

Number of Cylinders	Single-Fuse or Circuit Breaker Size
6	1@ 30 A
8	1@ 40 A
12	2@ 30 A
16	2@ 40 A
20	2@ 30 A 1@ 40 A

Table 3-8 Fuse Size for Single Fuse Installations

NOTE:
A single-fuse installation does not provide redundancy on a critical circuit and does not prevent splicing of wire into fuse holders or power connectors.

Single fuse installations are simpler and less expensive than two fuse installations. See Figure 3-21.

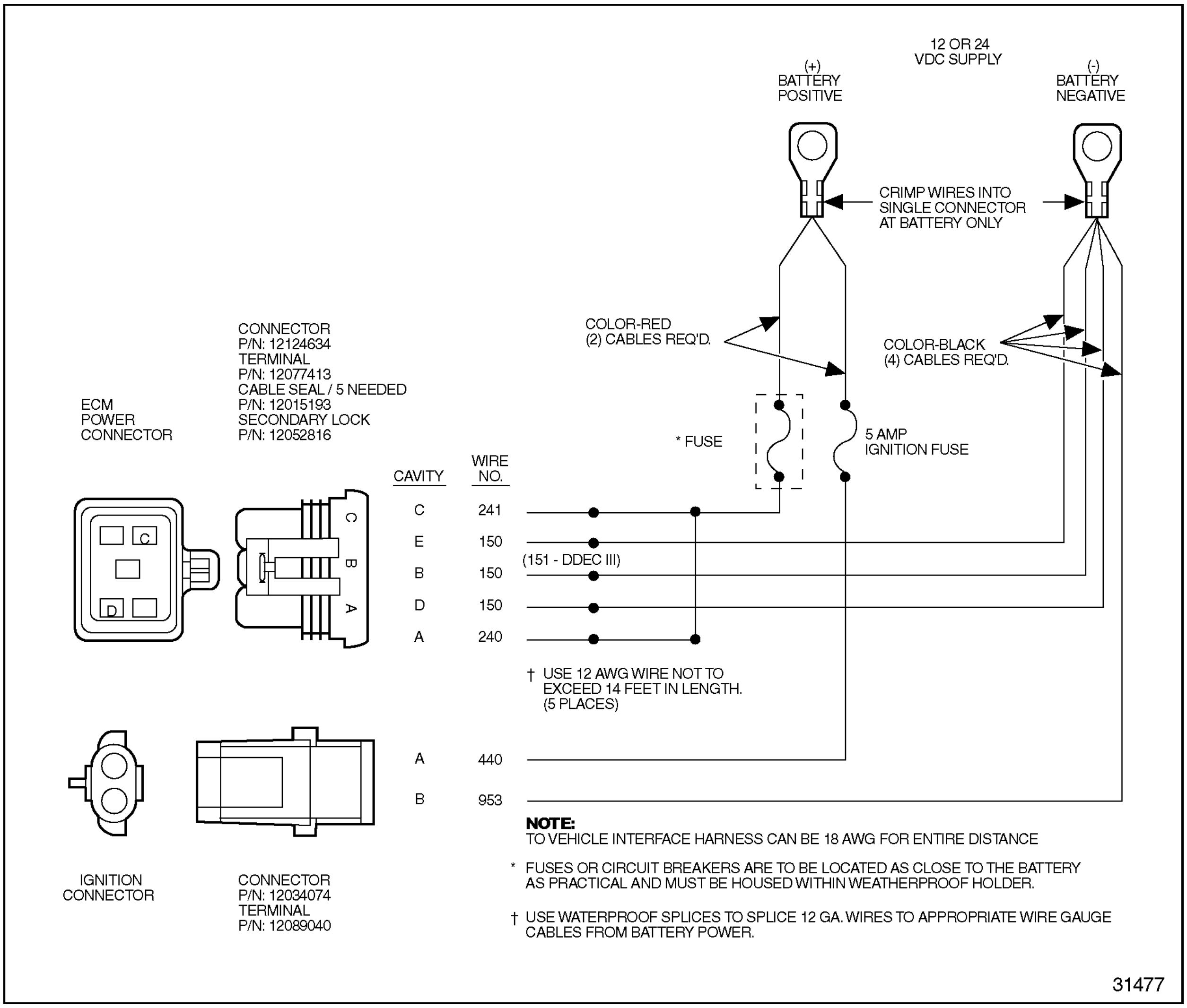


Figure 3-21 Power Harness - Single-ECM, Single-Fuse

The minimum cable gage based upon harness length from the battery source to the ECM is listed in Table 3-9.

Length from ECM to Battery or Bus Bar		Minimum Wire Size		Total Resistance of Maximum Length	
U.S. (ft)	International (m)	U.S. (Ga.)	International (mm^2)	U.S. (mΩ)	International (mΩ)
0 to 14	0 to 3	12	2.5	24.8	22.8
14 to 22	3 to 5	10	4	24.57	23.55
22 to 35	5 to 7	8	6	24.58	21.98
35 to 55	7 to 13	6	10	24.7	23.66
55 to 89	13 to 20	4	16	25.0	23.2

Table 3-9 Power Harness Length Criteria for Single Fuse Installations

If larger than 12 AWG wire is required, it should be spliced to 12 AWG wire as close as possible to the connector (see Figure 3-22).

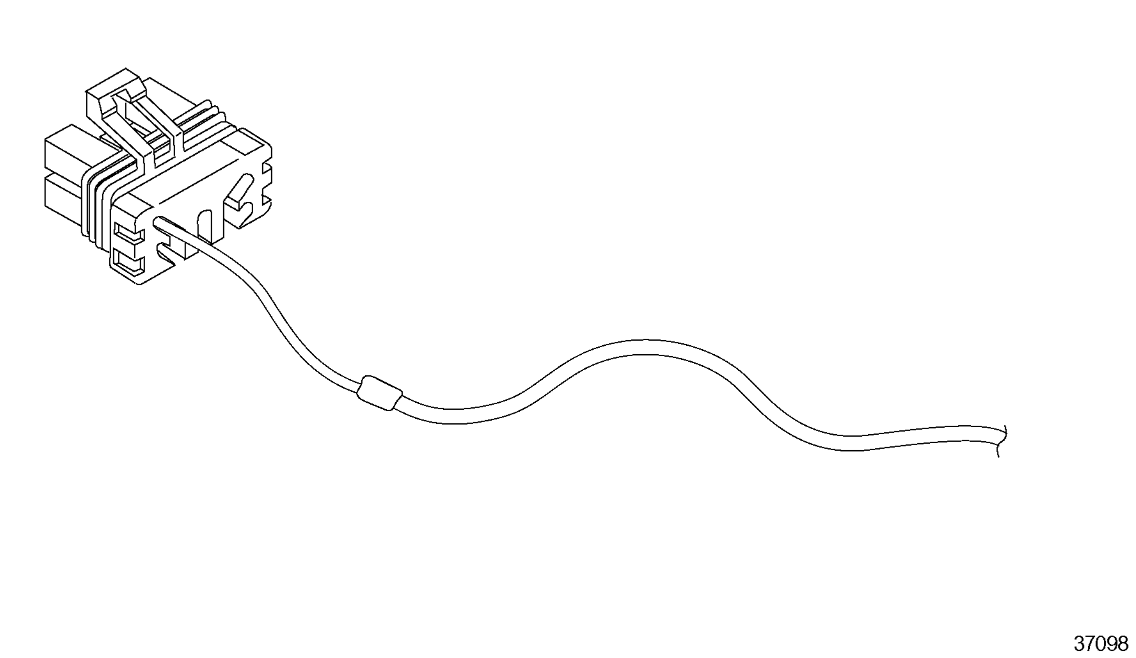


Figure 3-22 Spliced Power Connector Wire

These length and sizes are based on the use of stranded *annealed copper* not aluminum wire.

Splices must be soldered and sealed with a waterproof insulator. Alpha FIT-300, Raychem TAT-125 or any equivalent heat shrink - dual wall epoxy encapsulating adhesive polyolefin is required.

3.7.3 POWER HARNESS DESIGN

The following criteria are to be used when designing the Power Harness.

Criteria: Power Harness Design

The power connector is designed to accept 12 Ga. standard wall cable only.

The acceptable cable insulations are Teflon (EFTE), cross-link polyethylene (XLPE) or any equivalent self-extinguishing insulation such as GXL having a minimum rating of -40°C to 125°C. An equivalent insulation must meet the acceptable cable diameters 3.49 - 3.65 mm.

The conductor must be annealed copper not aluminum and must comply with the industry standard SAE J1128 document.

Splices must be soldered and sealed with a waterproof insulator. Alpha FIT-300, Raychem TAT-125 or any equivalent heat shrink - dual wall epoxy encapsulating adhesive polyolefin is required.

Detroit Diesel Corporation recommends color coding and hot stamping wire numbers in contrasting colors at intervals of four inches or less.

Wire Resistances

Twelve gage wires are required at the power harness connector. The total resistance of any power harness wire from the ECM to the battery (or bus bar) can not exceed 50 mΩ. The characteristics for Teflon coated and GXL type wire gages are listed in Table 3-10.

SAE Wire Gage	Metric Gage #	Area mm²	Resistance mΩ/m	Resistance mΩ/ft @ 20°C	Resistance mΩ/ft @ 120°C	Diameter mm
16	1	1.129	15.300	4.66	6.50	0.72
14	2	1.859	9.290	2.83	3.94	1.18
12	3	2.929	5.900	1.80	2.50	1.86
10	5	4.663	3.720	1.13	1.58	2.97
8	8	7.277	2.400	0.73	1.02	4.63

Table 3-10 Wire Characteristics

Fuse Holder and Connector

The use of weatherproof blade type fuses, circuit breakers, or equivalent protection is required. Blade fuse holders may be purchased from DDC parts distribution network. The part numbers are listed in Table 3-11.

Part	Part Number
Fuse Holder	12033769
Cover	12033731
Terminal	12033997

Table 3-11 Fuse Holder Part Numbers

Power harness connectors and terminals may be purchased from the DDC parts distribution network. The part numbers are listed in Table 3-12.

Part	Part Number
Connector Assembly	12124634
Terminal	12077413
Cable Seal	12015193
Secondary Lock	12052816

Table 3-12 Power Harness Connector Assembly

3.7.4 POWER HARNESS INSTALLATION

The following criteria should be used when installing power harnesses. See Figure 3-28for main power supply shutdown.

Criteria: Power Harness Installation

Power must be sourced directly from the battery or bus bar. An electrically solid connection to the battery or bus bar is required so the battery can filter electrical noise from the power lines. Power for other vehicle systems must not be sourced from the power harness assembly. ***Do not*** use chassis ground.

The DDEC ground wire must be electrically separate from chassis ground.

Power and ground bus bars may be used. The bus bar must be connected to the battery posts with 0 AWG or larger wire depending upon the total vehicle current requirement. The connecting wires must be as short as possible to minimize circuit resistance. ***Do not*** connect the ground wire to the chassis ground.

Provide maximum physical separation of the power harness from other vehicle electrical systems. Other electrical system cables should ideally be at least three feet away from the power harness and should not be parallel to the power harness. This will eliminate coupling electromagnetic energy from other systems into the power harness.

Do not route harness near any vehicle moving parts.

Do not route harness assembly near exhaust system or any high heat source.

Use a protective sheath and clips to prevent wires from being cut or frayed when weaving a harness through the frame.

3.7.5 ENGINE POWER HARNESS - MULTI-ECMS

The Engine Power Harness (see Figure 3-23) for multi-ECM applications is usually installed at the factory and delivered connected to all ECMs. The Engine Power Harness terminates with a quick disconnect connector where the OEM Vehicle Power Harness connection is made. Refer to Appendix B for Engine Power Harness schematics.

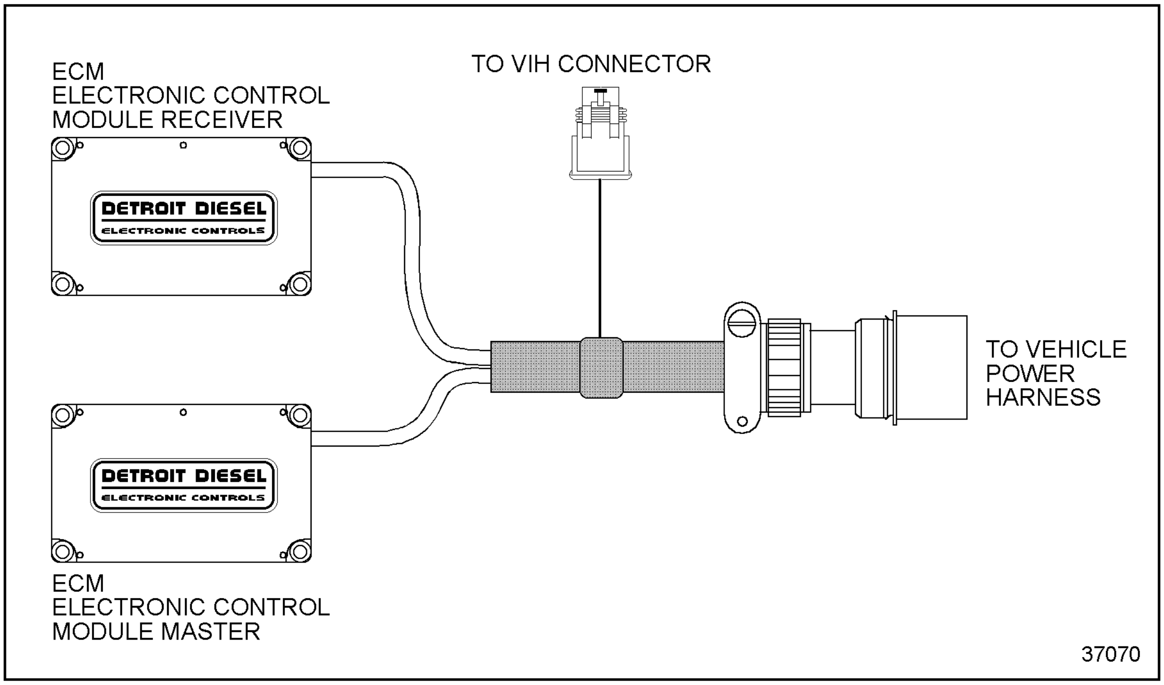


Figure 3-23 The Multi-ECM Engine Power Harness

3.7.6 VEHICLE POWER HARNESS

OEMs are required to provide a Vehicle Power Harness to interface the vehicle power and engine. Similar Power Harness guidelines for single ECM engines apply to multi-ECM engines. See Figure 3-24and Figure 3-25 that detail the Vehicle Power Harness for multi-ECM engines.

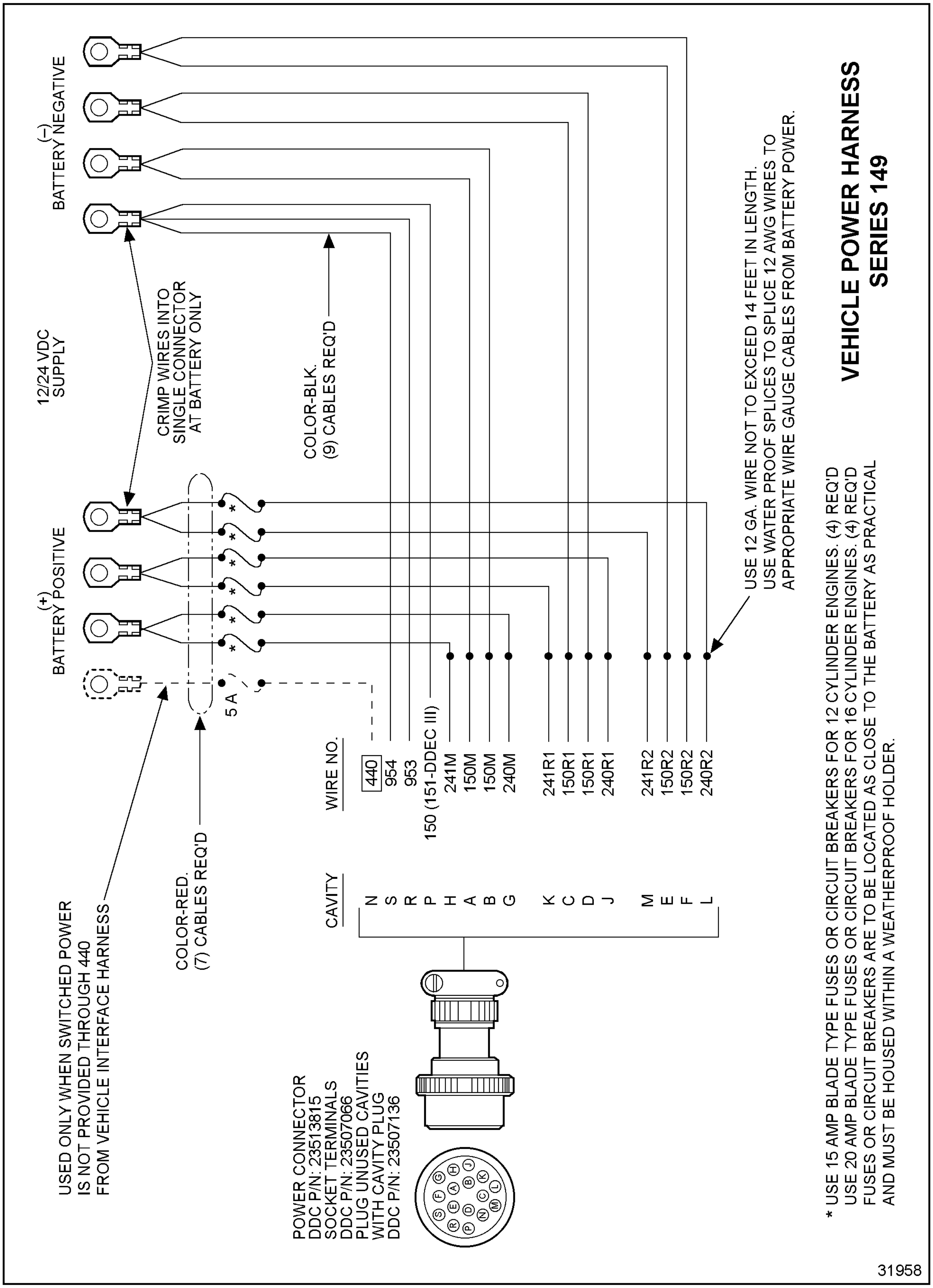


Figure 3-24 Series 149 Vehicle Power Harness

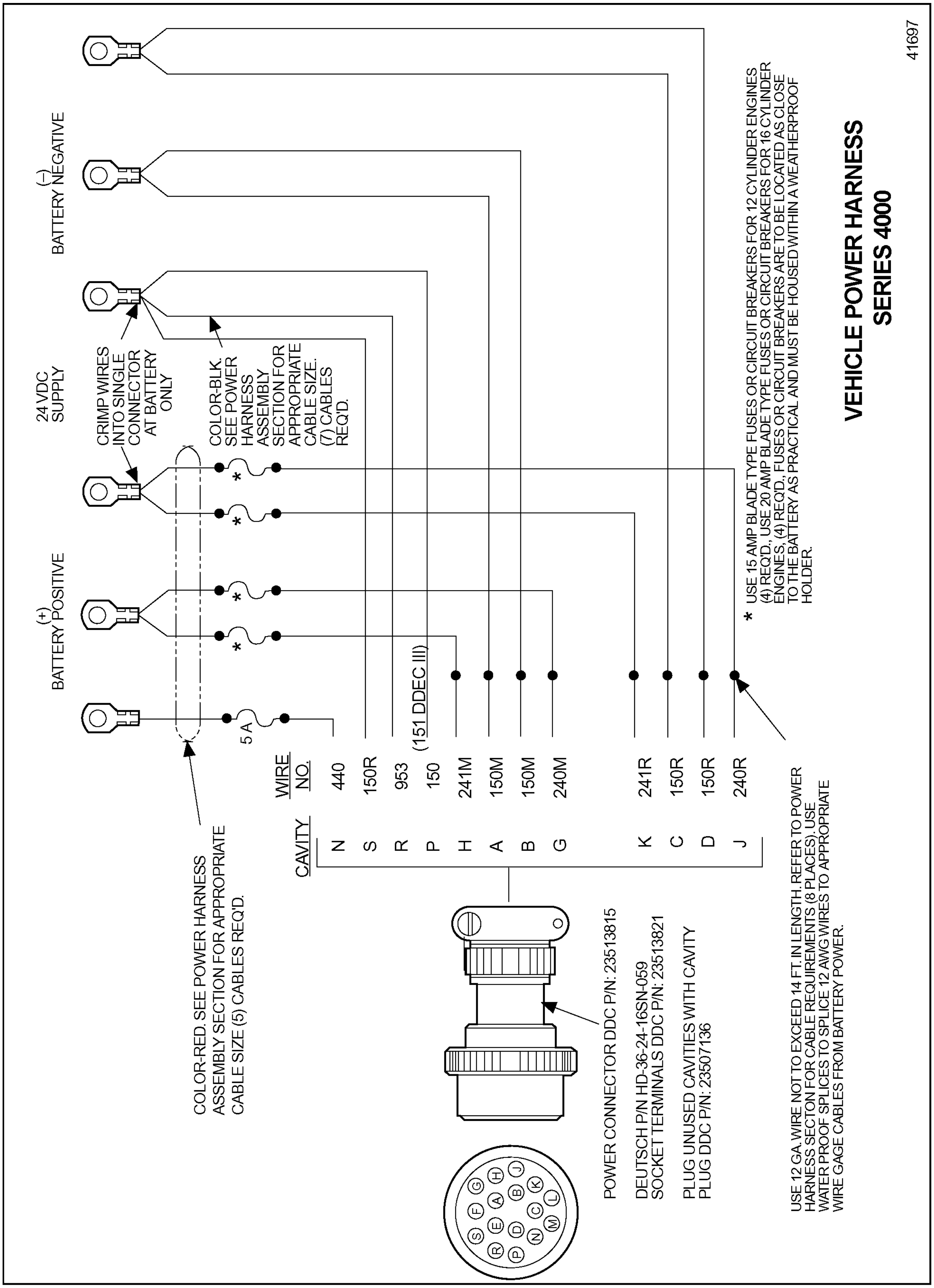


Figure 3-25 Series 4000 Vehicle Power Harness

3.8 POWER SUPPLY

Normal operating voltage for DDEC, listed in Table 3-13, is ECM dependent.

NOTICE:
Operating the ECM over the voltage limits listed in Table 3-13will cause damage to the ECM.

Part Number	Description	Normal Operating Voltage	Voltage Limits
23518645	DDEC III - Standard On-highway ECM	11-32 Volts DC	32 Volts
23518743	DDEC III - Universal ECM	11-32 Volts DC	32 Volts
23518744	DDEC III - Series 4000 ECM	11-32 Volts DC	32 Volts
23519307	DDEC IV - Standard On-highway ECM	11-14 Volts DC	14 Volts
23519308	DDEC IV - Universal ECM	11-32 Volts DC	32 Volts
23519309	DDEC IV - Series 4000 ECM	11-32 Volts DC	32 Volts

Table 3-13 Operating Voltage

Operating the ECM between 8 and 11 volts may result in degraded engine operation. (Transient operation in this range during engine starting is considered normal for 12 volt systems.)

NOTICE:
Reversing polarity will cause damage to the ECM if the power harness is not properly fused.

3.8.1 AVERAGE BATTERY DRAIN CURRENT

The average battery drain current for various engines may be found in the following tables. The current draw for single, dual and triple ECM configurations is listed in Table 3-14.

Engine	Condition	Current for 12V System (Average DC)	Current for 24V System (Average DC)
Single ECM	Ignition Off	20 mA	25 mA
Single ECM	Ignition On & Engine Stopped	500 mA	400 mA
Dual ECM	Ignition Off	40 mA	50 mA
Dual ECM	Ignition On & Engine Stopped	1.0 A	800 mA
Triple ECM	Ignition Off	60 mA	75 mA
Triple ECM	Ignition On & Engine Stopped	1.5 A	1.2 A

NOTE: Add up to 1.5 A to the current draw total for every digital output.

NOTE: Power supply and harness must be able to transition from 0 A to 30 A in .6 milliseconds with no more than 0.75 volt loss at the ECM.

Table 3-14 Average Battery Drain Current for Single, Dual, and Triple ECM Configurations

The current draw for two cycle engines is listed in Table 3-15.

Engine	Condition	Current for 12V System (Average DC)	Current for 24V System (Average DC)
6 Cylinder	Idle	1.5 A	1.0 A
6 Cylinder	Rated RPM, Full Load	6.0 A	3.8 A
8 Cylinder	Idle	2.0 A	1.5 A
8 Cylinder	Rated RPM, Full Load	8.0 A	4.5 A
12 Cylinder	Idle	3.2 A	2.0 A
12 Cylinder	Rated RPM, Full Load	12.0 A	7.5 A
16 Cylinder	Idle	4.0 A	2.5 A
16 Cylinder	Rated RPM, Full Load	16.0 A	9.0 A
20 Cylinder	Idle	5.0 A	3.0 A
20 Cylinder	Rated RPM, Full Load	20.0 A	12.0 A

NOTE: Add up to 1.5 A to the current draw total for every digital output.

NOTE: Power supply and harness must be able to transition from 0 A to 30 A in .6 milliseconds with no more than 0.75 volt loss at the ECM.

Table 3-15 Average Battery Drain Current for Two Cycle Engines - Series 71, Series 92, and Series 149

The current draw for the Series 50 engine is listed in Table 3-16.

Engine	Condition	Current for 12V System (Average DC)	Current for 24V System (Average DC)
4 Cylinder	Idle	1.0 A	0.8 A
4 Cylinder	Rated RPM, Full Load	3.0 A	2.0 A

NOTE: Add up to 1.5 A to the current draw total for every digital output.

NOTE: Power supply and harness must be able to transition from 0 A to 30 A in .6 milliseconds with no more than 0.75 volt loss at the ECM.

Table 3-16 Average Battery Drain Current for the Series 50

The current draw for the Series 60 is listed in Table 3-17.

Engine	Condition	Current for 12V System (Average DC)	Current for 24V System (Average DC)
6 Cylinder	Idle	1.0 A	0.8 A
6 Cylinder	Rated RPM, Full Load	4.5 A	3.0 A

NOTE: Add up to 1.5 A to the current draw total for every digital output.

NOTE: Power supply and harness must be able to transition from 0 A to 30 A in .6 milliseconds with no more than 0.75 volt loss at the ECM.

Table 3-17 Average Battery Drain Current for the Series 60

The current draw for the Series 2000 is listed in Table 3-18.

Engine	Condition	Current for 12V System (Average DC)	Current for 24V System (Average DC)
8 Cylinder	Idle	1.4 A	1.1 A
8 Cylinder	Rated RPM, Full Load	6.0 A	4.0 A
12 Cylinder	Idle	2.0 A	1.6 A
12 Cylinder	Rated RPM, Full Load	9.0 A	6.0 A
16 Cylinder	Idle	2.7 A	2.2 A
16 Cylinder	Rated RPM, Full Load	12.0 A	8.0 A

NOTE: Add up to 1.5 A to the current draw total for every digital output.

NOTE: Power supply and harness must be able to transition from 0 A to 30 A in .6 milliseconds with no more than 0.75 volt loss at the ECM.

NOTE: Series 2000 engines with sequential turbo control require 24 volt supplies.

Table 3-18 Average Battery Drain Current for the Series 2000

The current draw for the Series 4000 is listed in Table 3-19.

Engine	Condition	Current for 12V System (Average DC)*	Current for 24V System (Average DC)
8 Cylinder	Idle	N/A	1.5 A
8 Cylinder	Rated RPM, Full Load	N/A	4.5 A
12 Cylinder	Idle	N/A	2.0 A
12 Cylinder	Rated RPM, Full Load	N/A	7.5 A
16 Cylinder	Idle	N/A	2.5 A
16 Cylinder	Rated RPM, Full Load	N/A	9.0 A

* Series 4000 engines require 24 volt supplies.

NOTE: Add up to 1.5 A to the current draw total for every digital output.

NOTE: Power supply and harness must be able to transition from 0 A to 30 A in .6 milliseconds with no more than 0.75 volt loss at the ECM.

Table 3-19 Average Battery Drain Current for the Series 4000

3.8.2 REQUIREMENTS FOR 12 OR 24 VOLT SYSTEM

The alternator size must be suitable for the amount of current drawn as listed in Table 3-14, Table 3-15, Table 3-16, Table 3-17, Table 3-18, and Table 3-19.

The ECM will not activate injectors at speeds below 120 RPM.

3.8.3 BATTERY ISOLATOR

Some applications require a battery that is dedicated to the engine and completely isolated from the rest of the vehicle. Commercially available battery isolators can be used.

When interfacing inputs, outputs, analog throttle, and PWM outputs to other OEM control systems that utilize isolated battery systems with uncommon battery grounds, one of the following must be done:

☐ The DDEC circuit must be isolated using an isolation amplifier (see Figure 3-26).

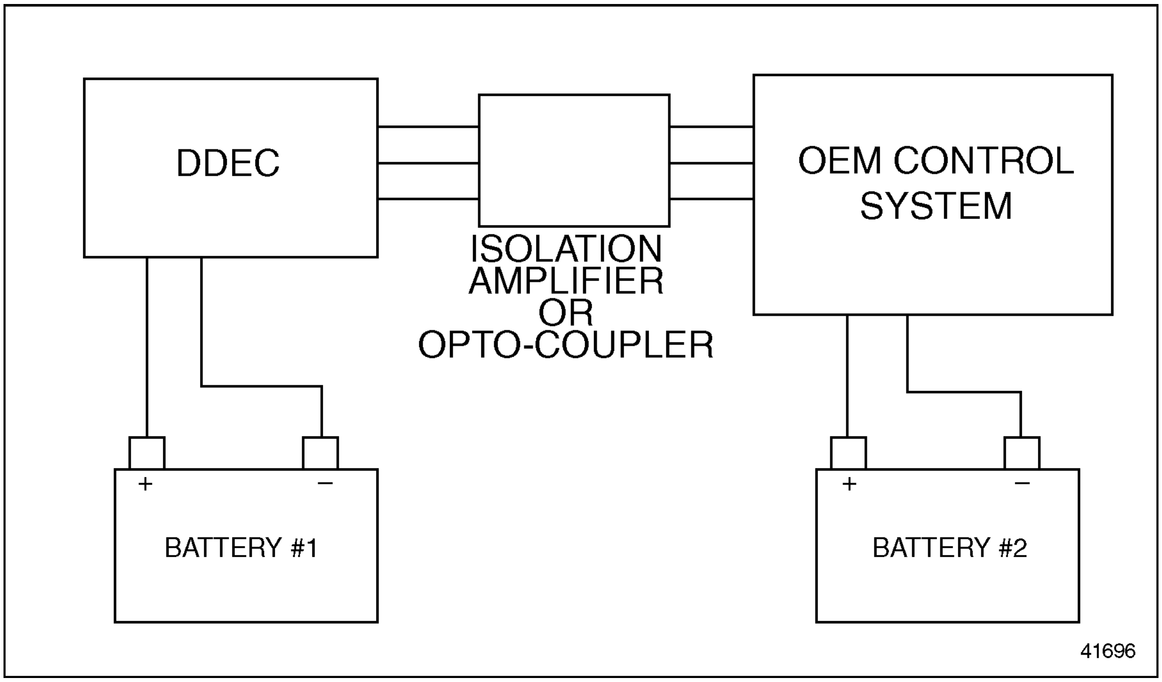


Figure 3-26 DDEC Circuit Isolated Using an Isolation Amplifier

☐ The battery grounds of the various battery systems MUST be connected together using a high ampacity cable (see Figure 3-27).

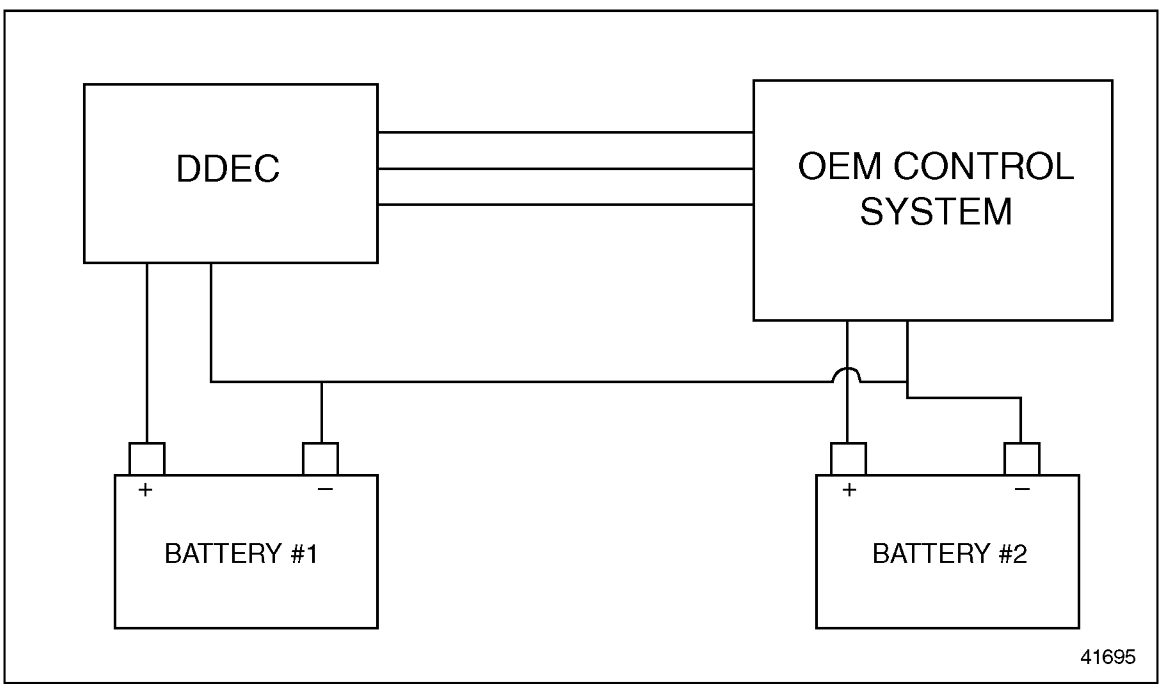


Figure 3-27 Battery System Grounds Connected Using a High Ampacity Cable

3.8.4 MAIN POWER SHUTDOWN

The main power supply shutdown schematic shows the DDC approved method for main power switch implementation. See Figure 3-28.

NOTE:
Disconnecting positive power is not sufficient to isolate the ECM for welding purposes.

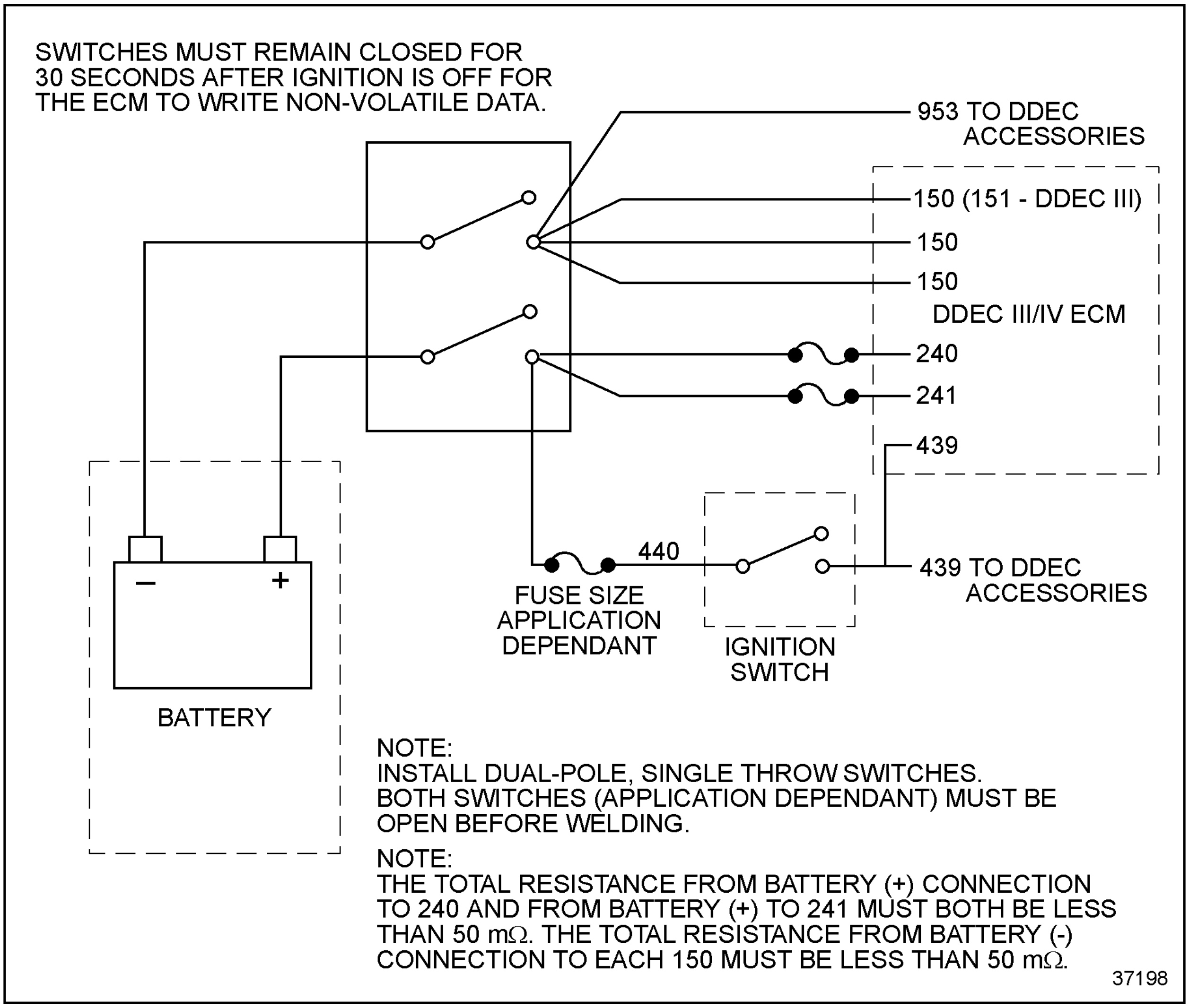
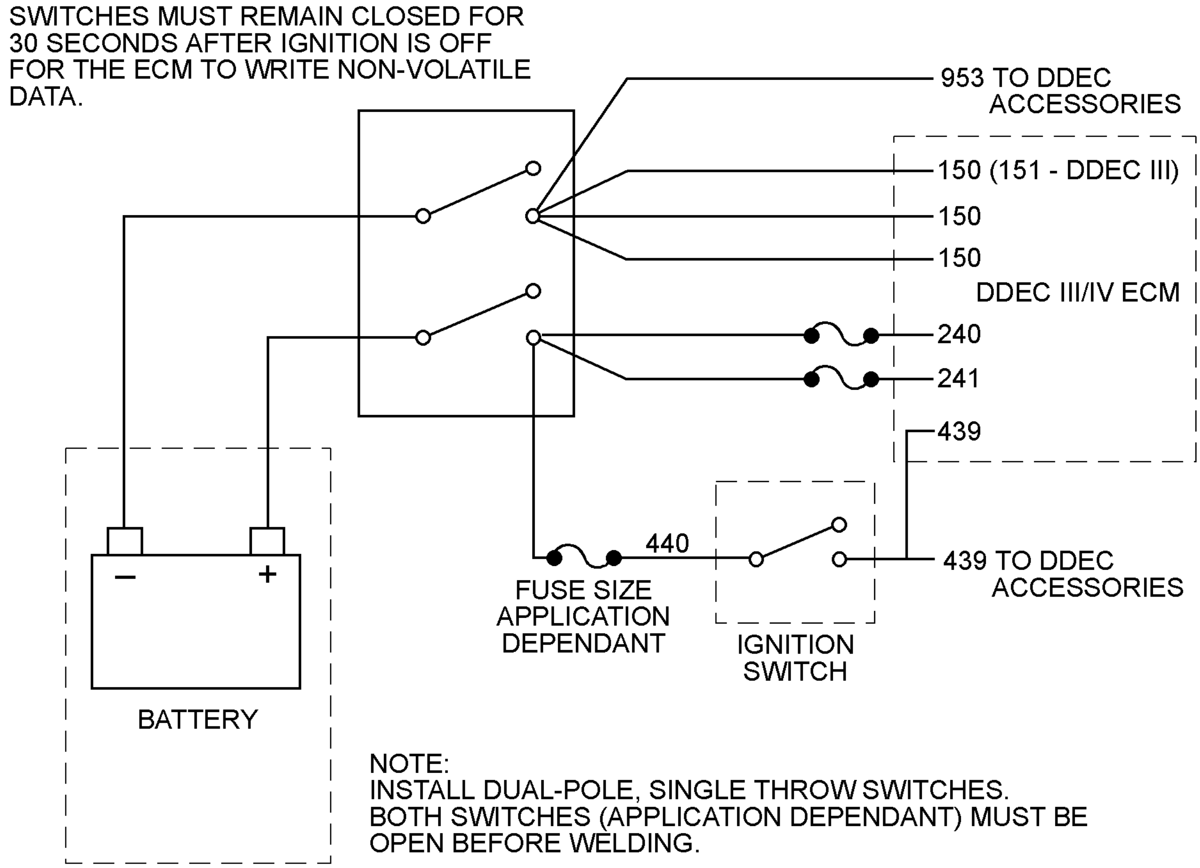


Figure 3-28 Main Power Supply Shutdown 12 or 24 Volt Systems

3.8.5 WELDING CAUTION

Prior to any weldingon the vehicle or equipment, the following precautions must be taken to avoid damage to the electronic controls and/or the engine (see Figure 3-29 and Figure 3-30).



NOTICE:

When welding, the following must be done to avoid damage to the electronic controls or the engine:

- ❑ Both the positive (+) and negative (-) battery leads must be disconnected before welding.
- ❑ Ground cable must be in close proximity to welding location – engine must never be used as a grounding point.
- ❑ Welding on the engine or engine mounted components is NEVER recommended.

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Figure 3-29 Welding Precaution

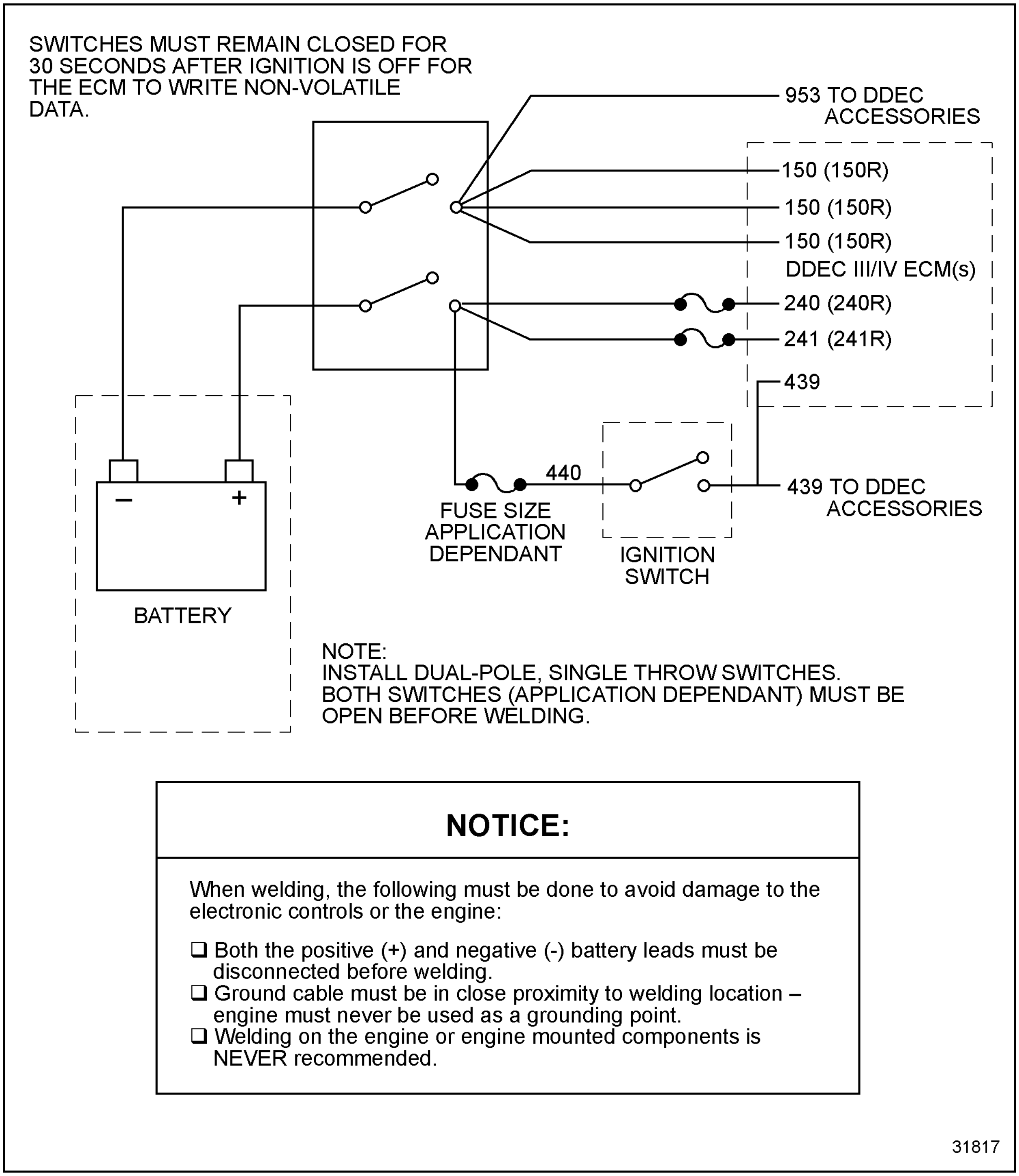


Figure 3-30 Welding Precaution - Multi-ECMs

3.9 FUSES

A Battery (+) fuse and an ignition circuit fuse must be provided by the vehicle wiring harness. Blade-type automotive fuses are normally utilized; however, manual or automatic reset circuit breakers which meet the following requirements are also acceptable. The fuse voltage rating must be compatible with the ECU's maximum operating voltage.

CAUTION:

To avoid injury from fire, additional loads should not be placed on existing circuits. Additional loads may blow the fuse (or trip the circuit breaker) and/or cause the circuit to overheat and burn.

CAUTION:

To avoid injury from fire, do not replace an existing fuse with a larger amperage fuse. The increased current may overheat the wiring, causing the insulation and/or surrounding materials to burn.

The ignition fuse current rating must be sized for the loads utilized in each application; however, a rating of between 5 and 10 amps is usually sufficient.

The Battery (+) fuse current rating must satisfy two criteria:

- ☐ Must not open during normal operation
- ☐ Must open before the ECU is damaged during a reverse battery condition

Acceptable blow times versus current and temperature derating characteristics are listed in Table 3-20and Table 3-21.

% of Rated Fuse Current	Minimum Blow Time	Maximum Blow Time
100%	100 hours	-
135%	1 minute	30 minutes
200%	6 seconds	40 seconds

Table 3-20 Fuse Current and Blow Time

Temperature	% of Rated Fuse Current
-40°C	110% max
+25°C	100%
+120°C	80% min

Table 3-21 Fuse Temperature and Current

3.10 CONNECTORS

The connectors listed in this section are required to properly wire a Detroit Diesel engine equipped with DDEC. The OEM is responsible for procuring most of these connectors. The terminals, locks, cavity plugs, etc. needed to properly install connectors are contained in the component section. For example, the terminals and locks needed to properly install the Ambient Air Temperature Sensor connector are contained in the Air Temperature Sensor section. The DDEC connectors are listed in Table 3-22.

Connector	Part Number	Comments
Pressure Sensor Harness	12162182	Metri-Pack 150 Series, pull-to-seat
Communication Harness Connector Assembly	12066317	Metri-Pack 150 Series, pull-to-seat
Temperature Sensor Harness	12162193	Metri-Pack 150 Series, pull-to-seat
Fire Truck Pressure Sensor (PSG)	12065287	Metri-Pack 150 Series, pull-to-seat
ESH-to-ECM	12034400	Metri-Pack 150 Series, pull-to-seat
VIH-to-ECM	12034398	Metri-Pack 150 Series, pull-to-seat
SRS Harness	12162193	Metri-Pack 150 Series, pull-to-seat
TRS Harness	12162197	Metri-Pack 150 Series, pull-to-seat
MAS Pigtail Connector Mate	12047937	Metri-Pack 150 Series, pull-to-seat
Air Filter Restriction Sensor	12110293	Metri-Pack 150 Series, pull-to-seat
Coolant Level Sensor	15300027	Metri-Pack 280 Series, push-to-seat
Power Harness/Engine Power Harness	12124634	Metri-Pack 280 Series, push-to-seat
Ignition Connector Power Harness Side	12034074	Weather Pack, push-to-seat
Ignition Connector VIH Side	12015378	Weather Pack, push-to-seat
Engine Brake Connector Series 60	12010973	Weather Pack, push-to-seat
Allison Interface Module	12015791	Weather Pack, push-to-seat
Allison Interface Module Maximum Feature	12015799	Weather Pack, push-to-seat
Diagnostic	23513052	Deutsch, push-to-seat
Engineminder	23512222	Deutsch, push-to-seat
Mastermind - Power and Communication Link	23512221	Deutsch, push-to-seat
Mastermind - Inputs and Outputs	23512223	Deutsch, push-to-seat
Glow Plug Lamps - Methanol Engines	Deutsch P/N: HD16-5-16S	Deutsch, push-to-seat
Vehicle Power Harness	23513815	Deutsch, push-to-seat
Vehicle Interface Harness (multi-ECM)	23515462	Cannon, push-to-seat
Engine Interface Harness	Cannon P/N: CA3106E28-21PBF80A176	Cannon, push-to-seat

Table 3-22 DDEC Connectors

3.10.1 METRI-PACK 150 SERIES CONNECTORS

Metri-Pack 150 series connectors are pull-to-seat connectors. Each wire must be pushed through the connector prior to crimping the terminal. Cable seals are inserted into the shell of the connector and hold many wires.

NOTE:
DDC does not require the use of dielectric grease.

3.10.2 WEATHER PACK, METRI-PACK 280, AND METRI-PACK 630 SERIES CONNECTORS

Weather Pack, Metri-Pack 280, and Metri-Pack 630 series connectors are push-to-seat. The terminal is crimped onto each wire before it is inserted into the connector. A cable seal is crimped onto each wire at the same time the terminal is crimped onto the wire. Weather Pack connectors use a secondary lock on both male and female connector bodies and the lock snaps into place over the cable seals after installation. Some Metri-Pack connectors have secondary locks as well.

NOTE:
The power harness uses a minimum of 12 AWG wire. Use the appropriate crimp and removal tools listed in Table 3-34. Refer to section 3.7.3, "Power Harness Design."

3.10.3 DEUTSCH CONNECTORS

Deutsch connectors have cable seals molded into the connector. These connectors are push-to-seat connectors with cylindrical terminals. The diagnostic connector terminals are gold plated for clarity. Refer to section 3.10.7.

3.10.4 ECM VEHICLE HARNESS CONNECTORS -SINGLE ECM

The ECM vehicle harness connections are on the right side of the ECM (see Figure 3-31).

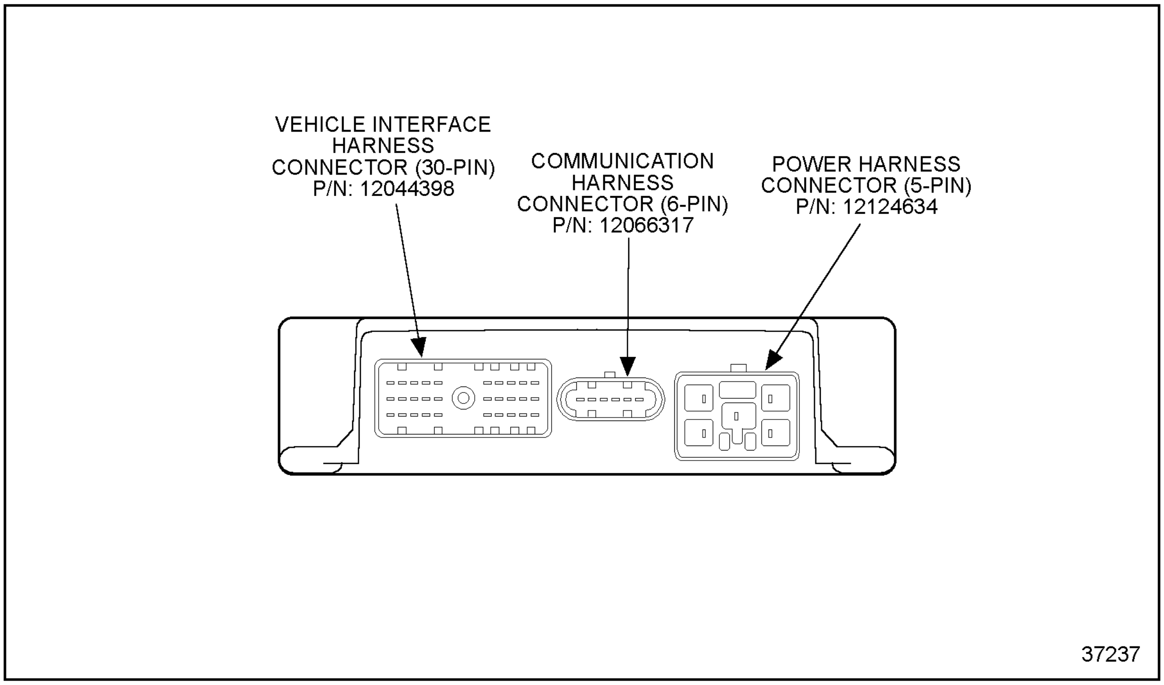


Figure 3-31 ECM Right Side, Vehicle Harness Connections

VIH-to-ECM Connector

The digital input and output ports of the VIH 30-pin connector (see Figure 3-32) can be configured for a variety of software options. The location of the connector pin for each software option can be specified at the time of engine order or with VEPS or the DDEC Reprogramming System. For more information on software options for these ports refer to section 4.1 and section 4.2.

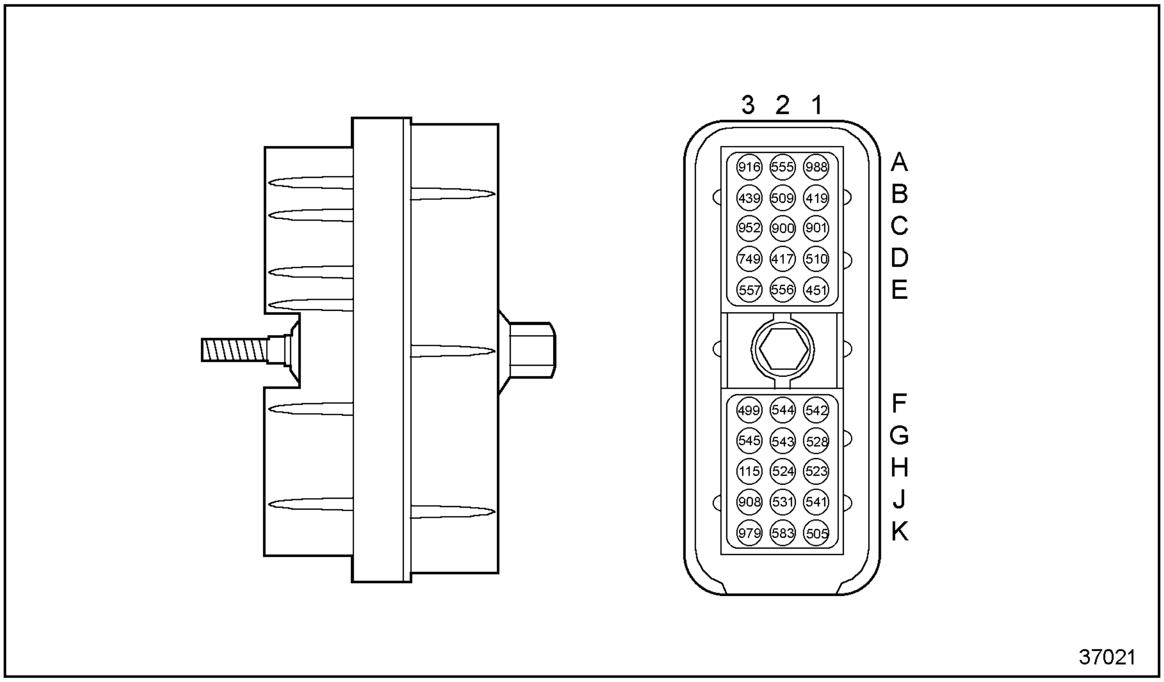


Figure 3-32 VIH-to-ECM Connector

NOTICE:
The wire comb for the 30-pin VIH connector must be used in all Series 50, Series 149, and industrial applications.

The wire comb is a strain relief for the back of the VIH connector to prevent water from entering the connector from the back. To use the wire comb, the original bolt in the VIH connector must be removed and discarded. The wire comb should be attached to the back of the VIH connector. The new bolt must be inserted through the assembly and used to tighten the VIH connector into the ECM. These parts listed in Table 3-23are available from the Detroit Diesel Parts Distribution Center.

Description	Part Number
Wire Comb	12110546
Bolt	12129426

Table 3-23 Wire Comb Part Numbers

The ECM connector assembly (12034398) center screw must be torqued to 7-13·lb in. (0.79 - 1.47 N·m).

The wiring for the 30-pin VIH-to-ECM connector is listed in Table 3-24.

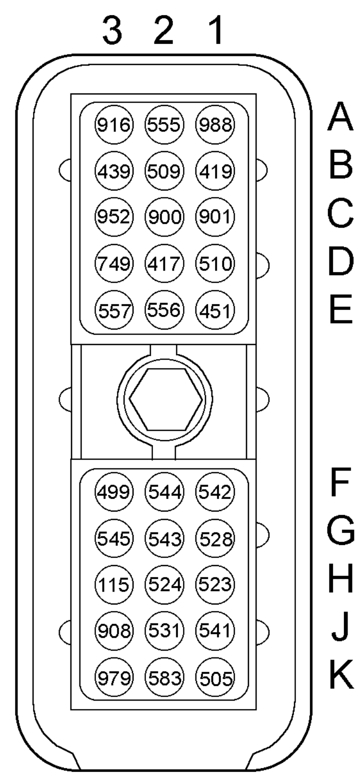
Cavity	Wire No.	Label	VIH-to-ECM Connector
H-3	115	COOLANT LEVEL	 37018
D-2	417	LIMITING SPEED GOVERNOR	
B-1	419	CHECK ENGINE LIGHT	
B-3	439	IGNITION	
E-1	451	DIGITAL INPUT #1	
F-3	499	DIGITAL OUTPUT #1	
K-1	505	TACHOMETER DRIVE	
B-2	509	STOP ENGINE LIGHT	
D-1	510	VARIABLE SPEED GOVERNOR	
H-1	523	DIGITAL INPUT #9	
H-2	524	DIGITAL INPUT #10	
G-1	528	DIGITAL INPUT #7	
J-2	531	DIGITAL INPUT #5	
J-1	541	DIGITAL INPUT #8	
F-1	542	DIGITAL INPUT #2	
G-2	543	DIGITAL INPUT #6	
F-2	544	DIGITAL INPUT #4	
G-3	545	DIGITAL INPUT #3	
A-2	555	DIGITAL OUTPUT #2	
E-2	556	VEHICLE SPEED (+)	
E-3	557	VEHICLE SPEED (-)	
K-2	583	DIGITAL INPUT #11	
D-3	749	FIRE TRUCK PUMP PRESSURE OR ESS TRANSMISSION OR EXHAUST TEMPERATURE	
C-2	900	DATA LINK (+)	
C-1	901	DATA LINK (-)	
J-3	908	PWM #1 OUTPUT	
A-3	916	SENSOR SUPPLY (5VDC)	
C-3	952	SENSOR RETURN	
K-3	979	DIGITAL INPUT #12	
A-1	988	DIGITAL OUTPUT #8	

Table 3-24 Typical VIH-to-ECM Connector Pin Definitions

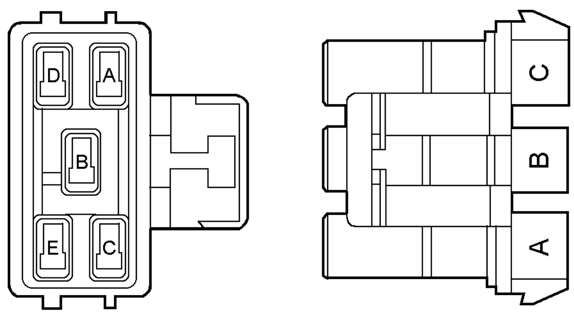
The 30-pin VIH-to-ECM connector, listed in Table 3-25, is a Metri-Pack 150 series pull-to-seat connector.

Part	Part Number
Connector	12034398
Terminal	12103881
Seal	In Connector
Plug	12034413

Table 3-25 30-pin VIH-to-ECM Connector Part Numbers

Power Harness-to-ECM Connector

See Figure 3-33 for the wiring for the ECM-to-Power Harness connector. Refer to section 3.7for more information on the Power Harness.



LABEL	WIRE NO.	CAVITY	COLOR
BATTERY (+)	240	A	RED
BATTERY (-)	150	B	BLACK
BATTERY (+)	241	C	RED
BATTERY (-)	150	D	BLACK
BATTERY (-)	150	E	BLACK

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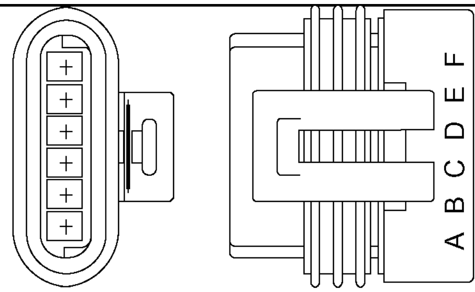
Figure 3-33 Five-Pin Power Harness Connector

Communication Harness-to-ECM Connector

See Figure 3-34 for the wiring for the ECM-to-Communication Harness connector. Refer to section 3.5for more information on the Communication Harness.



LABEL	WIRE NO.	CAVITY	COLOR
J 1922 (+) DATA LINK	800	A	TAN/WHT
J 1922 (-) DATA LINK	801	B	TAN
IGNITION*	439	C	PNK
CAN_SHIELD / J 1939 SHIELD	927	D	WHT/BLU
CAN_L / J 1939 (-) DATA LINK	926	E	DK BLU/WHT
CAN_H / J 1939 (+) DATA LINK	925	F	DK BLU

* NOT REQUIRED IF IGN IS WIRED TO A 30-PIN VIH CONNECTOR

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Figure 3-34 Communication Harness Connector

3.10.5 ECM VEHICLE HARNESS CONNECTORS - MULTI-ECM

The multi-ECM Engine Interface Harness is usually installed at the factory and delivered connected to all ECMs. The Power Harness is installed at the factory and delivered connected to all ECMs. Both harnesses end with a quick disconnect connector.

Engine Interface Harness Quick Disconnect Connector

The multi-ECM Engine Interface Harness normally terminates with a quick disconnect connector where the OEM Vehicle Interface Harness begins.

The recommended wiring for the Engine Interface Harness quick disconnect connector for the Series 4000 and Series 149 Vehicle Interface Harness is listed in Table 3-26.

Cavity	Wire No.	Label	Cavity	Wire No.	Label
c	115M	Coolant Level	m	564M	Digital Output X-3
N	417	Limiting Speed Governor	s	565M	Digital Output Y-3
P	419	Check Engine Light	X	573	Auxiliary Timed Input
A	439	Ignition	B	583	Digital Input K-2
J	440	Power Harness-jumper	d	749M	Analog Input
g	451M	Digital Input E-1	H	900	Data Link (+)
a	451R	Digital Input E-1--R1	P	901	Data Link (-)
S	451R2	Digital Input E-1--R2 Series 149	K	908M	PWM #1 Output
r	499M	Digital Output F-3	U	916M	Sensor Supply (5VDC)
E	505M	Tachometer Drive-master	W	952M	Sensor Return
n	509	Stop Engine Light	G	953	Battery Ground
V	510	Variable Speed Governor	C	979	Digital Input K-3
b	523M	Digital Input H-1	R	988M	Digital Output A-1
T	524	Digital Input H-2			
j	528	Diagnostic Request / SEO-M			
F	531M	Digital Input J-2			
L	541M	Digital Input J-1			
e	542M	Digital Input F-1			
S	543M	Digital Input G-2 Series 4000			
k	544	Digital Input F-2			
h	545M	Digital Input G-3			
Z	555M	Digital Output A-2			
M	556	Vehicle Speed (+)			
D	557	Vehicle Speed (-)			
f	563M	Digital Output W-3			

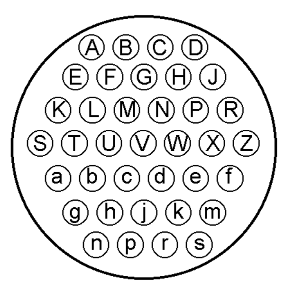

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Table 3-26 Recommended Interface Harness Connector Pin Definitions - Series 4000 and Series 149

The Engine Interface Harness quick disconnect connector is a single-point, sealed, weatherproof, bayonet-type connector. The connectors must be protected with a suitable cover, when disconnected.

Refer to section 3.11.7 for assembly instructions for the plug and socket end of the 37-pin connector.

Engine Power Harness Connector

The Engine Power Harness terminates with a quick disconnect connector where the OEM Vehicle Power Harness connection is made. The connector is a 16 pin Deutsch connector.

The recommended wiring for the Engine Power Harness quick disconnect connector for the Series 4000 Vehicle Power Harness is listed in Table 3-27.

Cavity	Wire No.	Label
A	150M	Battery Negative
B	150M	Battery Negative
C	150R	Battery Negative
D	150R	Battery Negative
E	Plug	--
F	Plug	--
G	240M	Battery Positive
H	241M	Battery Positive
J	240R	Battery Positive
K	241R	Battery Positive
L	Plug	--
M	Plug	--
N	440	Battery Positive
P	151 (ALL ECM)	Battery Negative
R	953	Battery Negative
S	953	Battery Negative

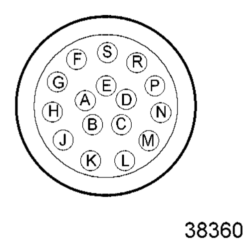
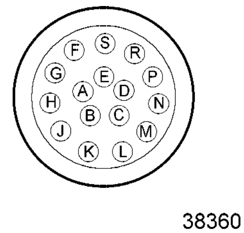


Table 3-27 Series 4000 - Recommended Vehicle Power Harness Connector Pin Definitions

The wiring for the Engine Power Harness quick disconnect connector for the Series 149 Vehicle Power Harness is listed in Table 3-28.

Cavity	Wire No.	Label
A	150M	Battery Negative
B	150M	Battery Negative
C	150R1	Battery Negative
D	150R1	Battery Negative
E	150R2	Battery Negative
F	150R2	Battery Negative
G	240M	Battery Positive
H	241M	Battery Positive
J	240R1	Battery Positive
K	241R1	Battery Positive
L	240R2	Battery Positive
M	241R2	Battery Positive
N	440*	Battery Positive
P	150	Battery Negative
R	953	Battery Negative
S	953	Battery Negative



* Used only when switched power is not provided through 440 from VIH.

Table 3-28 Series 149 - Recommended Vehicle Power Harness Connector Pin Definitions

3.10.6 ECM ENGINE HARNESS CONNECTORS

The ECM engine harness connections are on the left side of the ECM and come factory installed (see Figure 3-35).

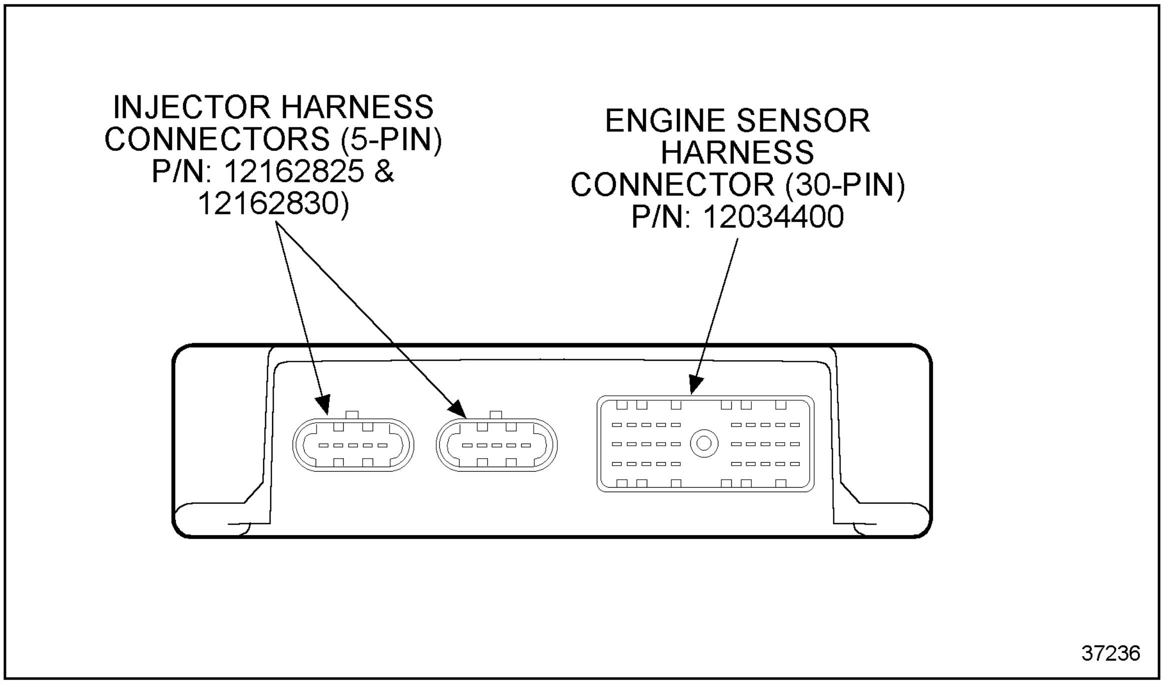


Figure 3-35 ECM Left Side, Engine Harness Connections

ESH-to-ECM Connector

The digital output ports of the ESH 30-pin connector (see Figure 3-36) can be configured for a variety of software options. The three digital output ports (563, 564, 565) are located on a pigtail off the Engine Sensor Harness. The software options can be ordered at the time of engine order or with VEPS or the DDEC Reprogramming System. The location of the connector pin for each option can be specified at the time of engine order. For more information on software options for these ports refer to section 4.2.

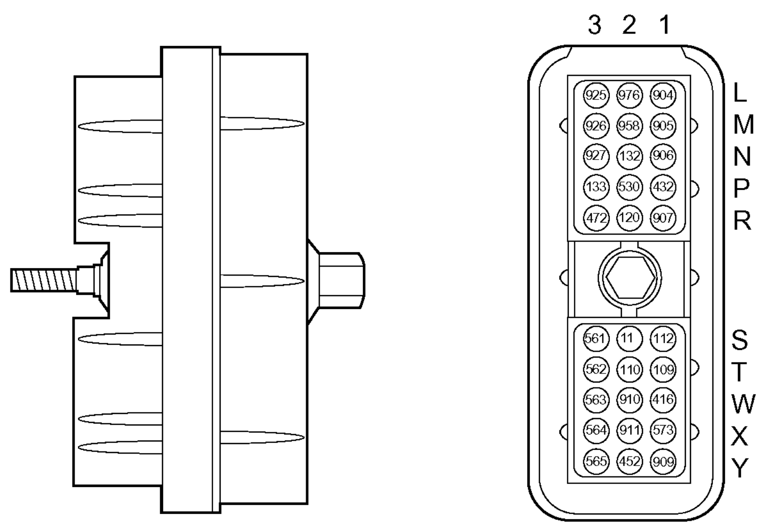


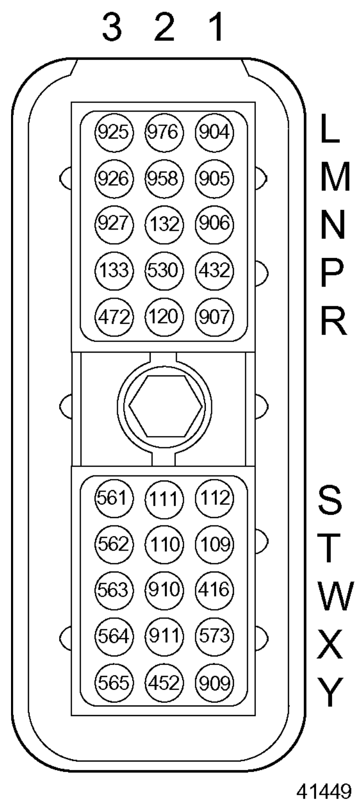
Figure 3-36 ESH-to-ECM Connector

The 30-pin ESH-to-ECM connector, listed in Table 3-29, is a Metri-Pack 150 series pull-to-seat connector.

Part	Part Number
Connector	12034400
Terminal	12103881
Seal	In Connector
Plug	12034413

Table 3-29 30-pin ESH-to-ECM Connector Part Numbers

The wiring for the 30-pin ESH-to-ECM connector is listed in Table 3-30.

Cavity	Wire No	Label	ESH-to-ECM Connector
T-1	109	TRS (-)	
T-2	110	TRS (+)	
S-2	111	SRS (+)	
S-1	112	SRS (-)	
R-2	120	OIL TEMPERATURE	
N-2	132	AIR TEMPERATURE	
P-3	133	COOLANT TEMP	
W-1	416	SENSOR SUPPLY (5VDC)	
P-1	432	TURBO BOOST	
Y-2	452	SENSOR RETURN (ENGINE)	
R-3	472	FUEL TEMP	
P-2	530	OIL PRESSURE	
S-3	561	ENGINE BRAKE MED	
T-3	562	ENGINE BRAKE LO	
W-3	563	DIGITAL OUTPUT W-3	
X-3	564	DIGITAL OUTPUT X-3	
Y-3	565	DIGITAL OUTPUT Y-3	
X-1	573	TIMED INPUT	
L-1	904	AIR FILTER RESTRICTION*	
M-1	905	FUEL RESTRICTION*	
N-1	906	ADD COOLANT LEVEL*	
R-1	907	AMBIENT AIR TEMPERATURE*	
Y-1	909	OI ALARM*	
W-2	910	OI STARTER*	
X-2	911	FAN CONTROL — VARIABLE SPEED*	
L-3	925	J1939 (+)	
M-3	926	J1939 (-)	
N-3	927	J1939 SHIELD	
M-2	958	OI THERMOSTAT*	
L-2	976	OIL LEVEL*	

* Used in some applications

Table 3-30 Typical On-highway ESH-to-ECM Connector Pin Definitions

3.10.7 DATA LINK CONNECTORS

The connectors used to connect the data links are a 6-pin Deutsch connector for the J1708/J1587 Data Link or a 9-pin Deutsch connector for the J1939/1708 Data Link. DDC recommends that the OEM-supplied Data Link Connector be conveniently positioned in a well protected location facilitating subsequent DDDL/DDR usage (i.e., reprogramming, diagnostics, etc.).

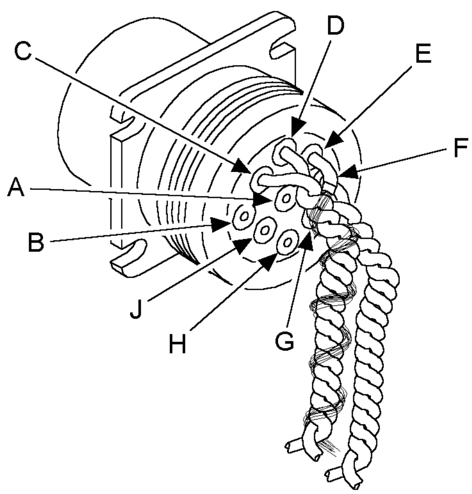
SAE J1939/J1587 Data Link Nine-pin Connector (Recommended)

The SAE J1939/J1587 nine-pin data link connector is the recommended diagnostic connector. The following components are required to incorporate an SAE J1939/J1587 Data Link in a VIH so a DDR or other diagnostic devices can be attached without a unique jumper are listed in Table 3-31.

Component	DDC Part Number	Deutsch Part Number
Nine-pin Deutsch connector	23529496	HD10-9-1939P
Connector Cover	23529497	HDC 16–9
Two (2) Cavity Plugs	23507136	11407
Seven (7) Terminals	23507132	0460-202-16141

Table 3-31 Required Components to Incorporate an SAE J1939/J1587 Data Link in the VIH

The following illustration shows the wiring for the nine-pin connector (see Figure 3-37).



WIRE NO.	CAVITY	LABEL
953	A	BATTERY GROUND
440	B	+12V DC
925	C	J1939 DATA LINK (+)
926	D	J1939 DATA LINK (-)
927	E	J1939 SHIELD
900	F	J1587 DATA LINK (+)
901	G	J1587 DATA LINK (-)
-	H	PLUG
-	J	PLUG

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Figure 3-37 Wiring for Nine-pin Data Link Connector

The SAE J1939 Data Link must be twisted nine turns per foot. The maximum length for the SAE J1939 Data Link is 130 ft (40m).

SAE J1708/J1587 Data Link Six-pin Connector

The components are required to incorporate a SAE J1708/J1587 Data Link in a VIH so a DDR or other diagnostic devices can be attached without a unique jumper are listed in Table 3-32.

Components	DDC Part Numbers	Deutsch Part Numbers
Six-pin Deutsch Connector	23513052	HD-10-6-12P
Two (2) Cavity plugs	23507136	11407
Connector Cover	23507154	HDC-16-6
Four (4) Terminals	23513053	0460-220-1231

Table 3-32 Required Components to Incorporate an SAE J1708/J1587 Data Link in the VIH

The following illustration shows the wiring for the 6-pin connector (see Figure 3-38).

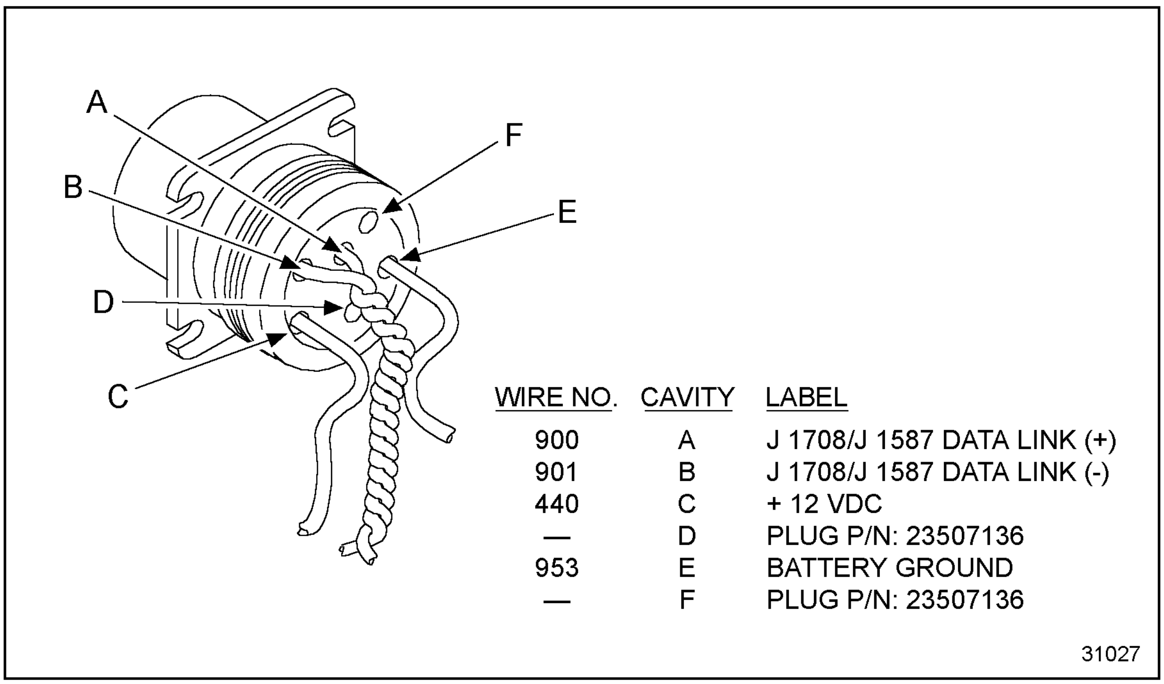

Figure 3-38 Wiring for Six-pin Data Link Connector

The SAE J1708/J1587 Data Link must be twisted a minimum of 12 turns per foot. The maximum length for the SAE J1708/J1587 Data Link is 130 ft (40m).

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3.11 WIRES AND WIRING

Detroit Diesel Corporation recommends color coding and hot stamping wire numbers in contrasting colors at intervals of four inches or less.

3.11.1 GENERAL REQUIREMENTS

NOTE:
Avoid renumbering DDC circuits since all troubleshooting guides reference the circuit numbers shown in the schematic. DDC suggests including a prefix or suffix with the DDC circuit numbers when conflicts exist.

3.11.2 GENERAL WIRE

All wires used in conjunction with the DDEC must meet the following criteria:

NOTICE:
DDC does not recommend using any type of terminal lubricant or grease compounds. These products may cause dirt or other harmful substances to be retained in the connector. DDC has not tested these products and cannot stand behind their use.

NOTICE:
Insulation must be free of nicks.

Criteria: Wires

Tape, conduit, loom or a combination thereof must be used to protect the wires. Refer to sections 3.12 and 3.13.

All wires must be annealed copper wire (not aluminum).

All wires must comply with SAE J1128.

All wires should be insulated with cross-link polyethylene (XLPE) such as GXL, or any self-extinguishing insulation having a minimum rating of -40°C (-40°F) to 125°C (257°F).

3.11.3 WIRING FOR VIH-TO-ECM CONNECTOR

NOTICE:
Wires greater than 2.97 mm (.117 in.) must not be used in the VIH-to-ECM connector, as irreparable damage to the seal may result.

NOTICE:
Failure to use the proper cable diameter may result in the inability to obtain proper terminal installation.

The VIH 30-pin connector is designed to accept 18 gage (0.75 - 0.80 mm^2) standard wall thickness cable, only.

3.11.4 RETURN POWER (GROUND) CIRCUITS

Switch ground (circuit 953) must only be used to provide ground for DDEC components and must be sourced directly from the negative battery or bus bar terminal

NOTE:
This circuit can not be used to provide ground for non- DDEC IV OEM-supplied electronics.

3.11.5 DATA LINK CIRCUITS

Twisting of the following wire pairs a minimum of 12 turns per foot (305 mm), is required to minimize electromagnetic field coupling effects.

- ☐ Data link circuits 900 and 901 (SAE J1587)
- ☐ Data link circuits 800 and 801 (SAE J1922)
- ☐ Data link circuits 925 and 926 (SAE J1939)

Circuits 900 (Data Link +) and 901 (Data Link -) are used as the J1587 communication link. These circuits also exist in the DDEC six-pin or nine-pin diagnostic connector for use with the DDR.

Circuits 800 (Data Link +) and 801 (Data Link-) as shown on the communications harness schematic are used as the SAE J1922 communication link.

Circuits 925 [CAN_H/J1939 (+)], 926 [CAN_L J1939 (-)] and 927 (CAN_SHLD/J1939 Shield) as shown on the communications harness schematic are used as the SAE J1939 communication link. See Figure 3-15.

3.11.6 POWER HARNESS WIRE RESISTANCE

Twelve gage wires are required at the power harness connector. The total resistance of any power harness wire from the ECM to the battery (or bus bar) can not exceed 50 mΩ. The characteristics for Teflon coated and GXL type wire gages are listed in Table 3-33.

SAE Wire Gage	Metric Gage #	Area mm^2	Resistance $m\Omega/m$	Resistance $m\Omega/ft$ @ $20^{o}C$	Resistance $m\Omega/ft$ @ $120^{o}C$	Diameter mm
16	1	1.129	15.300	4.66	6.50	0.72
14	2	1.859	9.290	2.83	3.94	1.18
12	3	2.929	5.900	1.80	2.50	1.86
10	5	4.663	3.720	1.13	1.58	2.97
8	8	7.277	2.400	0.73	1.02	4.63

Table 3-33 Power Harness Wire Characteristics

3.11.7 TERMINAL INSTALLATION AND REMOVAL

The method of terminal installation and removal varies, depending on the terminal/connector design. Crimp techniques and harness dressing must also be performed in accordance with recommended procedures to assure waterproof connections.

NOTICE:
Terminals should not be soldered to the cable.

Crimp and Removal Tools

Crimp tools and connector removing tools can be purchased from Kent-Moore. The part and associated part numbers are listed in Table 3-34 below:

Connector	Tool	Kent-Moore P/N
Metri-Pack 150	Removing	J 35689-A
	Crimp	J 35123
Weather Pack	Removing	J 36400-5
Metri-Pack 280	Removing (18 AWG)	J 33095
	Crimp (18 AWG)	J 38125-12A
	Removing (12 AWG - Used for power harness)	J 33095
	Crimp (12 AWG - Used for power harness)	J 39848
Deutsch	Removing (12 AWG)	J 37451
	Removing (16-18 AWG)	J 34513-1
	Crimp	J 34182

Table 3-34 Crimp and Removal Tools

Kent-Moore
29784 Little Mack
Roseville, Michigan 48066-2298
Phone: (800) 328-6657

Push-to-Seat Terminal Installation Guidelines

The following guidelines apply to all push-to-seat terminals.

NOTICE:
If a separate seal is required, be sure to install the seal onto the wire before stripping the insulation.

NOTICE:
No more than one strand in a 16 strand wire may be cut or missing.

1. Position a seal on each terminal lead so 5.0 0.5 mm (.20 .02 in.) conductor and 1.0 0.1 mm (.05 .005 in.) cable protrudes past the seal after being stripped (see Figure 3-39).

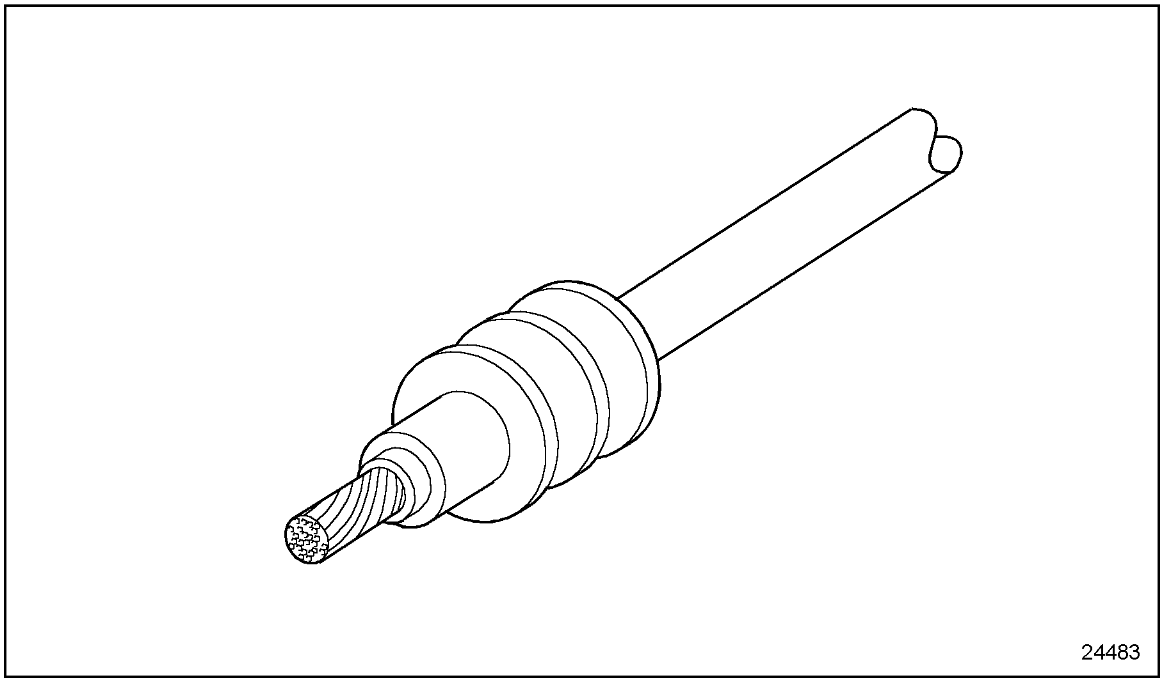


Figure 3-39 Seal Positioning

2. Remove the insulation from the end of the cable with J 35615 (or equivalent), exposing 5.0 0.5 mm (0.2 .02 in.) conductor (wire), a sufficient amount of wire to be crimped by the terminal core wings (see Figure 3-40).

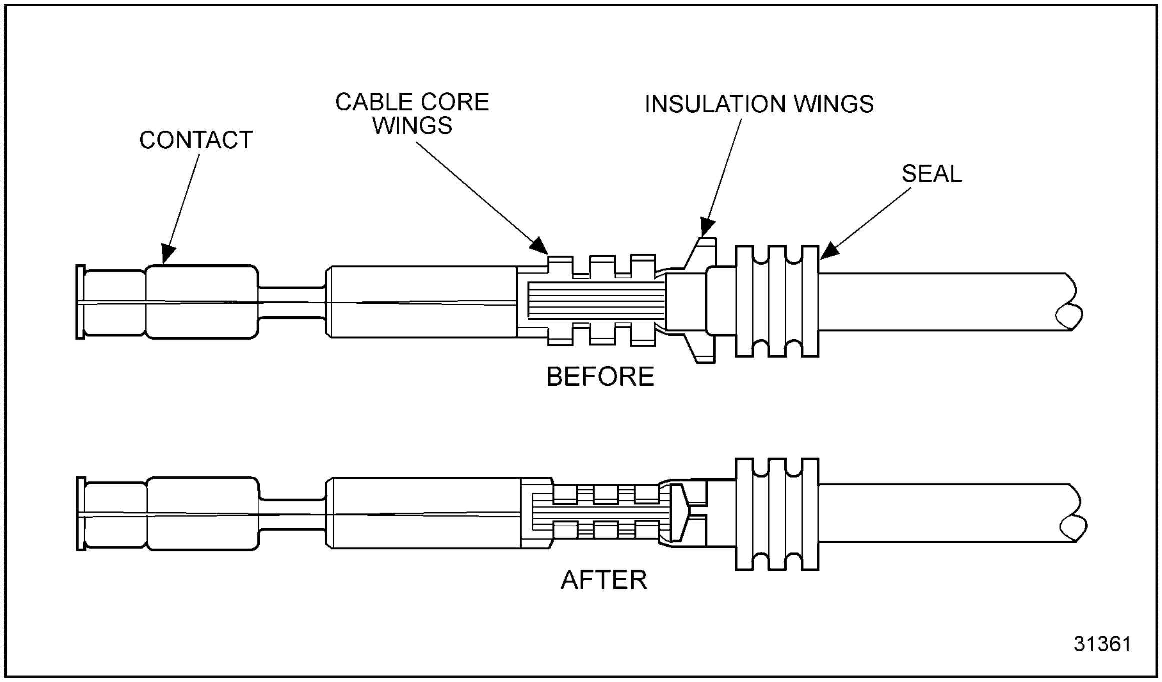


Figure 3-40 Terminal Installation (Shown with a Seal)

3. Insert the terminal into the locating hole of the crimping tool using the proper hole according to the gage and function of the cable to be used. See Figure 3-41.

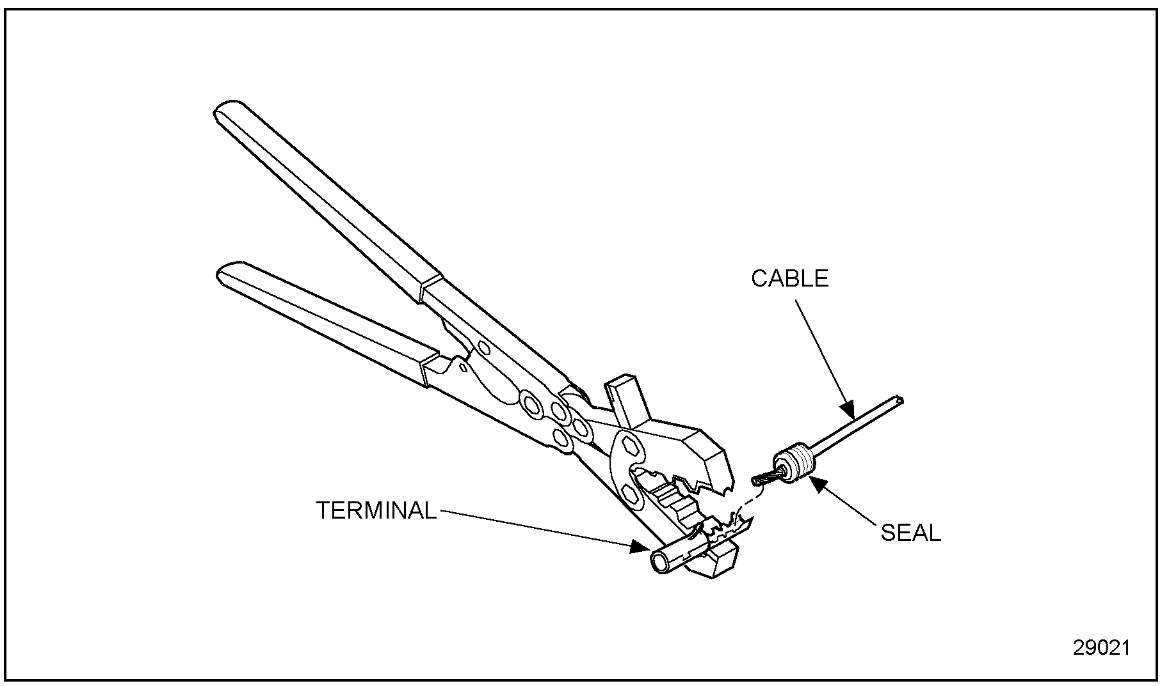


Figure 3-41 Terminal Position (Shown With a Seal)

4. Insert the cable in the terminal so the stripped portion is positioned in the cable core wings and the insulated portion of the cable is in the insulation wings (see Figure 3-41). Position the seal on the cable so the insulation wings grip the seal (see Figure 3-40).
5. Compress the handles of the crimping tool to crimp the core and insulation wings until the ratchet automatically releases.
6. To install the remaining terminals, repeat steps 3 and 4.

NOTE:
Release the crimping tool with the lock lever located between the handles, in case of jamming.

7. Gently tug on the terminal to make sure it is secure. The criteria listed in Table 3-35 must be met.

Wire Gage	Must Withstand Applied Load
14 AWG	45 lb (200 N)
16 AWG	27 lb (120 N)
18 AWG	20 lb (90 N)

Table 3-35 Applied Load Criteria for the Terminal

NOTICE:
Any terminal that is cracked or ruptured is unacceptable as malfunctions may occur.

8. Replace incorrectly installed and damaged terminals by cutting off the terminal just after the insulation wings.

9. Insert terminals into connector and push to seat (see Figure 3-42). Insert the secondary lock(s) to position and secure the assembly.

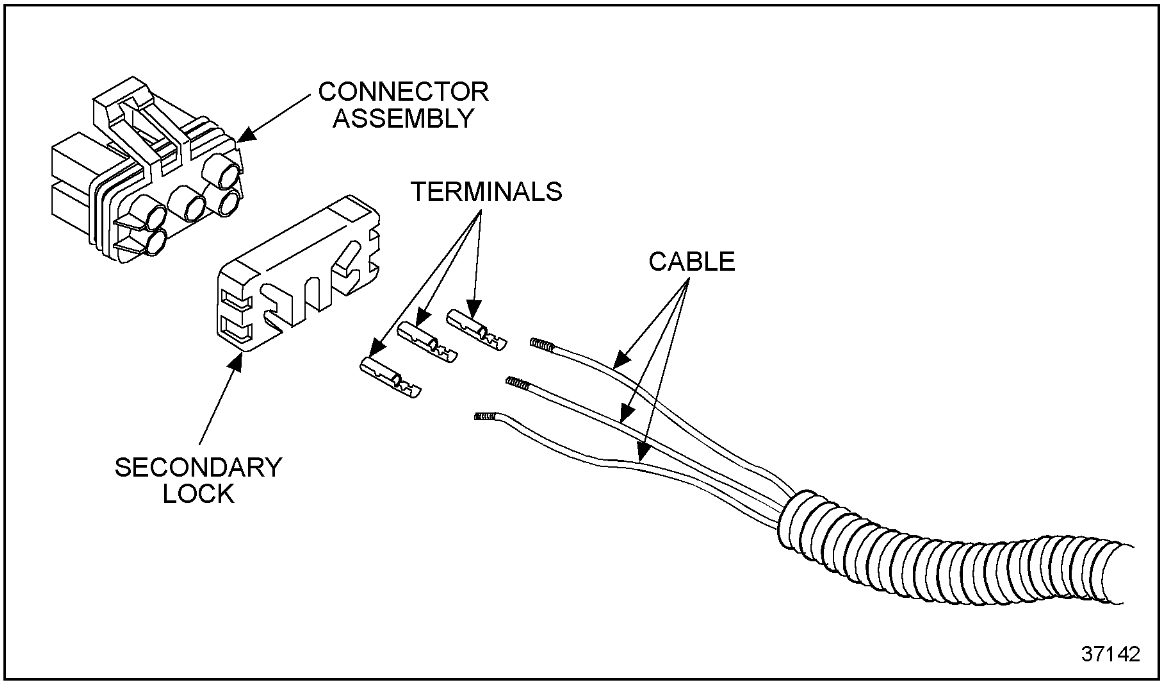


Figure 3-42 Typical Push-to-Seat Terminal Installation

Push-to-Seat Terminal Removal

One locking tang secures the push-to-seat terminals to the connector body. Use the following instructions for removing terminals from the connector body.

1. Grasp the cable to be removed and push the terminal to the forward position.
2. Insert the removal tool straight into the front of the connector cavity until it rests on the cavity shoulder. See Figure 3-43.

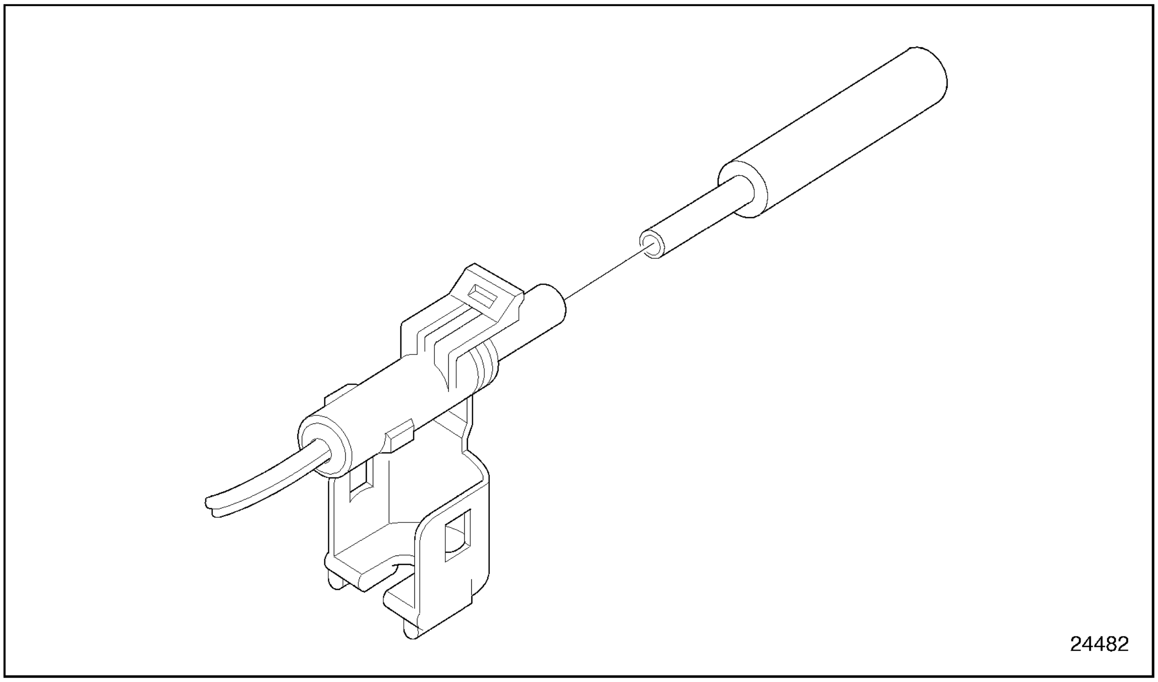


Figure 3-43 Removal Tool Procedure

3. Grasp the cable and push it forward through the connector cavity into the tool while holding the tool securely in place. The tool will depress the locking tangs of the terminal.
4. Pull the cable rearward (back through the connector).
5. Remove the tool from the connector cavity.
6. Cut the wire immediately behind the terminal crimp.
7. Follow the installation instructions for crimping on a replacement terminal.

Pull-to-Seat Terminal Installation Guidelines

The following guidelines apply to all pull-to-seat terminals.

Use the following instructions for pull-to-seat terminal installation without a seal:

1. Insert the wire through the appropriate connector hole/cavity (see Figure 3-44).

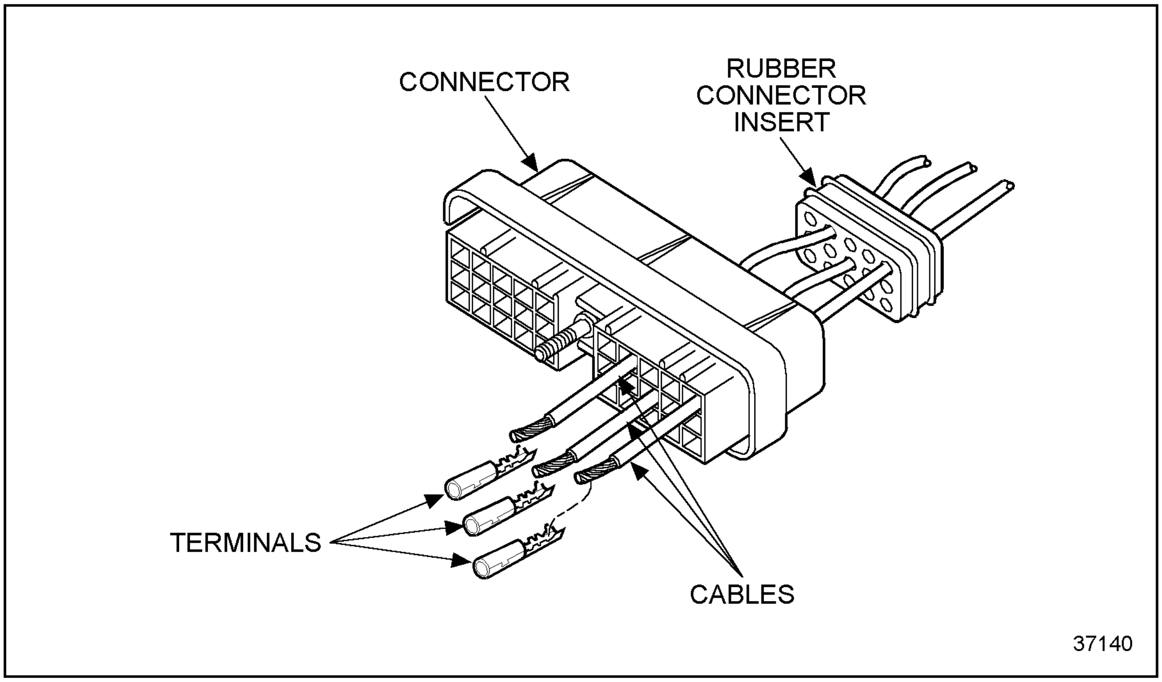


Figure 3-44 Wire Inserted Through the Connector

2. Remove the insulation from the end of the cable, exposing a sufficient amount of core leads to be crimped by the terminal core wings (see Figure 3-44).
3. Insert the terminal into the locating hole of the crimping tool using the proper hole according to the gage of the cable to be used (see Figure 3-45).

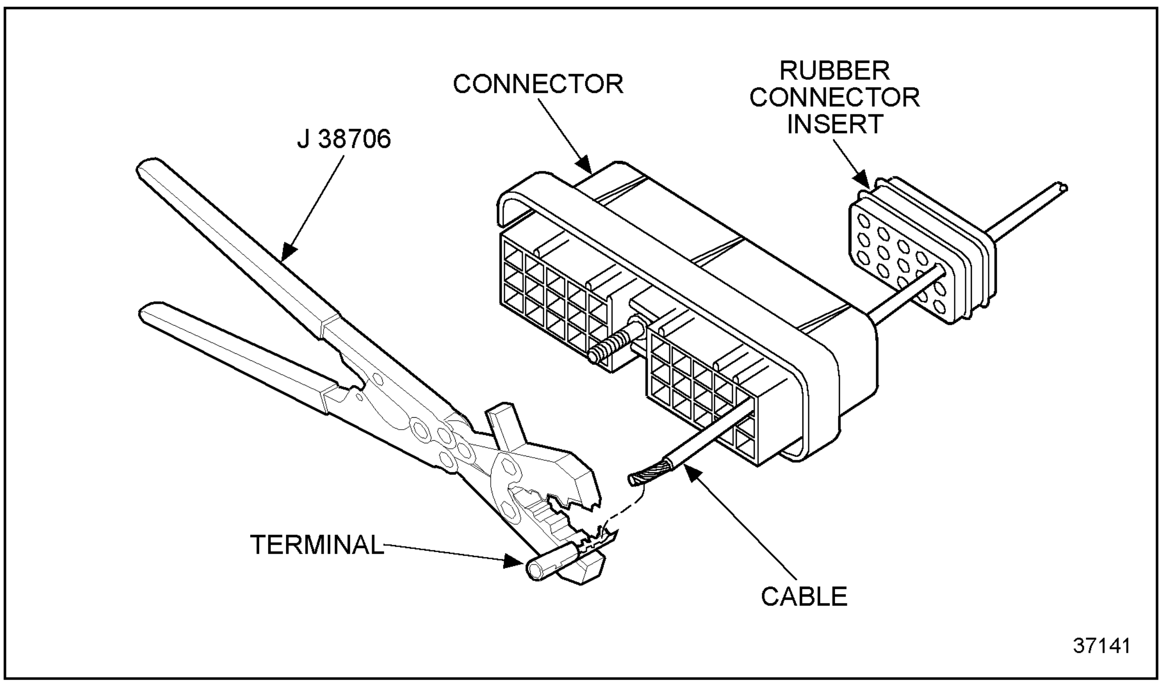


Figure 3-45 Typical Terminal Position

4. Insert the cable into the terminal so the stripped portion is positioned in the cable core wings and the insulated portion of the cable is in the insulation wings (see Figure 3-46).

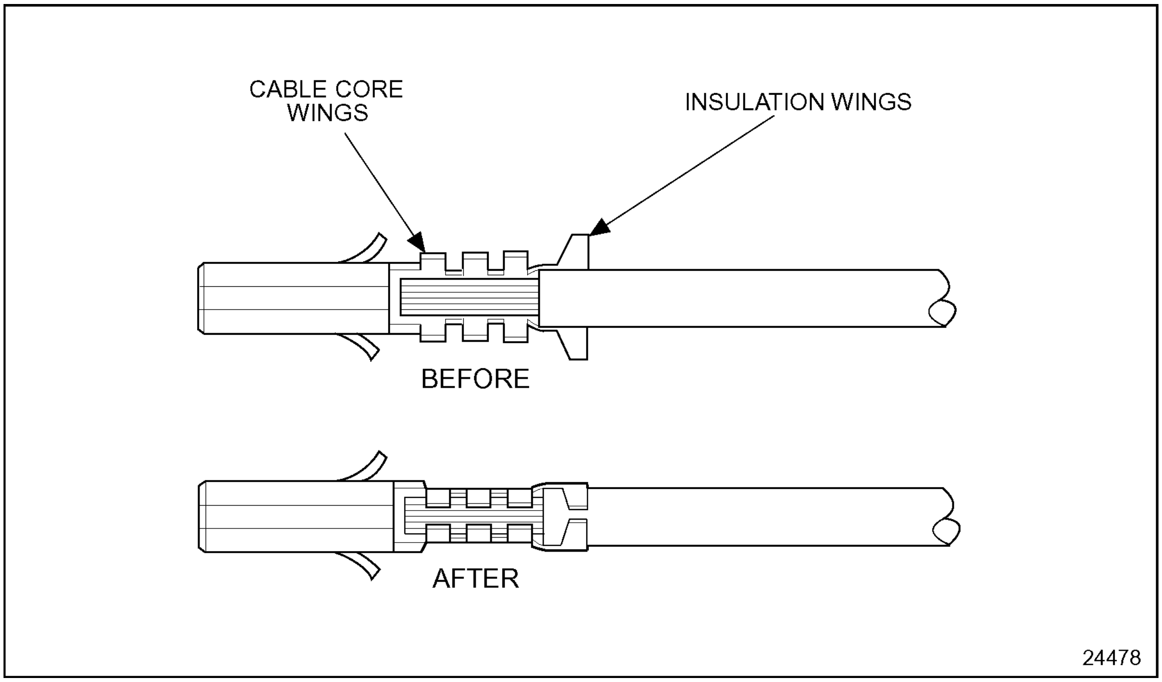


Figure 3-46 Typical Terminal Installation

5. Compress the handles of the crimping tool to crimp the core wing until the ratchet automatically releases.
6. Repeat steps 3, 4, and 5.

NOTE:
Release the crimping tool with the lock lever located between the handles, in case of jamming.

7. Gently tug on the terminal to make sure it is secure. The criteria listed in Table 3-36 must be met.

Wire Gage	Must Withstand Applied Load
14 AWG	45 lb (200 N)
16 AWG	27 lb (120 N)
18 AWG	20 lb (90 N)

Table 3-36 Applied Load Criteria for the Terminal

NOTICE:
Any terminal that is cracked or ruptured is unacceptable as malfunctions may occur.

8. Replace incorrectly installed and damaged terminals by cutting off the terminal just after the insulation wings.

Pull-to-seat Terminal Removal

A tang on the terminal locks into a tab molded into the plastic connector to retain the cable assembly. Remove terminals using the following instructions:

1. Insert the removal tool into the cavity of the connector, placing the tip of the tool between the locking tang of the terminal and the wall of the cavity.
2. Depress the tang of the terminal to release it from the connector.
3. Push the cable forward through the terminal until the complete crimp is exposed.
4. Cut the cable immediately behind the damaged terminal to repair it.
5. Follow the installation instructions for crimping the terminal and inserting it into the connector.

Deutsch Terminal Installation Guidelines

Deutsch connectors have cable seals molded into the connector. These connectors are push-to-seat connectors with cylindrical terminals. The diagnostic connector terminals are gold plated for clarity.

NOTICE:
Improper selection and use of crimp tools have varying adverse effects on crimp geometry and effectiveness. Proper installation of terminals require specialized tools. Do not attempt to use alternative tools.

The crimp tool to use in Deutsch terminal installation is J 34182 (Kent-Moore part number).

NOTICE:
Terminal crimps must be made with the Deutsch crimp tool P/N: HDT-48-00 to assure gas tight connections.

NOTICE:
If a separate seal is required, be sure to install the seal onto the wire before stripping the insulation.

Use the following instructions for installing Deutsch terminals:

1. Strip approximately .25 inch (6 mm) of insulation from the cable.
2. Remove the lock clip, raise the wire gage selector, and rotate the knob to the number matching the gage wire that is being used.
3. Lower the selector and insert the lock clip.
4. Position the contact so that the crimp barrel is 1/32 of an inch above the four indenters. See Figure 3-47. Crimp the cable.

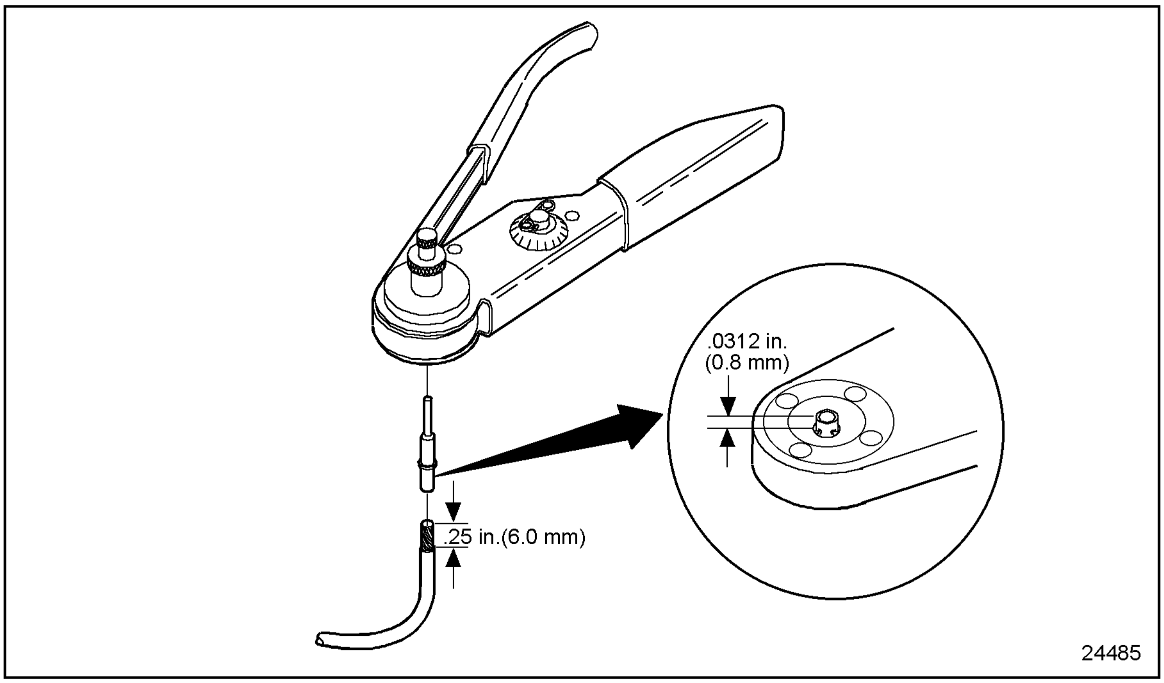


Figure 3-47 Setting Wire Gage Selector and Positioning the Contact

5. Grasp the contact approximately one inch behind the contact crimp barrel. Hold the connector with the rear grommet facing you. See Figure 3-48.

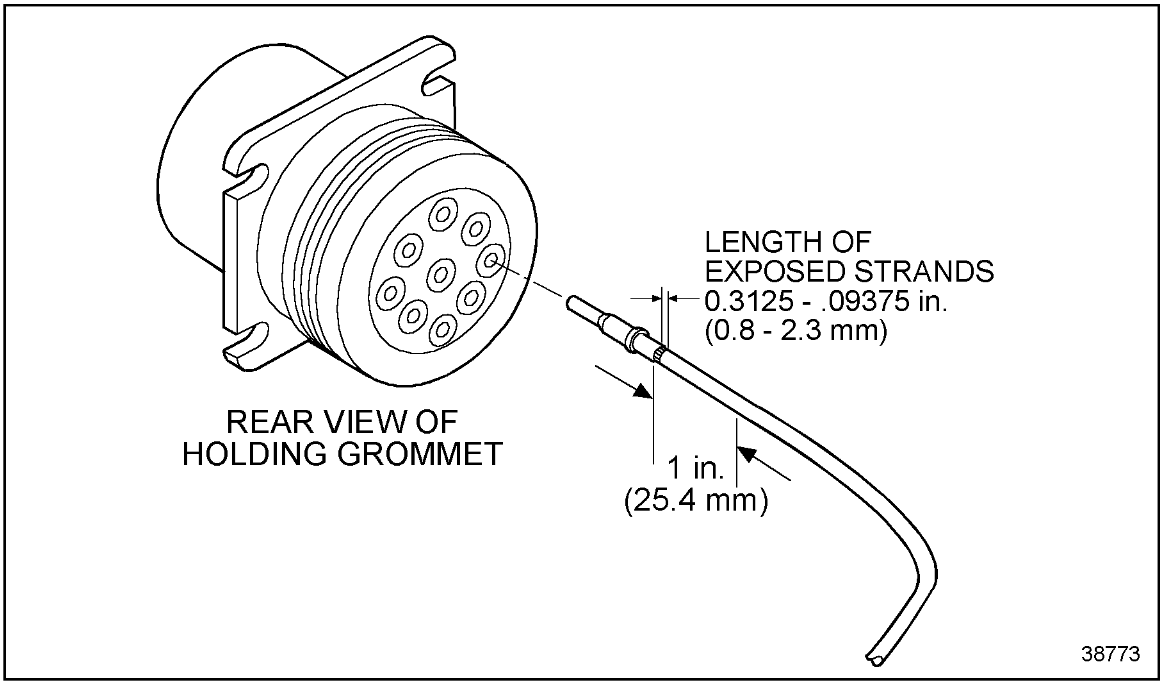


Figure 3-48 Pushing Contact Into Grommet

6. Push the contact into the grommet until a positive stop is felt. See Figure 3-48. A slight tug will confirm that it is properly locked into place. See Figure 3-49.

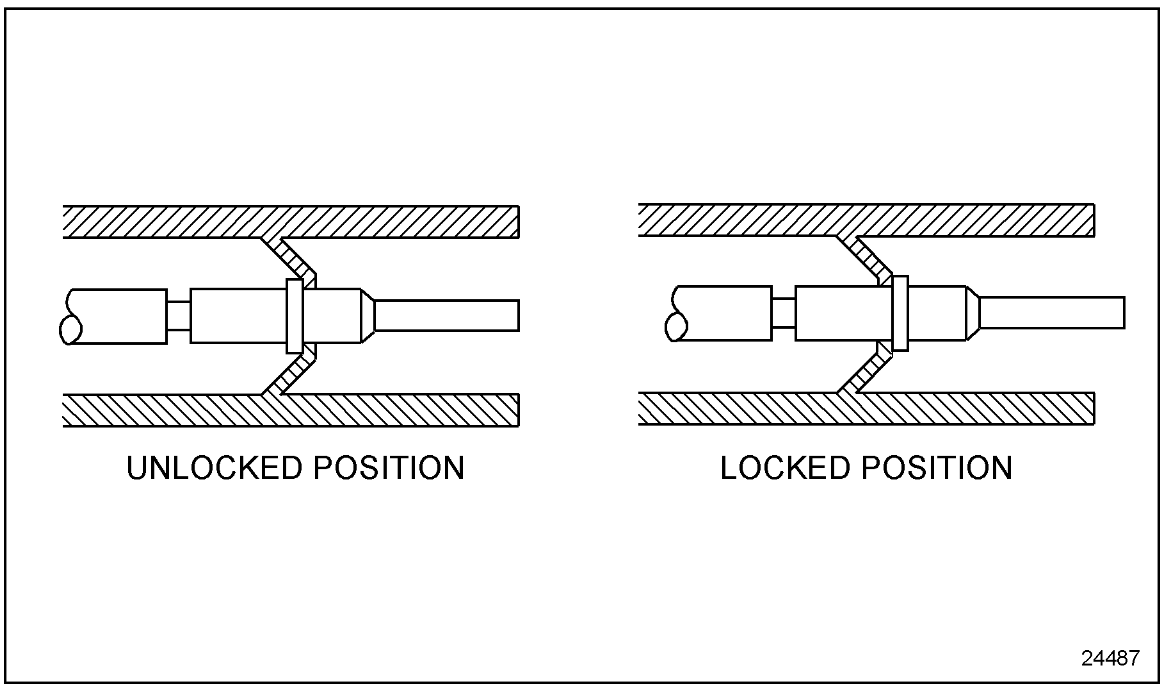


Figure 3-49 Locking Terminal Into Connector

Deutsch Terminal Removal

The appropriate size removal tool should be used when removing cables from connectors. The proper removal tools are listed in Table 3-37.

Tool	Kent-Moore Part Number
Removing (12 AWG)	J 37451
Removing (16-18 AWG)	J 34513-1

Table 3-37 Removal Tools for Deutsch Terminals

Remove Deutsch terminals as follows:

1. With the rear insert toward you, snap the appropriate size remover tool over the cable of contact to be removed. See Figure 3-50.

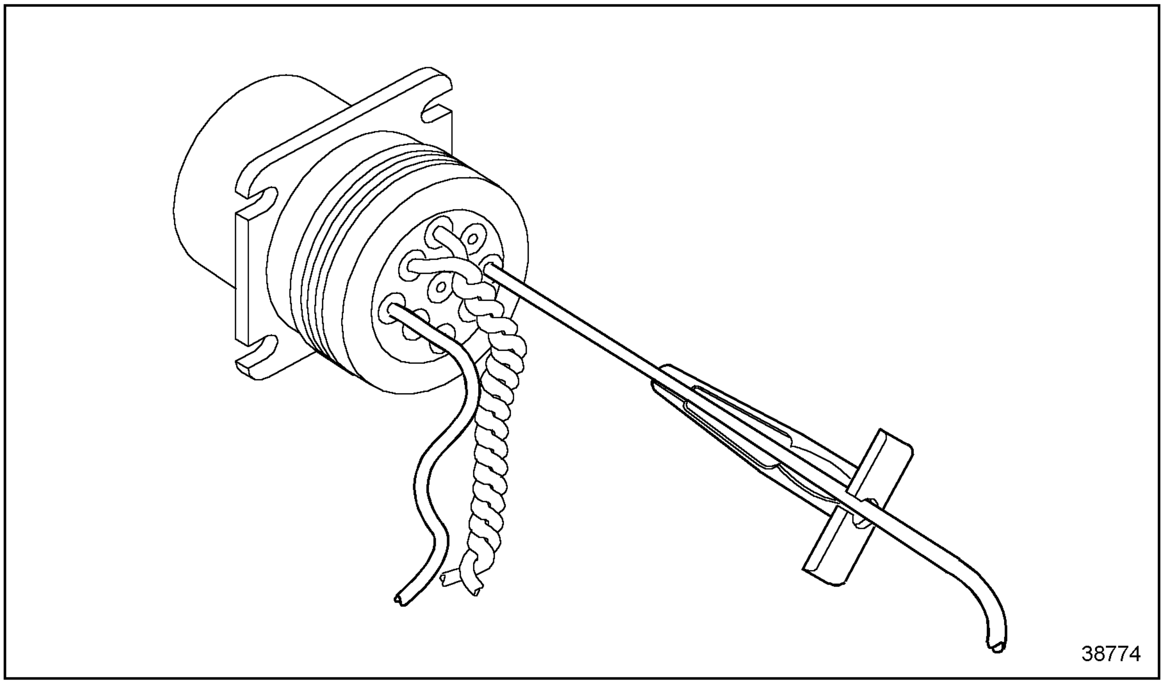


Figure 3-50 Removal Tool Position

2. Slide the tool along the cable into the insert cavity until it engages and resistance is felt. Do not twist or insert tool at an angle. See Figure 3-51.

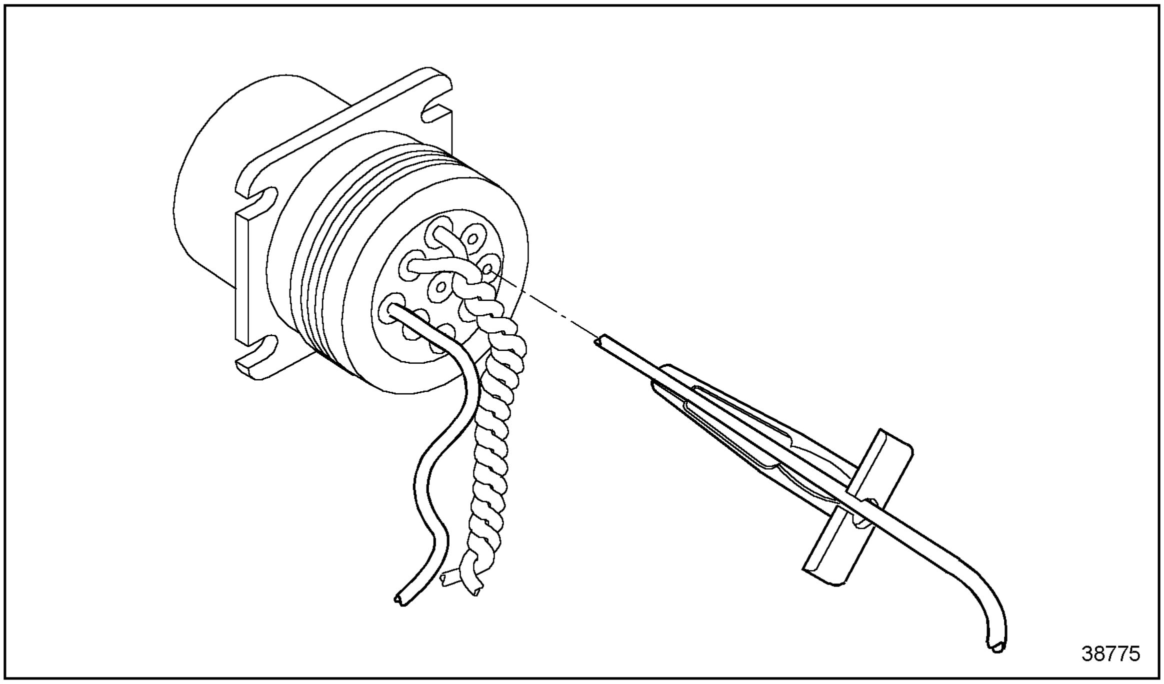


Figure 3-51 Removal Tool Insertion

3. Pull contact cable assembly out of the connector. Keep reverse tension on the cable and forward tension on the tool.

Quick Disconnect Canon Connector Installation Guidelines

The terminals must be crimped and installed on the VIH wires for both the plug and socket end of the 37-pin connector.

Crimp the terminals on to the wires as follows:

1. Strip the wires to the appropriate length, .245 in. (6.2 mm).
2. Open the crimp tool (ITT Canon P/N: 192990-2050) by squeezing the handles.

3. Push the latch on the turret to pop up the locator. Attach the turret (ITT P/N: 995-0002-052) to the crimp tool using the two captive hex bolts in the turret (see Figure 3-52).
4. Select the proper locator position, as listed in Table 3-38, by rotating the locator until the proper color is aligned with the index mark. Push the locator down until it snaps into position.

Pin Locator Color	Socket Locator Color
Green	Red

Table 3-38 Proper Locator Position

5. Adjust the dial for proper wire gauge with the lock pin. Remove the lock pin and lift the center of the dial. Turn to the desired wire gauge and replace the lock pin on the dial (see Figure 3-52).

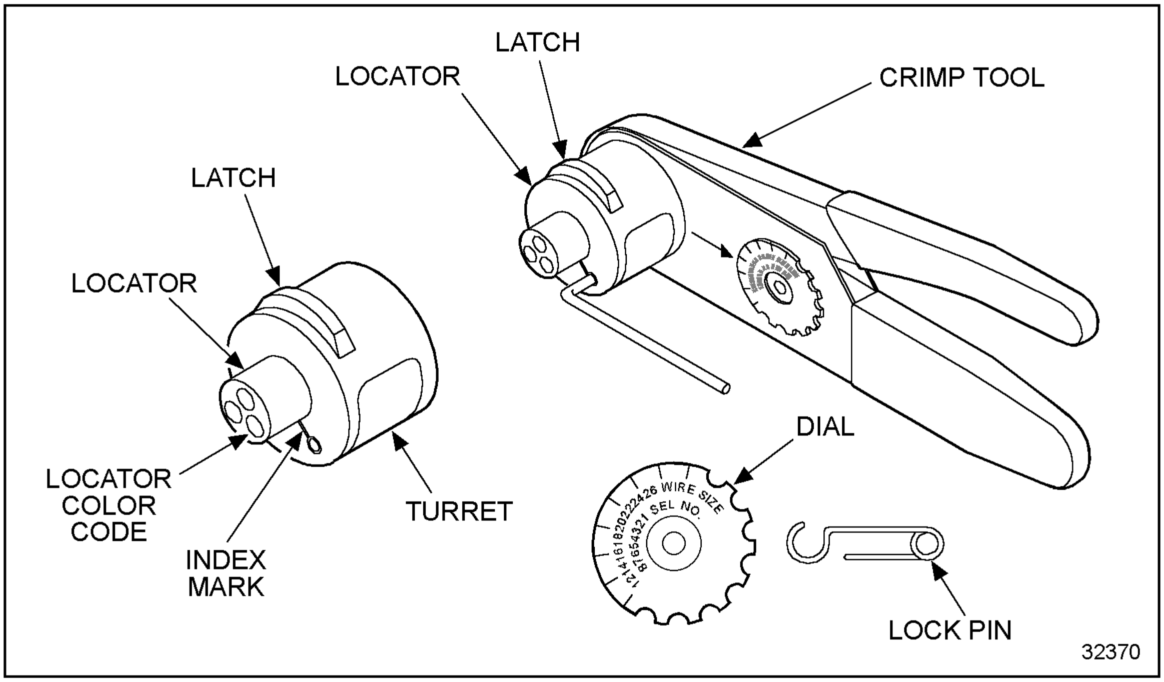


Figure 3-52 Hand Crimp Tool for 37-pin Connector Terminals

6. Cycle the tool before inserting the terminal to be sure the tool is in the open position.
7. Drop the terminal, mating end first, into the crimp cavity. Squeeze the tool handle just enough to grip the terminal without actually crimping it (see Figure 3-53, A).

8. Insert the stripped wire into the terminal with a slight twisting motion. All wire strands must be inside the contact (see Figure 3-53, B).

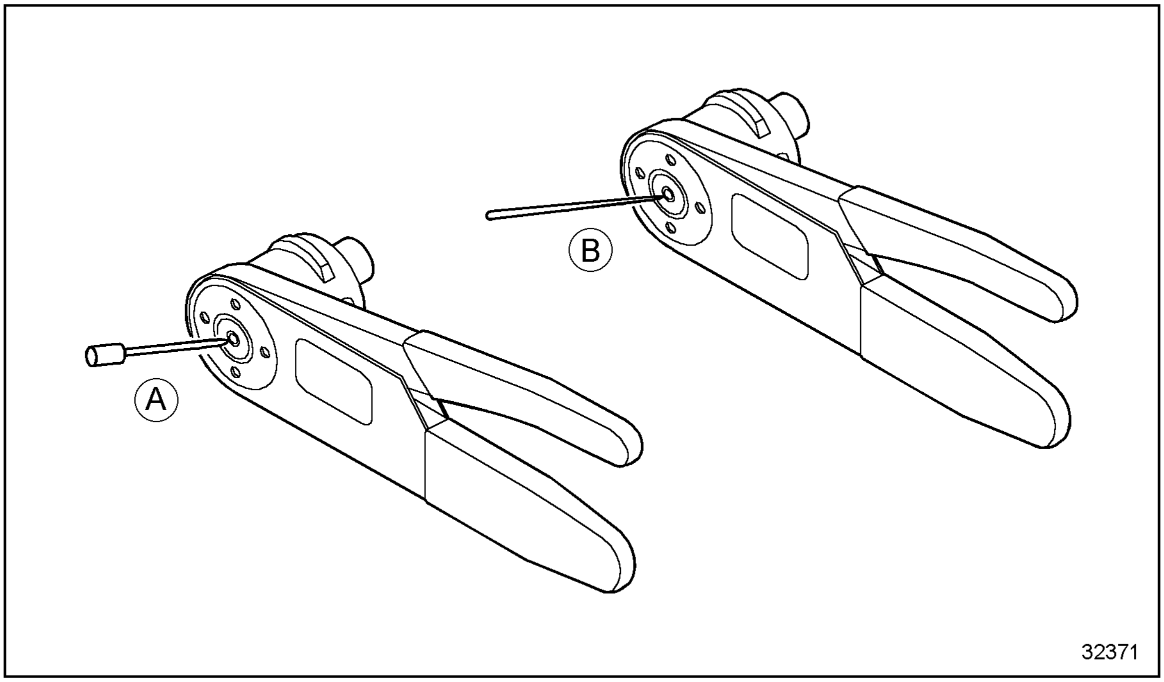


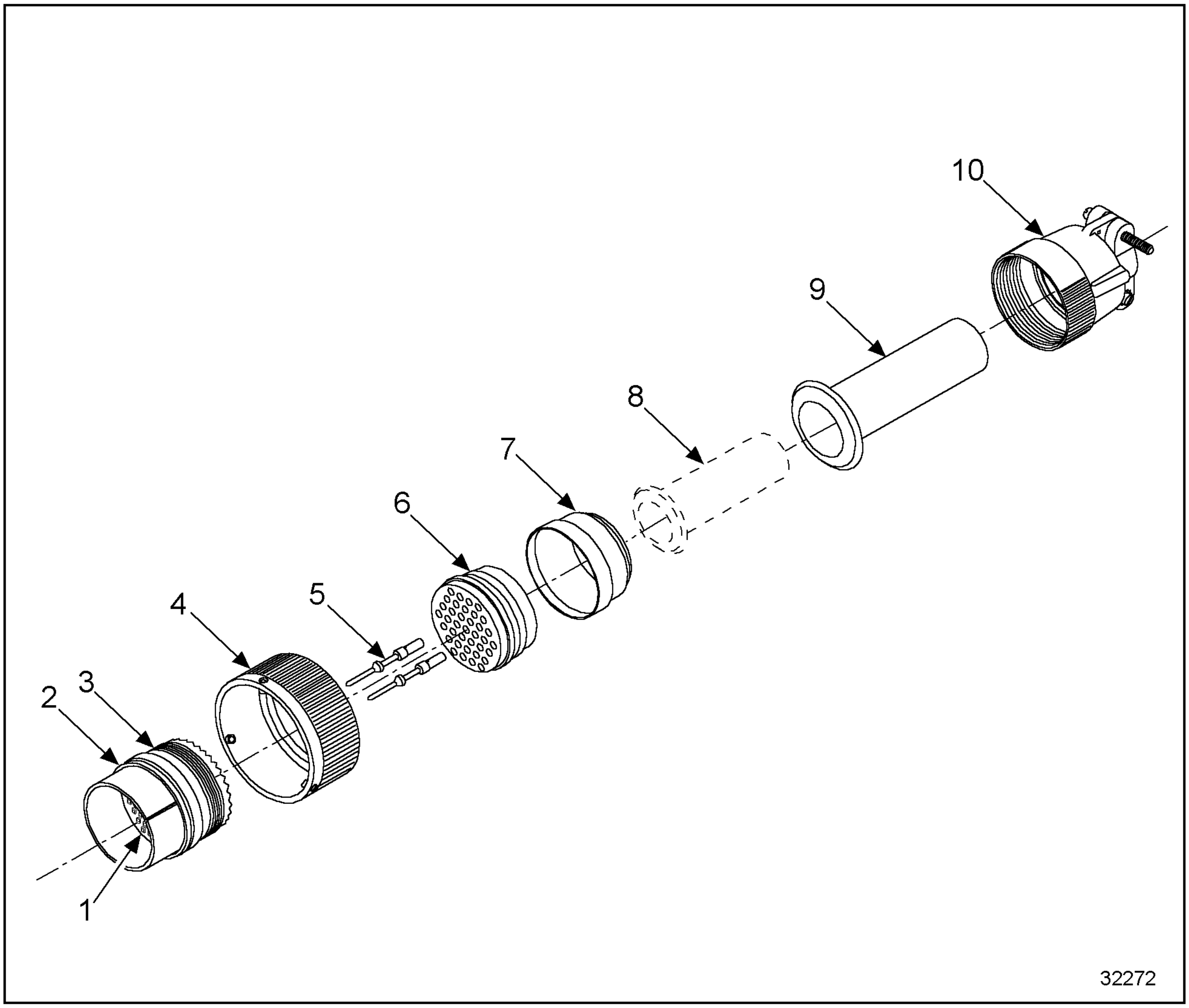
Figure 3-53 Inserting the Terminal and the Stripped Wire.

9. Squeeze the handle. The handle will not release until the terminal is completely crimped.

NOTICE:
Any terminal that is cracked or ruptured is unacceptable as malfunctions may occur.

10. Remove the crimped terminal. Visually inspect the crimp for the following:
    - [a] The conductor must be visible through the wire inspection hole on the terminal.
    - [b] The insulation should butt up against the end of the terminal.

The parts of the plug end can be seen in the following illustration (see Figure 3-54).



1. 37-pin Insulator
2. O-ring
3. Barrel
4. Bayonet Coupling Nut
5. Terminals (Male, Pull-to-Seat)
6. Grommet
7. Ferrule
8. Optional Telescope Bushing (Small)
9. Telescope Bushing (Large)
10. Cable Clamp

Figure 3-54 Exploded View of 37-Pin Plug Kit

Insert terminals into the plug end (P/N: 23516830) as follows:

1. Slide the rear accessories over the wire bundle in the proper sequence for reassembly (see Figure 3-55):
   [a] Cable clamp
   [b] Large Telescope bushing
   [c] Small telescope bushing, if needed to reduce side-to-side clearance between bundle and the large telescope bushing.

[d] Ferrule

[e] Bayonet coupling nut

2. Place the terminal in a pliers style insertion tool (ITT Canon P/N: CIT-F80-16). The tool should butt against the shoulder of the terminal (see Figure 3-55, A). Install guide pin (guide pins, ITT Canon P/N: 226-1017-000, must be used with socket terminals).
3. Lubricate the grommet with isopropyl alcohol. Do not use any other lubricant.
4. Insert the terminal through the appropriate cavity in the grommet (starting at the center of the grommet pattern, see Figure 3-55, B).

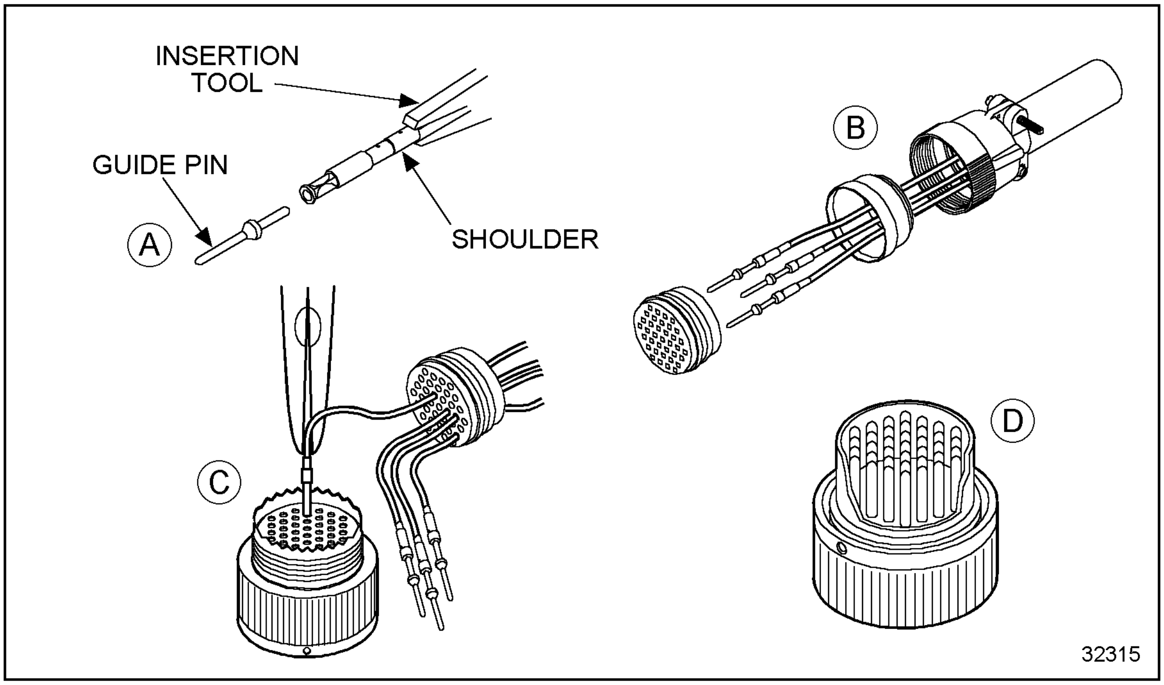
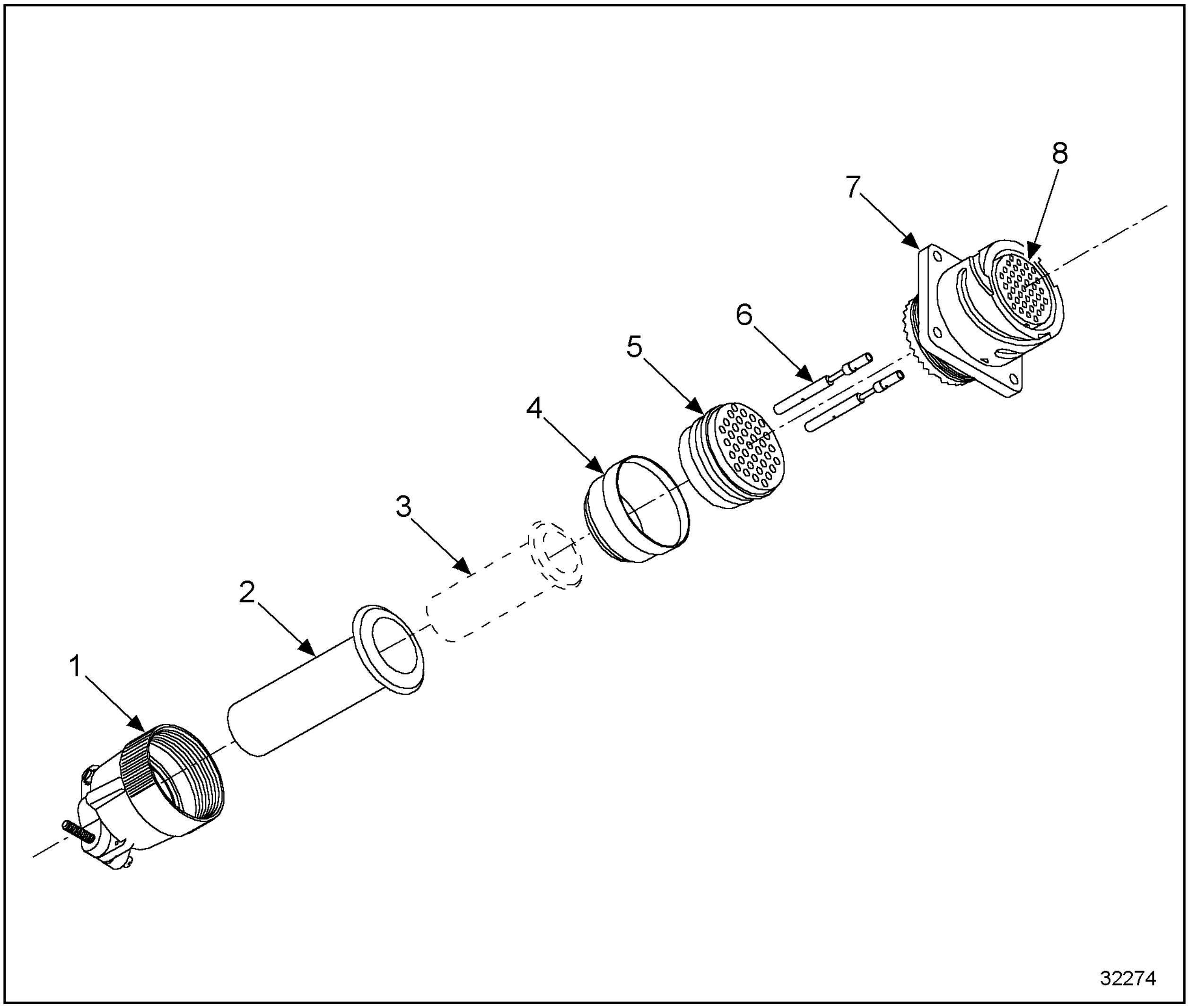


Figure 3-55 Inserting Terminals

5. Lubricate the contact cavities of the connector insulator with isopropyl alcohol (do not use any other type of lubricant).
6. Starting at the center of the connector insulator pattern, push guide pin and terminal straight down with a firm even pressure until the terminal snaps into position (see Figure 3-55, C). Allow clearance on the mating face of the connector for the guide pins to come through the connector during insertion.
7. Fill any unused connector insulator cavities with uncrimped terminals.
8. Check the mating face of the connector to insure that all the same size terminals are on the same plane and fully inserted (see Figure 3-55, D). Any terminal not fully inserted must be removed and reinserted. Do not reinsert the insertion tool to correct the problem.
9. Insert a plug into the grommet behind the uncrimped terminals to maintain the sealing integrity of the connector.

10. Slide the connector accessories back down the cable over the rear of the connector and tighten using appropriate tools.

The parts of the socket end can be seen in the following illustration (see Figure 3-54).



1. Cable Clamp
2. Telescope Bushing (Large)
3. Optional Telescope Bushing (Small)
4. Ferrule
5. Grommet
6. Terminals (Female, Pull-to-Seat)
7. Shell
8. 37-pin Insulator

Figure 3-56 Exploded View of the 37-pin Receptacle (Socket End)

Insert terminals into the socket end (P/N: 23515462) as follows:

1. Slide the rear accessories over the wire bundle in the proper sequence for reassembly:

   [a] Cable clamp

   [b] Telescope bushing

   [c] Ferrule

2. Place the terminal in a pliers style insertion tool. The tool should butt against the shoulder of the terminal.
3. Lubricate the grommet with isopropyl alcohol. Do not use any other lubricant.
4. Insert the terminal through the appropriate cavity in the grommet (starting at the center of the grommet pattern).
5. Starting at the center of the connector insulator pattern, push guide pin and terminal straight down with a firm even pressure until the terminal snaps into position.
6. Fill any unused cavities with uncrimped terminals.
7. Insert a plug into the grommet behind the uncrimped terminals to maintain the sealing integrity of the connector.
8. Slide the connector accessories back down the cable over the rear of the connector and tighten.

Terminal Removal

Remove the terminals as follows:

1. Remove the endbell accessories and slide them back over the wires.
2. Use extraction tool, ITT Canon P/N: CET-F80-16 (see Figure 3-57).

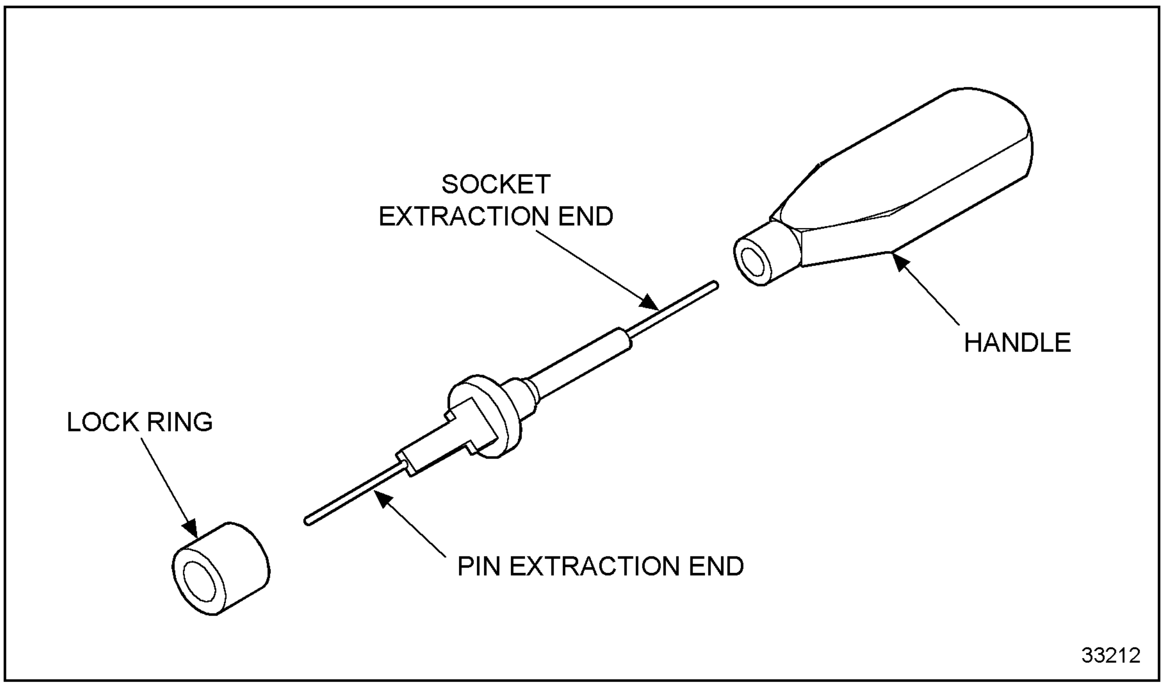


Figure 3-57 Extraction Tool

3. On the mating face of the connector, insert the tool over the pin terminal or into the socket terminal until the tool stops (see Figure 3-58).

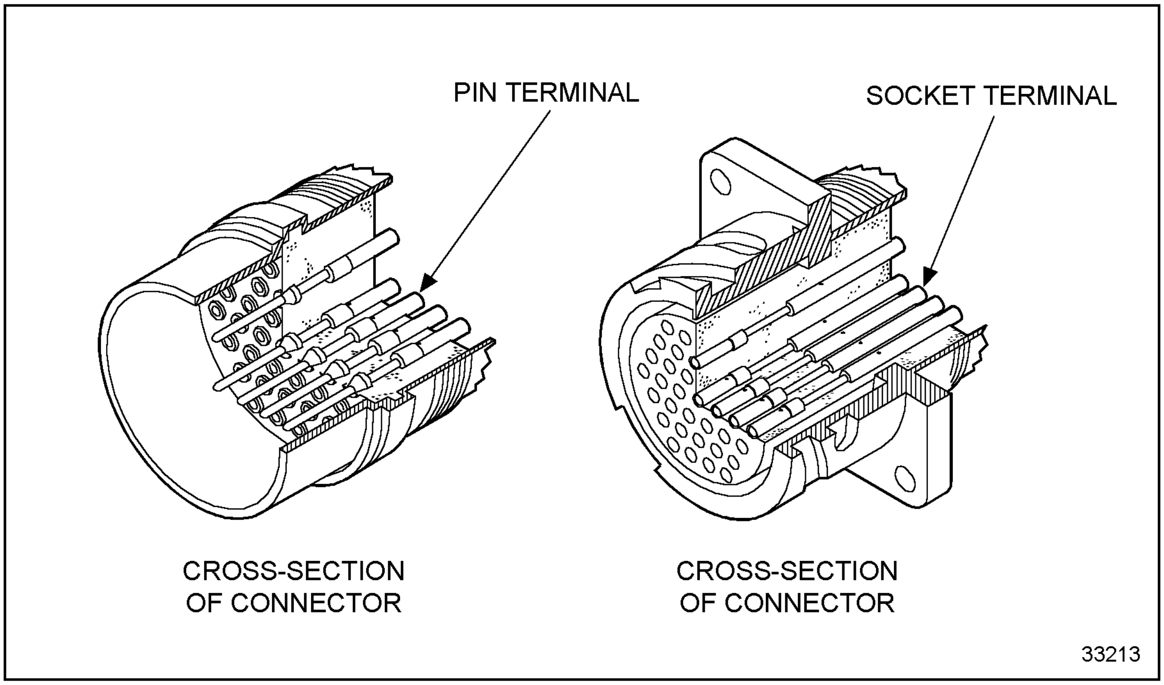


Figure 3-58 Connector Cross-section With Pin and Socket Terminals

4. Apply a slow continuous pressure to push the contact out the rear of the connector. When the shoulder of the tool hits ("thunks") against the insulator, the contact is extracted.
5. Carefully remove the extraction tool from the connector to avoid damage to the insulator.

3.11.8 SPLICING GUIDELINES

The following are guidelines which may be used for splices. The selection of crimpers and splice connectors is optional. Select a high quality crimper equivalent to the Kent-Moore tool, J 38706, and commercially available splice clips.

The recommended technique for splicing and repairing circuits (other than power and ignition circuits) is a clipped and soldered splice. Alternatively, any method that produces a high quality, tight (mechanically and electronically sound) splice with durable insulation is considered to be acceptable.

Clipped and Soldered Splicing Method

The tools required are listed in Table 3-39.

Tool	Part Number
Heat Gun	--
Sn 60 solder with rosin core flux	--
Wire Stripper	Kent-Moore J 35615 or equivalent
Splice Clips (commercially available)	Wire size dependent
Heat Shrink Tubing	Raychem HTAT or equivalent

Table 3-39 Recommended Splicing Tools

Criteria: Splicing Straight Leads

No more than one strand in a 16 strand wire may be cut or missing.
Use Sn 60 solder with rosin core flux.
The exposed wire must be clean before the splice is soldered.

Soldering splice connectors is optional. To solder splice connectors:

1. Position the leads, so one overlaps the other. See Figure 3-59.

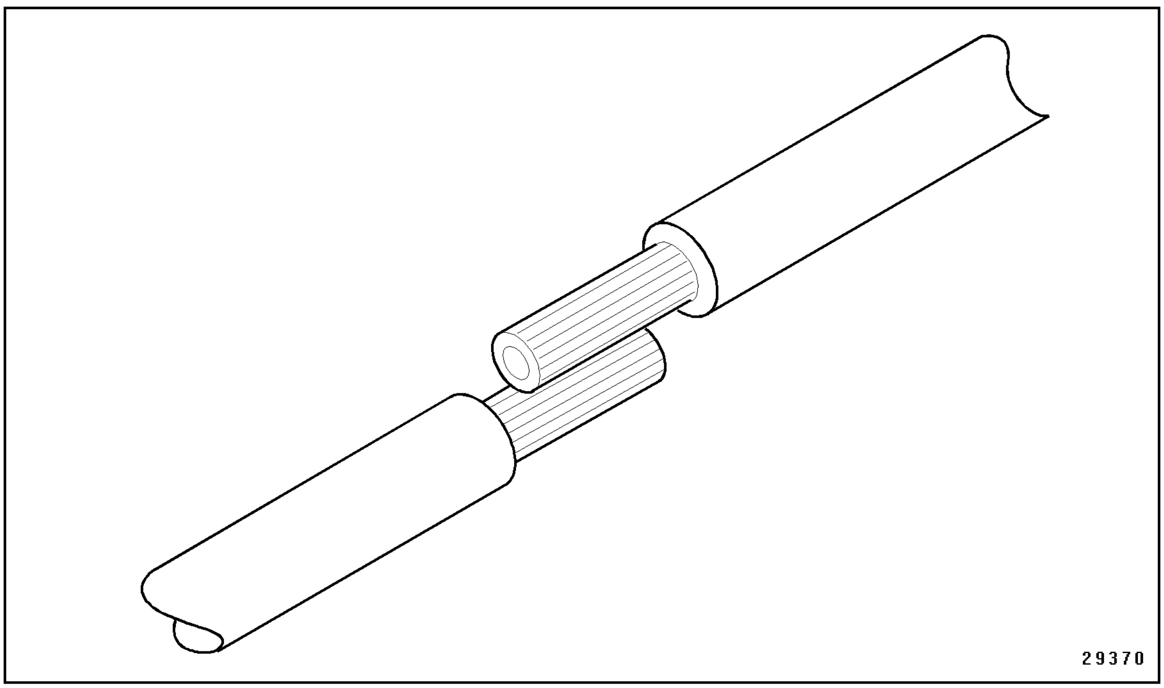


Figure 3-59 Positioning the Leads

2. Secure the leads with a commercially available clip and hand tool. See Figure 3-60.

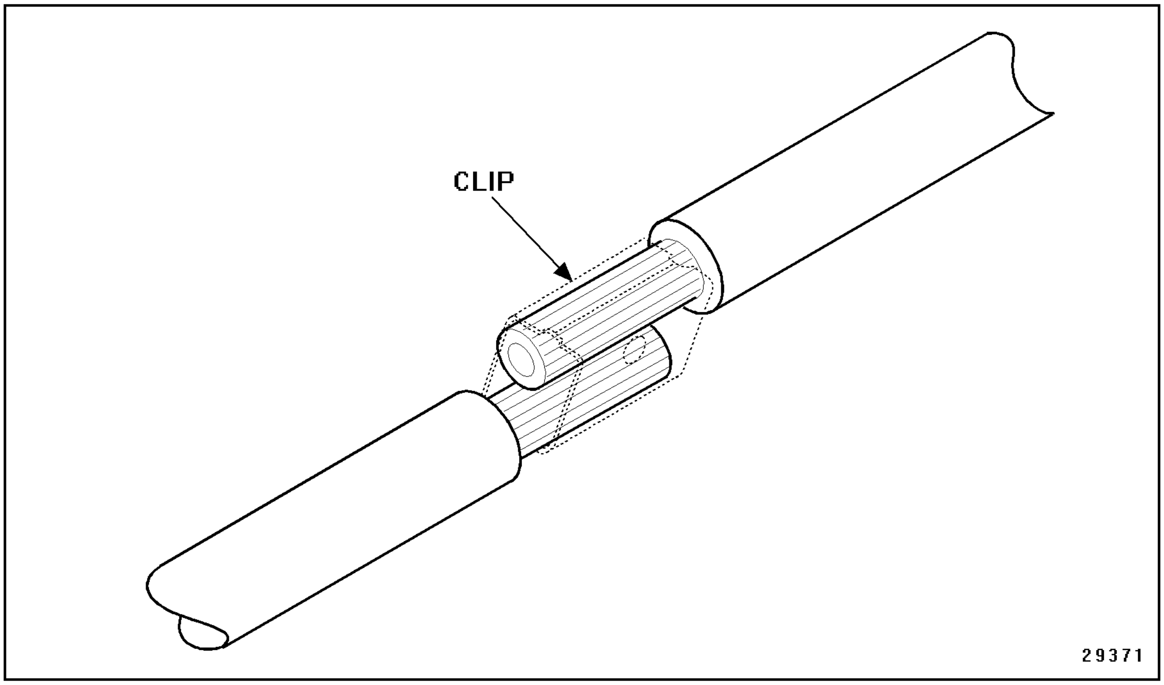


Figure 3-60 Securing the Leads With a Clip

3. Use a suitable electronic soldering iron to heat the wires. Apply the solder to the heated wire and clip (not to the soldering iron) allowing sufficient solder flow into the splice joint.
4. Pull on wire to assure crimping and soldering integrity. The criteria listed in Table 3-40 must be met.

Wire Gage	Must Withstand Applied Load
14 AWG	45 lb (200 N)
16 AWG	27 lb (120 N)
18 AWG	20 lb (90 N)

Table 3-40 Applied Load Criteria for Terminals

5. Loop the lead back over the spliced joint and tape. See Figure 3-61.

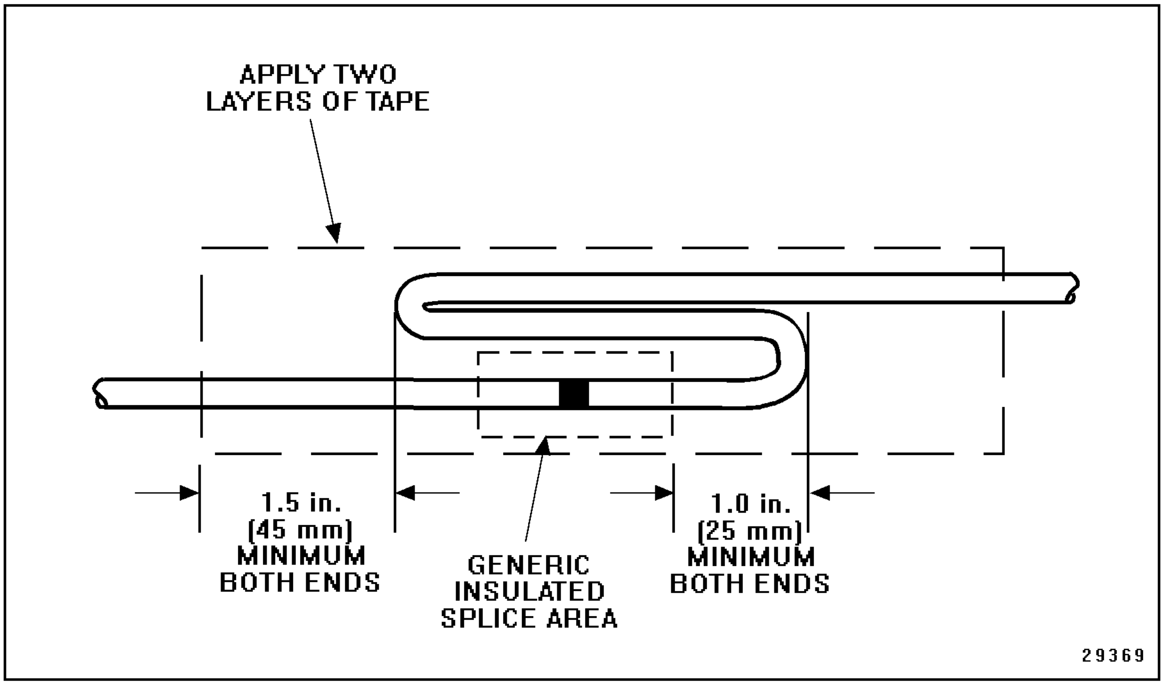


Figure 3-61 Recommended Strain Relief of Spliced Joint

Splicing and Repairing Straight Leads-Alternate Method 1

The tools required are listed in Table 3-41.

Tool	Part Number
Heat Gun	--
Wire Stripper	Kent-Moore J 35615 or equivalent
Splice Clips (commercially available)	Wire size dependent
Heat Shrink Tubing	Raychem HTAT or equivalent
Terminal Crimper for Metri-Pack 280 (12 AWG)	Kent-Moore J 38125-6
Terminal Crimper for Metri-Pack 280 (18 AWG)	Kent-Moore J 39848
Terminal Crimper for Weather Pack	Kent-Moore J 35606
Terminal Crimper for Deutsch	Kent-Moore J 34182
Terminal Crimper for Metri-Pack 150	Kent-Moore J 35123

Table 3-41 Recommended Splicing Tools

Criteria: Splicing Straight Leads

No more than one strand in a 16 strand wire may be cut or missing.

The recommended method to splice straight leads follows:

1. Locate broken wire.
2. Remove insulation as required; be sure exposed wire is clean and not corroded.
3. Insert one wire into the splice clip until it butts against the clip. Stop and crimp (see Figure 3-62, A).
4. Insert the other wire into the splice clip until it butts against the clip stop (see Figure 3-62, B).

NOTICE:

Any terminal that is cracked or ruptured is unacceptable as malfunctions may occur.

5. Visually inspect the splice clip for cracks, rupture, or other crimping damage. Remove and replace damaged clips before proceeding.
6. Pull on wire to ensure the splice integrity. The criteria listed in Table 3-42 must be met.

Wire Gage	Must Withstand Applied Load
14 AWG	45 lb (200 N)
16 AWG	27 lb (120 N)
18 AWG	20 lb (90 N)

Table 3-42 Applied Load Criteria for Terminals

7. Shrink the splice clip insulative casing with a heat gun to seal the splice (see Figure 3-62, C).

NOTICE:

Splices may not be closer than 12 in. (.3 m) apart to avoid degradation in circuit performance. Replace wire to avoid having splices closer than 12 in. (.3 m) apart.

8. Loop the lead back over the spliced joint and tape. See Figure 3-61.

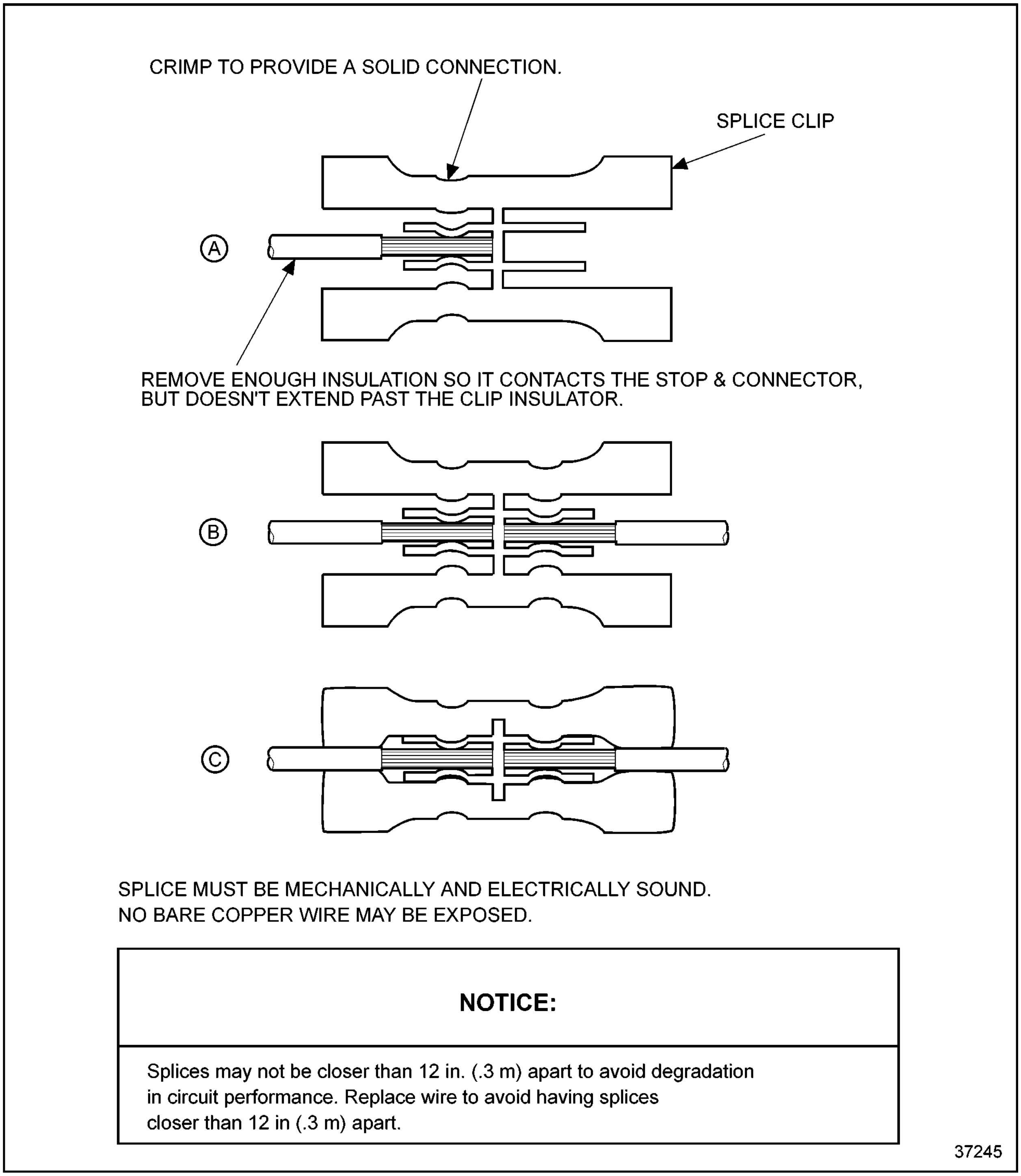


Figure 3-62 Splicing Straight Leads - Alternate Method 1

Splicing and Repairing Straight Leads - Alternate Method 2

This method is not allowed or recommended for power or ignition circuits. The tools required are listed in Table 3-43.

Tool	Part Number
Heat Gun	--
Wire Stripper	Kent-Moore J 35615 or equivalent
Splice Clips (commercially available)	Wire size dependent
Heat Shrink Tubing	Raychem HTAT or equivalent
Terminal Crimper for Metri-Pack 280 (12 AWG)	Kent-Moore J 38125-6
Terminal Crimper for Metri-Pack 280 (18 AWG)	Kent-Moore J 39848
Terminal Crimper for Weather Pack	Kent-Moore J 35606
Terminal Crimper for Deutsch	Kent-Moore J 34182
Terminal Crimper for Metri-Pack 150	Kent-Moore J 35123

Table 3-43 Recommended Splicing Tools

Criteria: Splicing Straight Leads

No more than one strand in a 16 strand wire may be cut or missing.

An acceptable option for splicing straight leads is:

1. Locate broken wire.
2. Remove insulation as required; be sure exposed wire is clean and not corroded.
3. Slide a sleeve of glue lined, shrink tubing (Raychem HTAT or equivalent) long enough to cover the splice clip on the wire and overlap the wire insulation, about .25 in. (6 mm) on both sides (see Figure 3-63, A).
4. Insert one wire into splice clip until it butts against the splice clip. Stop and crimp (see Figure 3-63, B).
5. Insert the remaining wires into the splice clip one at a time until each butts against the splice clip; stop and crimp (see Figure 3-63, B).

NOTICE:
Any terminal that is cracked or ruptured is unacceptable as malfunctions may occur.

6. Visually inspect the terminal for cracks, rupture, or other crimping damage. Remove and replace damaged terminal before proceeding.
7. Slide the shrink tubing over the crimped splice clip (see Figure 3-63, C).
8. Shrink tubing with a heat gun to seal the splice (see Figure 3-63, D).

NOTICE:
A minimum of two layers of heat shrink tubing must be applied to splices that have more than one lead in or out.

9. Loop the lead back over the spliced joint and tape. See Figure 3-61.

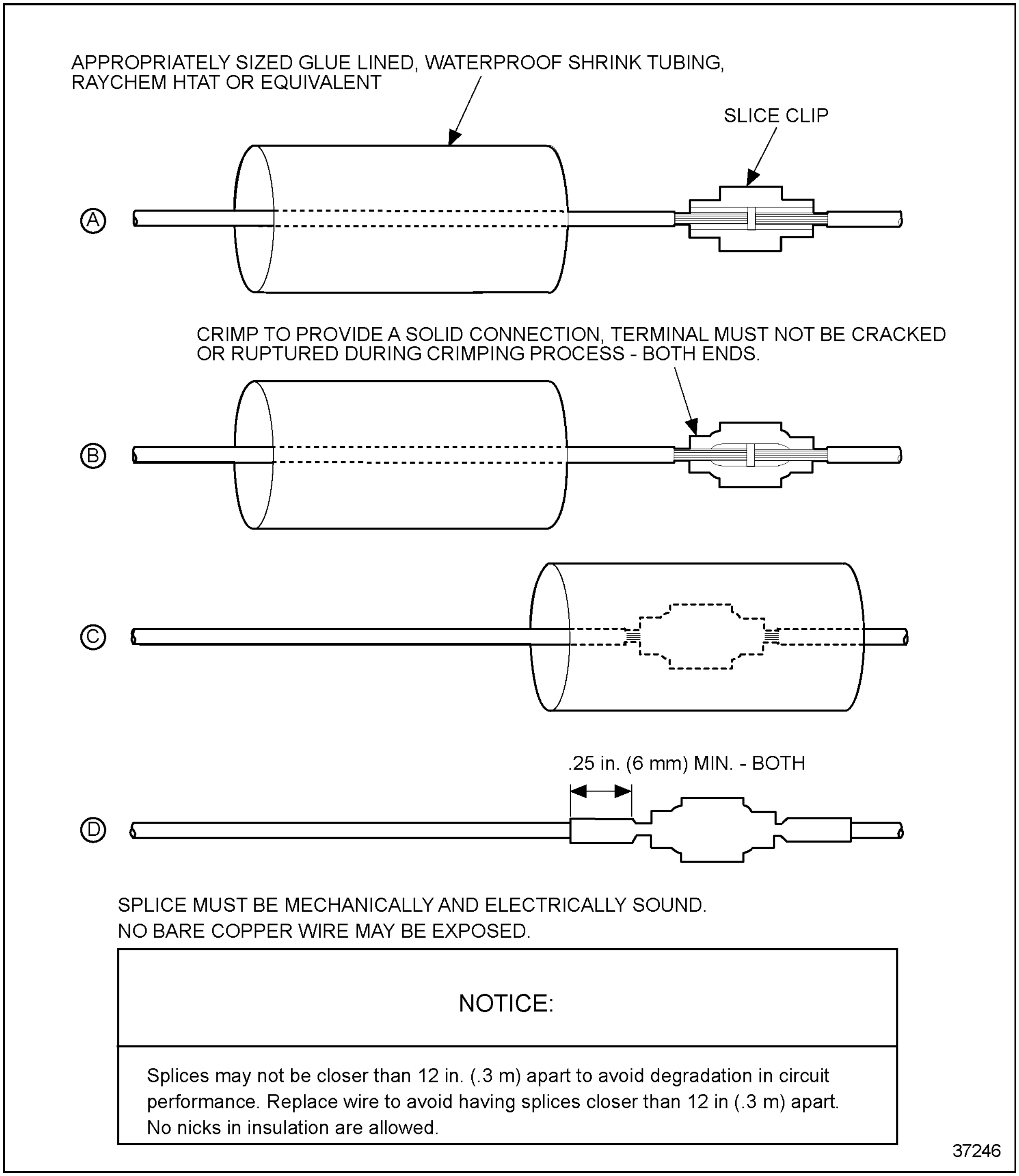


Figure 3-63 Splicing Straight Leads - Alternate Method 2

Shrink Wrap

Shrink wrap is required when splicing non insulated connections. Raychem HTAT or any equivalent heat shrink dual wall epoxy encapsulating adhesive polyolefin is required. Shrink wrap must extend at least .25 in. (6 mm) over wire insulation past splice in both directions.

Alpha Wire Corporation
711 Lidgerwood Ave
P.O. Box 711
Elizabeth, New Jersey 07207-0711
1-800-52ALPHA

Raychem Corporation, Corporate Division
300 Constitution Drive, Bldg. B
Menlo Park, CA 94025
650-361-2755

To heat shrink wrap a splice:

NOTICE:
The heat shrink wrap must overlap the wire insulation about .25 in. (6 mm) on both sides of the splice.

1. Select the correct diameter to allow a tight wrap when heated.
2. Heat the shrink wrap with a heat gun; do not concentrate the heat in one location, but apply the heat over the entire length of shrink wrap until the joint is complete.
3. Repeat step 2 to apply a second layer of protection (if required by splicing guidelines).

Staggering Wire Splices

Position spliced wires properly as follows:

NOTICE:
You must stagger positions to prevent a large bulge in the harness and to prevent the wires from chafing against each other.

1. Stagger the position of each splice (see Figure 3-64) so there is at least a 2.5 in. (65 mm) separation between splices.

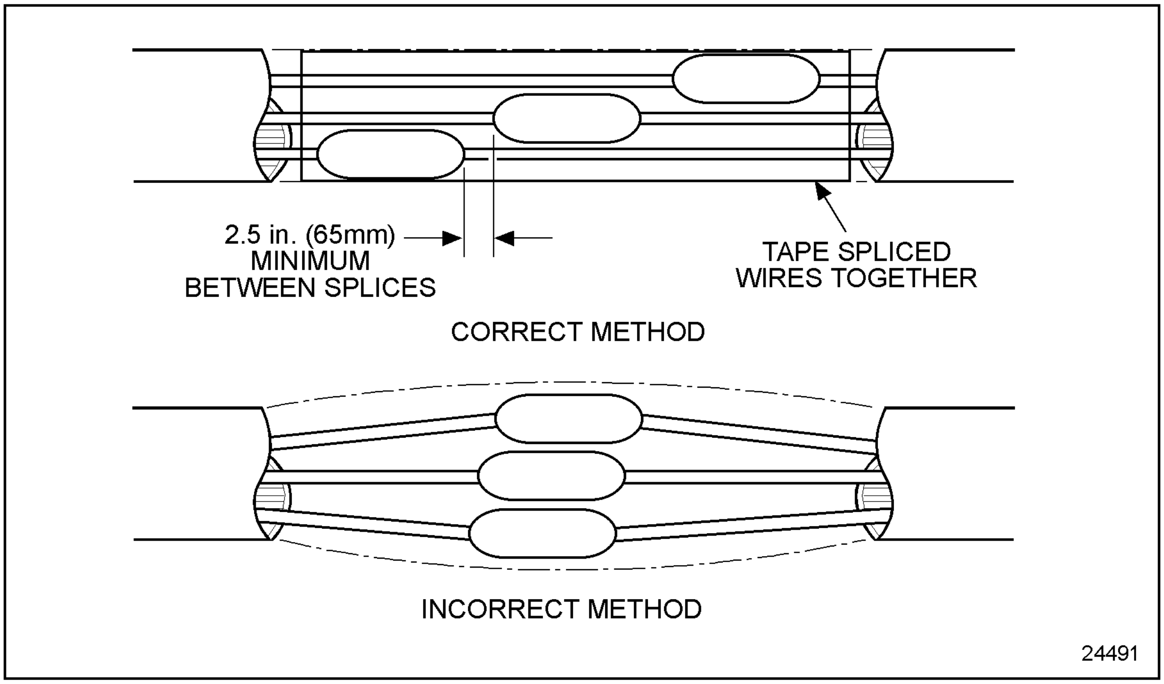


Figure 3-64 The Correct and Incorrect Method of Staggering Multiple Splices

NOTICE:
A minimum of two layers of heat shrink tubing extending .25 in. (6 mm) past the splice must be used to complete the splice.

2. Heat shrink a minimum of two layers of heat shrink tubing.
3. Tape the spliced wires to each other. Refer to section 3.12.

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3.12 CONDUIT AND LOOM

Conduit must be used to protect the harness cable and cable splices.

NOTICE:
The conduit must not cover any connectors, switches, relays, fuses, or sensors.

The following guidelines should be used when designing a harness:

NOTICE:
Wires should be sized and cut to near equal length prior to installing conduit.

- ☐ The distance between the back of the connector or other listed devices to the end of the conduit should not exceed:
  - ☐ 1.0 in. (25 mm) for a single connector/device
  - ☐ 3 in. (75 mm) for multiple connectors/devices
- ☐ All cable breakouts and conduit ends must be secured in place with conduit outlet rings or tape.

Criteria: Conduit and Loom

Due to the wide variety of operating conditions and environments, it is the responsibility of the OEM to select a conduit that will survive the conditions of the specific applications. Flame retardant convoluted polypropylene conduit or equivalent may be used for most installations. Heat retardant nylon conduit or oil, water, acid, fire, and abrasion resistant non-metallic loom conforming to SAE J562A* is also acceptable. The diameter of conduit should be selected based on the number of wires being protected.

* If non-metallic loom is used, secure the ends with tightly wrapped nylon straps to prevent unraveling.

Conduit should cover the wires without binding and without being excessively large.

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3.13 TAPE AND TAPING

Tape must be used when conduit is utilized. Be sure to follow the tape manufacturers' guidelines. The harness manufacturer may use tape under the harness covering (conduit or loom) to facilitate harness building. Tape must be tightly wrapped at all conduit interconnections with a minimum of two layers (refer to section 3.12). Be sure to firmly secure the start and finish ends of tape.

Criteria: Tape

NOTICE:
Black vinyl electrical tape should not be used in applications where the temperature exceeds 176°F (80°C).

In applications where the temperature doesn't exceed 176°F (80°C), black vinyl electrical tape that is flame retardant and weather resistant may be used.

In applications where temperature exceeds 176°F (80°C), vinyl electrical tape should not be used. For these applications, adhesive cloth backed, flame retardant polyethylene or fiber glass tape (Delphi #PM-2203, Polikan #165 or equivalent) is recommended.

Criteria: Taping

The tape must extend a minimum of 1 in. (25 mm) past the conduit.

The tape must be crossed over butted conduit ends.

The tape must be extended a minimum of 1 in. (25 mm) in each direction at all branches.

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3.14 SENSORS

The DDEC IV system is designed to operate with several types of sensors as listed in Table 3-44.

Sensor Type	Description
Variable Reluctance	Used to monitor the crankshaft position and the engine speed.
Thermistor	Used to monitor temperatures.
Variable Capacitance	Used to monitor barometric air, manifold, oil gallery and optional pump pressures.
Variable Resistance (Potentiometer)	Used to sense throttle position. The output should between .5 and 4.5 V.
Switch	Used to signal coolant level, inlet air restriction, and oil level.
Magnetic Pickup	Used to sense vehicle speed, accumulate trip distance, and to use several vehicle features.

Table 3-44 Sensor Types

The sensors integrated into the Engine Sensor Harness are factory-installed (refer to section 3.14.1). The sensors integrated into the Vehicle Interface Harness are installed by the OEM (refer to section 3.14.15).

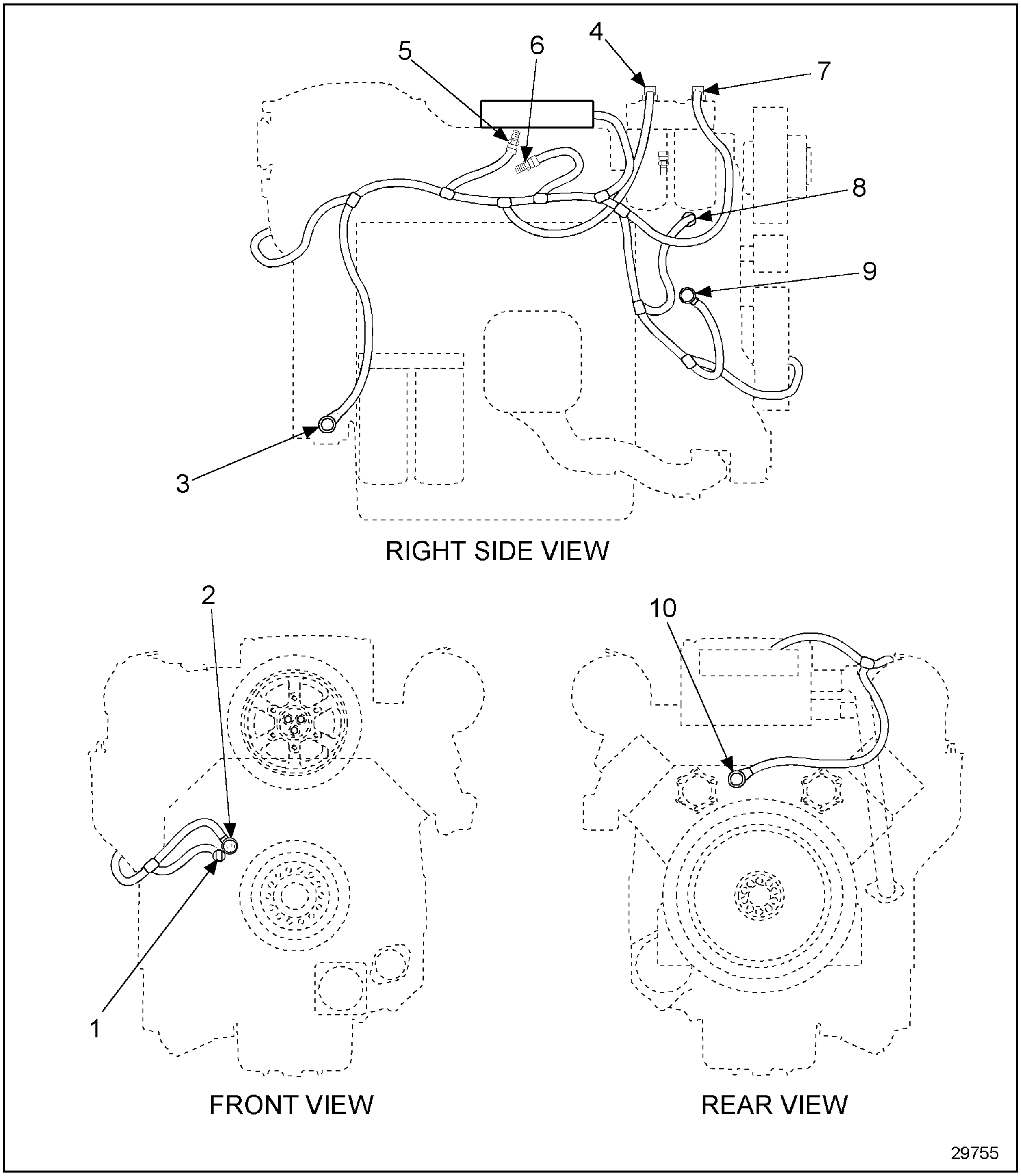
3.14.1 FACTORY-INSTALLED SENSORS

The sensors integrated into the factory-installed Engine Sensor Harness are listed in Table 3-45.

Sensor	Function
Air Temperature Sensor (ATS) and Charge Air Temperature Sensor*	Senses air temperature for functions such as fan control and engine fueling.
Common Rail Fuel Pressure Sensor (CFPS)*	Senses fuel pressure to warn of impending power loss and engine fueling.
Coolant Pressure Sensor (CPS)* and Intercooler Coolant Pressure Sensor (ICPS)*	Senses coolant pressure for functions such as engine protection.
Coolant Temperature Sensor (CTS) and Intercooler Coolant Temperature Sensor (ICTS)*	Senses coolant temperature for functions such as engine protection, fan control and engine fueling.
Crankcase Pressure Sensor (CCPS) *	Senses crankcase pressure for functions such as engine protection.
Fuel Restriction Sensor (FRS)†	Senses fuel filter restriction to warn of the condition of the fuel filter for maintenance purposes.
Fuel Pressure Sensor (FPS)*	Senses fuel pressure to warn of impending power loss and engine fueling.
Fuel Temperature Sensor (FTS)	Senses fuel temperature for functions such as engine fueling.
Oil Level Sensor (OLS)†	Senses oil level for functions such as engine protection.
Oil Pressure Sensor (OPS)	Senses gallery oil pressure for functions such as engine protection.
Oil Temperature Sensor (OTS)	Senses oil temperature for functions such as reducing variation in fuel injection and fan control.
Synchronous Reference Sensor (SRS)	Indicates a specific cylinder in the firing order.
Timing Reference Sensor (TRS)	Senses crankshaft position and engine speed for functions such as fuel control strategy.
Turbo Boost Sensor (TBS)	Senses turbo boost for functions such as smoke control and engine protection.

* Available in some applications
† Available with the Maintenance Alert System

Table 3-45 Function of Factory-installed Sensors



1. Oil Temperature Sensor
2. Oil Pressure Sensor
3. Timing Reference Sensor
4. Fuel Temperature Sensor
5. Charge Air Temperature Sensor
6. Turbo Boost Sensor
7. Fuel Pressure Sensor
8. Coolant Temperature Sensor
9. Coolant Pressure Sensor
10. Synchronous Reference Sensor

Figure 3-65 Typical Location for Factory-installed Sensors - Series 2000 C&I

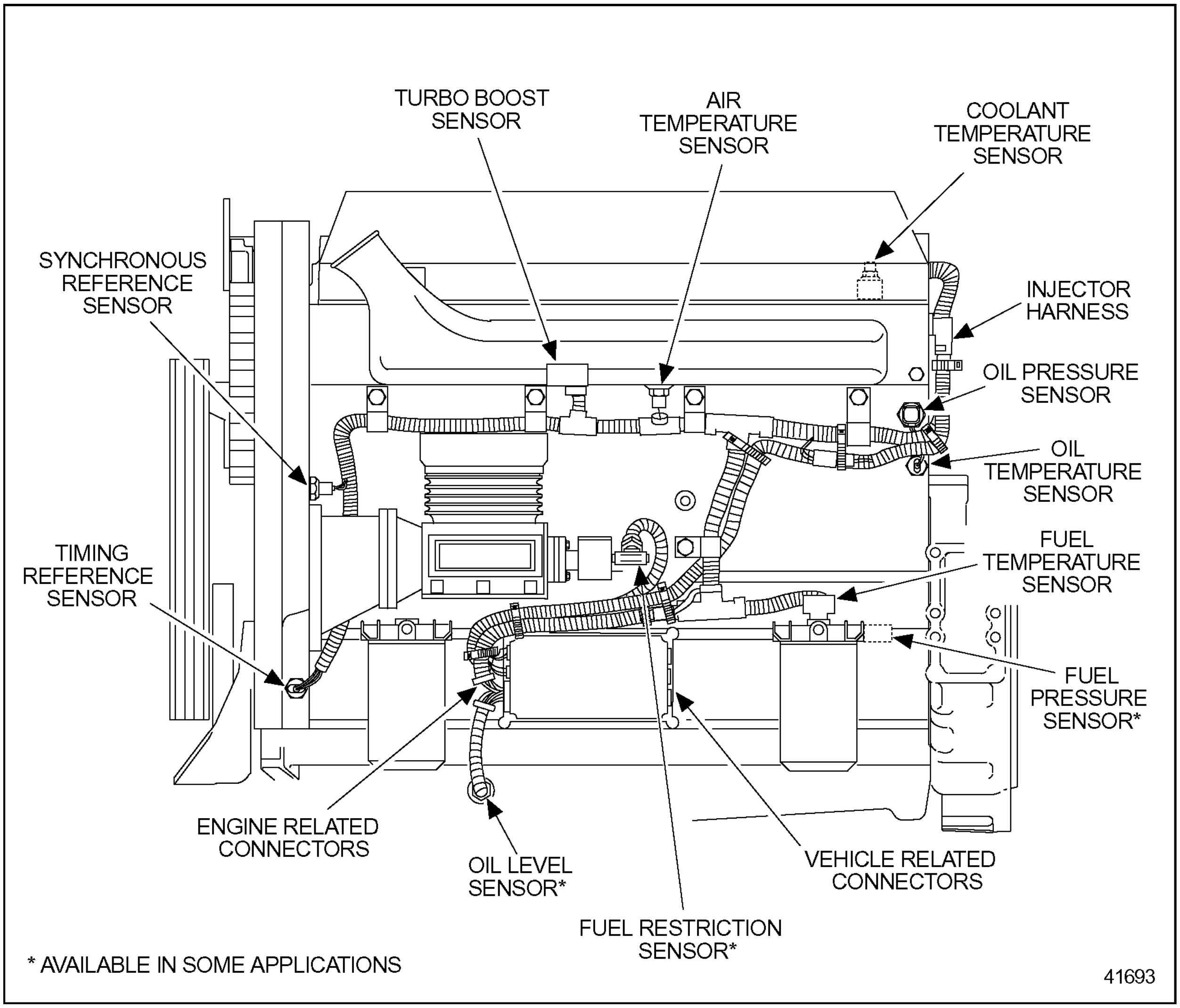
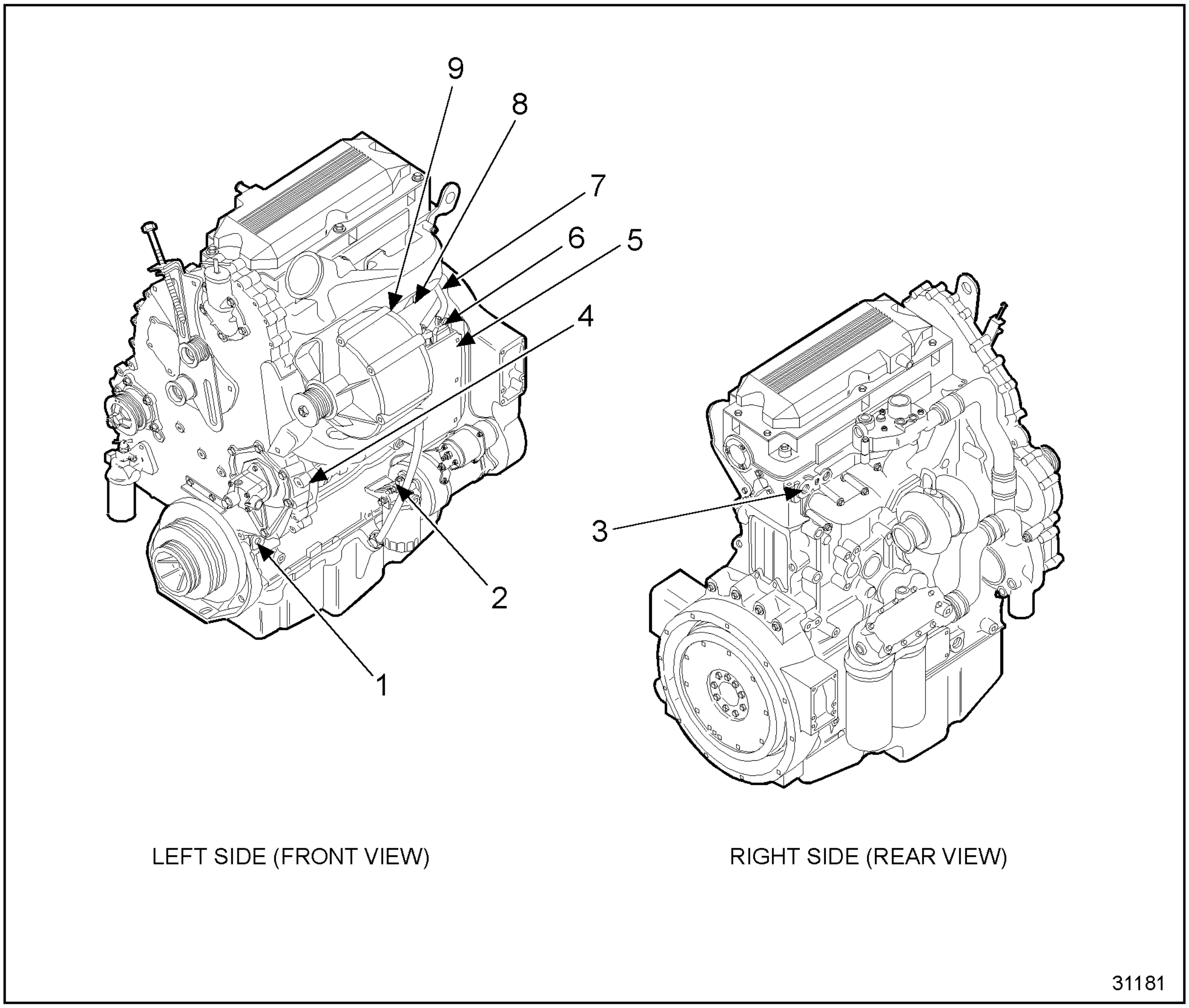
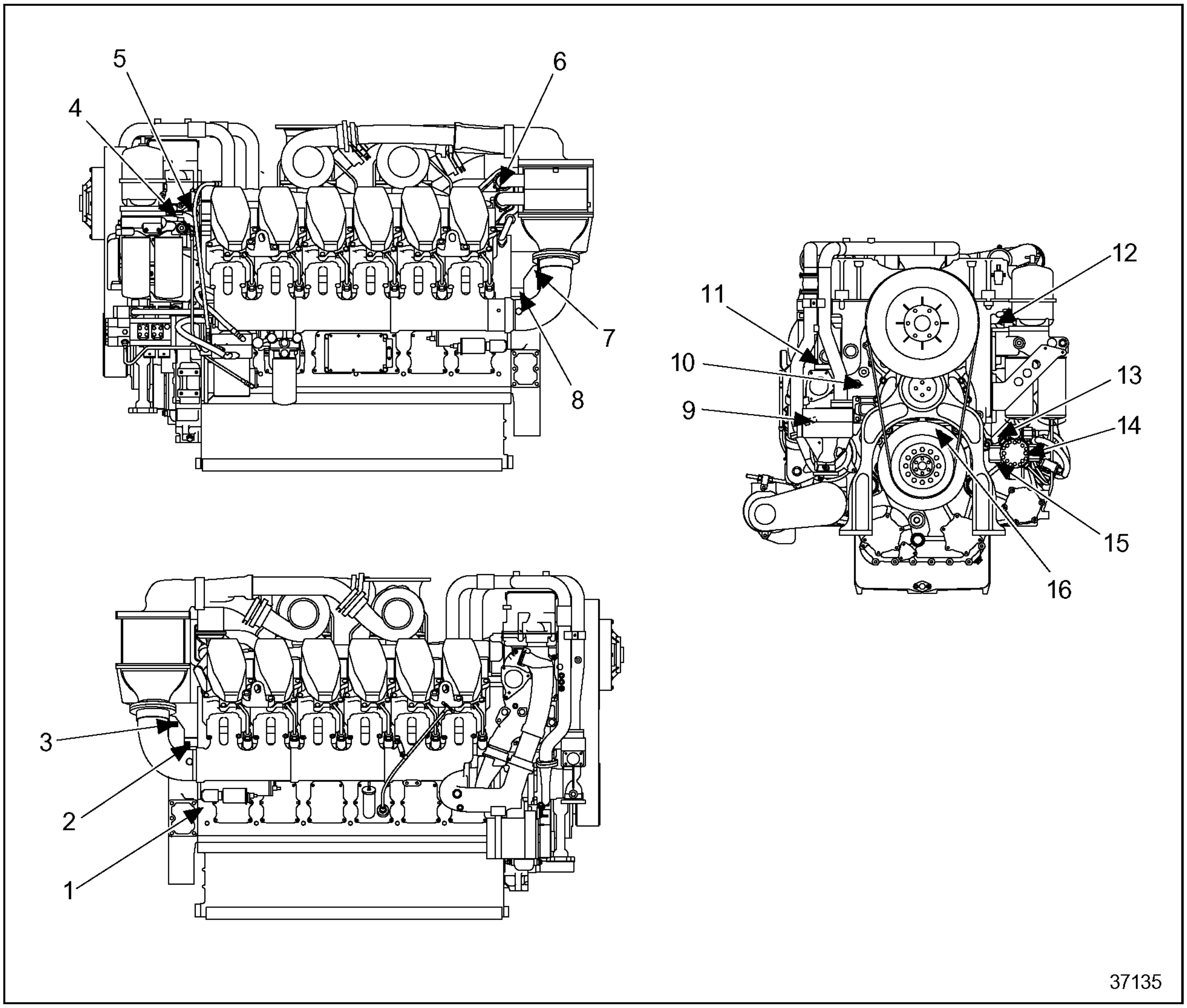


Figure 3-66 Engine Sensor Harness and Sensor Location - Series 60 Engine



1. Timing Reference Sensor
2. Fuel Pressure Sensor
3. Coolant Temperature Sensor
4. Synchronous Reference Sensor
5. Electronic Control Module
6. Oil Temperature Sensor
7. Oil Pressure Sensor
8. Turbo Boost Sensor
9. Air Temperature Sensor

Figure 3-67 Engine Sensor Harness and Sensor Location - Series 50 Engine, On-highway



1. Timing Reference Sensor	9. Intercooler Coolant Pressure Sensor (Behind Thermostat Housing)
2. Air Temperature Sensor (Receiver)	10. Engine Coolant Pressure Sensor
3. Turbo Boost Sensor (Receiver)	11. Engine Coolant Temperature Sensor
4. Oil Temperature Sensor	12. Oil Pressure Sensor
5. Crankcase Pressure Sensor	13. Fuel Supply Pressure Sensor
6. Intercooler Coolant Temperature Sensor	14. Fuel Temperature Sensor
7. Turbo Boost Sensor (Master)	15. Common Rail Fuel Pressure Sensor
8. Air Temperature Sensor (Master)	16. Synchronous Reference Sensor

Figure 3-68 Typical Location for Factory-installed Sensors - Series 4000 C&I

3.14.2 AIR TEMPERATURE AND CHARGE AIR TEMPERATURE SENSOR

The ATS (see Figure 3-69) is a thermistor type sensor that has a variable resistance, when exposed to different temperatures. The ATS provides necessary input for various functions such as varying hot idle speed, fan control, and injection timing which results in improved cold starts and reduced white smoke.

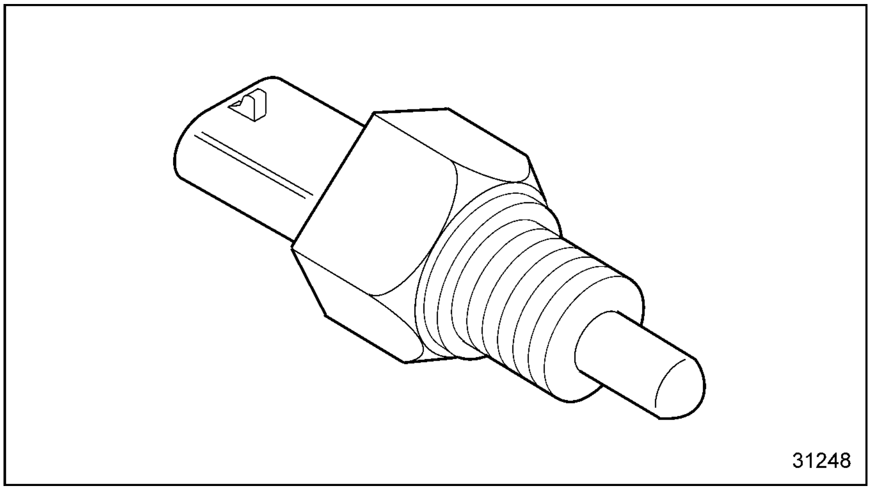


Figure 3-69 Air Temperature Sensor

See Figure 3-70 for the Charge Air Temperature Sensor used in the Series 2000.

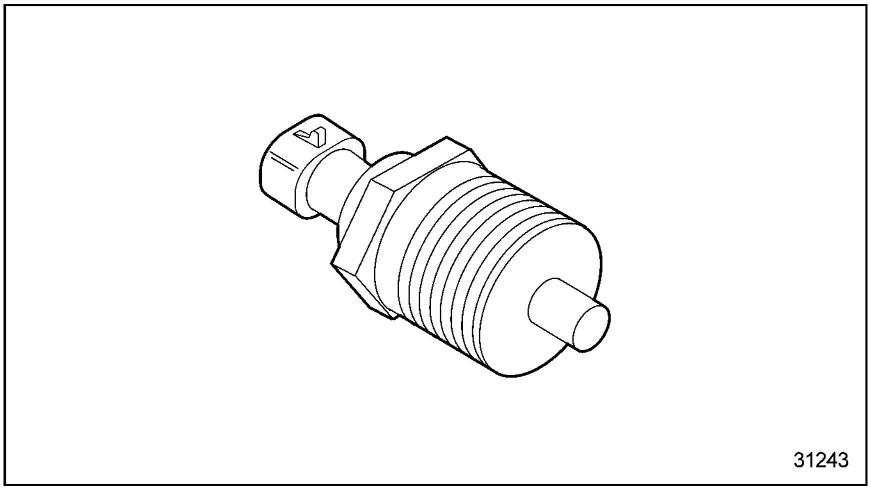


Figure 3-70 Charge Air Temperature Sensor - Series 2000 C & I Applications

3.14.3 COMMON RAIL FUEL PRESSURE SENSOR

The FPS is a variable capacitance sensor that produces a linear analog signal, indicating fuel pressure to warn the operator of impending power loss. See Figure 3-71.

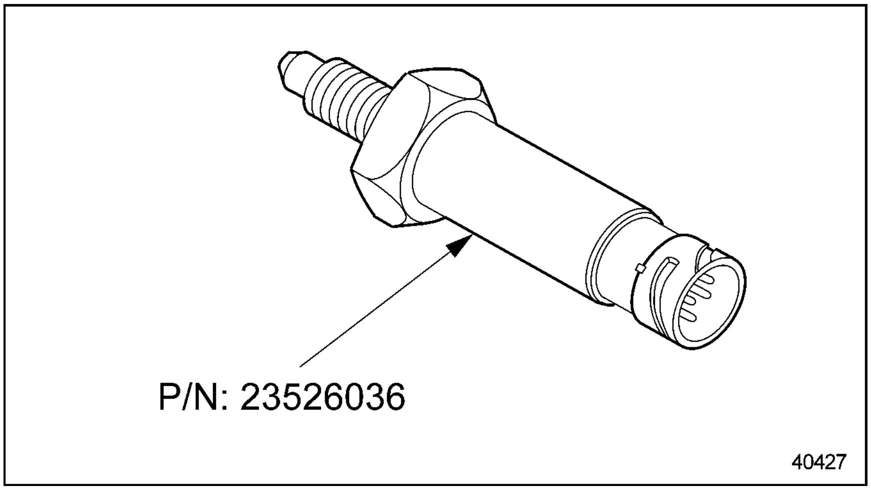


Figure 3-71 Common Rail Fuel Pressure Sensor - Series 4000

3.14.4 COOLANT AND INTERCOOLER COOLANT PRESSURE SENSOR

The CPS is a variable capacitance sensor that produces a linear analog signal, indicating coolant pressure; the same sensor is used as the ICPS. See Figure 3-72.

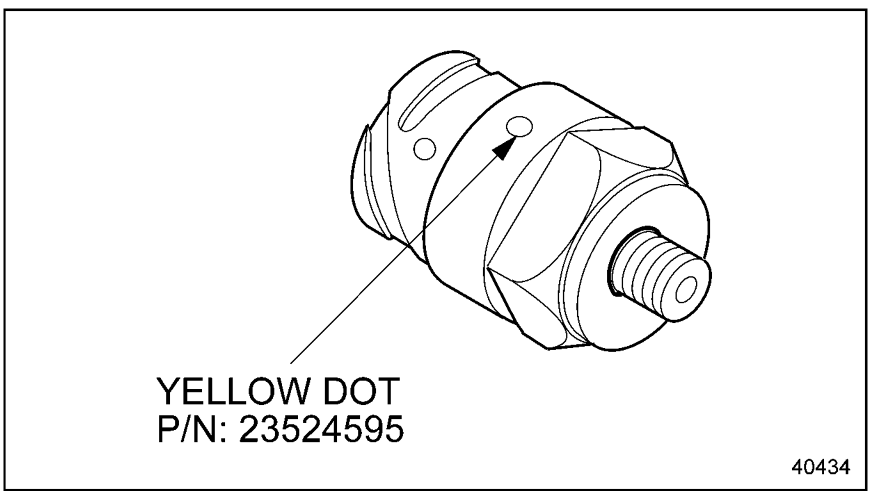


Figure 3-72 Coolant Pressure Sensor - Series 2000 and Series 4000

3.14.5 COOLANT AND INTERCOOLER COOLANT TEMPERATURE SENSOR

The CTS is a thermistor type sensor that has a variable resistance, when exposed to different temperatures. The CTS senses coolant temperature. See Figure 3-73.

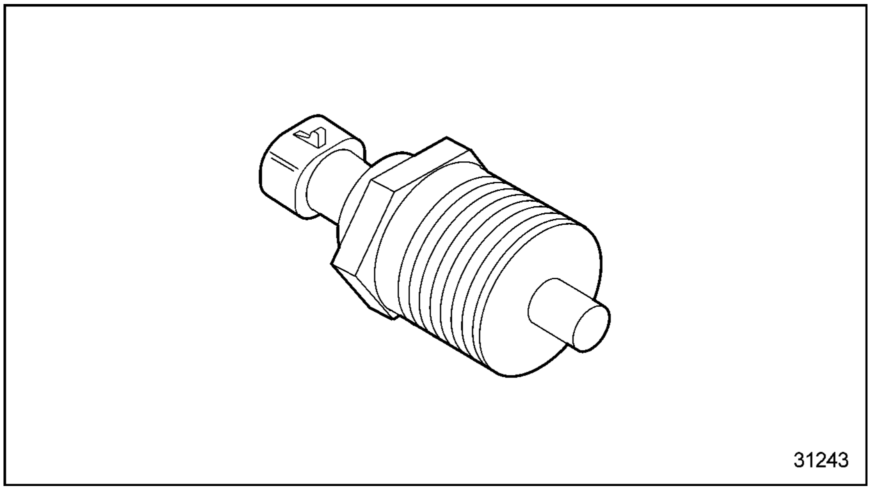


Figure 3-73 Coolant Temperature Sensor - Series 50 and Series 60

See Figure 3-74 for the CTS used in the Series 2000 C & I applications and Intercooler Coolant Temperature Sensor (ICTS) used in Series 4000, C& I applications.

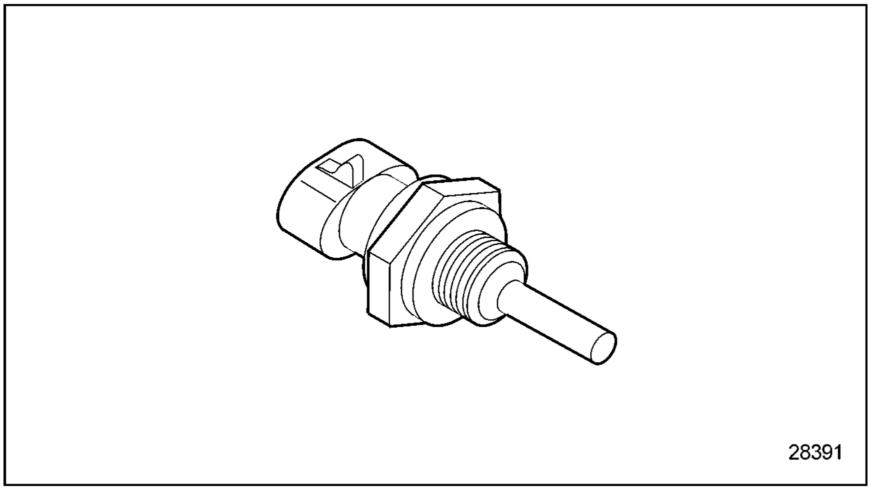


Figure 3-74 Series 2000 CTS , Series 4000 ICTS

3.14.6 CRANKCASE PRESSURE SENSOR

A Crankcase Pressure Sensor is available on Series 149 (see Figure 3-75) and Series 4000 (see Figure 3-76) engines. The sensor activates engine protection if the crankcase pressure is too high. An activated sensor for the Series 149 must be reset by removing the safety cover and pushing in the reset button.

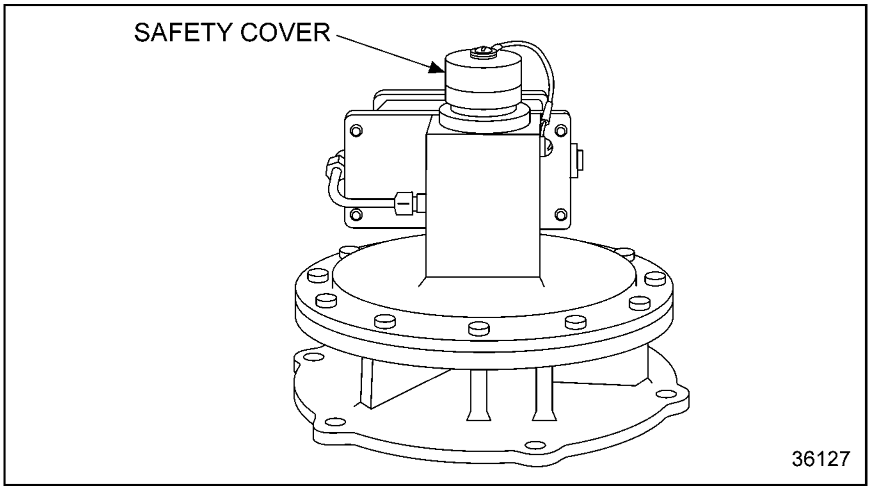


Figure 3-75 Crankcase Pressure Sensor - Series 149

See Figure 3-76 for the Crankcase Pressure Sensor for the Series 4000.

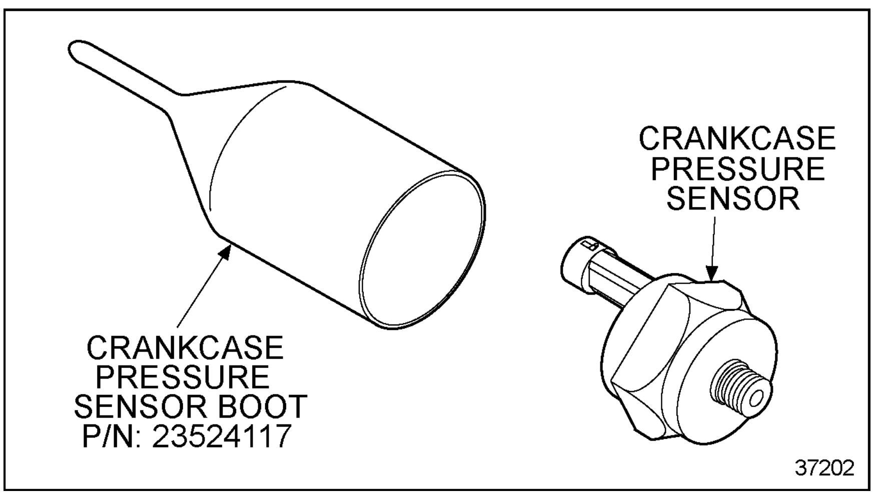


Figure 3-76 Crankcase Pressure Sensor - Series 4000

3.14.7 FUEL PRESSURE SENSOR

The FPS is a variable capacitance sensor that produces a linear analog signal, indicating fuel pressure to warn the operator of impending power loss. The FPS for the Series 2000 engine has a green dot (see Figure 3-77).

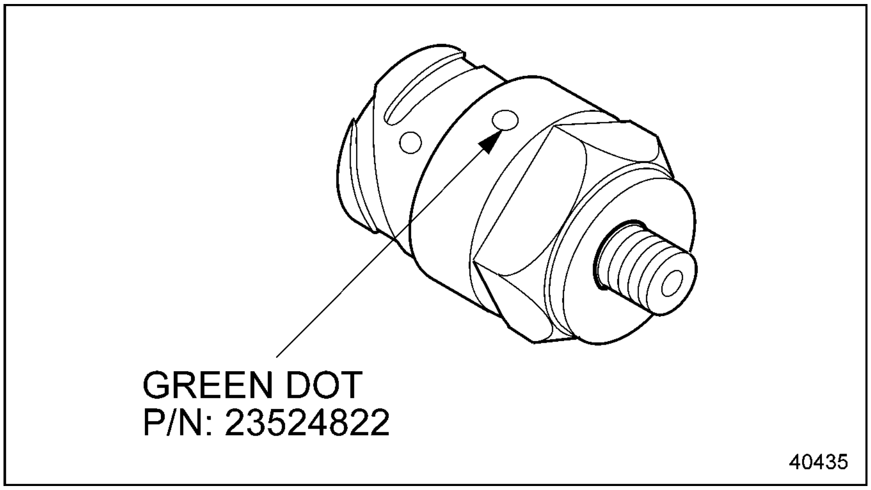


Figure 3-77 Fuel Pressure Sensor - Series 2000

The FPS for the Series 4000 engine has a white dot (see Figure 3-78).

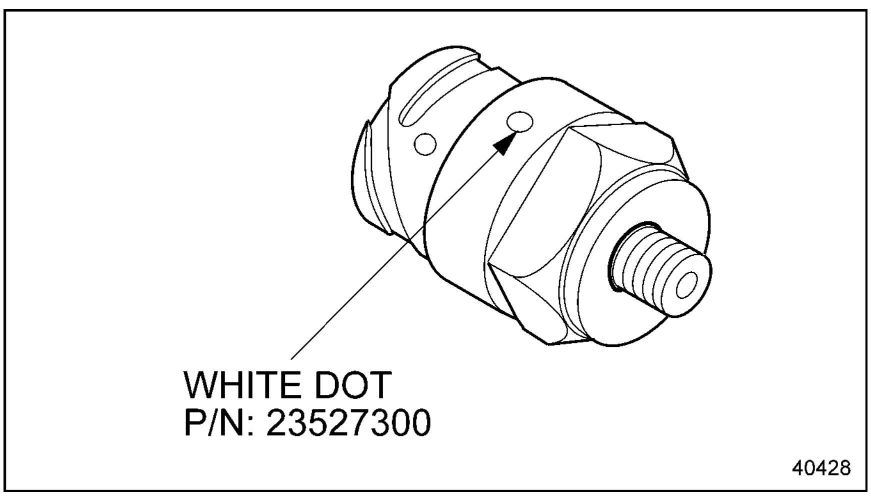


Figure 3-78 Fuel Pressure Sensor - Series 4000

3.14.8 FUEL RESTRICTION SENSOR

The FRS (see Figure 3-79) monitors the condition of the fuel filter. FRS is factory installed at DDC for applications which have the Maintenance Alert System (MAS).

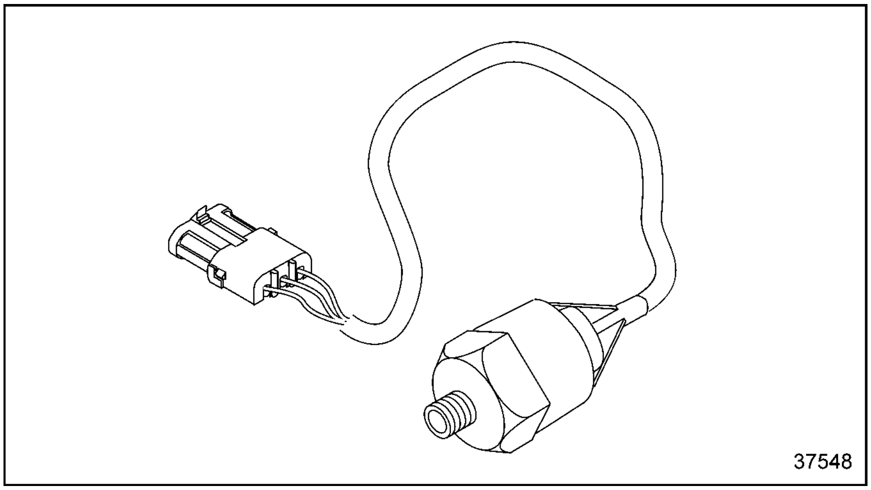


Figure 3-79 Fuel Restriction Sensor

3.14.9 FUEL TEMPERATURE SENSOR

The FTS (see Figure 3-80) is a thermistor type sensor that has a variable resistance, when exposed to different temperatures. The FTS measures fuel temperatures necessary for fuel consumption calculations and fuel input compensation.

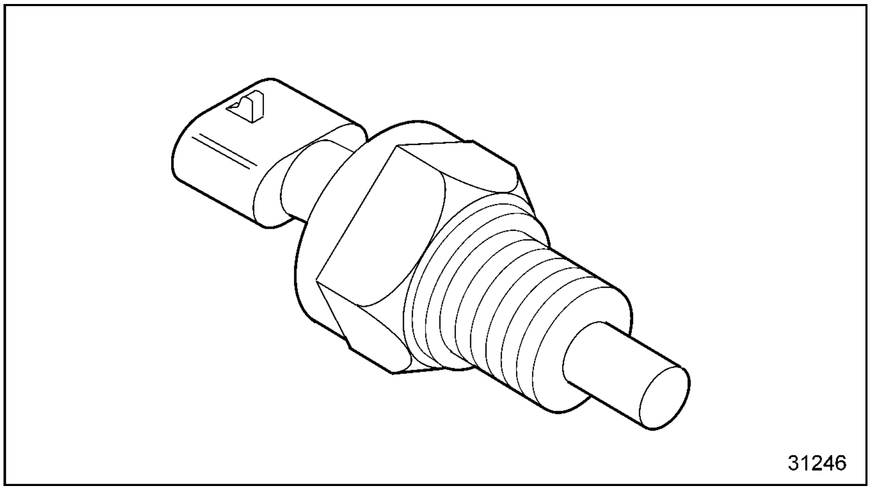


Figure 3-80 Fuel Temperature Sensor

See Figure 3-81 for the FTS used in the Series 2000, Construction and Industrial applications.

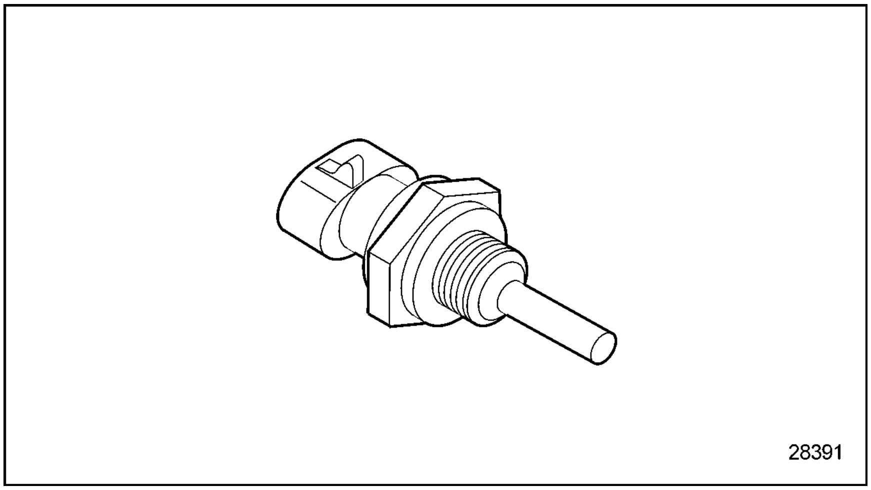


Figure 3-81 Fuel Temperature Sensor - Series 2000

3.14.10 OIL LEVEL SENSOR

The OLS (see Figure 3-82) is factory-installed at DDC and is incorporated into the DDC Engine Sensor Harness for applications which have the Maintenance Alert System (MAS).

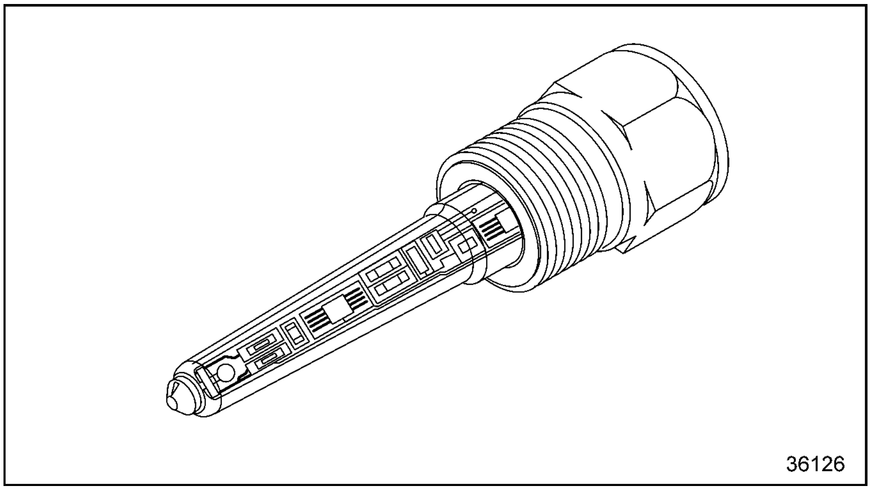


Figure 3-82 Oil Level Sensor

3.14.11 OIL PRESSURE SENSOR

The OPS is a variable capacitance sensor that produces a linear analog signal, indicating engine oil pressure (see Figure 3-83).

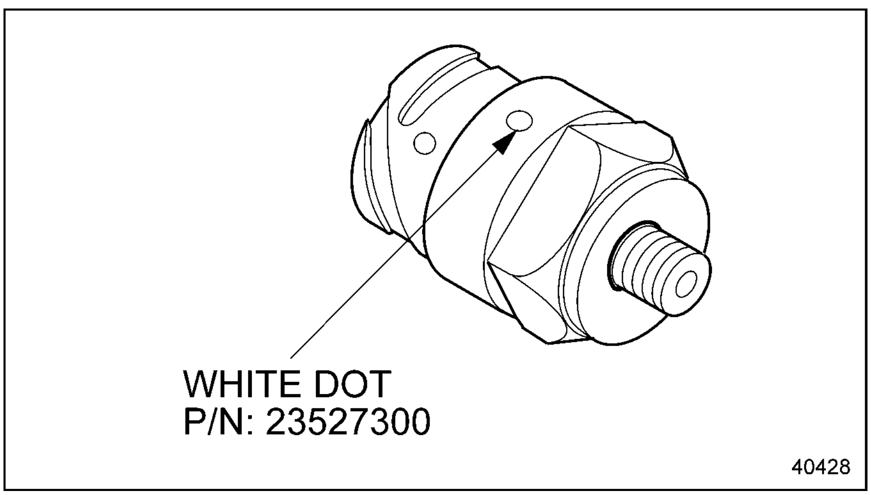


Figure 3-83 Oil Pressure Sensor - Series 2000 and Series 4000

3.14.12 OIL TEMPERATURE SENSOR

The OTS is a thermistor type sensor that has a variable resistance, when exposed to different temperatures. See Figure 3-84.

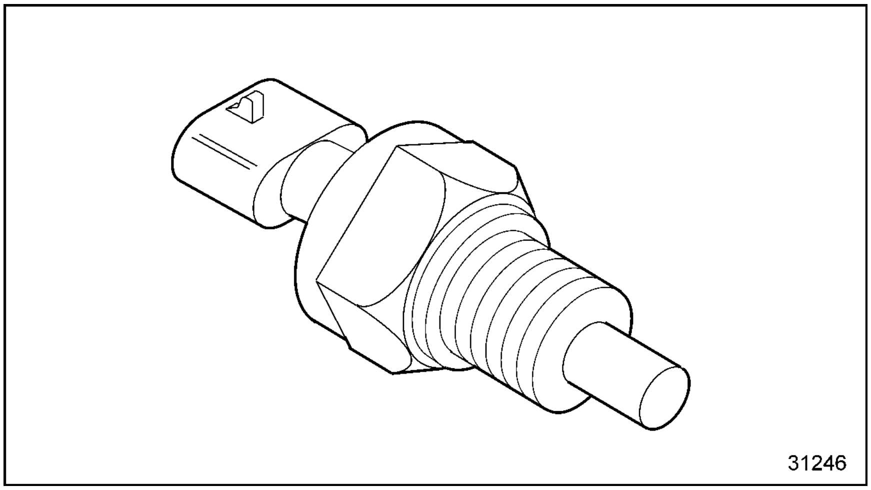


Figure 3-84 Oil Temperature Sensor

See Figure 3-85 for the OTS used in the Series 2000 and Series 4000, Construction and Industrial applications.

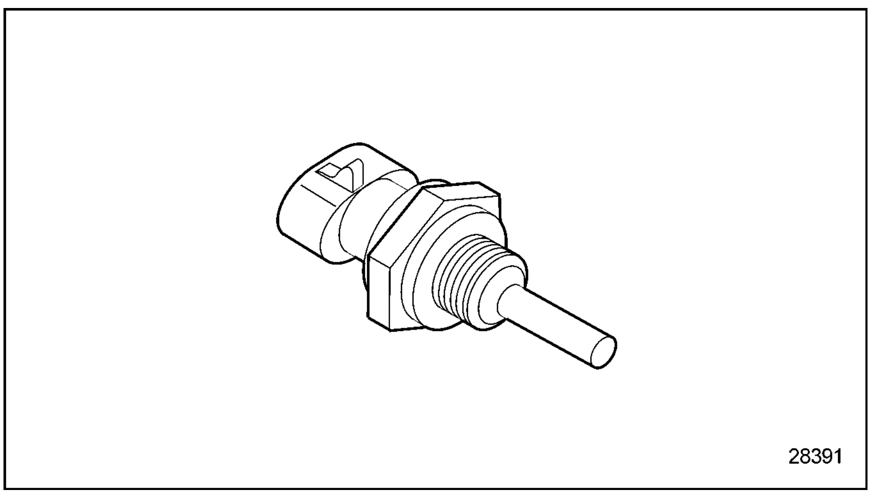


Figure 3-85 Oil Temperature Sensor - Series 2000 and Series 4000

The ECM uses the OTS signal to determine the quantity and timing of fuel required to optimize starting over a range of temperatures.

The OTS provides a signal to vary idle speed and injection timing resulting in improved cold starts and reduced white smoke. It also activates the engine protection, if the oil temperature exceeds the specified limits.

3.14.13 TIMING AND SYNCHRONOUS REFERENCE SENSORS

The Timing Reference Sensor (TRS) is a variable reluctance type sensor that indicates crank position of every cylinder. The TRS tells the ECM where the rotation of the engine is or when to fuel each cylinder.

The Synchronous Reference Sensor (SRS) indicates a specific cylinder in the firing order.

The SRS and TRS are mounted in the flywheel housing for the Series 2000 engine. The same SRS and TRS as those used for the Series 60 engine are used for the Series 2000 engine when the standard option flywheel housing is used.

See Figure 3-86 for the Series 50, Series 60, and Series 2000 engine TRS and SRS.

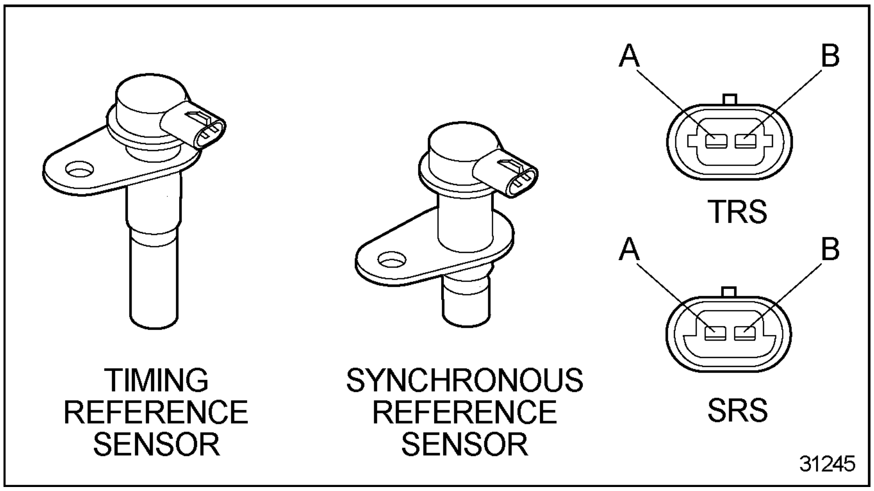


Figure 3-86 The SRS and TRS - Series 50, Series 60, and Series 2000 Engines

See Figure 3-87 for the Series 4000 engine TRS and SRS.

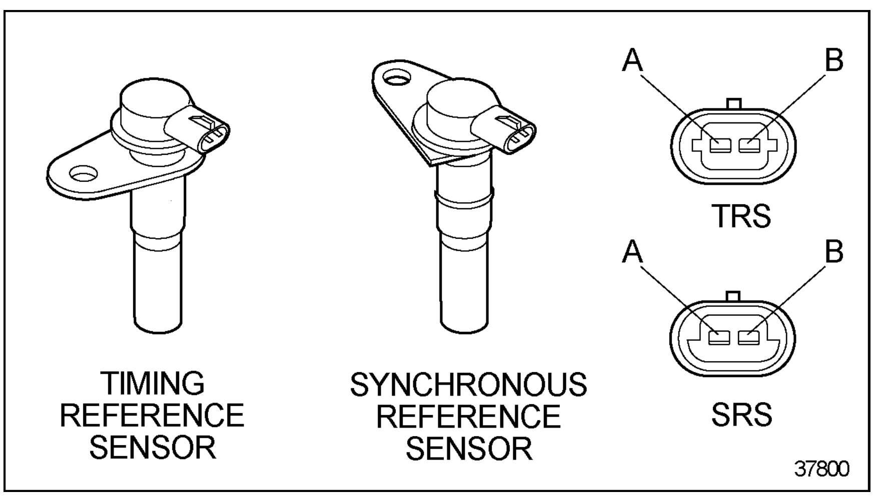


Figure 3-87 The SRS and TRS - Series 4000

See Figure 3-88 for the Series 92 6/8V, 8V-92, and Series 71 12V engine TRS and SRS.

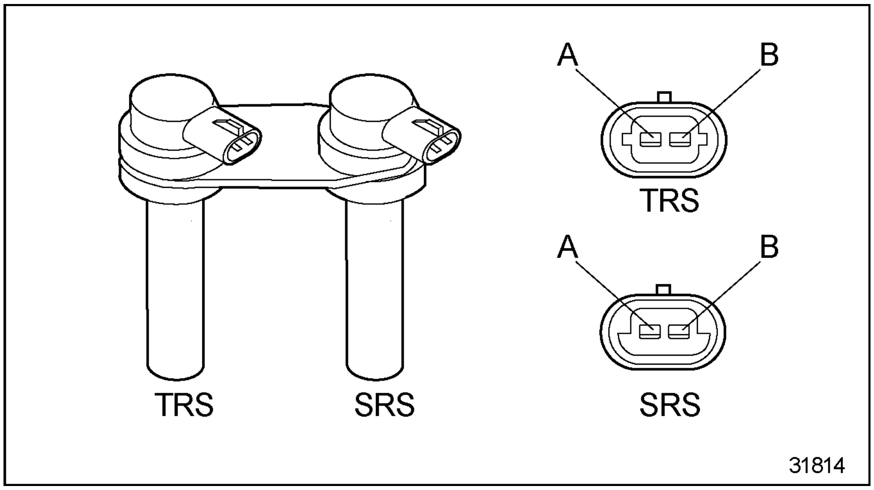


Figure 3-88 The SRS and TRS - Series 92 6/8V and Series 71 12V Engines

See Figure 3-89 for the Series 71 4/6V engine TRS and SRS.

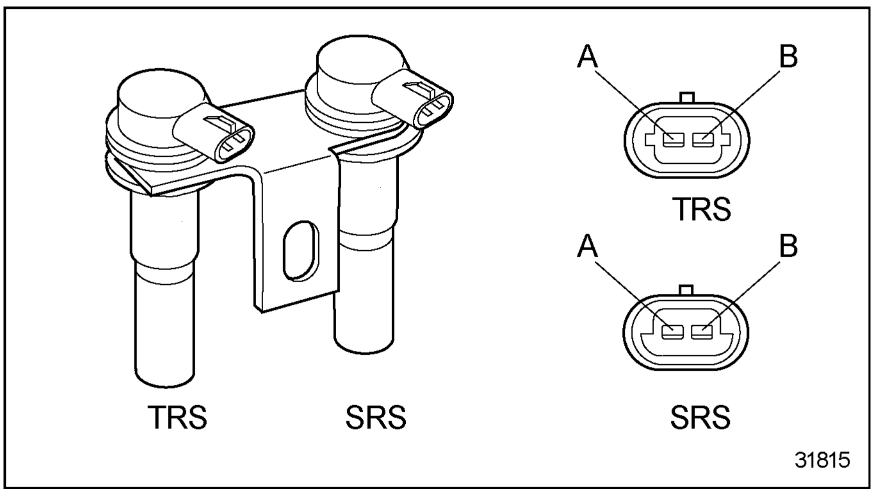


Figure 3-89 The SRS and TRS - Series 71 4/6V Engines

See Figure 3-90 for the Series 149, Series 92 12/16V engine TRS and SRS.

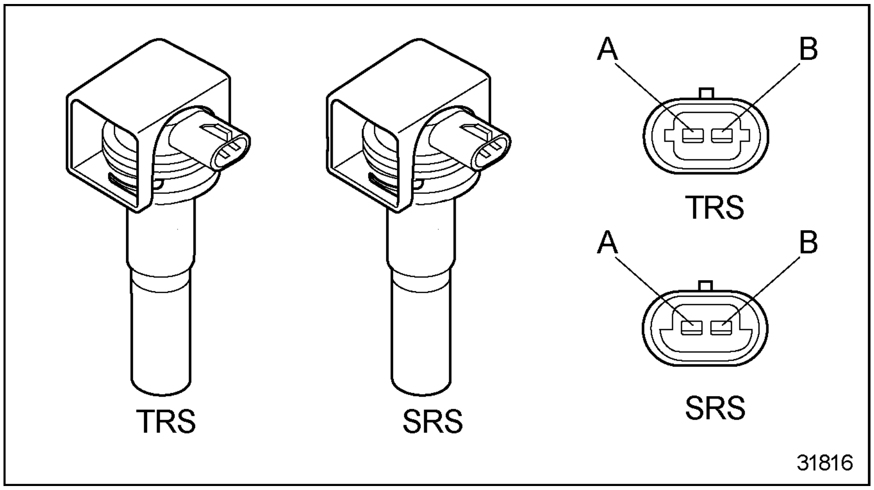


Figure 3-90 The SRS and TRS - Series 149, Series 92 12/16V Engines

See Figure 3-91 for the Series 53 6V engine TRS and SRS.

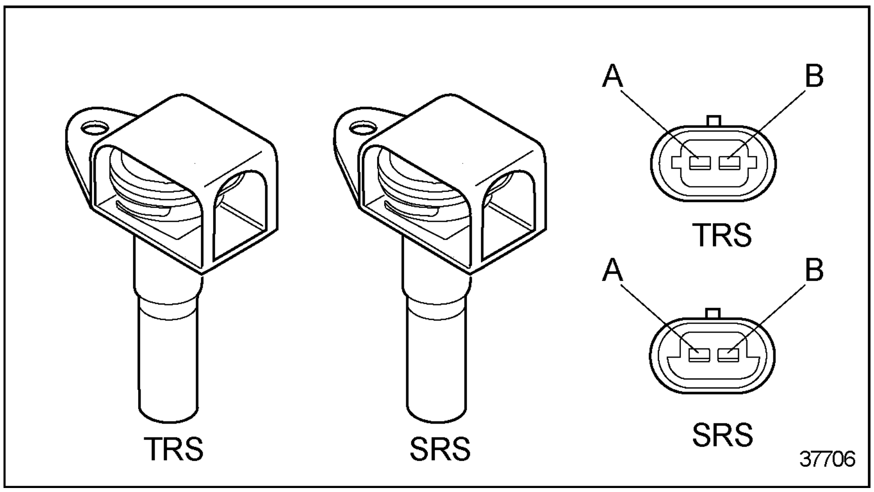


Figure 3-91 The SRS and TRS - Series 53 6V Engine

3.14.14 TURBO BOOST SENSOR

The TBS provides data to the ECM for use in engine fueling (smoke control). See Figure 3-92 for the sensor used in on-highway applications.

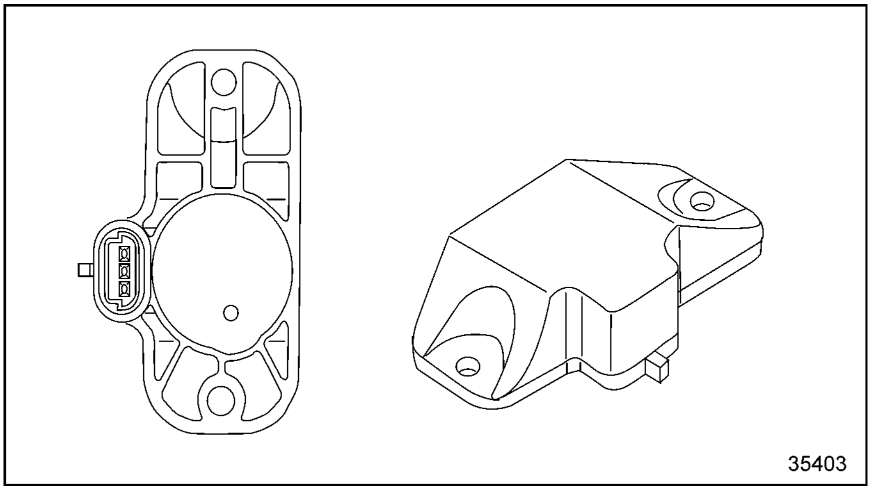


Figure 3-92 The Turbo Boost Sensor - On-highway Applications

See Figure 3-93 for the sensor used in construction and industrial applications.

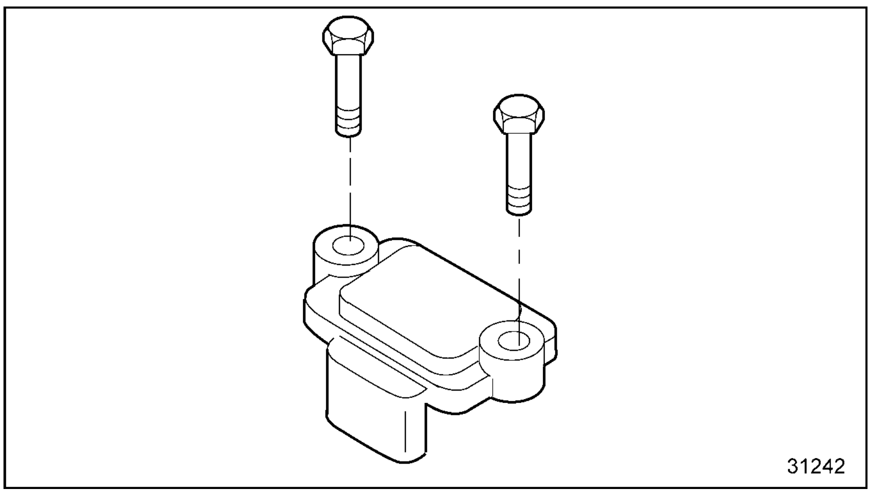


Figure 3-93 The Turbo Boost Sensor - Construction and Industrial Applications

See Figure 3-94 for the Turbo Boost Sensor used in the Series 2000 and Series 4000 engines.

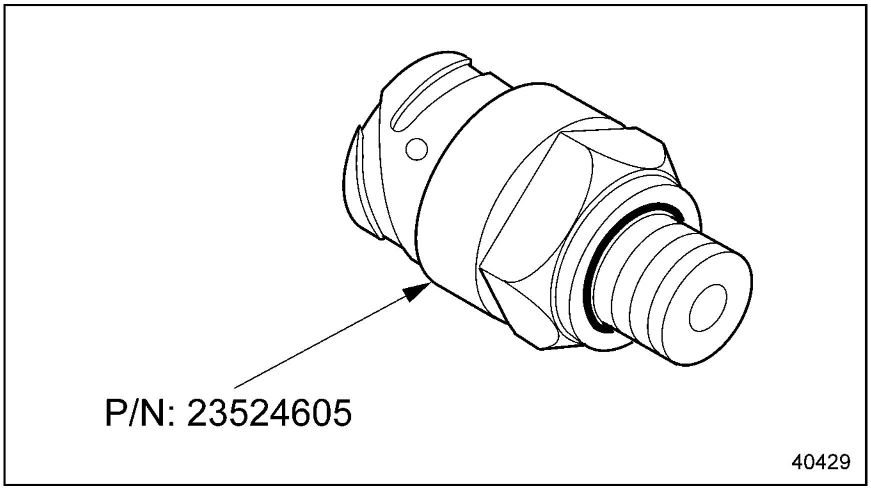


Figure 3-94 Turbo Boost Sensor - Series 2000 and Series 4000

3.14.15 OEM-INSTALLED SENSORS

All sensors must be of the proper type and continuously monitor vehicular and environmental conditions, so the ECM can react to changing situations.

The OEM is responsible for installing the sensors listed in Table 3-46. These sensors are application dependent.

Sensor	Part Number	Function
Add Coolant Level Sensor (ACLS)†	23522855 23520380 23520381	Senses coolant level for engine maintenance. Refer to section 3.14.20.
Air Compressor Pressure Sensor (ACPS)*	23518254	Senses air outlet pressure to maintain a set pump pressure. Refer to section 3.14.16.
Air Filter Restriction Sensor (AFRS)†	23526140	Senses the condition of the air inlet filter for engine maintenance. Refer to section 3.14.17.
Air Intake Temperature Sensor*	--	Senses the air intake temperature and derates the engine if the temperature exceeds DDC factory set limits. Used on Series 149 engines only. Refer to section 3.14.18.
Coolant Level Sensor (CLS)	23522855 23520380 23520381	Senses coolant level for engine protection. Refer to section 3.14.19.
Exhaust Temperature Sensor (ETS)*	23521882	Senses exhaust temperature for engine protection. Refer to section 3.14.22.
Fire Truck Pump Pressure Sensor *	23520795	Senses water pump pressure to maintain a constant fire truck pump pressure. Refer to section 3.14.23.
Optical Coolant Level Sensor*	23519175	Senses coolant level for engine protection in applications where electrical isolation from the chassis is required. Refer to section 3.14.21.
Throttle Position Sensor (TPS)	--	Senses operator's input to the ECM for throttle input. Refer to section 3.14.24.
Vehicle Speed Sensor (VSS)	--	Senses vehicle speed for Cruise Control and PTO Control. Total distance accumulation required for ProDriver and a speedometer. Refer to section 3.14.25.

* Available in some applications
† Available with the Maintenance Alert System

Table 3-46 Function and Guidelines for OEM-installed Sensors

3.14.16 AIR COMPRESSOR PRESSURE SENSOR

The ACPS (see Figure 3-95) is a variable capacitance sensor that produces a linear analog (voltage) signal proportional to air outlet pressure. The ECM monitors the air outlet pressure while varying the engine speed and controlling the compressor inlet or outlet valve to maintain the set pump pressure. The ACPS range is 0 to 300 psi.

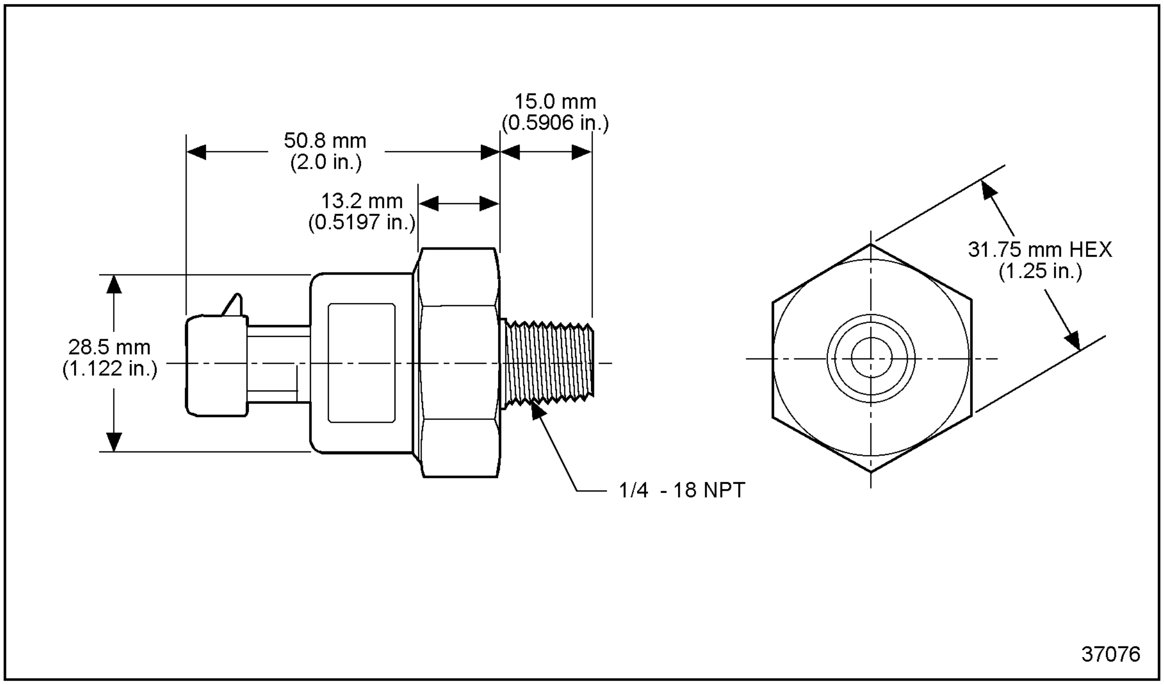
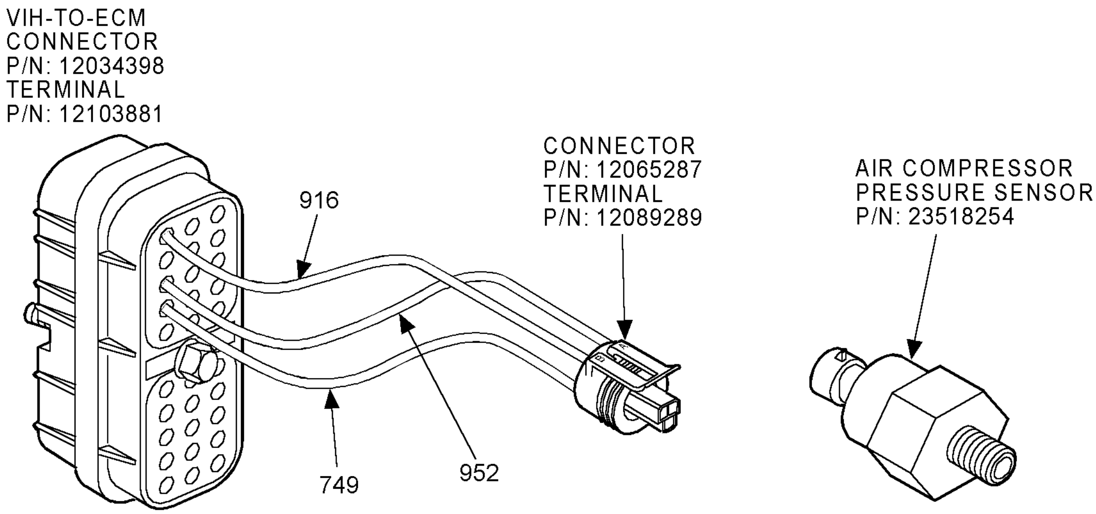


Figure 3-95 Air Compressor Pressure Sensor

See Figure 3-96 for ACPS installation.



LABEL	WIRE NO.	VIH-TO-ECM CONNECTOR CAVITY	WIRE COLOR	AIR COMPRESSOR PRESSURE CONNECTOR CAVITY
SENSOR RETURN	952	C3	BLK	A
AIR COMPRESSOR PRESSURE	749	D3	YEL	C
SENSOR SUPPLY	916	A3	RED/BLK	B

37077

Figure 3-96 Air Compressor Pressure Sensor Installation

3.14.17 AIR FILTER RESTRICTION SENSOR

The AFRS is available only with the Maintenance Alert System (Release 27.0 or later software). The AFRS (see Figure 3-97) has two trip points, one at 18 in. of water and the second at 25 in. of water.

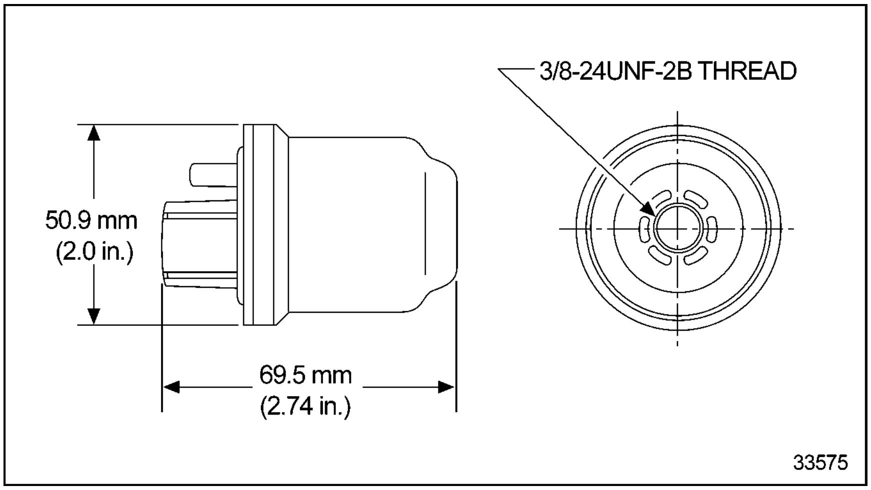
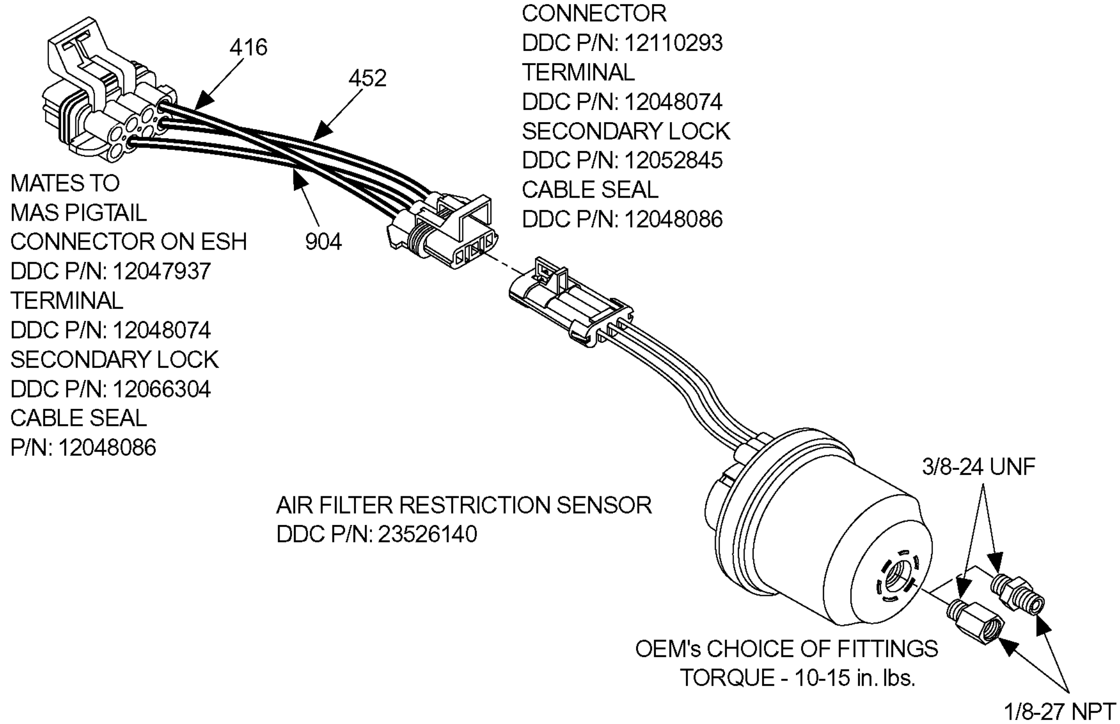


Figure 3-97 Air Filter Restriction Sensor

The AFRS is mounted downstream of the air filter and upstream of the turbocharger. The AFRS must be in a straight section of pipe or where the OEM mechanical unit is normally mounted. This sensor must be enabled with VEPS or the DDEC Reprogramming System (DRS). A pigtail on the DDC installed Engine Sensor Harness will be used to wire the sensor (see Figure 3-98).



LABEL	WIRE NO.	MAS PIGTAIL MATING CONNECTOR	WIRE COLOR	AFRS CONNECTOR	ESH-TO-ECM CONNECTOR CAVITY
AFRS	904	B	PPL/WHT	B	L1
SENSOR GROUND	452	D	BLK	A	Y2
SENSOR SUPPLY	416	E	GRA	C	W1

33576

Figure 3-98 Air Filter Restriction Sensor Wiring Diagram

3.14.18 AIR INTAKE TEMPERATURE SENSOR

The OEM is responsible for installing the Air Intake Temperature Sensor on Series 149 engines. The sensor should be located in the left bank compressor inlet. This sensor is used to monitor the air temperature and derate the engine if the temperature exceeds DDC factory set limits. The sensor is connected to the pigtail labeled *Air Temperature Sensor*supplied with the engine.

3.14.19 COOLANT LEVEL SENSOR

The CLS is required for DDEC IV installations. Its purpose is to provide an input to the engine protection system and warn the operator if a low coolant level has been reached. Other non-DDC supplied coolant level sensors may be used but may require the use of a signal interface.

The main component of the CLS consists of a conductivity probe, which connects to the ECM (see Figure 3-99).

NOTICE:
The probe has an operational temperature range of -58 to 257°F (-50 to 125°C). Exposure to temperatures beyond this range may result in unacceptable component life, or degraded sensor accuracy.

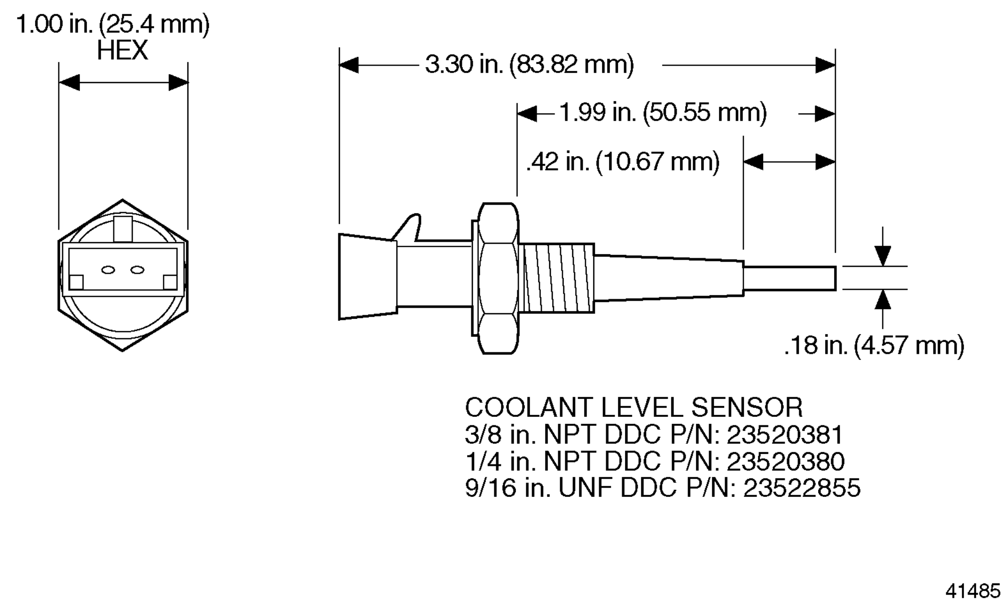


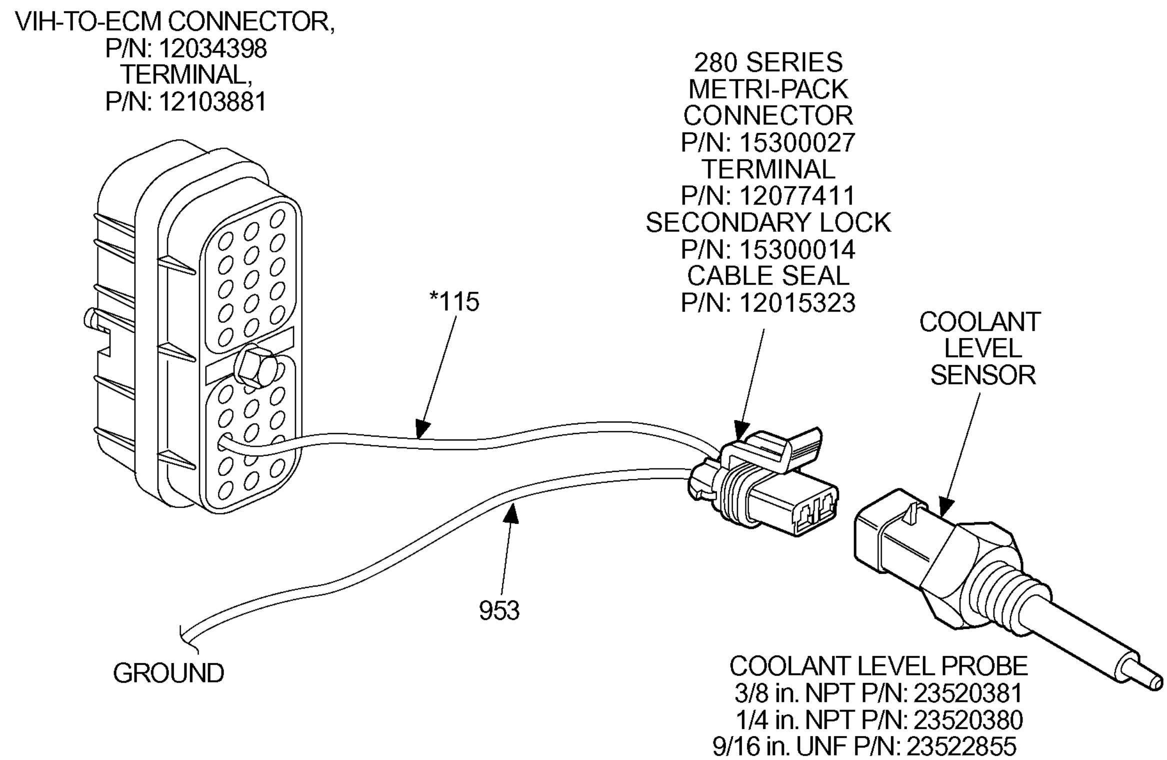
Figure 3-99 Coolant Level Sensor Specifications

The connector listed in Table 3-47is a Metri-Pack 280 series push-to-seat connector.

Coolant Level Sensor Connector	
Connector	P/N: 15300027
Terminal	P/N: 12077411
Seal	P/N: 12015323
Secondary Lock	P/N: 15300014

Table 3-47 Metri-Pack 280 Connectors and Part Numbers

The OEM must connect the CLS probe as shown in the next illustration (see Figure 3-100). Polarity of the ground and signal must be correct for proper operation.



LABEL	WIRE NO.	VIH-TO-ECM CONNECTOR CAVITY	WIRE COLOR	CLS CAVITY
COOLANT LEVEL	*115	H-3	ORN	A
GROUND	953	•	BLK/WHT	B

*115M FOR MULTI-ECM APPLICATIONS

41670

Figure 3-100 Coolant Level Sensor Installation

The probe should be located in either the radiator top tank or a remote mounted surge tank. It should be mounted horizontally in the center of the tank to minimize tilt operation sensitivity and must be in a position to signal low coolant before aeration occurs. Typically, this is a height representing 98% of the drawdown quantity. The probe should be located so that it is not splashed by deaeration line, stand pipe or coolant return line flows. The insulated portion of the probe should be inserted into the coolant .5 in. or more past the inside wall of the tank. See Figure 3-101.

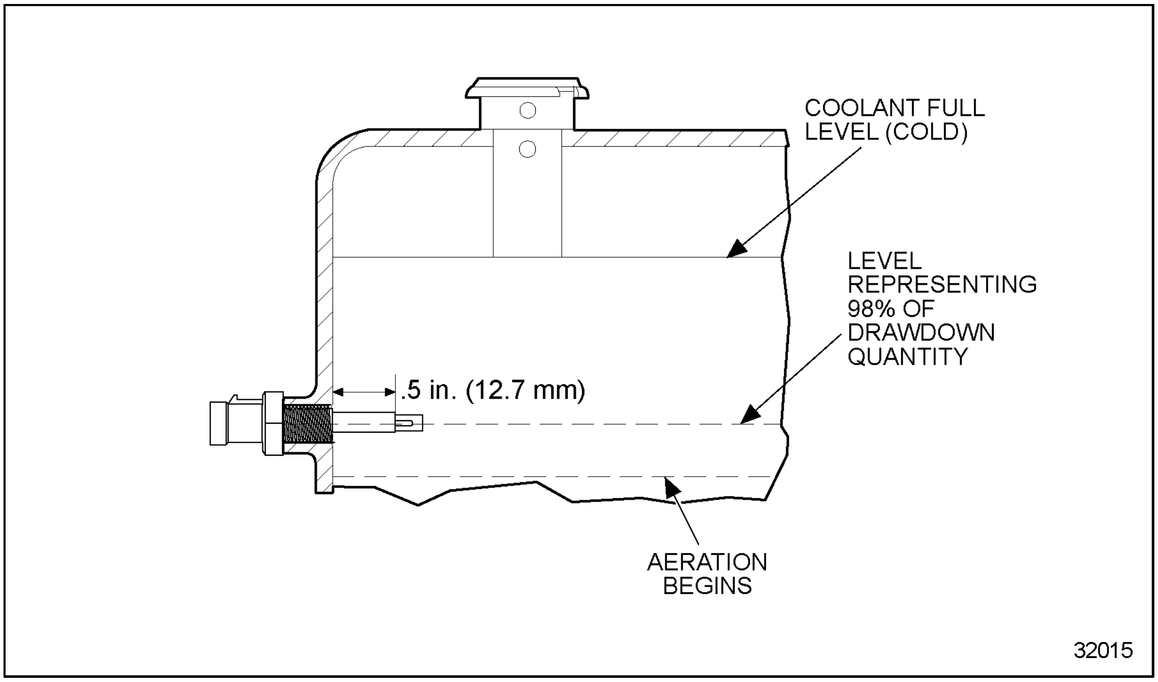


Figure 3-101 Coolant Level Sensor Location - Top of Radiator Tank

Determine proper location for low coolant level sensor while running the drawdown test. It *must* actuate a warning before the satisfactory drawdown level is reached.

The CLS components are OEM-supplied hardware and can be purchased as kits or individual components, depending on OEM requirements.

The following kits listed in Table 3-48and Table 3-49 provide all the necessary hardware for proper installation of the CLS. Kits are available through the DDC parts distribution network.

Component	Part Number
CLS Probe	23520380
Metri-Pack Connector Kit	15300027
Metri-Pack Terminals	12077411
Secondary Lock	15300014
Cable Seal	12015323
Terminal	12103881

Table 3-48 CLS Installation Kit 1/4 in. NPTF P/N: 23515397

Component	Part Number
CLS Probe	23520381
Metri-Pack Connector Kit	15300027
Metri-Pack Terminals	12077411
Secondary Lock	15300014
Cable Seal	12015323
Terminal	12103881

Table 3-49 CLS Installation Kit 3/8 in. NPTF P/N: 23515398

3.14.20 ADD COOLANT LEVEL SENSOR

The ACLS is used to warn the driver that the coolant level is below the recommended level. If the tank is equipped with an "ADD" level, the sensor should be installed there. This sensor will be activated approximately mid-way between the cold full level and the level where the standard (engine protection) CLS is located (see Figure 3-102).

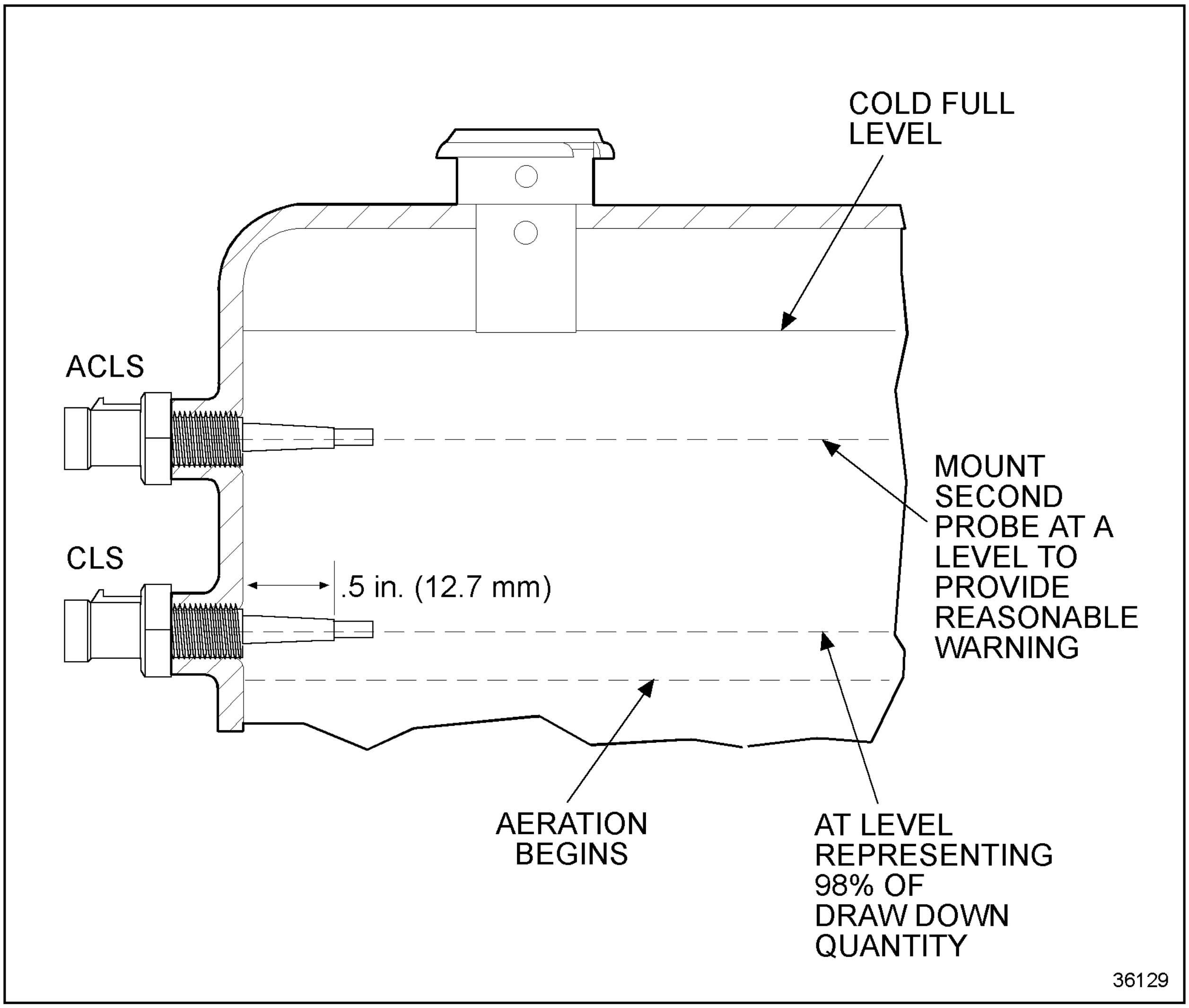
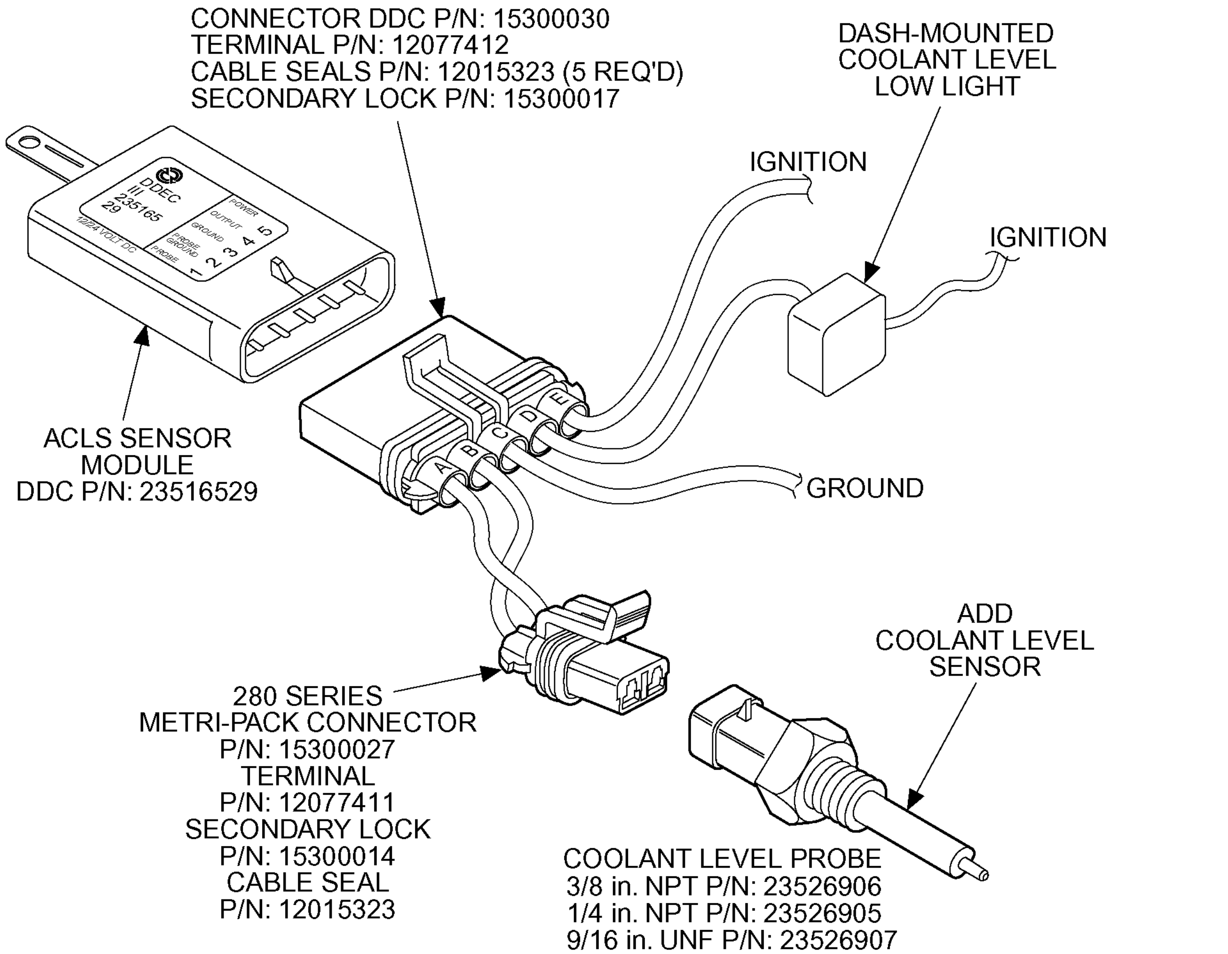


Figure 3-102 Add Coolant Level Sensor Location - Radiator Surge Tank

The ACLS probe is connected to a separate module. The module provides an output to drive an indicator light on the dash or can be used with the Maintenance Alert System. See Figure 3-103for the installation of a Coolant Level Low Light.

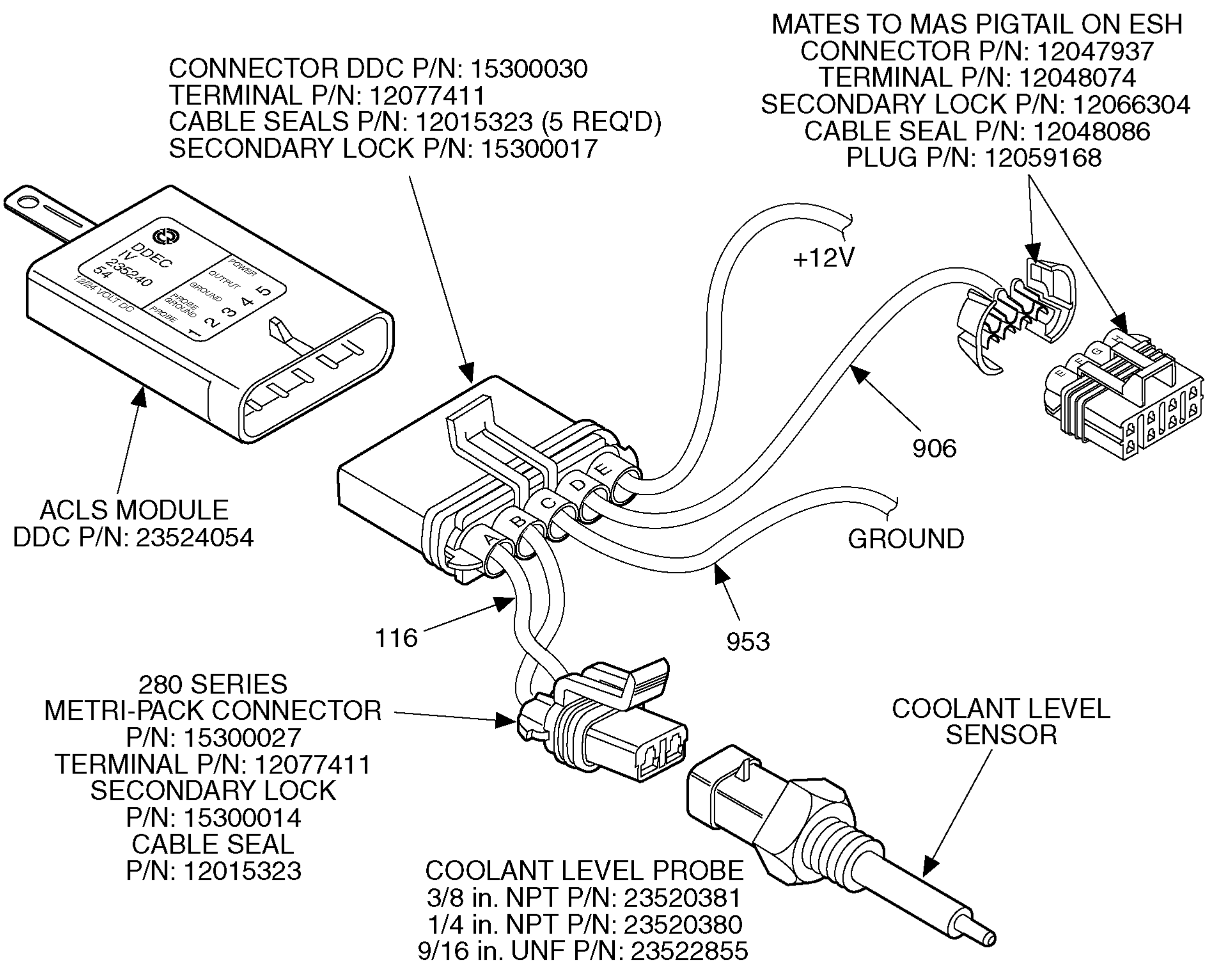


LABEL	ADD COOLANT LEVEL MODULE CONNECTOR CAVITY	WIRE COLOR	ACLS SENSOR CAVITY
ACLS SENSOR	A	WHT/YEL	A
GROUND	B	BLK/WHT	B
GROUND	C	BLK/WHT	–
ACLS SENSOR LOW LIGHT	D	–	–
IGN	E	PNK	–

41694

Figure 3-103 Add Coolant Level Sensor with Dash-mounted Light Installation

When the ACLS is used with MAS, an additional module (P/N: 23524054) is required to condition the sensor signal. The module output will be connected to a pigtail on the DDC supplied Engine Sensor Harness. See Figure 3-104 for wiring schematic. This sensor must be enabled with VEPS (Release 24 software or later) or the DDEC Reprogramming System.



LABEL	WIRE NO.	COOLANT LEVEL MODULE CONNECTOR CAVITY	WIRE COLOR	CLS CAVITY	ESH-MAS PIGTAIL CONNECTOR CAVITY	ESH-TO-ECM CONNECTOR CAVITY
ADD COOLANT LEVEL	116	A	ORN	A	–	–
GROUND	953	B	BLK/WHT	B	–	–
GROUND	953	C	BLK/WHT	–	–	–
ACLS	906	D	ORN	–	G	N1
BATTERY (+12V)	–	E	RED	–	–	–

41668

Figure 3-104 Add Coolant Level Sensor Installation

3.14.21 OPTICAL COOLANT LEVEL SENSOR

The optical CLS (see Figure 3-105) can be used in place of the standard coolant level sensor in applications where electrical isolation from the chassis is required.

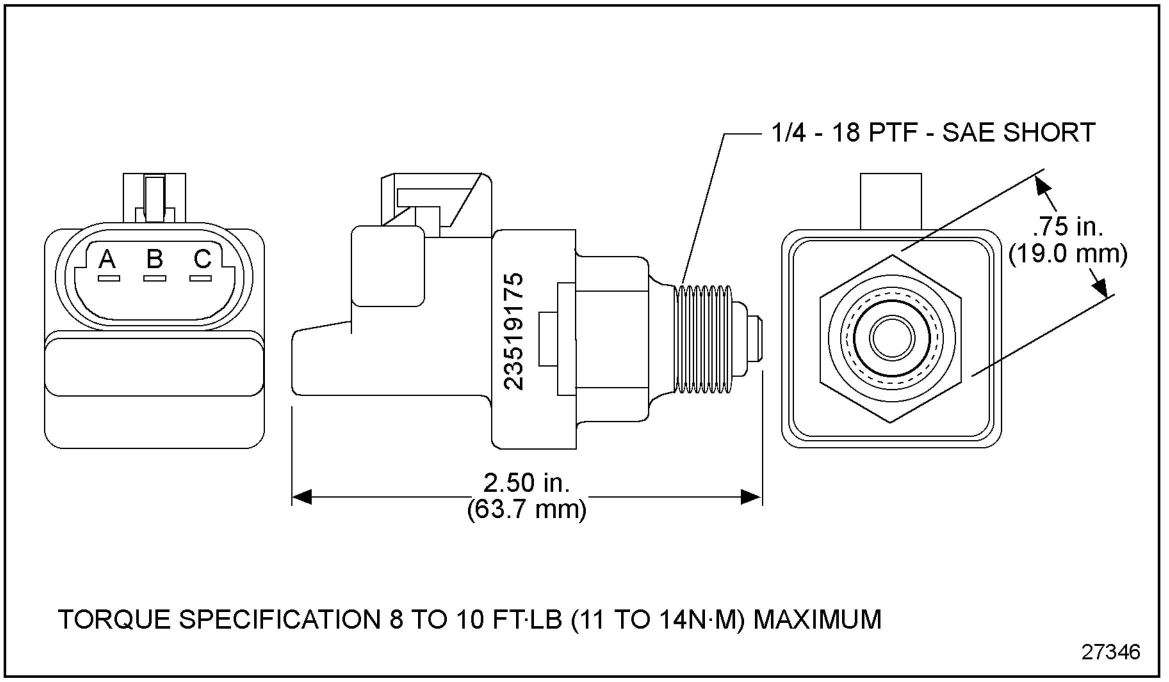
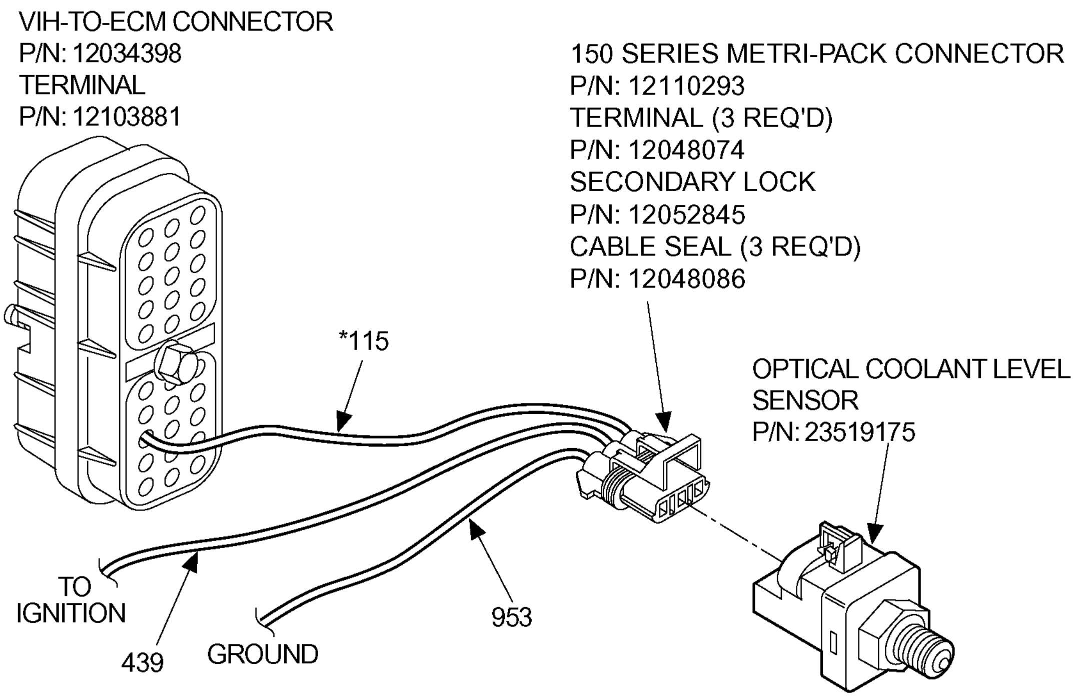


Figure 3-105 Optical Coolant Level Sensor Specifications

The optical CLS does not have a connection to the chassis but uses the angle of refraction of light emitted from the probe to determine if the sensor is in or out of the coolant. See Figure 3-106for a schematic of the optical CLS harness.



LABEL	WIRE NO.	VIH-TO-ECM CONNECTOR CAVITY	WIRE COLOR	OPTICAL CLS CAVITY
COOLANT LEVEL	*115	H-3	ORN	C
GROUND	953	–	BLK/WHT	A
IGNITION	439	–	PNK	B

*115M FOR MULTI-ECM APPLICATIONS

41672

Figure 3-106 Optical Coolant Level Sensor Harness

NOTE:
This sensor is to be used with DDEC III or IV only.

The sensor part numbers are listed in Table 3-50.

Description	Part Number
Optical CLS - DDEC III or IV	23519175
Connector	12110293
Terminals	12048074
Cable Seals	12048086
Secondary Lock	12052845

Table 3-50 Optical Coolant Level Sensor and Parts

3.14.22 EXHAUST TEMPERATURE SENSOR

Excessive exhaust temperature may indicate a concern with the fuel system or a mechanical fault. An Exhaust Temperature Sensor (see Figure 3-107) will provide early warning and prevent damage for certain applications. This sensor is configured by the Application Code System (ACS).

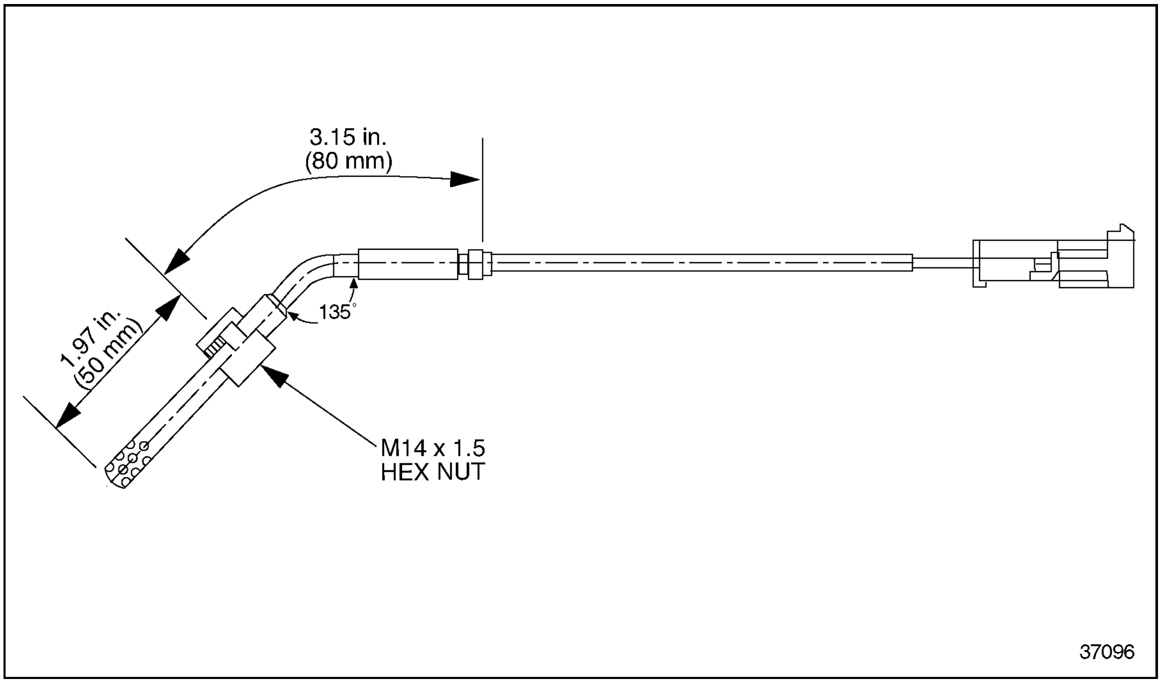


Figure 3-107 Exhaust Temperature Sensor

Exhaust Temperature Sensor Installation

Kits containing the Exhaust Temperature Sensor Harness and sensor are available from Canton Parts Distribution Center. The kits are listed in Table 3-51.

Kit Part Numbers	Description	Component Part Numbers
23524968	Harness - 232 in.*	23524831
	Exhaust Temperature Sensor	23521882
23525702	Harness - 170 in. length*	23525686
	Exhaust Temperature Sensor	23521882
23525703	Harness - 100 in. length*	23525685
	Exhaust Temperature Sensor	23521882

* Total length includes 72 in. lead on P/N: 23521882

Table 3-51 Exhaust Temperature Sensor and Harness Kits

To install the Exhaust Temperature Sensor (see Figure 3-108):

1. Unplug the connector from the TBS.
2. Plug the Exhaust Temperature Sensor Harness connector (P/N: 12162182) into the TBS.

3. Plug the TBS connector (from the ESH) you unplugged in step 1 into the 3-pin connector on the Exhaust Temperature Sensor Harness.
4. Route the harness along the ESH toward the ECM-VIH 30-pin connector. Remove the VIH 30-pin connector from the ECM.
5. Insert the single lead (circuit 749) into cavity D3 of the VIH 30-pin connector. Crimp the terminal on the lead and pull to seat.

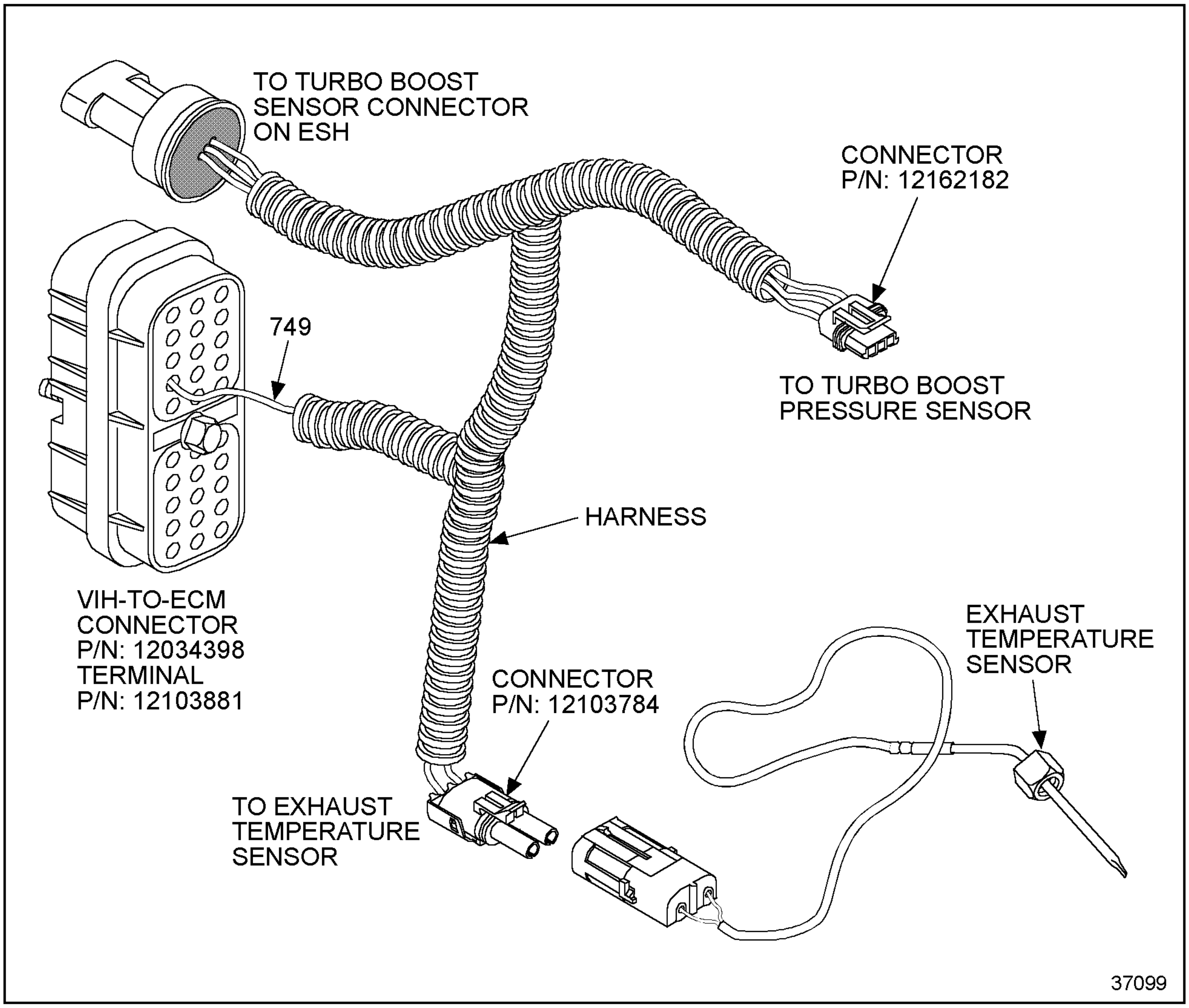


Figure 3-108 Exhaust Temperature Sensor Installation

6. Reinstall the VIH 30-pin connector.
7. Route the body of the harness to the location of the Exhaust Temperature Sensor and plug the connector (P/N: 12103784) into the sensor.

3.14.23 FIRE TRUCK PUMP PRESSURE SENSOR

The Fire Truck Pump Pressure Sensor is used with the DDEC IV pressure sensor governor. It provides a fire truck pump pressure signal to the ECM, which modulates engine fueling to maintain a constant fire truck pump pressure. See Figure 3-109. The Pressure Sensor is capable of reading up to 400 psia and is located in the water pump discharge manifold.

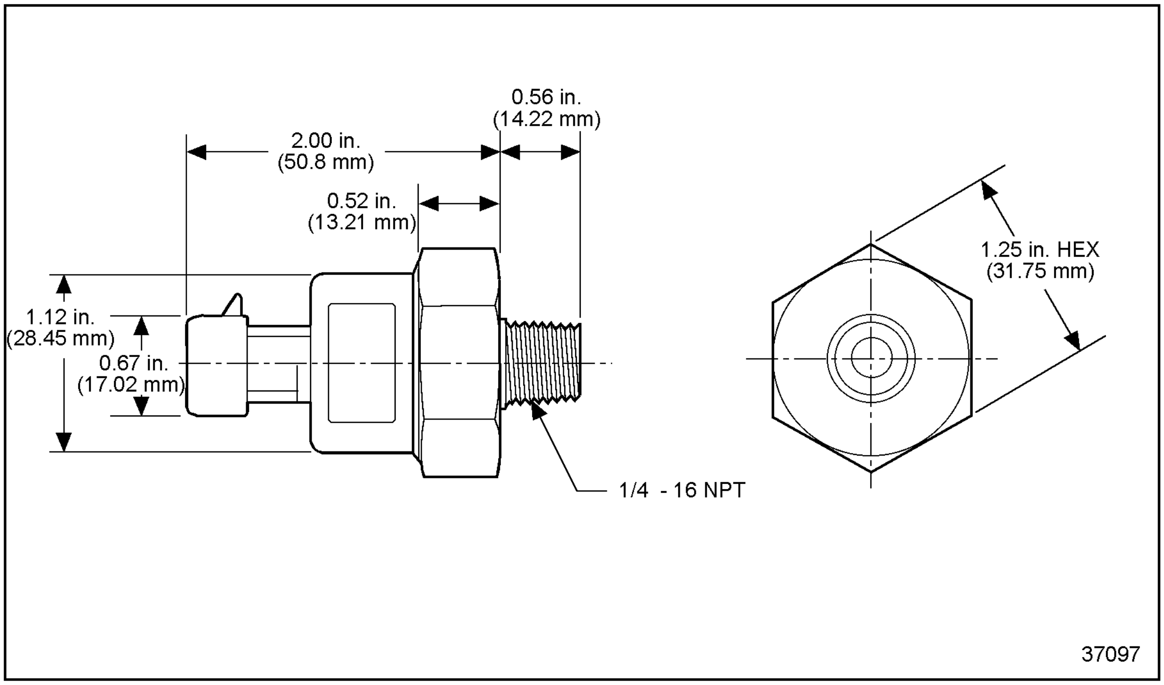


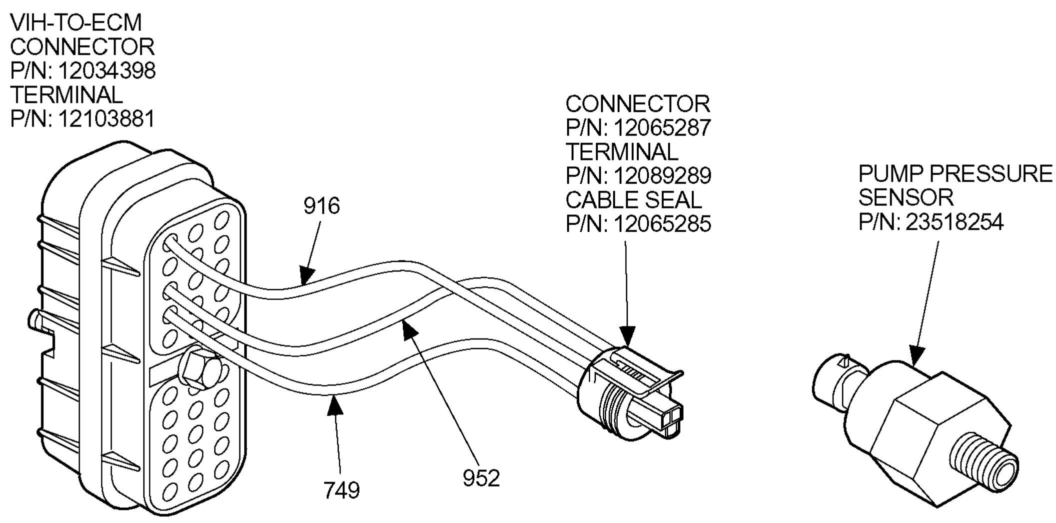
Figure 3-109 The Fire Truck Pump Pressure Sensor

The Fire Truck Pump Pressure Sensor connector, listed in Table 3-52, is a Metri-Pack 150 series pull-to-seat connector.

Fire Truck Pressure Sensor (PSG)	
Connector	P/N: 12065287
Terminal	P/N: 12089289
Cable Seal	P/N: 12065285

Table 3-52 Fire Truck Pump Pressure Sensor Connector

See Figure 3-110 for the installation of the Fire Truck Pump Pressure Sensor.



LABEL	WIRE NO.	VIH-TO-ECM CONNECTOR CAVITY	WIRE COLOR	PUMP PRESSURE CONNECTOR CAVITY
SENSOR RETURN	952	C3	BLK	A
PUMP PRESSURE SENSOR	749	D3	YEL	C
SENSOR SUPPLY	916	A3	RED/BLK	B

37100

Figure 3-110 Fire Truck Pump Pressure Sensor Installation

3.14.24 THROTTLE POSITION SENSOR

The EFPA contains the Throttle Position Sensor (TPS) which converts the operator's hand throttle and/or foot pedal input into a signal for the ECM. Refer to section 3.15.1 for additional information on the Electronic Foot Pedal Assembly.

3.14.25 VEHICLE SPEED SENSOR

The DDEC IV ECM can calculate vehicle speed providing that the ECM is properly programmed and interfaced with a vehicle speed signal that meets DDC requirements. The VSS (see Figure 3-111) provides a vehicle speed signal for use in Cruise Control and Vehicle Speed Limiting. The VSS signal type can be changed with the DDR, VEPS, or DRS.

NOTE:
DDC does not approve of the use of signal generator sensors.

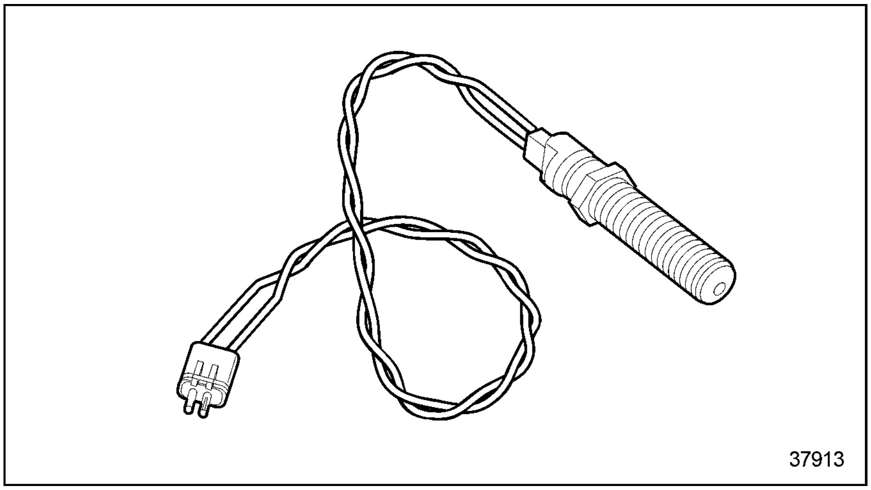


Figure 3-111 Vehicle Speed Sensor

To obtain accurate vehicle mileage, the parameters listed in Table 3-53 must be programmed with the DDR, DDDL, VEPS, DRS or at order entry.

Parameter	Description	Choice / Display
VSS ENABLED	Enables or disables the vehicle speed sensor input.	YES, NO
VSS TYPE	Type of vehicle speed sensor used	TAIL, WHEEL
VSS TEETH	Number of teeth on the vehicle speed sensor wheel.	0 to 250
VSS SIGNAL	Type of vehicle speed sensor signal.	SWITCHED, MAGNETIC
TIRE REVS/MI or REV/KM	Vehicle tire revolutions per mile.	100 to 999
AXLE RATIO	Indicates the rear axle ratio of the vehicle.	2.00 to 19.99
TOP GEAR RATIO	Indicates the vehicle transmission final drive ratio.	0.5 to 2.55

Table 3-53 Vehicle Speed Sensor Parameters

Magnetic Pickup

The magnetic pickup requirements are listed in Table 3-54. Magnetic Pickup size is determined by installation requirements. Both circuits 556 and 557 must be used.

Parameters	Range
Input amplitude Range	800 mV-100V peak to peak
Input Frequency Range	1 - 3000 Hz

Table 3-54 Magnetic Pickup Vehicle Speed Sensor Requirements

See Figure 3-112 for the installation of magnetic pickup VSS.

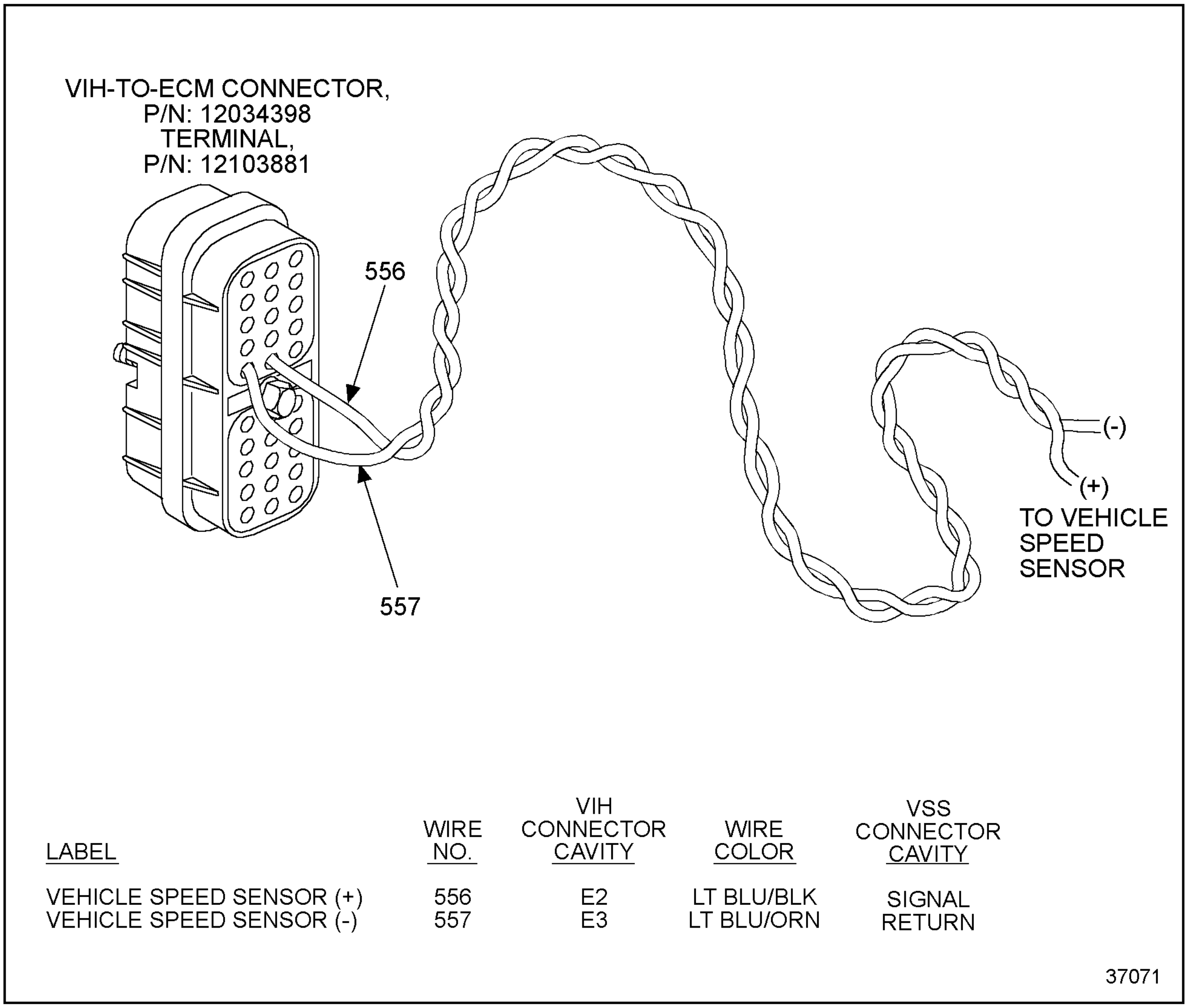


Figure 3-112 Magnetic Pickup Vehicle Speed Sensor Installation

Magnetic Vehicle Speed Sensors can be obtained from the following sources:

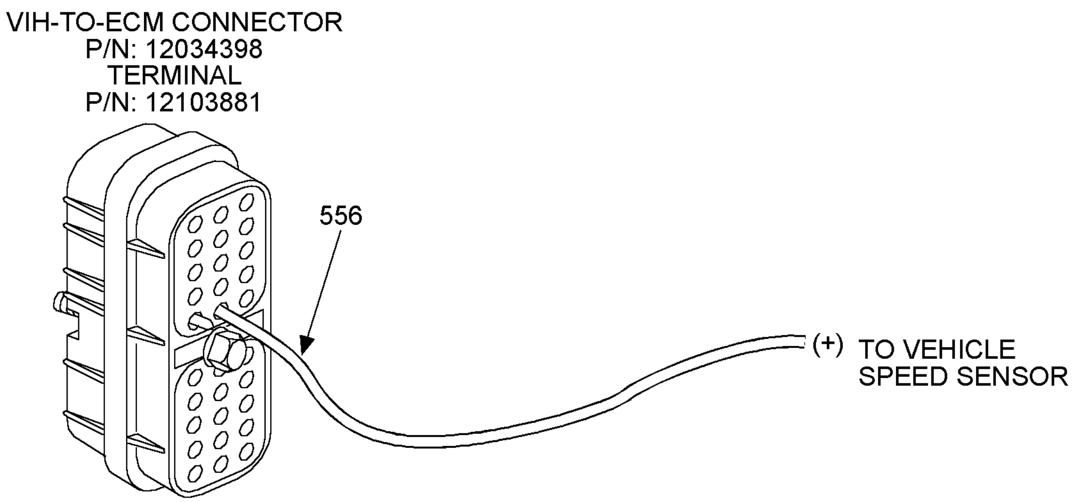
Wabash Technologies
1375 Swan Street
Huntington, Indiana 46750-0829
Tel: 219-356-8300
Fax: 219-356-3846

Airpax Instruments
Phillips Technologies
150 Knotter Drive
Chesire, Connecticut 06410
Tel: 800-643-0643

Electro Corporation
1845 57th Street
Sarasota, Florida 34243
Tel: 941-355-8411
Fax: 941-355-3120

Open Collector

The open collector input is defined as a single wire input that alternates between a high voltage of at least 4 V DC and a low voltage of 1.0 V DC or less. Typically, the input is connected to a transistor collector output whether open or through a pull up resistor. A pull up resistor is preferred as this eliminates the need to configure the signal type as open collector. See Figure 3-113 for open collector VSS installation.



LABEL	WIRE NO.	VIH CONNECTOR CAVITY	WIRE COLOR	VSS CONNECTOR CAVITY
VEHICLE SPEED SENSOR (+)	556	E2	LT BLU/BLK	SIGNAL
VEHICLE SPEED SENSOR (-)	PLUGGED	–	–	–

37072

Figure 3-113 Open Collector Vehicle Speed Sensor Installation

Allison Transmission Electronic Controls have an open collector output. DDEC IV circuit #556 is connected to Allison circuit #205 (Allison Transmission Electronic Controls) or Allison circuit #157 (World Transmission). This device is an electrically operated switch that grounds or opens the input signal. The VSS frequency (pulses/mile) may range between 7,000 and 145,000 pulses/mile.

The open collector requirements are listed in Table 3-55. Only circuit 556 is used. 557 cavity must be empty.

Parameters	Range
High State	4.0 <E_{in} <Battery (+) with $I_{leakage}$ <0.2mA
Peak to Peak Voltage Maximum	-2.0 <E_{in} <1.0 V while I_{source} <5.0mA
Input Frequency Range	1 - 3000 Hz

Table 3-55 Open Collector Vehicle Speed Sensor Requirements

SAE J1939 Data Link

A VSS wired to the ECM is not required if the transmission output shaft speed message is being transmitted over the SAE J1939 Data Link. The transmission type, listed in Table 3-56, must be set to 16 (Auto/J1939). The transmission type is set by VEPS or the DRS.

Parameter	Description	Choice
Transmission Type	Select the transmission type.	16

Table 3-56 Transmission Type

To obtain accurate vehicle mileage, the parameters listed in Table 3-57 must be programmed with the DDR, DDDL, VEPS, DRS, or at order entry. The VSS type will automatically be set to SAE J1939 when the appropriate transmission type is selected (trans type = 16).

Parameter	Description	Choice / Display
VSS ENABLED	Enables or disables the vehicle speed sensor input.	YES, NO
VSS TYPE	Type of vehicle speed sensor used	J1939
TIRE REVS/MI or REV/KM	Vehicle tire revolutions per mile.	100 to 999
AXLE RATIO	Indicates the rear axle ratio of the vehicle.	2.00 to 19.99
TOP GEAR RATIO	Indicates the vehicle transmission final drive ratio.	0.5 to 2.55

Table 3-57 Vehicle Mileage Parameters

Two faults (SID 216 FMI 14 and PID 84 FMI 12) will be logged simultaneously if DDEC is calibrated to receive output shaft speed over a SAE J1939 Data Link and the data is not being received or the data is bad. This indicates that there is a problem with the sensor on the transmission or the transmission controller. The fault is available with Release 27.0 or later software). If these faults are received in addition to a SAE J1939 Data Link failure (SID 231, FMI 12), then the problem is with the SAE J1939 Data Link itself.

VSS Anti-Tamper

If the sensor appears to be working improperly but the vehicle speed is not zero, VSS Anti-Tamper logs a VSS fault and limits engine speed. VSS Anti-Tamper must be programmed by the DRS, DDDL, or the DDR. Refer to section 5.37for additional information.

3.14.26 AFTERMARKET INSTALLED SENSORS

Two sensors are installed aftermarket, the Ambient Air Temperature Sensor (Ambient ATS) and the Exhaust Back Pressure Sensor.

3.14.27 AMBIENT AIR TEMPERATURE SENSOR

The Ambient ATS is a thermistor type sensor with a variable resistance that produces an analog signal between 0 and 5 V, representing the temperature of the ambient air. The Ambient ATS (see Figure 3-114and see Figure 3-115) is used with the Idle Shutdown Timer, specifically for the Ambient Air Temperature Override Disable feature.

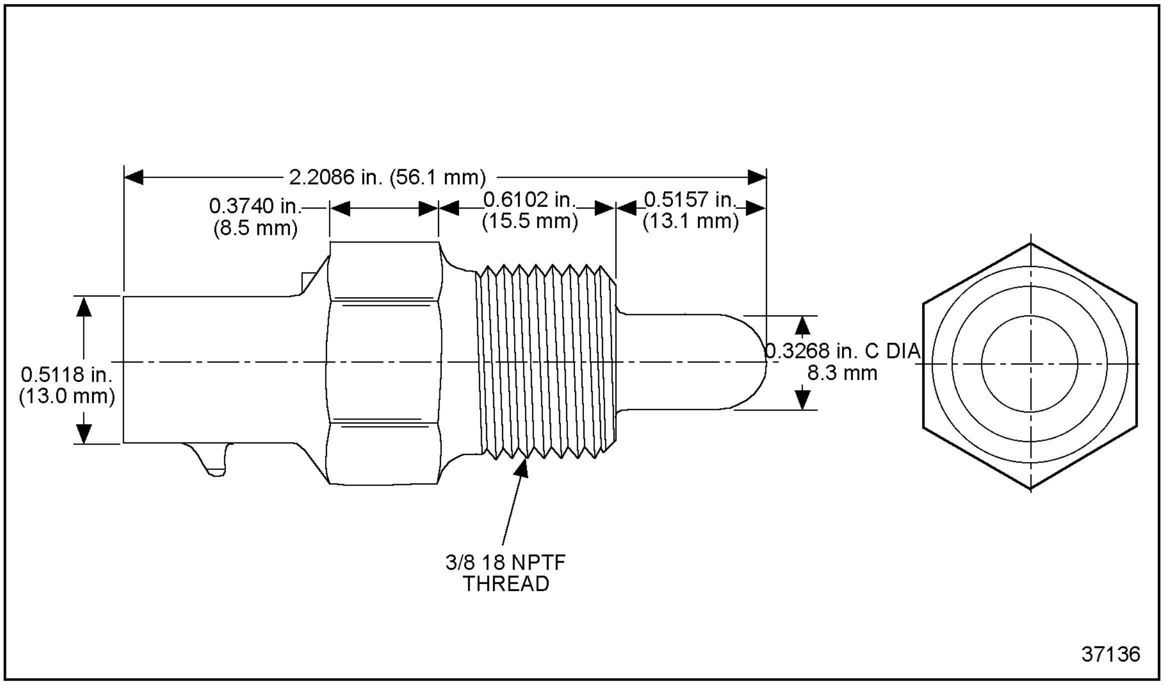


Figure 3-114 Ambient Air Temperature Sensor

This option allows the override to be disabled based on ambient air temperature. Although DDEC can calculate ambient air temperature, an Ambient ATS should be installed. If the upper and lower temperature limits are set and the ambient temperature is within the specified limits, the override will be disabled and the engine will be shutdown after the specified time limit is met. To disable this feature, the upper and lower limits must be set to 167°F.

The installation of an Ambient ATS is recommended if the Ambient Air Temperature Override Disable feature is enabled. Install the Ambient ATS where ambient air temperature can be read. A protected location on the frame rails where it will not be splattered with dirt and grime and is removed from any heat source such as exhaust is preferred. Refer to section 5.18 for more information on the Idle Shutdown Timer.

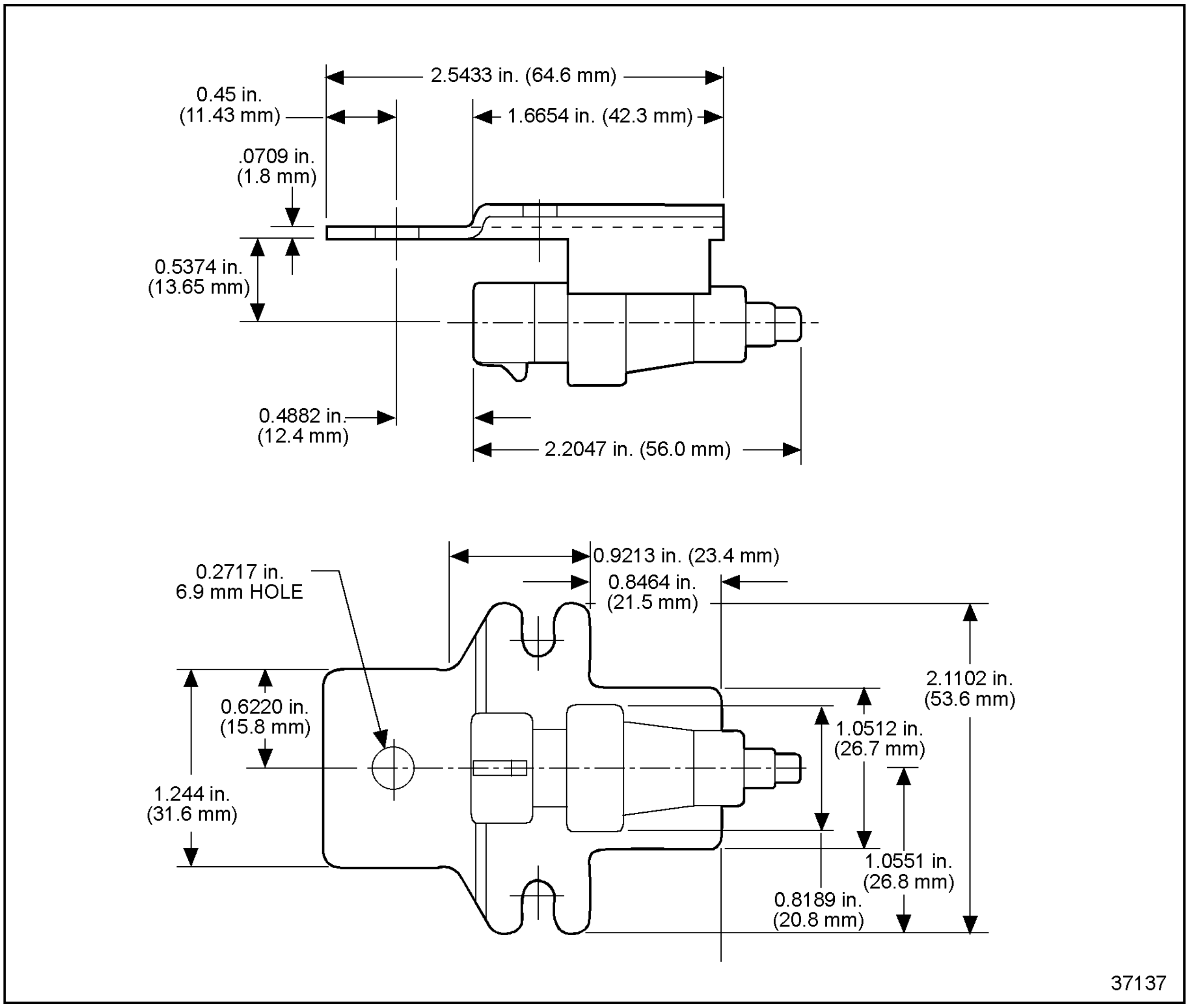


Figure 3-115 Ambient Air Temperature Sensor With Integrated Mounting Brackets

Ambient Air Temperature Sensor Installation

An Ambient ATS Kit (P/N: 23524171) is available through the Canton Parts Distribution Center. The Kit contains all the necessary hardware to install an Ambient ATS.

To install the Ambient ATS and harness (see Figure 3-116):

1. Select the desired Ambient ATS (listed in Table 3-58) for the application:

Ambient ATS	Mounting
Ambient ATS P/N: 23515250 (see Figure 3-114)	Mounts in a 3/8 in. NPTF hole
	Requires that a bracket be fabricated with a drilled and tapped hole.
Ambient ATS P/N: 23518328 With Integrated Mounting Brackets (see Figure 3-115)	Mounting: Integrated mounting pad/ not threaded

Table 3-58 Available Ambient Air Temperature Sensors

2. Unplug the connector from the Oil Pressure Sensor (OPS) located on the intake manifold.
3. Plug the connector (P/N: 12162182) on the Ambient ATS harness into the OPS.
4. Plug the OPS connector that you unplugged in step 2 into the 3-pin connector (OPS connector mate) on the Ambient ATS harness.

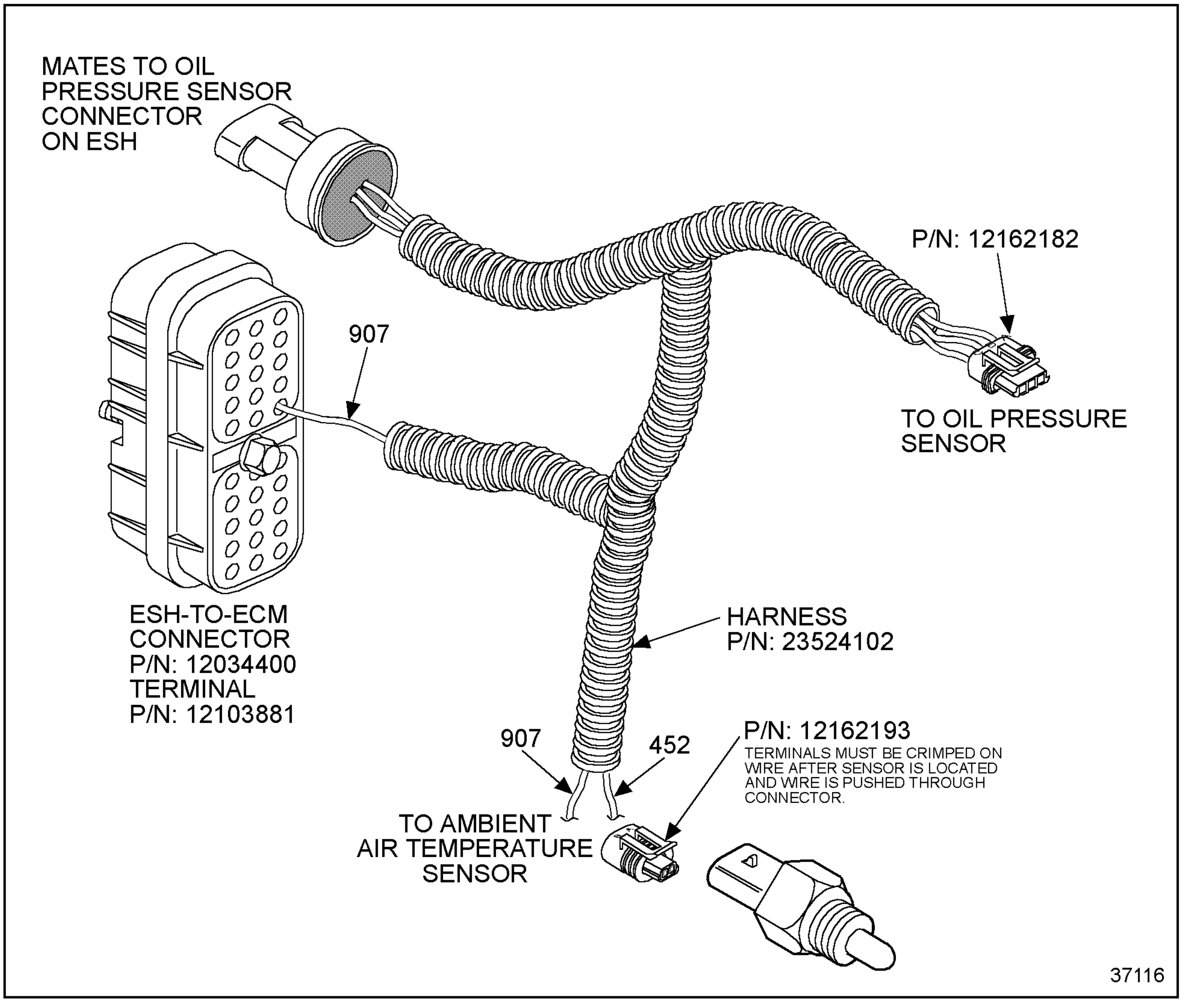


Figure 3-116 Ambient ATS Harness

5. Route the harness along the Engine Sensor Harness towards the ECM 30-pin connector.

6. Remove the Engine Sensor Harness 30-pin connector from the ECM.
7. Insert the single lead (circuit 907) into cavity R-1. Crimp a terminal (P/N: 12103881) on the lead using tool J 35123.
8. Seat the terminal into the connector and reinstall the 30-pin connector.
9. Route the body of the harness to the desired location for the Ambient ATS. Remove any excess harness material and discard.

NOTE:
Do not splice wire 452 on the Engine Sensor Harness.

10. Install the black lead (circuit 452) into cavity "A" of Ambient ATS connector (P/N: 12162193) and the green lead (circuit 907) into cavity "B." Crimp the terminals (P/N: 12103881) on each lead using tool J 35123. Insert the terminals into the connector.
11. Secure the sensor to the desired location with connector pointing down and plug in the Ambient ATS connector.
12. Secure the harness to adjacent components with wire ties.

The following kit, parts listed in Table 3-59, is available from Detroit Diesel's Parts Distribution Center.

Part No.	Qty.	Description
23524102	1	Harness, Air Temp. Sensor
23518328	1	Sensor, Air Temp. (W/ Mtg. Brkt.)
23515250	1	Sensor, Air Temp. (3/8 in. NPTF)
12162193	1	Connector, Air Temp. Sensor
12103881	5	Terminal, Female
18SP397	1	18SP397 Installation Instructions

Table 3-59 Ambient Air Temperature Kit P/N: 23524171

3.14.28 EXHAUST BACK PRESSURE SENSOR

The Exhaust Back Pressure Sensor comes in the Exhaust Back Pressure Sensor Kit. This kit is intended for installation on Detroit Diesel DDEC IV Series 50 Diesel and Series 60 Diesel Coach Engines. The Kit components, used in conjunction with aftertreatment systems, provides diagnostic capability and engine protection in the event of excessive exhaust backpressure. This kit is required for Emitless® particulate filter installations. It may be used as an option with catalytic converter installations.

NOTE:
Contact an authorized Detroit Diesel distributor to inquire if the kit is released for your engine model.

The Exhaust Back Pressure Sensor is bracket mounted and ported to the exhaust pipe upstream of the particulate filter or catalytic converter. The exhaust temperature sensor is installed directly into the outlet side of the Emitless particulate filter or catalytic converter.

NOTE:
An exhaust temperature sensor is required for all particulate filter and catalytic converter installations.

The wiring harness in these exhaust back pressure kits include both Exhaust Back Pressure and Exhaust Temperature Sensor connectors.

See Figure 3-117.

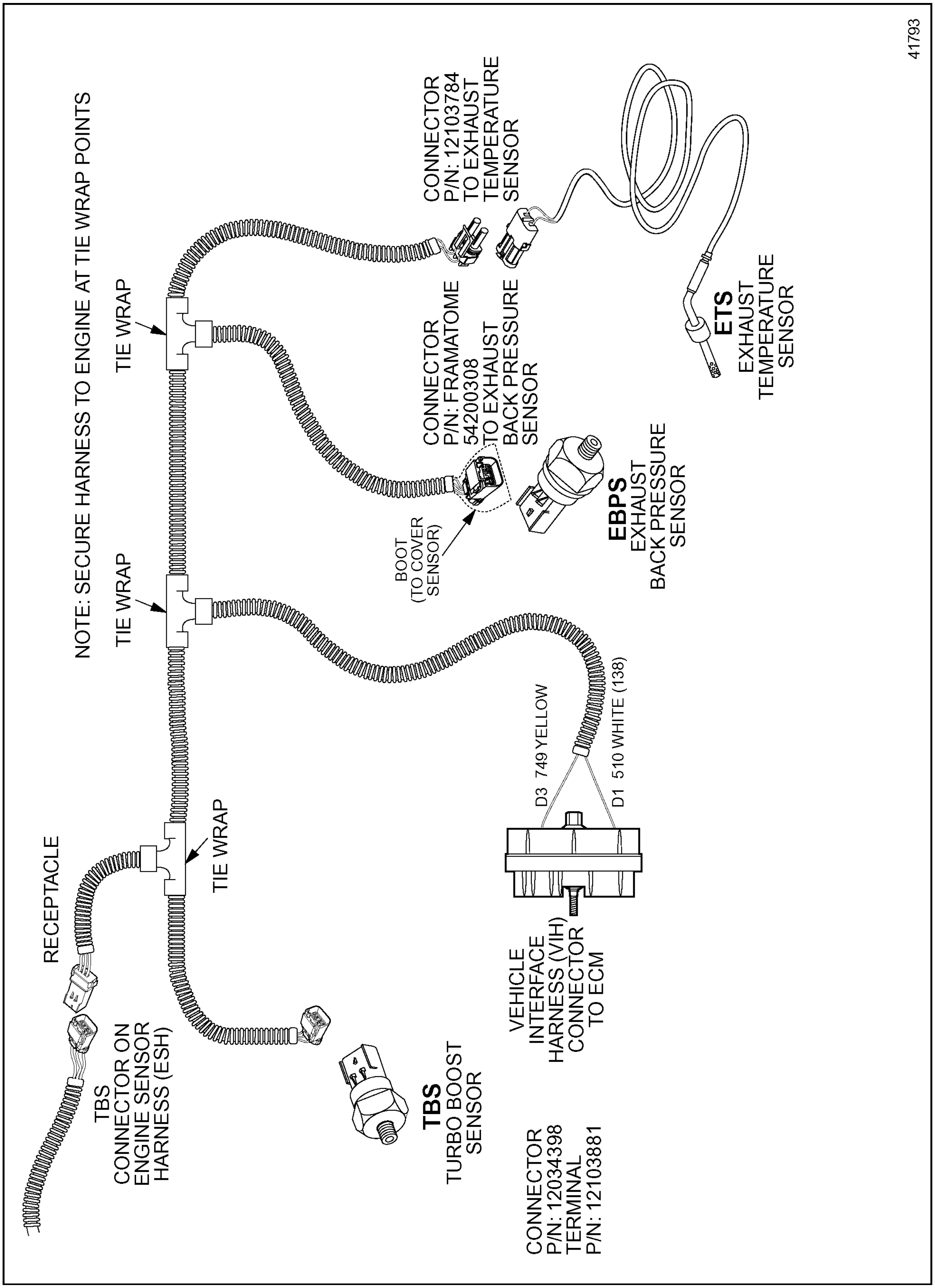


Figure 3-117 Exhaust Temperature and Pressure Sensor Harness

Three service kits with different length sensor harnesses are available. The parts to the three kits are listed in Table 3-60, Table 3-61, and Table 3-62.

NOTE:
Kits are assembled without an Exhaust Temperature Sensor to accommodate customers retrofitting engines have sensor P/N: 23521882 (with 182 cm/72 in. cable) previously installed. If an exhaust temperature sensor was not previously installed, obtain one from an authorized Detroit Diesel distributor.

Part Number	Quantity	Description
23528951	1	Exhaust Temperature/Pressure Harness, 589 cm/232 in. in Length
23528948	1	Exhaust Back Pressure Sensor
23529151	1	Stainless Steel Braided hose, 91 cm/36 in. in Length
23529152	1	Sensor Mounting Bracket
23529150	1	Bulkhead Compression Fitting with Female 3/8 in. NPTF Pipe Thread
23528903	1	Compression Fitting with Weld End
11505299	2	Bolt, M10 X 1.5 X 30 (Flange Head)
11506101	2	Nut, M10 X 1.5 (Flange Head)
18SP548	1	Installation Instructions

Kits do not include an Exhaust Temperature Sensor

Table 3-60 Exhaust Back Pressure Sensor Kit with 589 cm/232 in. Harness, P/N: 23529470

Part Number	Quantity	Description
23528952	1	Exhaust Temperature/Pressure Harness 432 cm/170 in. Length
23528948	1	Exhaust Back Pressure Sensor
23529151	1	Stainless Steel Braided hose, 91 cm/36 in. Length
23529152	1	Sensor Mounting Bracket
23529150	1	Bulkhead Compression Fitting with Female 3/8 in. NPTF Pipe Thread
23528903	1	Compression Fitting with Weld End
11505299	2	Bolt, M10 X 1.5 X 30 (Flange Head)
11506101	2	Nut, M10 X 1.5 (Flange Head)
18SP548	1	Installation Instructions

Kits do not include an Exhaust Temperature Sensor

Table 3-61 Exhaust Back Pressure Sensor Kit with 432 cm/170 in. Length Harness, P/N: 23529471

Part Number	Quantity	Description
23528953	1	Exhaust temperature/Pressure Harness, 254 cm/100 in. Length
23528948	1	Exhaust Back Pressure Sensor
23529151	1	Stainless Steel Braided hose, 91 cm/36 in. Length
23529152	1	Sensor Mounting Bracket
23529150	1	Bulkhead Compression Fitting with Female 3/8 in. NPTF Pipe Thread
23528903	1	Compression Fitting with Weld End
11505299	2	Bolt, M10 X 1.5 X 30 (Flange Head)
11506101	2	Nut, M10 X 1.5 (Flange Head)
18SP	1	Installation Instructions

Kits do not include an Exhaust Temperature Sensor

Table 3-62 Exhaust Back Pressure Sensor Kit with 254 cm/100 in. Length Harness P/N: 23529472

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3.15 THROTTLE DEVICES

There are several types of throttle controls which may be used for engine control.

- ☐ Hand throttle
- ☐ Electronic Foot Pedal Assembly (EFPA)
- ☐ Cruise Control switches
- ☐ Fast Idle Switch (beginning with Release 2.0 software)
- ☐ Voltage dividers
- ☐ Frequency input

The throttle input device is OEM-supplied.

There are two types of engine governors that are used with throttle controls. The engine governors are:

- ☐ The Limiting Speed Governor (LSG) for torque control
- ☐ The Variable Speed Governor (VSG) for speed control

3.15.1 ELECTRONIC FOOT PEDAL ASSEMBLY

The EFPA contains the Throttle Position Sensor (TPS) which converts the operator's hand throttle and/or foot pedal input into a signal for the ECM. The EFPA and the TPS are shown in Figure 3-118.

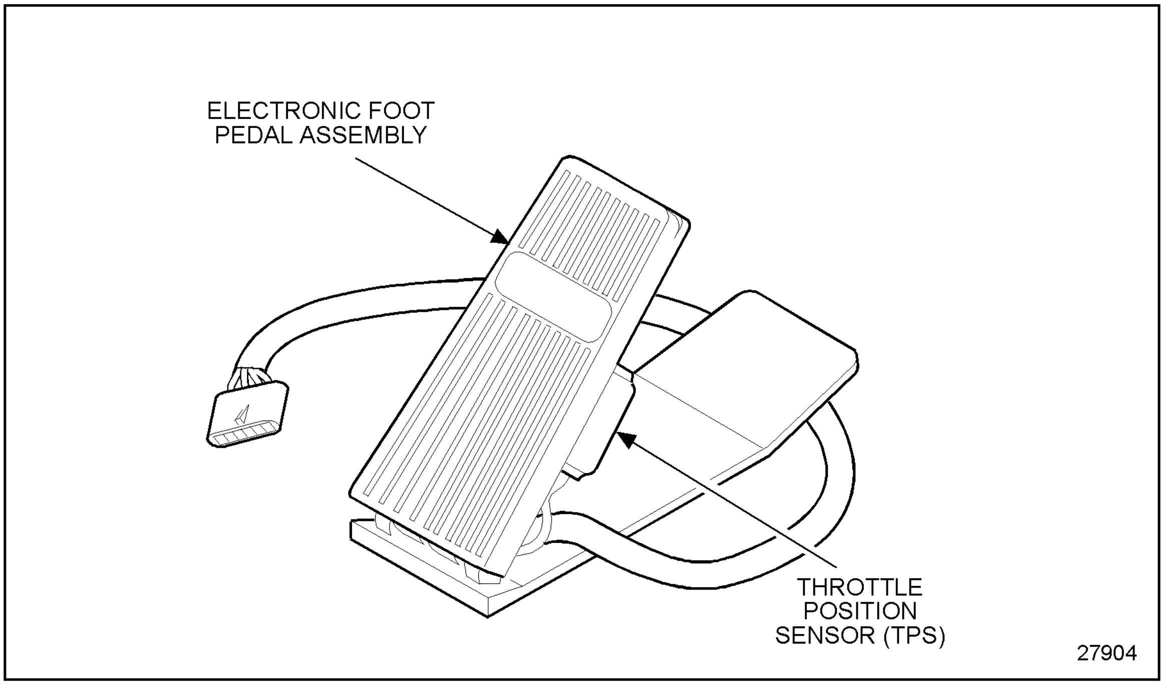

Figure 3-118 Typical EFPA Throttle Device (Shown with 6-pin Connector)

The EFPA sends the ECM an input signal which controls engine power on the LSG, proportional to the foot pedal position. This assembly is also referred to as the Throttle Position Sensor (TPS) assembly.

The system fault detection diagnostics will return the engine to idle speed in the event of a sensor or associated wiring malfunction. The fault detection diagnostics work with or without an idle validation switch on the EFPA. An idle validation switch provides redundancy to assure that the engine will be at idle in the event of an in-range malfunction. The connectors for the TPS are Weather Pack push-to-seat connectors and are listed in Table 3-63.

Throttle Position Sensor, Harness Side		Throttle Position Sensor, Sensor Side	
Connector	P/N: 12015793	Connector	P/N: 12010717
Terminal	P/N: 12089188	Terminal	P/N: 12034051
Seal	P/N: 12015323	Seal	P/N: 12015323

Table 3-63 Connectors for the Throttle Position Sensor

The EFPA can be used with both LSG and VSG.

3.15.2 CRUISE CONTROL SWITCHES

The Cruise Control switches can be used to control the VSG set speed. This feature is referred to as Cruise Switch VSG. For more information on Cruise Switch VSG, refer to section 5.3.3 and section 5.33.2.

3.15.3 HAND THROTTLE

A hand throttle (potentiometer) may be used to control engine speed on the VSG between the minimum and maximum VSG speed. The total resistance must be between 1kΩ and 10 kΩ.

When active, the hand throttle will control the engine speed on the VSG between the VSG minimum speed and the VSG maximum speed. For more information on the hand throttle, refer to section 5.33.2.

3.15.4 FAST IDLE SWITCH (ALTERNATE MINIMUM VSG)

The Alternate Minimum VSG option allows a customer to select an alternate idle speed when its digital input is switched to battery ground.

For more information on Alternate Minimum VSG/Fast Idle, refer to section 5.33.2.

3.15.5 VOLTAGE DIVIDERS

Voltage dividers can be used with the VSG input to provide a means to select a predetermined engine speed. Voltage dividers can be used to provide a fast idle operation or other engine operations where a fixed engine speed is desired.

For more information on voltage dividers, refer to section 5.33.2.

3.15.6 FREQUENCY INPUT

A frequency input can be used to control the VSG. This frequency is connected to the vehicle speed input or ATI port. Frequency speed control offers better resolution than analog throttles. For more information on frequency input, refer to section 5.33.2.

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3.16 LIGHTS

The instrument panel warning lights, the Check Engine Light (CEL) and the Stop Engine Light (SEL), are supplied by the OEM. The functionality of each light along with the wiring requirements are covered separately in the following sections.

3.16.1 CHECK ENGINE LIGHT

The CEL is controlled by the DDEC ECM. The CEL remains ON:

- ☐ For approximately five (5) seconds at the start of every ignition cycle (a bulb check)
- ☐ When an electronic system fault occurs (This indicates the problem should be diagnosed as soon as possible.)

The CEL flashes:

- ☐ When the Diagnostic Request Switch is used to activate the CEL to flash inactive codes
- ☐ During last 90 seconds before Idle Shutdown if programmed for override
- ☐ When Idle Shutdown occurs or the Optimized Idle system shutdown occurs

CEL activity with the Maintenance Alert System (MAS) is set with the DDR (Release 24), VEPS, DRS, or DDDL. The four options for using the CEL with MAS are:

1. CEL and SEL will not illuminate or flash for MAS Warnings - sensor faults will still be logged (recommended for vehicles equipped with display modules).
2. CEL will illuminate continuously while the warning is active, i.e. low fluid levels (oil or coolant), filter restrictions.
3. Flashes CEL and SEL for 15 seconds when the ignition is first turned ON and warnings have been present.
4. Both 2 and 3.

The CEL is active with the PasSmart feature. When the Passing Speed Duration time expires, the CEL will begin to flash one minute prior to ramping the Vehicle Limit Speed (VLS) down to the normal limit. The rampdown event always takes five seconds regardless of the Passing Speed Increment programmed into the ECM. The rampdown alert can be distinguished from an engine fault warning in that the CEL flashes for the former and remains on constantly for the latter.

PasSmart still operates when there is an active engine fault. In this situation, the CEL goes from constant illumination to flashing one minute before rampdown from the VSL. At the end of the passing event when PasSmart is deactivated, the CEL returns to constant illumination if the engine fault is still active.

The CEL is also active the DDEC Reports Periodic Maintenance Intervals. If a maintenance interval is within a specified percentage of expiration (default is 20%), the CEL flashes six times when the ignition is turned on. The ignition must have been off for less than 30 seconds prior to being turned on. If the off time has been greater than 30 seconds, no indication of maintenance interval status is given.

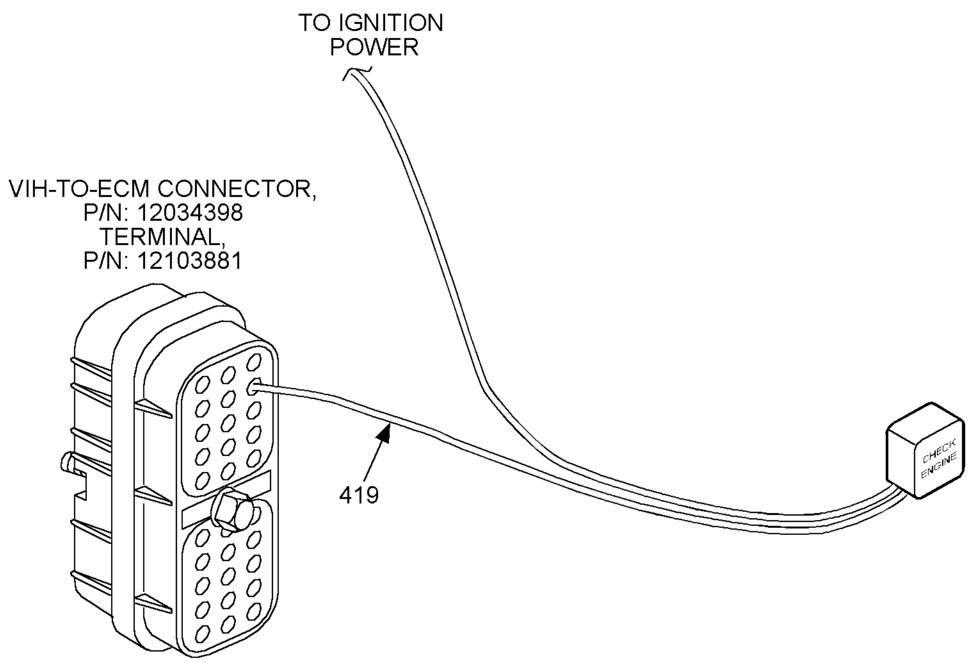
Check Engine Light Requirements and Guidelines

The following requirements and guidelines apply to the CEL:

- ☐ The CEL must be supplied by the OEM.
- ☐ A 12 or 24 volt light of less than 1.5 A (DC) is required depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance. A low-side digital output sinks 60 A when OFF.
- ☐ The CEL must be integrated into the instrument panel or placed in clear view of the equipment operator.
- ☐ The lens color must be amber.
- ☐ The words CHECK ENGINE must appear on or near the CEL lamp.

Check Engine Light Wiring

The CEL is connected to wire 419 in the VIH. See Figure 3-119 for the recommended CEL wiring.



LABEL	WIRE NO.	WIRE GAUGE	VIH CONNECTOR CAVITY	WIRE COLOR
CHECK ENGINE LIGHT	419	18	B-1	PPL/WHT
TO IGNITION POWER (+12/24 V)		16		

35402

Figure 3-119 Check Engine Light Wiring

3.16.2 STOP ENGINE LIGHT

The SEL is controlled by the DDEC ECM. The SEL remains ON:

- ☐ For approximately five (5) seconds at the start of every ignition cycle (a bulb check)
- ☐ When a potentially engine damaging fault is detected

The SEL flashes:

- ☐ After Engine Protection Shutdown occurs
- ☐ When the Diagnostic Request Switch is used to activate the SEL to flash active codes

SEL activity with the MAS is set with the DDR (Release 24 or later), VEPS, DRS, or DDDL. The two options for using the SEL with MAS are:

1. CEL and SEL will not illuminate or flash for MAS Warnings - sensor faults will still be logged (recommended for vehicles equipped with display modules).
2. Flashing CEL and SEL for 15 seconds when the ignition is first turned ON and warnings have been present.

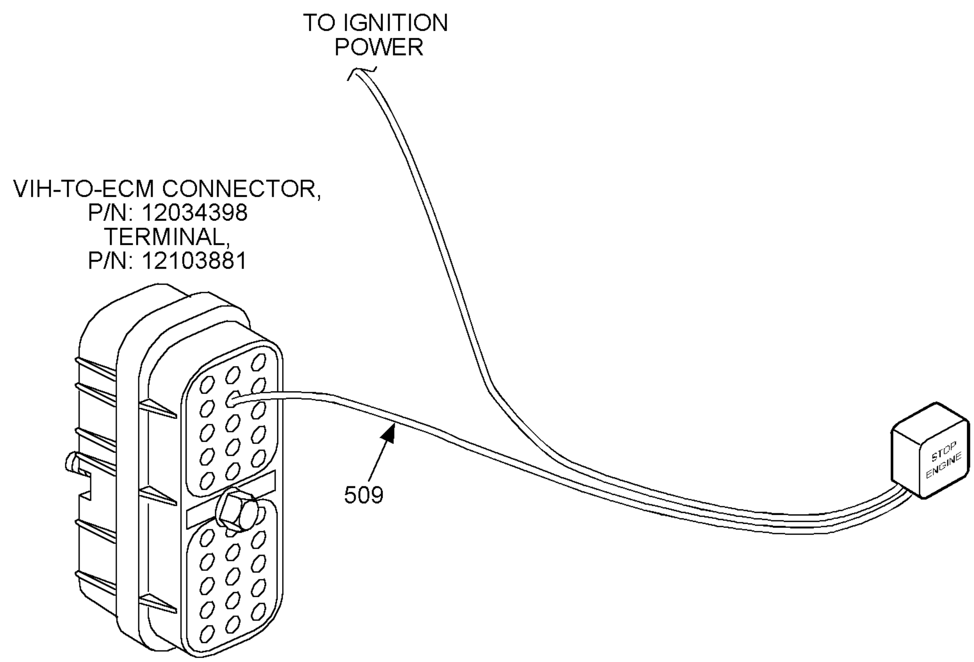
Stop Engine Light Requirements and Guidelines

The following requirements and guidelines apply to the SEL:

- ☐ The SEL must be incorporated into the VIH by the OEM.
- ☐ A 12 or 24 volt light of less than 1.5 A (DC) is required depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance. A low-side digital output sinks 60 A when OFF.
- ☐ The SEL must be integrated into the instrument panel or placed in clear view of the equipment operator.
- ☐ The lens color must be red.
- ☐ The words STOP ENGINE must appear on or near the SEL lamp.

Stop Engine Light Wiring

See Figure 3-120 for the recommended SEL wiring.



LABEL	WIRE NO.	WIRE GAUGE	VIH CONNECTOR CAVITY	WIRE COLOR
STOP ENGINE LIGHT	509	18	B-2	PPL
TO IGNITION POWER (+12/24 V)		16		

35401

Figure 3-120 Stop Engine Light Wiring

3.16.3 MULTIPLE ECM ENGINES

Each ECM uses a common SEL and CEL except for the Series 149 engine. The Series 149 Engine has a single SEL and CEL for each ECM.

3.16.4 MULTIPLE CEL/SEL WIRING

Some applications require two sets of CEL and SEL at different control stations. See Figure 3-121.

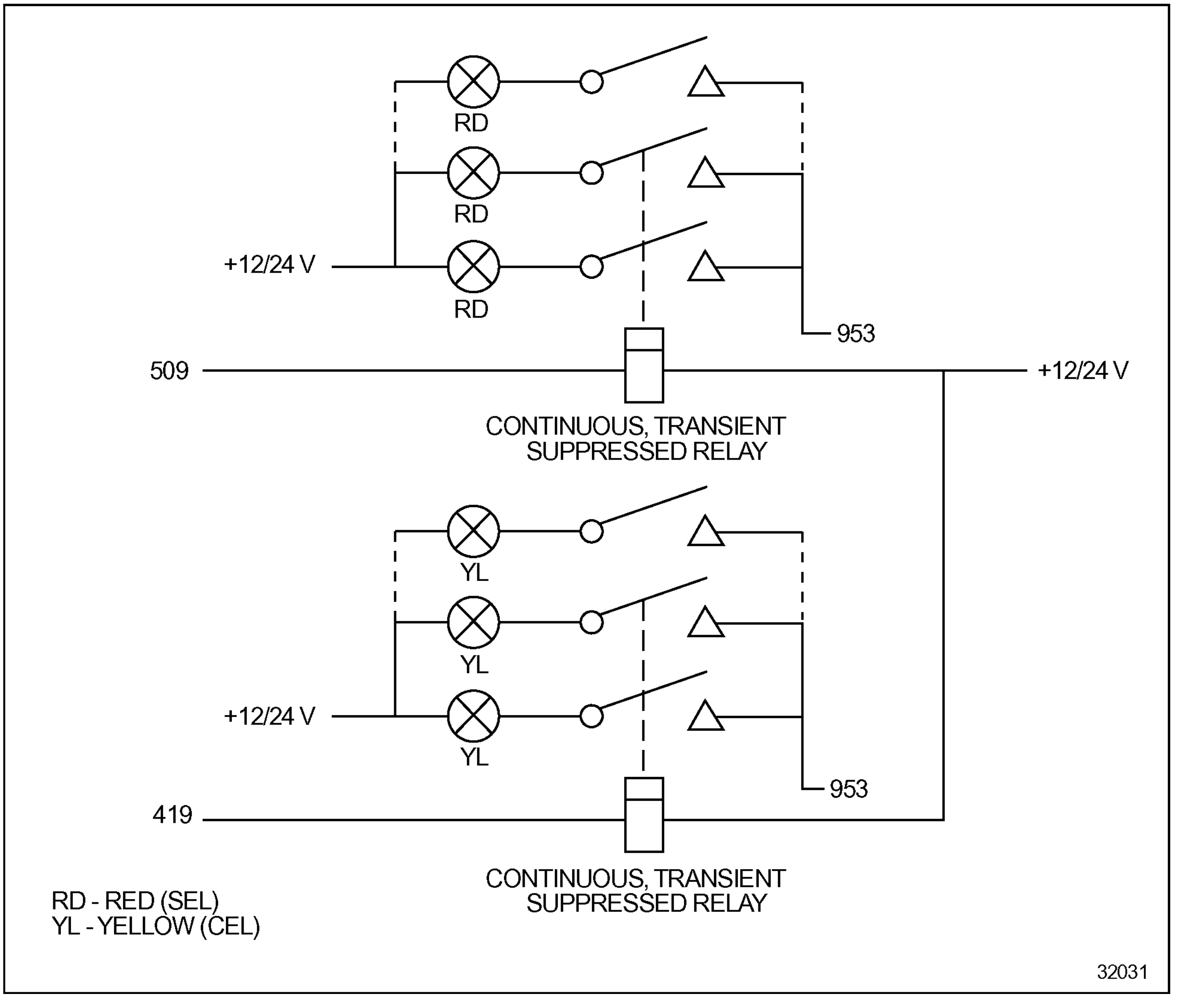


Figure 3-121 Multiple CEL/SEL Configuration - Single ECM Engine

3.17 DDEC REQUIREMENTS FOR GASEOUS HAZARDOUS ENVIRONMENTS

A hazardous environment DDEC package has been developed that meets North American, European, and Asian hazardous environment certification requirements. The DDEC system has been certified for operation in Class 1 Division 2 or Group II Zone 2 (Category 3) hazardous gaseous environments for all gas groups. The means used to obtain compliance vary somewhat between engine series due to engine hardware differences. Engine series currently available for Class I Division 2 and Group II Zone 2 hazardous environments include Series 60, Series 50 and Series 2000.

The information provided is necessary to install a DDEC IV engine certified and/or listed for Class 1 Division 2 or Group II Zone 2 (Category 3) category hazardous environments. The information is intended to supplement current DDEC requirements as listed in this manual.

NOTE:
This section is to take precedence over other sections in this manual in the event of conflicting information.

CAUTION:

Explosion Hazard — Substitution of components may impair suitability for Class 1 Division 2. UL1604

CAUTION:

Explosion Hazard — Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

CAUTION:

Explosion Hazard — Substitution of components may impair suitability for Group II Zone 2 (Category 3).
EN 50021, EN 50014, and EN 50028

This section is written for those familiar with hazardous environment applications. It is the responsibility of the installer to procure the standards that are discussed in this section in order to ensure their compliance with the appropriate standard.

3.17.1 HAZARDOUS GASEOUS ENVIRONMENT OVERVIEW

The following information should be used to provide a broad overview of Hazardous Environments only, it is not intended to be a definitive reference guide.

Hazardous Environment Classification - North America

Class I: Hazardous location due to the presence of flammable substances such as gases or vapors.

Division 1: Danger can be present during normal functioning, during repair or maintenance, or where a fault may cause the simultaneous failure of electrical equipment.

Division 2: Combustible material is present but confined to a closed container or system, or an area adjacent to a Division 1 location.

Hazardous Environment Classification - Europe

Group II: Hazardous location due to the presence of flammable substances such as gases or vapors.

Zone 1 (Category 2): An area in which an explosive air/gas mixture is LIKELY to occur in normal operation.

Zone 2 (Category 3): An area in which an explosive air/gas mixture is UNLIKELY to occur; but, if it does, only for short periods of time.

Gas Classification

Gas classifications are made on the basis of the gas or vapors ease of ignition.

North America: Groups A - D

- A Is Most Stringent (readily ignitable)
- D Is Least Stringent (more difficult to ignite)

Europe: Groups C - A

- C Is Most Stringent (readily ignitable)
- A Is Least Stringent (more difficult to ignite)

The DDC-supplied hardware IP code is listed in Table 3-67, “Hazardous Environment Classification for DDC Supplied Hardware.”.

Ingress Protection

Ingress protection specifies the degree of protection:

- From contact with live or moving parts
- Against the intrusion of solid foreign bodies or liquid into a component

The codes for the level of protection are listed in Table 3-64.

Degree of Protection	Solid Bodies	Degree of Protection	Liquid
0	No Protection	0	No Protection
1	Objects > 50 mm	1	Vertically Dripping Water
2	Objects > 12mm	2	Angled Dripping Water
3	Objects > 2.5 mm	3	Sprayed Water
4	Objects > 1.0 mm	4	Splashed Water
5	Dust Protected	5	Water Jets
6	Dust Tight	6	Heavy Seas
--	--	7	Effects of Immersion
--	--	8	Indefinite Immersion

Table 3-64 Ingress Protection Codes

Example: Protection degree is specified by a code such as IP64. The first numeral (6) defines the degree of protection against contact with live or moving parts and against the intrusion of solid foreign bodies. The second numeral (4) defines the degree of protection against the intrusion of liquid. Therefore, IP64 is a dust tight device that is resistant to splashed water.

The DDC-supplied hardware IP code is listed in Table 3-67, "Hazardous Environment Classification for DDC Supplied Hardware.".

Temperature Classification

The maximum surface temperature must be lower than the minimum ignition temperature of the gas present. Temperature classifications are listed in Table 3-65.

Maximum Surface Temperature (°C)	Temperature Class
450°C	T1
300°C	T2
200°C	T3
135°C	T4
100°C	T5
85°C	T6

Table 3-65 Temperature Classification

The DDC-supplied hardware IP code is listed in Table 3-67, "Hazardous Environment Classification for DDC Supplied Hardware.".

Detroit Diesel provides two options, which have been certified by both Nemko and Underwriters Laboratories for use in Group II Zone 2 (Category 3) and Class 1 Division 2 for all types of combustible gases. Refer to Chapter 8 for certification information.

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3.18 HARDWARE AND INSTALLATION REQUIREMENTS FOR HAZARDOUS ENVIRONMENT

The following sections list the additional hardware and installation requirements for Group II Zone 2 (Category 3), or Class I Division 2 hazardous environment. The supplier of the specific hardware components, OEM or DDC, is listed in Table 3-66.

Hardware	Supplier
Power Supply (refer to section 3.18.1 for specific installation requirements)	OEM
Fuses (refer to section 3.18.2 for specific installation requirements)	OEM
Wiring (refer to section 3.18.3 for specific installation requirements)	OEM
Junction Box (Optional) (refer to section 3.18.4 for specific installation requirements)	OEM
Exhaust Temperature Sensor (Optional) (refer to section 3.18.5 for specific installation requirements)	OEM
Engine-mounted ECM (Standard Option) (refer to section 3.18.6 for specific installation requirements)	DDC

Table 3-66 Hardware Supplied by OEM and DDC

The hazardous environment ingress protection (IP), gas group and temperature classifications for DDC-supplied hardware listed in Table 3-67 apply to Class I Division 2 and Group II Zone 2 (Category 3).

Hardware	Rating		
	IP	Gas Group	Temperature
Engine-mounted ECM (with molded connectors)	IP65	All	T4
Series 50/60 Rocker Cover	IP54	All	T4
Series 2000 EUP with Pigtail	IP54	All	T4

Table 3-67 Hazardous Environment Classification for DDC-supplied Hardware

3.18.1 POWER SUPPLY

Detroit Diesel's standard power supply requirements (refer to section 3.8, "Power Supply") are valid. Table 3-13 indicates a normal operating voltage of 11 – 32 volts DC for all DDEC IV ECMs except for ECM (P/N: 23519307) . ECM (P/N: 23519307) which is limited to a normal operating voltage of 11 – 14 Volts DC and is not typically used.

Class I Division 2

UL requires that electronic systems complying with UL 1604 “Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations” also comply with UL 508, “Industrial Control equipment.” Devices that are listed or recognized by UL must be used within their electrical ratings. The DDEC system power supply must be a limited voltage circuit (refer to UL 508, Section 32.5, Seventeenth Edition). The power supply must be a limited voltage circuit (Refer to UL 508 Section 32.5, Seventeenth Edition). Compliance with the DDEC power supply and fuse requirements for hazardous environments will meet the requirements for a limited voltage circuit. The power supply must be located in a safe (non-hazardous) location. The connections between the power supply and the ECM must comply with National Electric Code (NEC) (ANSI/NFPA 70-1993) section 501-4b or appropriate safety standard.

Group II Zone 2 (Category 3)

It is the customers responsibility to provide a power supply and connection to the DDEC ECM according to the relevant requirements in EN 50021.

3.18.2 FUSES AND FUSE ASSEMBLIES

DDEC power may be fused using dual 15 amp fuses or a single 30 amp fuse per ECM (refer to section 3.7, "Power Harness" and section 3.9, "Fuses").

Class I Division 2

Class I, Division 2 hazardous locations overcurrent protection devices shall be provided in accordance with the requirements for limited voltage overcurrent protection, which are found in UL 508 Section 33. UL requires that the overcurrent protective devices comply with the National Electric Code (NEC) (ANSI/NFPA 70-1993). Some acceptable overcurrent devices include:

- ☐ Circuit breakers
- ☐ Class CC, J, T, G, HK, L, RK1, RK5 cartridge fuses

NOTE:
The overcurrent protection must be located in a safe (non-hazardous) environment.

Group II Zone 2 (Category 3)

It is the customers responsibility to comply with the relevant requirements of EN 50021.

3.18.3 DDEC WIRING

The following requirements are in ADDITION to those already listed in other sections of this manual. The OEM-installed components listed in Table 3-68have been classified as non-incendive and do not require hazardous environment wiring.

NOTE:
Devices which are not listed must be certified prior to use with the DDEC system in Class I Division 2 and Group II Zone 2 (Category 3) hazardous environment.

Item	Description	Part Number
Switches	Air Filter Restriction Sensor	23526140
	Alarmstat Single Switch No. 220	23518803
Throttle Controls	Morse Hand Throttle Clockwise Increase	310714-001 (Morse P/N)
	Morse Hand Throttle Counter Clockwise Increase	310714-004 (Morse P/N)
NTC Thermistors (Simple Apparatus)	Exhaust Temperature Sensor	23521882
	Ambient Air Temperature Sensor	23518328
Level Sensors	Optical Coolant Level Sensor	23517763
	*Optical Coolant Level Sensor 1/4 in.	23519175
	Oil Level Sensor	23522788
	Coolant Level Sensor 1/4-18 PTF	23520380
	Coolant Level Sensor 3/8-18 PTF	23520381
	Coolant Level Sensor 9/16-18 UNF	23522855
	DDEC IV Add Coolant Level Sensor Module	23524054
Pressure Sensors	Sensor Asm - Governing Pressure	23505962
	Pressure Sensor	23520795
	Air Compressor Pressure	23518254

* - 310 mA for 100 sec max

Table 3-68 Non-incendive Components

Class I Division 2

The harnesses must use UL approved wire for Class I, Division 2 hazardous locations for all gas groups.

DDEC wiring to the non-incendive components listed in Table 3-68 must comply with non-hazardous locations wiring requirements as detailed in the National Electric Code (NEC). These non-incendive components must be connected directly to the ECM with a maximum wire length of 200 ft (61 m) of cable/wire. The cable/wire provided with these non-incendive circuits does not need to be a UL Recognized Component (R/C) (AVLV2) and does not need to comply with NEC 501-4b. The sensors receive all electrical power from the ECM. Devices which are not listed in Table 3-68 must comply with hazardous locations wiring requirements as detailed in NEC (ANSI/NFPA 70-1993) section 501-4b or appropriate safety standard.

The electrical circuits for the DDEC IV ECM must be installed in accordance with Class I, Division 2 wiring methods.

NOTE:
Class 1 Division 2 hazardous environment locations where the ECM ambient temperature is not kept below 60°C may void compliance with UL standards. It is the customer/installer's responsibility to ensure compliance.

Group II Zone 2 (Category 3)

The standard used for Group II Zone 2 (Category 3) wiring is "CENELEC EN 50021; 1999 Electrical apparatus for potentially explosive atmospheres – TYPE N."

All OEM supplied wiring to the DDEC ECM must fulfill the relevant requirements of EN 50021.

The following DDEC information is pertinent to EN 50021:

- ☐ The DDEC ECM is a low power apparatus according to Clause 13.
- ☐ Devices complying with Clause 13 are not required to comply with Clause 8 or Clause 9.
- ☐ All DDEC ECM connections to engine sensors and certain OEM installed components (i.e. the Coolant Level Sensor and hand throttle) are energy limited according to Clause 21.

3.18.4 JUNCTION BOX

The OEM is responsible for complying with the appropriate standard for termination of the OEM-side wiring. A typical installation may include an EExe box with appropriate cable entries.

3.18.5 EXHAUST TEMPERATURE SENSOR

Exhaust Temperature Sensor configuration is currently available only as part of the unique 06N04C0784 group for hazardous environments. Refer to section 8.9.1, "Hazardous Environment Petroleum Unique 6N4C Group," for more information.

The Exhaust Temperature Sensor helps prevent damage by providing early warning of excessive exhaust temperature. An Exhaust Temperature Sensor placed in the exhaust gas cooler of a hazardous environment DDEC engine will provide torque reduction if the exhaust gas temperature approaches 200°C. Torque reduction may reduce exhaust temperature low enough for the operator to continue running the engine. If the temperature does not drop below 200°C, DDEC will shut down the engine. Refer to section 3.14.22, "Exhaust Temperature Sensor," for installation information.

3.18.6 SERIES 50/SERIES 60 ENGINE-MOUNTED ECM (STANDARD OPTION)

This option contains an engine-mounted ECM that has anodized aluminum ECM connector shields mounted on each end of the ECM (See Figure 3-122). The ECM with the certified hazardous environment connectors installed complies with IP65.

NOTE:
Class 1 Division 2 hazardous environment locations where the ECM ambient temperature is not kept below 60°C may void compliance with UL standards. It is the customer/installer's responsibility to ensure compliance.

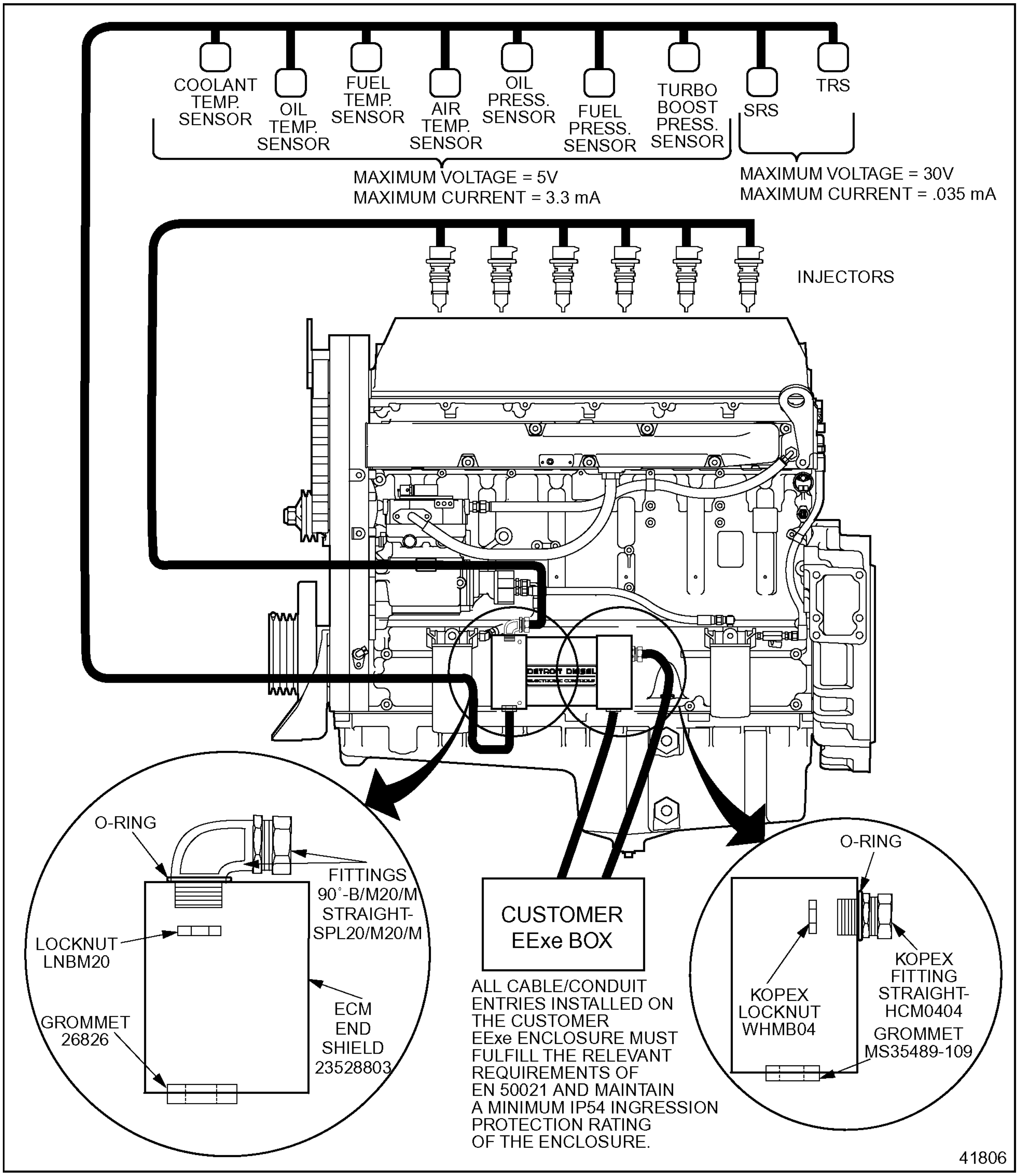

Figure 3-122 Series 50/Series 60 Engine-mounted ECM

The purpose of the ECM connector shields is to provide a method of attaching the flexible conduit required by UL for both the Injector Harness and Power Harness. The shields are also used to prevent access to the connectors without the use of a tool.

Series 50/Series 60 Engine Side of ECM

The engine side of the ECM includes the connector shield, Engine Sensor Harness, Injector Harness and associated wiring that is factory installed (see Figure 3-123).

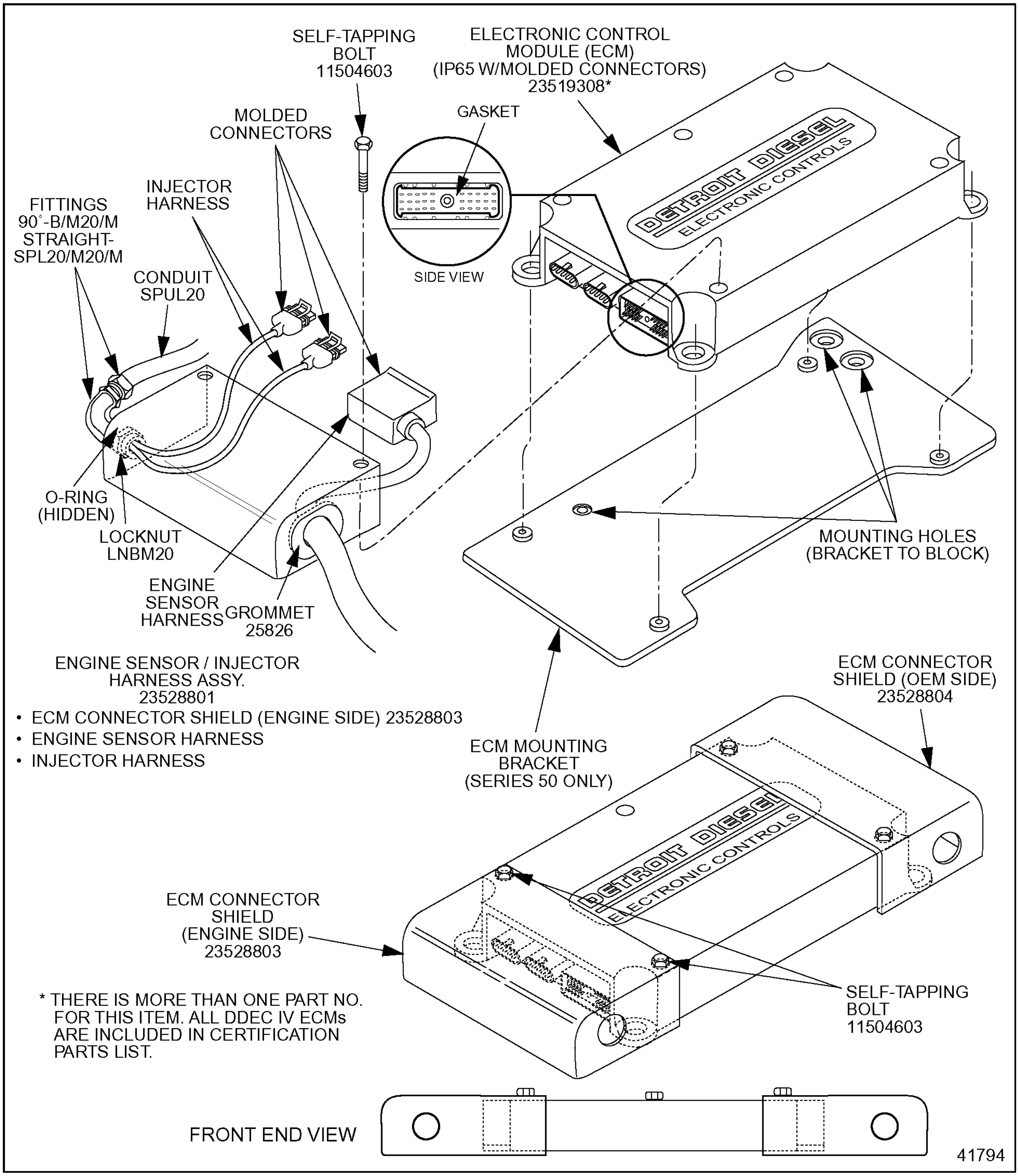

Figure 3-123 Series 50/Series 60 Engine Side Connectors, Cables, and Shield

Series 50/Series 60 OEM Side of ECM

The side containing the ECM shield and associated wiring that is not typically factory installed is referred to as the OEM side. This includes the ECM connector shield, Vehicle Interface Harness, Communication Harness (contains only the ignition wire), and Power Harness (see Figure 3-124).

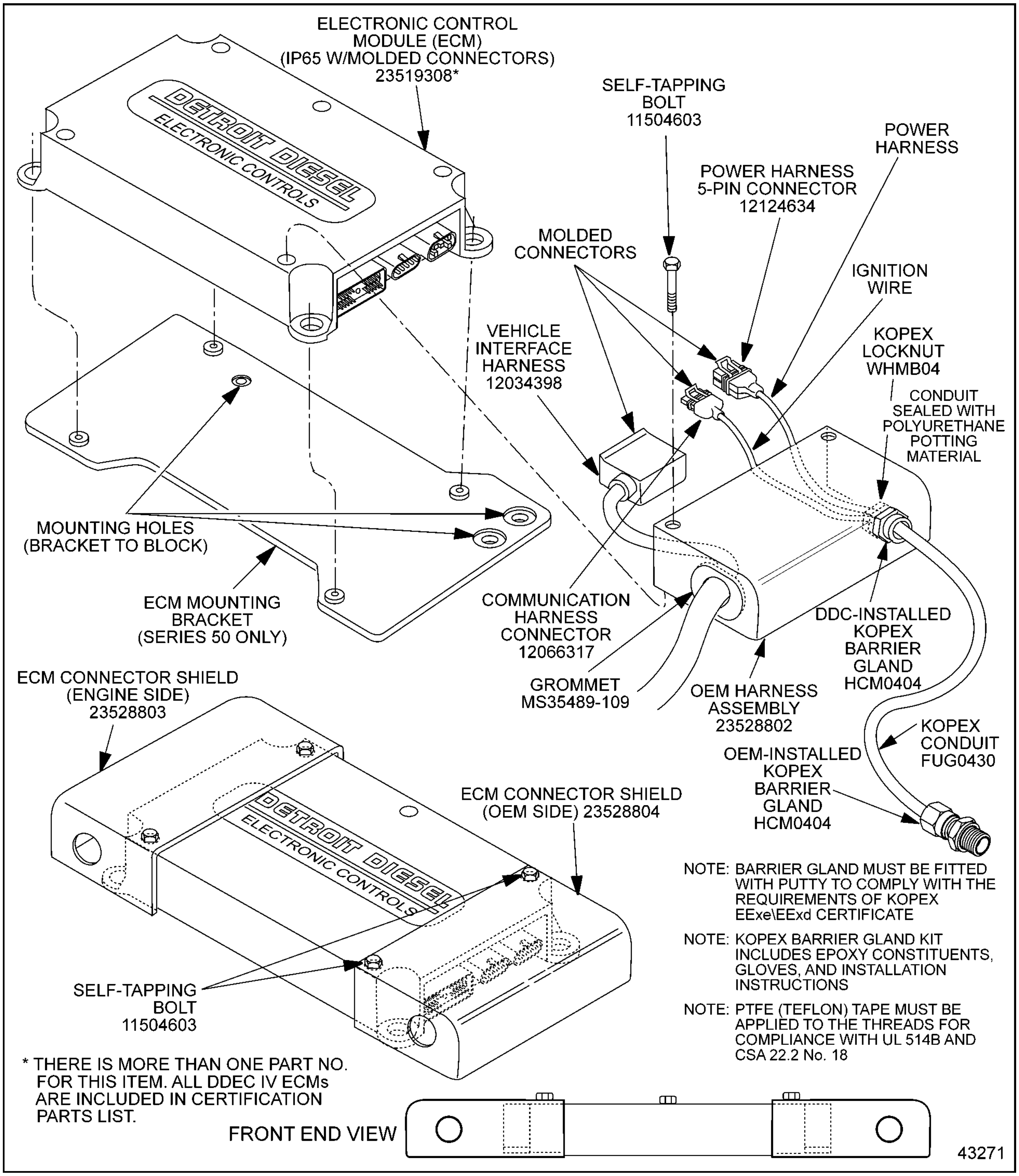

Figure 3-124 Series 50/Series 60 OEM Side Connectors, Cables, and Shield

This assembly is included in group 12E00-6EM. The OEM side harness assembly is intended to be connected to an EExe junction box.

Installation Information for Engine-mounted ECM Standard Option

The OEM side of the ECM assembly includes the ECM connector shield, Vehicle Interface Harness, Communication Harness (contains only the ignition wire), and Power Harness which are all included in the OEM Side Harness Assembly, groups 12H00-6001 and 12H06002. Group 12H00–6001 is listed in Table 3-69. Group 12H00–6002 is listed in Table 3-70. The ECM shield is made of anodized aluminum.

NOTE:
This harness assembly must be used to comply with certification and is included in the base engine model.

OEM Side Harness Assembly (20 ft) Group 12H00–6001		
Qty	**Part Number**	**Description**
2	11504603	Bolts (self-tapping)
1	23528802	Harness Assembly includes the next two parts:
1	HCM 0404 (Kopex P/N)	I/2 in. U.S. thread size (20 mm) EExe/EExd Conduit Fitting - Brass*
1	WHMB04 (Kopex P/N)	I/2 in. U.S. thread size (20 mm) lock nut*
1	N/A	Epoxy Putty Kit (Epoxy Constitutens, Gloves, Installation Instruction)

* For customer EExe junction box

Table 3-69 OEM Side Harness Assembly (20 ft)

OEM Side Harness Assembly (40 ft) Group 12H00–6002		
Qty	Part Number	Description
2	11504603	Bolts (self-tapping)
1	23529816	Harness Assembly includes the next two parts:
1	HCM 0606 (Kopex P/N)	I/2 in. U.S. thread size (20 mm) EExe/EExd Conduit Fitting - Brass*
1	WHMB06 (Kopex P/N)	I/2 in. U.S. thread size (20 mm) lock nut*

Table 3-70 OEM Side Harness Assembly (40 ft)

Vehicle Interface Harness Specifications:

- ☐ This harness contains conductors for all 30 cavities
- ☐ Material: The VIH has a neoprene jacket with a nominal temperature range of -55°C to +110°C
- ☐ Dimensions: 0.71 in. (18 mm) OD (nominal) 20 ft (6 m) long (optional 40 ft)
- ☐ Max current rating – This is a function of the installation

NOTE:
The ignition wire is NOT to be used on the 30-pin ECM connector for Class I Division 2 applications. The ignition wire is provided via the Communications Harness (pin C)

through a UL listed conduit. Using the ignition wire on the 30–pin ECM connector is a violation of the hazardous environment requirements.

Power/Communication Harness Specifications:

- ☐ Harness Length: 20 ft (optional 40 ft)
- ☐ UL 3173 Wire
- ☐ Wires 240/241 - 12 gauge
- ☐ Wires 150 - 12 gauge
- ☐ Wire 439 - 18 gauge
- ☐ Conduit fitting straight: Kopex HCM0404 20 mm brass EExe/EExd
- ☐ Locknut: WHMB04, Brass locknut 20 mm - Torque Specification: British Standards BS6121 specify turning compression nut and locknut to hand-tight plus 1/2 to 3/4 turns for clamping.

Conduit Specifications:

- ☐ P/N: FUG0430 (Kopex P/N) — 20 ft
- ☐ UL/CSA Approval
- ☐ Ingress Protection IP66 & IP67 when used with KF-F or KF-C connectors
- ☐ Temperature Rating: - 25°C to + 105°C
- ☐ Construction: Helically wound galvanized steel core with copper packing and a PVC covering
- ☐ Connector Pull off classification: Heavy
- ☐ Conduit Crush classification: Heavy
- ☐ Flame propagation: Flame dies in less than 60 seconds after ignition source is removed (3 applications)

OEM Harness Assembly Instructions

Use the following general assembly instructions when installing the OEM harness assembly:

1. Carefully push at least an additional 6 in. (152 mm) to 1 ft (0.30 m) of black neoprene cable into the shield. Do not dislodge the rubber grommet.
2. Insert the 30-pin VIH connector into the mating connector on the ECM.

NOTE:
You will need to tilt the ECM shield to access the connector (this is the reason for the additional cable in step 1).

3. Using a 9/32 in. socket, tighten the 30-pin VIH-to-ECM connector assembly (P/N: 12034398) center screw to 7-13 in.·lbs (0.79 - 1.47 Nm).
4. Pull the additional black cable out of the shield.
5. Plug in both 5-pin and 6-pin connectors.
6. Seat the shield on the ECM, aligning the bolt holes.
7. Install the two self-tapping bolts (P/N: 11504603) and tighten.
8. Check to ensure the grommet has not been dislodged.

3.18.7 REMOTE-MOUNTED ECM OPTION

For remote-mounted ECM information, contact Detroit Diesel Application Engineering. An application that might need a remote mount ECM is a Series 50 Engine with a left side dipstick.

3.18.8 SERIES 2000 ENGINE-MOUNTED ECM (STANDARD OPTION)

This option contains engine-mounted ECM installed under a protective steel cover (see Figure 3-125). The ECMs with the certified hazardous environment connectors installed comply with IP65.

NOTE:
Class 1 Division 2 hazardous environment locations where the ECM ambient temperature is not kept below 60°C may void compliance with UL standards. It is the customer/installer's responsibility to ensure compliance.

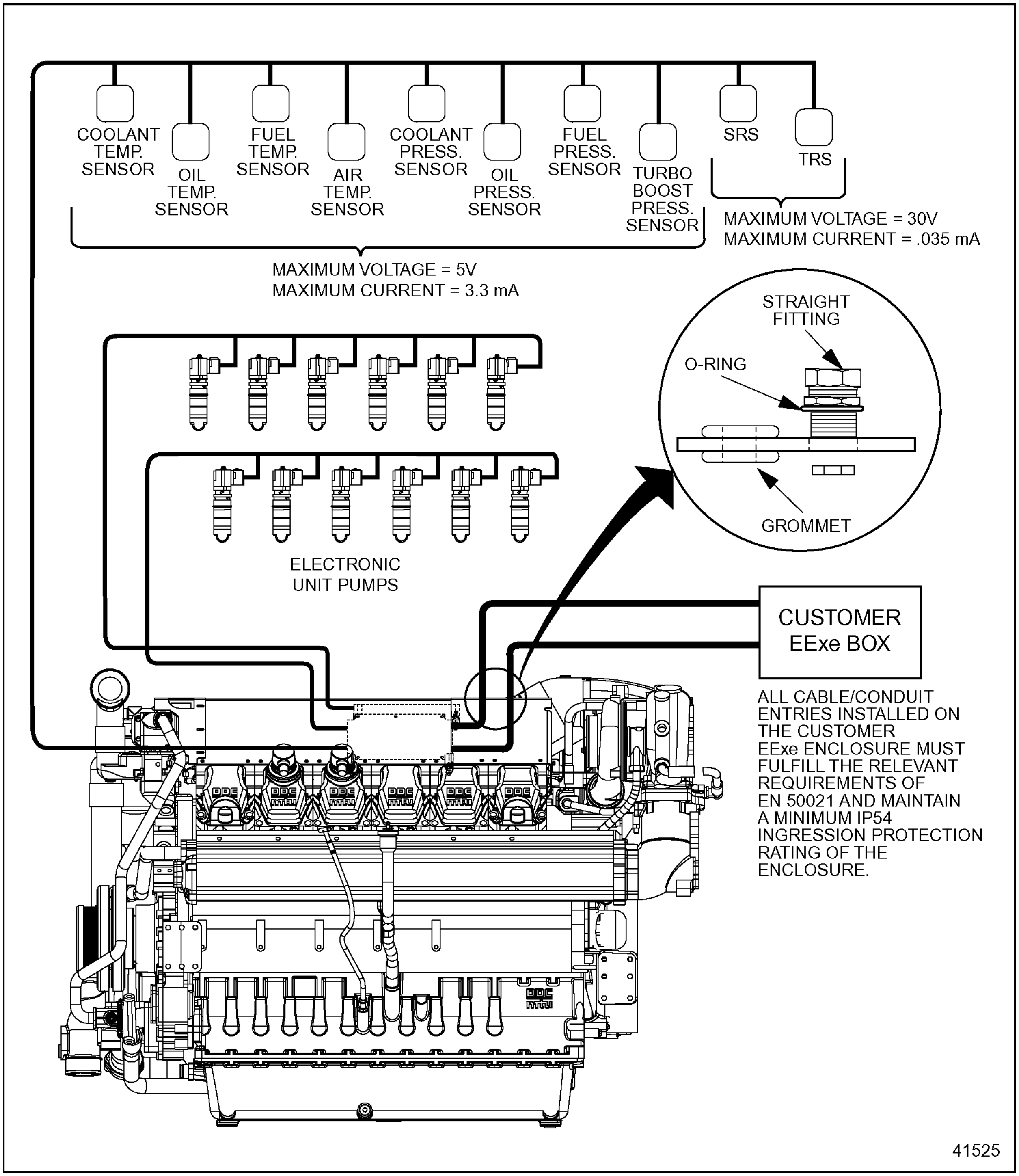

Figure 3-125 Series 2000 Engine-mounted ECMs

Series 2000 Engine Side of ECM

The engine side of the ECM includes the Engine Sensor Harness, Injector Harness and associated wiring under the protective steel cover (see Figure 3-123).

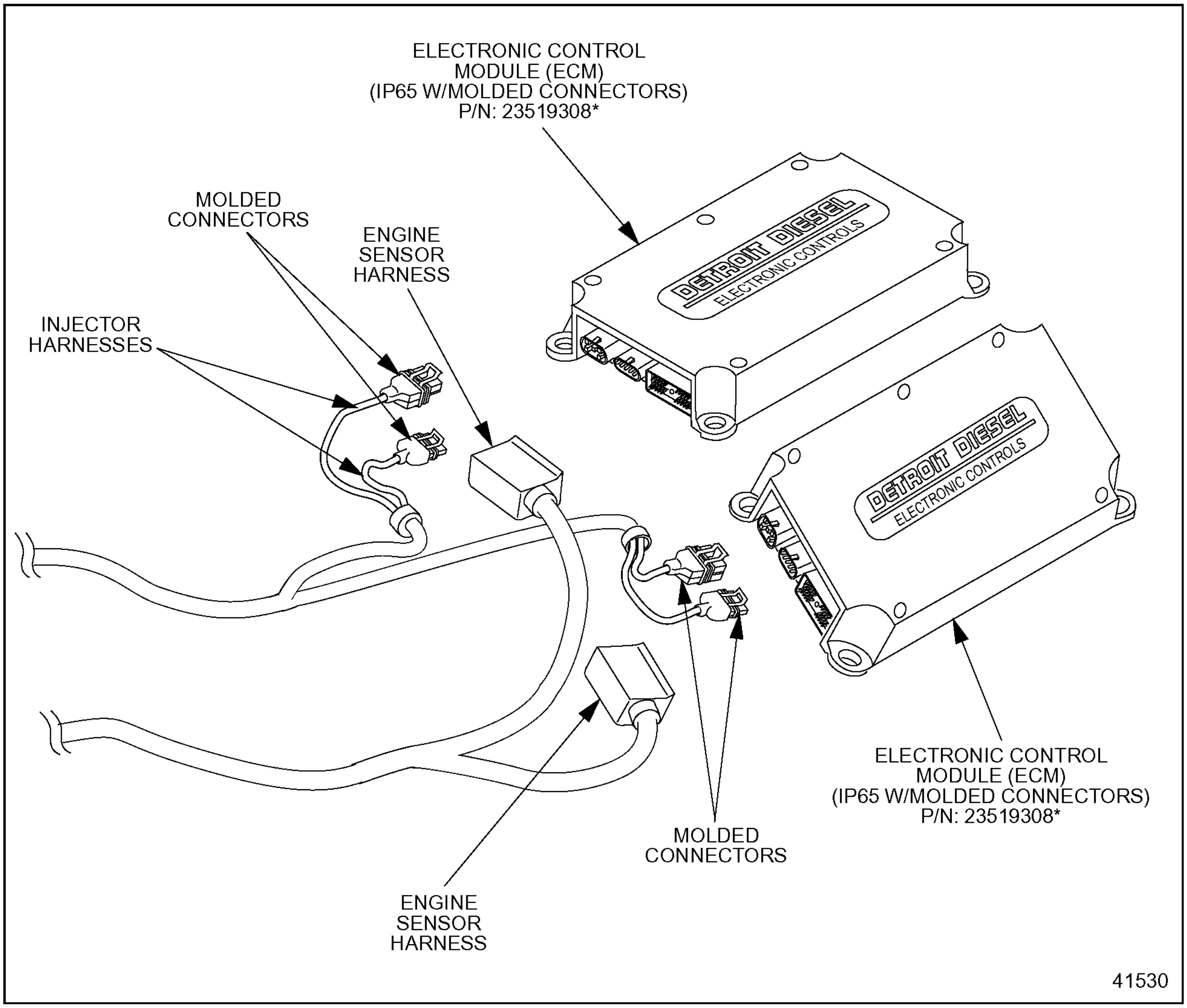

Figure 3-126 Series 2000 Engine Side Connectors and Cables

Series 2000 Equipment or OEM Side of ECM

The side containing the ECM and associated wiring that is not typically factory installed is referred to as the Equipment or OEM side. This includes the access cover, Vehicle Interface Harness, Communication Harness (contains only the ignition wire), and Power Harness (see Figure 3-127).

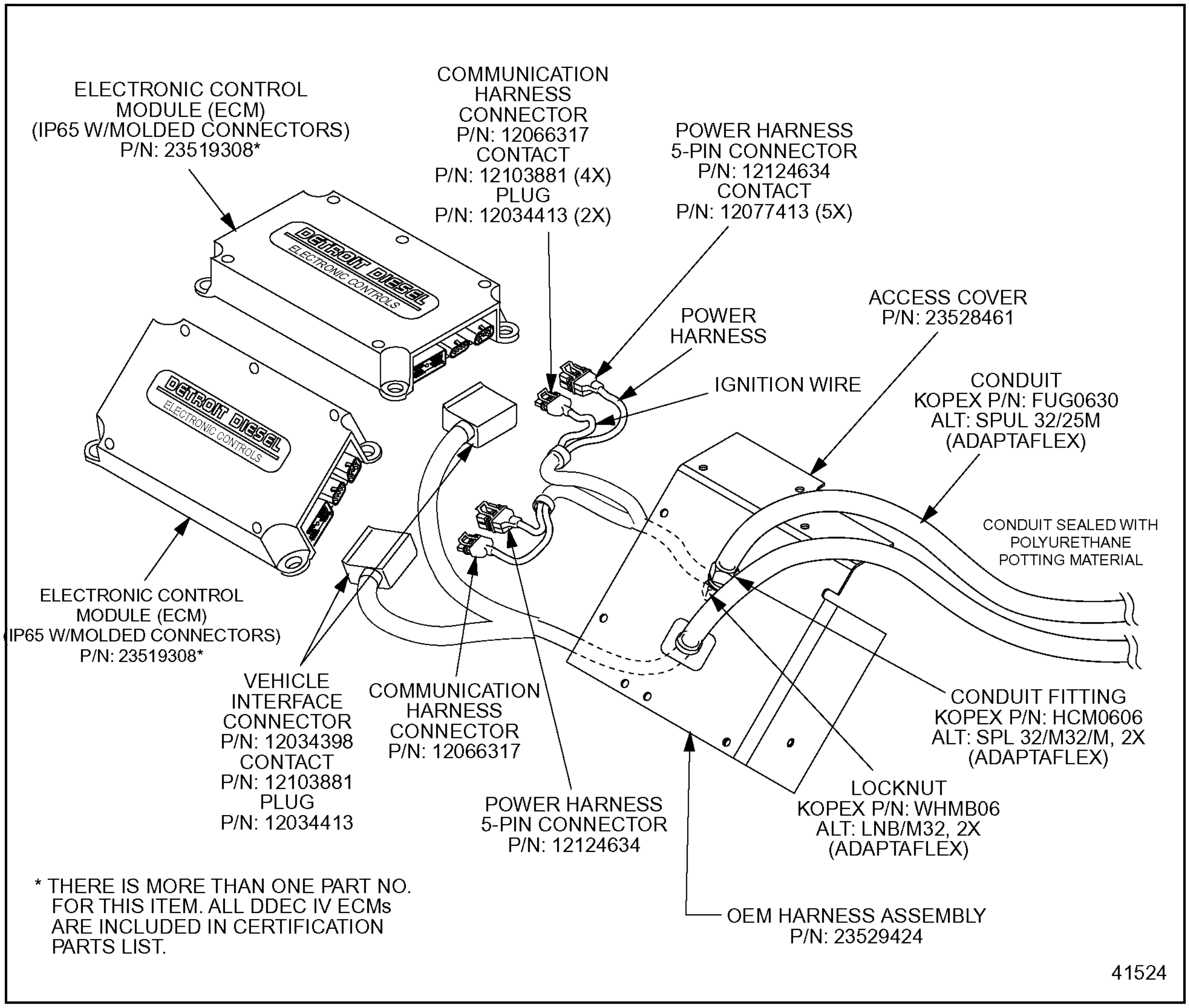

Figure 3-127 Series 2000 Equipment Side Connectors and Cables

This assembly is included in group 12H00-0554. The OEM side harness assembly is intended to be connected to an EExe junction box.

Installation Information for Engine-mounted ECM Standard Option

The Equipment or OEM side of the ECM assembly that includes the ECM access cover, Vehicle Interface Harness, Communication Harness (contains only the ignition wire), and Power Harness are included in group 12H00-0554 as listed in Table 3-71.

NOTE:
This harness assembly must be used to comply with certification and is included in the base engine model.

OEM Side Harness Assembly (20 ft) Group 12H00–0054		
Qty	**Part Number**	**Description**
9	11509511	Bolts
1	23529424	Harness Assembly which includes the following two parts:
1	HCM 0606 (Kopex P/N)	1 in. (32 mm) thread size EExe/EExd Conduit Fitting - Brass*
1	WHMB06 (Kopex P/N)	1 in. (32 mm) thread size lock nut*

* For customer EExe junction box

Table 3-71 OEM Side Harness Assembly

Vehicle Interface Harness Specifications:

- ☐ Material: The VIH has a neoprene jacket with a nominal temperature range of -55°C to +110°C
- ☐ Dimensions: 0.71 in. (18 mm) OD (nominal) 20 ft (6 m) long
- ☐ Max current rating – This is a function of the installation

NOTE:
The ignition wire is NOT to be used on the 30-pin ECM connector for Class I Division 2 applications. The ignition wire is provided via the Communications Harness (pin C) through a UL listed conduit. Using the ignition wire on the 30–pin ECM connector is a violation of the hazardous environment requirements.

Power/Communication Harness Specifications:

- ☐ Harness Length: 20 ft
- ☐ UL 3173 Wire
- ☐ Wires 240/241 - 12 gauge
- ☐ Wires 150 - 12 gauge
- ☐ Wire 439 - 18 gauge
- ☐ Conduit fitting straight: Kopex HCM0606 32 mm brass EExe/EExd
- ☐ Locknut: WHMB06, Brass locknut 1 in. (32 mm) - Torque Specification: British Standards BS6121 specify turning compression nut and locknut to hand-tight plus 1/2 to 3/4 turns for clamping.

Conduit Specifications:

- ☐ PN: FUG0430
- ☐ UL/CSA Approval
- ☐ Ingress Protection IP66 & IP67 when used with KF-F or KF-C connectors
- ☐ Temperature Rating: - 25°C to + 105°C
- ☐ Construction: Helically wound galvanized steel core with copper packing and a PVC covering
- ☐ Connector Pull off classification: Heavy
- ☐ Conduit Crush classification: Heavy
- ☐ Flame propagation: Flame dies in less than 60 seconds after ignition source is removed (3 applications)

OEM Harness Assembly Instructions

Use the following general assembly instructions when installing the OEM harness assembly:

1. Carefully push at least an additional 6 in. (152 mm) to 1 ft (0.30 m) of black neoprene cable into the access cover. Do not dislodge the rubber grommet.
2. Insert the 30-pin VIH connectors into the mating connectors on the ECMs.

NOTE:

You will need to tilt the ECM access cover to access the connector (this is the reason for the additional cable in step 1).

3. Using a 9/32 in. socket, tighten the 30-pin VIH-to-ECM connector assemblies (P/N: 12034398) center screws to 7-13 in.·lbs (0.79 - 1.47 Nm).
4. Pull the additional black cable out of the access cover.
5. Plug in both 5-pin and 6-pin connectors.
6. Seat the access cover on the engine cover, aligning the bolt holes.
7. Install the mounting bolts and tighten.
8. Check to ensure the grommet has not been dislodged.

4 DIGITAL INPUTS AND OUTPUTS

Section **Page**

4.1 DIGITAL INPUTS 4-3
4.2 DIGITAL OUTPUTS 4-20

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4.1 DIGITAL INPUTS

DDEC IV has twelve digital input ports located on the Vehicle Interface Harness. The Application Code System (ACS) sets the default function number for each of the twelve ports. These digital inputs can be configured for various functions. These functions can be ordered at the time of engine order, configured by VEPS or the DDEC Reprogramming System (DRS). Some digital input features are further customized by programming the ECM with a DDR, DDDL, VEPS, or DRS. DDEC does not detect broken or shorted wires on digital inputs.

The digital input functions are listed in Table 4-1.

Feature	Digital Input	Function Number
Cruise Control (Uses up to five inputs) Refer to section 4.1.1, page 4-6.	Cruise Enable	23
	Clutch Released	18
	Service Brake Released	17
	Set/Coast On (decrease)	20
	Resume/Acceleration On (Increase)	22
Engine Brake Refer to section 4.1.2, page 4-8.	Engine Brake Disable	26
	Engine Brake Low	1
	Engine Brake Medium	2
	Konstantdrossel Switch	40
Engine Protection Refer to section 4.1.3, page 4-10.	Auxiliary Shutdown #1	3
	Auxiliary Shutdown #2	4
	Diagnostic Request Switch	15
	SEO/Diagnostic Request Switch	25
Engine Ratings Refer to section 4.1.4, page 4-12.	Limiting Torque Curve	14
	Rating Switch #1	12
	Rating Switch #2	13
Fan Control Refer to section 4.1.5, page 4-13.	Transmission Retarder Status (Release 2.00 or later only)	27
	Air Conditioner Status	29
	Fan Control Override	32
Pressure Sensor Governor (PSG) (Uses four inputs) Refer to section 4.1.6, page 4-14.	Pressure Sensor Governor Enable	24
	Pressure/RPM Mode Switch	8
	Set/Coast On (Decrease)	20
	Resume/Acceleration On	22
Throttle Control Refer to section 4.1.7, page 4-15.	Alternate Minimum VSG/Fast Idle (Release 2.00 or later only)	16
	Dual Throttle (LSG)	28
	Idle Validation Switch	6
	Throttle Inhibit	9
	VSG Station Change	33
	VSG Station Change Complement	34
	External Engine Synchronization/ Frequency Input Active	10
	VSG Inhibit (Release 28.0 or later)	42
Engine Synchro Shift Transmission Refer to section 4.1.8, page 4-17.	In Neutral	38
	In Gear	39
Additional Functions Refer to section 4.1.9, page 4-18.	Auxiliary Coolant Level Switch	31
	Parking Brake Interlock	5
	Air Compressor Load Switch	35
	Throttle Kickdown	7
	RPM Freeze	11

Table 4-1 Digital Inputs Listed by Feature

Digital input functions are activated when the digital input wire is switched to battery ground (circuit 953), see Figure 4-1. The digital input can be controlled by either a switch or an OEM interlock depending on the function.

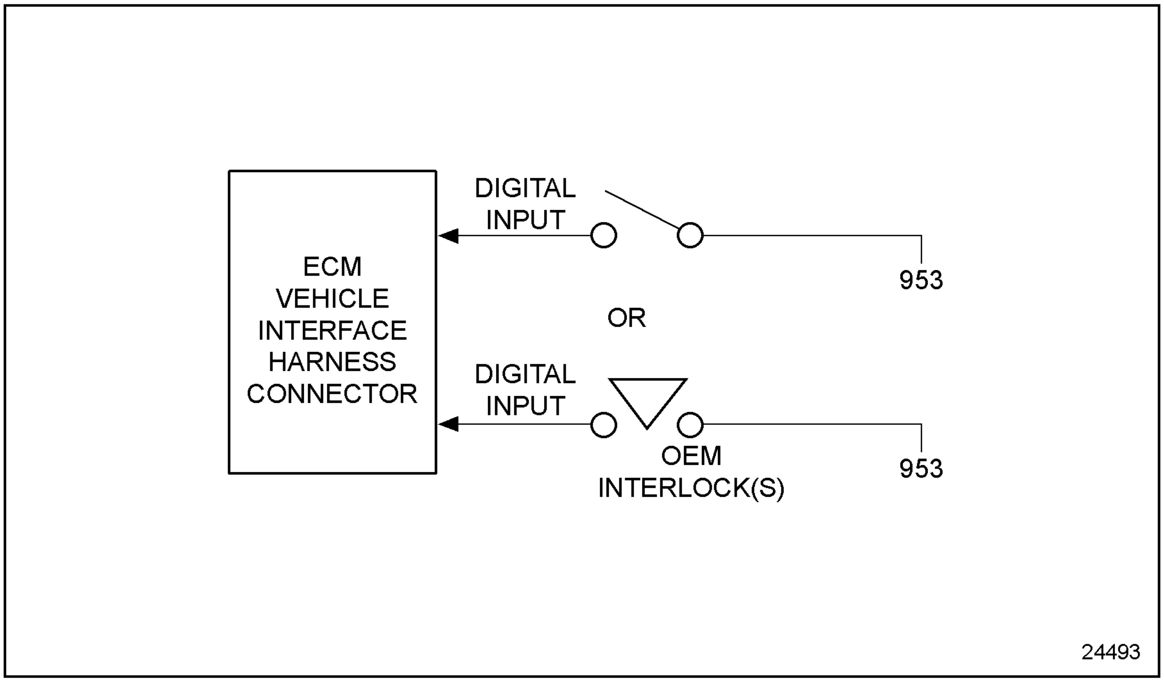

Figure 4-1 Two Methods to Activate a Digital Input

NOTE:
Digital input circuits are designed to source no more than 5 mA (DC).

For more information on the digital input configuration refer to section 3.10.4, "ECM Vehicle Harness Connectors - Single ECM," and section 3.10.5, "ECM Vehicle Harness Connectors - Multi-ECM." This section covers the location of the digital inputs on the Vehicle Interface Harness. Refer to chapter 8 for typical application dependent configurations.

The following sections contain a description of the available options.

4.1.1 CRUISE CONTROL

Up to five digital inputs are required (four for automatic transmission) for Cruise Control operation. Refer to section 5.3, "Cruise Control," for additional information. The Cruise Control inputs are described in the following sections.

Cruise Enable

Cruise Control is enabled, but not active when the Cruise Control Enable digital input is switched to battery ground.

Set / Coast On (Decrease)

Set: Cruise Speed is set by momentarily contacting the switch to the ON position (switching the digital input to battery ground). Cruise Control will become active and maintain the engine or vehicle speed present at the time.

Coast: When Cruise Control is active, the Set/Coast input can be used to reduce power and speed by toggling the switch. Momentarily toggling and releasing the Set/Coast switch will decrease the set point by 1 MPH increments for Vehicle Speed Cruise Control and 25 RPM increments for Engine Speed Cruise Control. Holding the Set/Coast will decrease the set point by 1 MPH per second (Vehicle Speed CC) or 25 RPM per seconds (Engine Speed CC). When released the Cruise Control set point will be at the new speed.

Resume / Accel On (Increase)

Resume: If Cruise Control has been disabled with the service brake or the clutch switch, momentary contact to the ON position (switching the input to battery ground) restores the previously set cruise speed.

Accel: When Cruise Control is active, the Resume/Accel input can be used to increase power and speed by toggling the switch. Momentarily toggling and releasing the Resume/Accel switch will increase the set point by 1 MPH increments for Vehicle Speed Cruise Control and 25 RPM increments for Engine Speed Cruise Control. Holding the Resume/Accel will increase the set point by 1 MPH per second (Vehicle Speed CC) or 25 RPM per seconds (Engine Speed CC). When released the Cruise Control set point will be at the new speed.

Clutch Released (Manual Transmissions)

This input indicates that the clutch is released and is used for suspending Cruise Control and Auto Resume.

When the clutch is released, the input is at battery ground. Cruise Control is suspended if the clutch is depressed once. If the clutch is depressed twice within three seconds, Cruise Control is automatically resumed.

NOTE:
When engine brake is configured and auto resume is enabled, the first time the clutch is depressed to suspend Cruise Control, the engine brakes will be delayed for three seconds.

The digital input logic for the Clutch Switch disables Cruise Control in the unlikely event of a broken clutch switch wire.

Service Brake Released (Automatic and Manual Transmissions)

This input indicates that the brake is released when switched to battery ground. If the brake is activated, then the input is not grounded and Cruise Control is suspended. Cruise Control is resumed by using the Resume/Accel Switch.

Programming Requirements and Flexibility

The digital inputs listed in Table 4-2can be configured at the time of engine order, configured by VEPS or DRS. Auto resume (Clutch Released) can be disabled/enabled with a DDR, DDDL, or VEPS.

Description	Function Number
Cruise Enable	23
Service Brake Released	17
Clutch Released	18
Set/Coast On	20
Resume/Accel On	22

Table 4-2 Cruise Control Digital Inputs

Interaction with Other Features

The Set/Coast On and Resume/Accel On inputs are also used by the Pressure Sensor Governor and the Air Compressor Governor. The Set/Coast On and Resume/Accel On switches follow similar logic as the Pressure Sensor Governor switches (Increase and Decrease). Refer to section 4.1.6for more information on the Pressure Sensor Governor digital inputs and section for more information on the Pressure Sensor Governor.

4.1.2 ENGINE BRAKE

The digital inputs associated with the engine brake option are described in the following sections. Refer to section 5.9, "Engine Brake Controls" for additional information.

Engine Brake Disable

Engine Brake Disable is a digital input which is switched to battery ground whenever a vehicle system such as a traction control device does not want engine braking to occur.

The ECM, which controls the engine brake directly, will not allow engine braking when the input is switched to battery ground. Allison Transmission requires that this input be used in all applications using engine brakes. This is to prevent engine brake operation when the transmission is in converter mode.

Engine Brake Low

The Engine Brake Low digital input selects Low Engine Brake when the input is switched to battery ground.

The No Engine Brake option occurs when the Engine Brake Low and Engine Brake Medium digital inputs are not switched to battery ground. This can be overridden by SAE J1939 communications, even if both switches are off (Release 2.00 or later only).

To select High Engine Brake both the Engine Brake Low and the Engine Brake Medium digital inputs are switched to battery ground.

Engine Brake Medium

The Engine Brake Medium digital input selects Medium Engine Brake for Series 60 engines.

The No Engine Brake option occurs when the Engine Brake Low and Engine Brake Medium digital inputs are not switched to battery ground. This can be overridden by SAE J1939 communications, even if both switches are off (Release 2.00 or later only).

To select High Engine Brake both the Engine Brake Low and the Engine Brake Medium digital inputs are switched to battery ground.

Konstantdrossel Switch

The Konstantdrossel (KD) digital input selects low engine brake when the input is switched to battery ground.

The No Engine Brake option occurs when this digital input is not switched to battery ground. This can be overridden by SAE J1939 communications, even if the switch is off.

Programming Requirements and Flexibility

These digital inputs may be ordered at the time of engine order, configured by VEPS or DRS. The digital inputs associated with Engine Brake and their function numbers are listed in Table 4-3.

Description	Function Number
Engine Brake Disable	26
Engine Brake Low	1
Engine Brake Medium	2
Konstantdrossel	40

Table 4-3 Engine Brake Digital Inputs

4.1.3 ENGINE PROTECTION

The digital inputs related to engine protection are described in the following sections.

Auxiliary Shutdown #1 and #2

The auxiliary shutdown digital inputs (auxiliary shutdown #1 and #2) are used by other vehicle systems when it is desirable to use the ECM's engine protection function. For example, the engine protection function may be used to protect a transmission or pump against failure. When a vehicle system needs the engine to shutdown, a digital input port configured as auxiliary shutdown is switched to battery ground.

The ECM can take three types of actions when an auxiliary shutdown digital input port is switched to battery ground: warning, rampdown or shutdown. Refer to section 5.10, "Engine Protection," for more information on engine protection.

Diagnostic Request Switch

The Diagnostic Request Switch is used to activate the CEL and SEL to flash codes. The SEL will flash the active codes and the CEL will flash the inactive codes. The inactive codes are flashed in numerical order and the active codes are flashed in the order they occur, most recent to least recent. The Diagnostic Request Switch can also be used as the Stop Engine Override (SEO) Switch.

The Diagnostic Request Switch is used to flash codes in the following circumstances:

- ☐ The engine is not running and ignition is ON
- ☐ The engine is idling

In both circumstances pressing and holding the Diagnostic Request Switch will flash out the engine codes. The codes are flashed out of the ECM connected to the switch. For multi-ECM installations, the Diagnostic Request Switch and SEO are combined on the master ECM. All receiver ECMs have a separate Diagnostic Request Switch.

Diagnostic Request Switch/Stop Engine Override Switch

A single digital input can be used as a Diagnostic Request Switch and a SEO Switch. The Diagnostic Request Switch is used to activate the CEL and SEL to flash codes. The SEL will flash the active codes and the CEL will flash the inactive codes. The inactive codes are flashed in numerical order and the active codes are flashed in the order they occur, most recent to least recent. The Diagnostic Request Switch is also used as the SEO Switch.

The Diagnostic Request Switch is used to flash codes in the following circumstances:

- ☐ The engine is not running and ignition is ON
- ☐ The engine is idling and not in an "engine protection" condition

In both circumstances activating and releasing the Diagnostic Request Switch will flash out the engine codes; activating the Diagnostic Request Switch a second time will stop the ECM from flashing the engine codes. Otherwise, the switch will act as a SEO Switch. The SEO Switch overrides an Engine Protection Shutdown sequence if Shutdown is enabled. Refer to section 5.10, "Engine Protection," for more information on the SEO Switch. The codes are flashed out of the ECM connected to the switch. For multi-ECM installations, the Diagnostic Request and SEO Switch are combined on the master ECM. All receiver ECMs have a separate Diagnostic Request Switch.

Programming Requirements and Flexibility

The type of engine protection, warning, rampdown or shutdown can be selected with the DDR, DDDL, VEPS, or DRS. The digital inputs listed in Table 4-4 can be configured at the time of engine order, by VEPS or DRS.

Description	Function Number
Diagnostic Request Switch	15
Stop Engine Override/Diagnostic Request Switch	25
Auxiliary Shutdown Protection #1	3
Auxiliary Shutdown Protection #2	4

Table 4-4 Engine Protection Digital Inputs

Diagnostics

When either Auxiliary Shutdown #1 or #2 is activated, the codes listed in will be logged.

Fault Description	SID	FMI	Flash Code
Auxiliary Shutdown #1	25	11	26
Auxiliary Shutdown #2	61	11	26

Table 4-5 Auxiliary Shutdown Flash Codes

4.1.4 ENGINE RATINGS

The digital inputs related to engine ratings are described in the following sections.

Limiting Torque Curve

A digital input activates the limiting torque curve. The limiting torque curve limits the torque with respect to speed whenever this digital input is switched to battery ground. This torque curve is part of the engine rating. Refer to section 5.11, "Engine Ratings," for additional information.

Rating Switch #1 and #2

Engine rating switch(es) are digital inputs used to switch between multiple engine ratings stored in the ECM. The first rating is the default rating and does not need to be selected with the digital input switches. Rating Switch #1 selects the second engine rating when the input is switched to battery ground. Rating Switch #2 selects the third engine rating when the input is switched to battery ground. The inputs and their function number are listed in Table 4-6.

Description	Function Number
Rating Switch #1	12
Rating Switch #2	13
Limiting Torque Curve	14

Table 4-6 Rating Switches

To select fourth engine rating, typically the cruise-power rating, both Rating Switch #1 and Rating Switch #2 digital inputs are switched to battery ground. The higher rating will activate only if Cruise control is enabled.

Refer to section 5.11, "Engine Ratings," for more information.

Programming Requirements and Flexibility

Limiting torque curve tables are generated by Application Engineering and can either be selected at the time of engine order or selected after engine order by DDC Technical Service.

The rating switches function must be enabled with the DDR, DDDL or VEPS. The ECM can hold up to four different engine ratings that can be selected with a DDR or with the use of digital inputs, depending upon application. Engine ratings are determined at the time of engine order. The DDR will display the engine rating choices that can be selected.

The digital inputs Rating Switch #1, #2, and Limiting Torque Curve may be configured at the time of engine order, by VEPS, or DRS.

Diagnostics

The horsepower rating can be monitored on the DDR via the Engine Configuration menu. After a switch change, the DDR must be disconnected and then reconnected to see the hp change.

4.1.5 FAN CONTROL

The digital inputs related to fan control are described in the following sections. Refer to section 5.14 for further information on fan control.

Air Conditioner Status Operation

This digital input indicates that the air conditioner is inactive. When a digital input is configured for air conditioner status and the input is open then the fan is turned ON (A/C switch is open). If A/C input is configured and not used that input must remain grounded for proper fan operation. The digital input logic enables the fan in the event of a broken A/C status wire. The default on-time for the fan is 180 seconds. Vehicle speed over 20 MPH disables the air conditioner control of the fan.

Fan Control Override Operation

This digital input is used to activate the fan when the input is switched to battery ground.

Transmission Retarder Active Operation

This digital input indicates that the transmission retarder is active. When the digital input is grounded, the fan is turned off. When the digital input is open, the fan will be turned on. The fan will be ON for a minimum of 30 seconds. Refer to the transmission manufacturers documentation to determine where to connect the input.

Programming Requirements and Flexibility

The digital inputs listed in Table 4-7 can be configured at the time of engine order, by VEPS, or DRS.

Description	Function Number
Air Conditioner Status	29
Fan Control Override	32
Transmission Retarder Status (Release 2.00 or later only)	27

Table 4-7 Fan Control Digital Inputs

The fan on-time can be set with VEPS or DRS as listed in Table 4-8.

Parameter	Description	Choice
AC Fan Timer	The minimum duration of time the fan will remain ON after the AC status digital input has indicated that the A/C unit has turned OFF. The timer starts when the input is grounded after being open.	0-255 seconds

Table 4-8 Fan On-time Parameter

4.1.6 PRESSURE SENSOR GOVERNOR

The digital inputs related to PSG are described in the following sections. Refer to section 5.29, "Pressure Sensor Governor," for additional information.

Pressure Enable Switch

The PSG enable switch is a digital input switch used to enable the PSG when the digital input is switched to battery ground. If the PSG enable switch is moved to the OFF position (not at battery ground), the PSG will be interrupted.

Pressure/RPM Mode Switch

This digital input switch is used in the PSG to switch between RPM and pressure mode. When the digital input is switched to battery ground, pressure mode is selected.

Decrease (Set/Coast On)

The pressure or engine speed is set by momentarily contacting the switch to the decrease position (grounding the digital input). The pressure/RPM setting will decrease by 4 psi (approximately 27.6 kPa) or 25 RPM increments when the decrease switch is momentarily contacted.

Holding the switch in the decrease position (grounding the digital input) will decrease the pressure or engine speed. The pressure or engine speed will decrease by 4 psi (approximately 27.6 kPa) or 25 RPM increments at a rate of two increments per second. Releasing the switch sets the pressure/RPM to the lower setting.

Increase (Resume/Acceleration On)

Momentarily contacting the increase switch at the initiation of PSG operation will set the pressure/RPM setting. The pressure/RPM setting will increase by 4 psi (approximately 27.6 kPa) or 25 RPM increments by momentarily contacting the Increase switch.

Holding the switch in the Increase position (grounding the digital input), will increase the pressure or engine speed. The pressure or engine speed will increase by 4 psi (approximately 27.6 kPa) or 25 RPM increments at a rate of two increments per second. Releasing the switch sets the PSG to the higher setting.

Programming Requirements and Flexibility

The digital inputs listed in Table 4-9can be configured at the time of engine order, by VEPS or DRS.

Description	Function Number
Pressure Sensor Governor Enable	24
Pressure/RPM Mode Switch	8
Set/Coast On (Decrease)	20
Resume/Acceleration On (Increase)	22

Table 4-9 Pressure Sensor Governor Digital Inputs

Interaction with Other Features

The Increase and Decrease input functions (Set/Coast On and Resume/Accel On) are also used for Cruise Control operation and the Air Compressor Governor. The Increase and Decrease switches follow similar logic as the Cruise Control switches (Set/Coast On and Resume/Accel On). Cruise Control cannot be used with the Pressure Sensor Governor.

4.1.7 THROTTLE CONTROL

This section discusses throttle control digital inputs.

Alternate Minimum VSG Speed/Fast Idle Operation

The Alternate Minimum VSG option (ALT MIN VSG) allows the use of a customer-selected high idle speed instead of the hot idle engine speed. The higher idle speed is called the alternate minimum VSG speed. A higher idle speed is useful in applications such as air compressors and generators.

The Alternate Minimum VSG speed is active when a digital input is switched to battery ground. The fast idle input is used instead of resistors on the VSG input to obtain a fast idle engine speed. When the digital input is switched to ground and the engine is running on the idle governor, the engine speed will be changed to the calibrated fast idle speed.

Dual Throttle (LSG) Operation

Some applications require Limiting Speed Governor controls at two stations. This special configuration is implemented with two EFPAs and a digital input. The digital input is switched to either ground potential or system voltage to indicate which EFPA is active. This configuration allows an EFPA to be at two locations with only one EFPA active at any one time. Refer to section 5.33, "Throttle Controls," for more information and a schematic.

External Engine Synchronization/Frequency Input Active

External Engine Synchronization provides a method of synchronizing the engine RPM of two or more engines using a frequency signal generated by an external vehicle controller or the tach drive output of another engine. This digital input is one of the required conditions. This also functions as an activation of open collector. Refer to section 5.33.2, "Variable Speed Governor - Nonroad."

Idle Validation Switch Operation

An idle validation switch provides redundancy to assure that the engine will be at idle in the event of a throttle malfunction. The idle validation switch is connected to a digital input on the ECM. When the idle validation switch on the EFPA is switched to battery ground, the engine speed will be at idle unless the vehicle is operating in Cruise Control or Cruise Switch VSG. There are fault detection diagnostics with the Idle Validation Switch and its wiring when compared to the Throttle Position Sensor (TPS) input.

Throttle Inhibit

This option disables the LSG whenever the throttle inhibit digital input is grounded. The operator can depress the throttle pedal, but the engine speed will remain unchanged as long as the digital input is grounded. Throttle inhibit is usually offered as a standard in coach calibrations to inhibit throttle input when the rear door is open, a wheelchair lift is operated, etc.

VSG Station Change and VSG Station Change Complement

The dual throttle Variable Speed Governor (VSG) feature provides the capability of having VSG throttles at two locations, with only one throttle active at any time. The dual throttle feature requires two digital inputs.

DDEC monitors the switch inputs and maintains the current engine RPM when a station switch occurs until the newly selected station is qualified by reducing the station position to idle and then increasing it to the current engine speed position. After qualification, the engine speed is controlled by the new station. If qualification does not occur within 30 seconds, the engine speed will be ramped down from its current value to VSG minimum speed. If the new station becomes qualified, the rampdown process will be stopped and the new station will have control. Refer to section 5.33, "Throttle Control/Governors."

VSG Inhibit (Release 28.0 or later)

This option disables the analog VSG (wire #510) and ALT MIN VSG whenever the VSG digital input is grounded. Grounding the VSG Inhibit digital input will reduce engine speed to idle. When the ground is removed from the input, the throttle must be reset to zero before engine speed can be increased from idle. Frequency input and J1939 commands are not affected. The engine speed will remain unchanged as long as the digital input is grounded regardless of VSG request.

Programming Requirements and Flexibility

The digital inputs listed in Table 4-10can be configured at the time of engine order, by VEPS or DRS. VSG Inhibit can be set at the time of engine order, by WinVeps (Release 3.00 or later) or DRS.

Description	Function Number
Alternate Minimum VSG/Fast Idle (Release 2.00 or later only)	16
Dual Throttle (LSG)	28
External Engine Synchronization/Frequency Input Active	10
Idle Validation Switch	6
Throttle Inhibit	9
VSG Station Change	33
VSG Station Change Complement	34
VSG Inhibit (Release 28.00 or later)	42

Table 4-10 Throttle Control Digital Inputs

4.1.8 ENGINE SYNCHRO SHIFT TRANSMISSION

Two digital inputs are required when an Engine Synchro Shift (ESS) Transmission is installed. Refer to section 5.34, "Transmission Interface," for additional information.

In Neutral

This digital input is switched to battery ground when the ESS transmission is in neutral.

In Gear

This digital input is switched to battery ground when the ESS transmission is in gear.

ESS Transmission Programming Flexibility

The digital inputs listed in Table 4-11can be configured at the time of engine order, by VEPS or DRS.

Description	Function Number
In Neutral	38
In Gear	39

Table 4-11 Engine Synchro Shift Inputs

Diagnostics

Code 73 (SID 226 FMI 11) will be logged if both switches are grounded at the same time. This should be impossible since the two digital switches occupy the same component.

4.1.9 ADDITIONAL FUNCTIONS

The following digital inputs are used for special applications.

Auxiliary Coolant Level Switch

A digital coolant level switch can be connected to the ECM through a digital input. The digital switch is placed in the coolant tank (see Figure 4-2) to indicate low coolant and is located above the analog coolant level sensor.

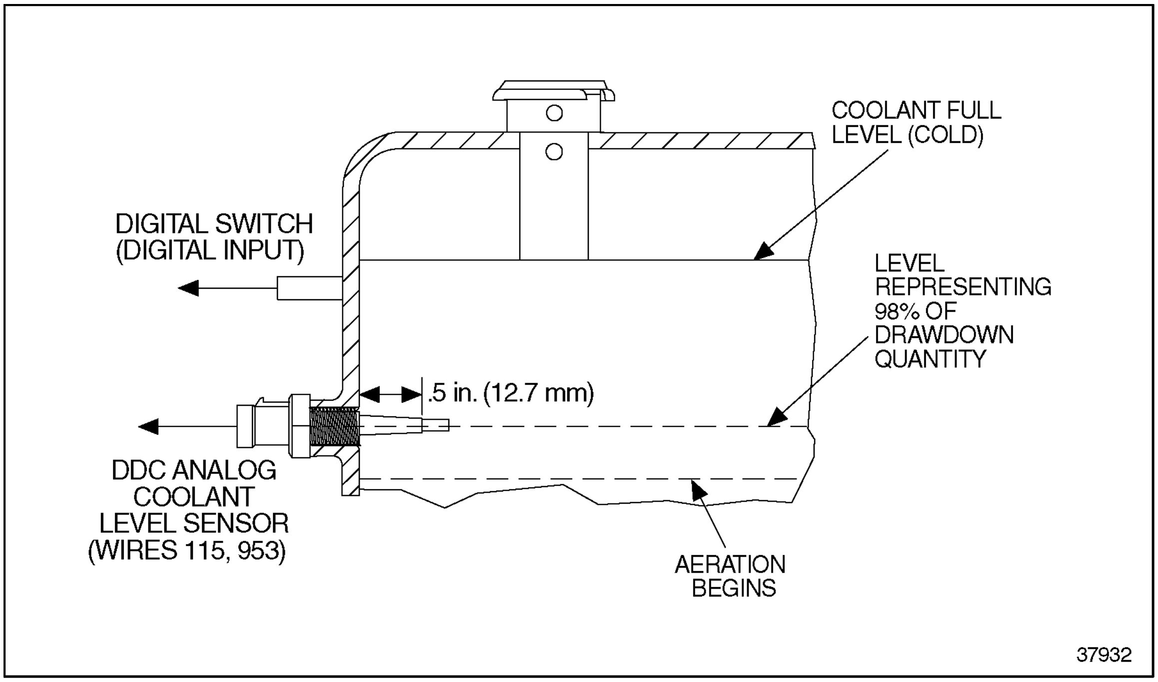

Figure 4-2 Coolant Level Switch Location

When the digital switch is in coolant, the digital input to DDEC is at battery ground. When the coolant level is below the digital switch (digital input open) for a period of time (to ignore the effects of slosh) a digital output is switched to battery ground.

The digital output can be used to drive a coolant level low light to avoid a Stop Engine Light event. The light provides a warning that the coolant level is getting low before it gets below the analog Coolant Level Sensor. This will not activate the Maintenance Alert System Add Coolant Level Sensor and will not log a code. If the coolant is below the analog sensor, the engine may be programmed for CEL to come on. Refer to section 4.2, "Digital Outputs," for more information. DDC recommends that the auxiliary coolant level module be used to drive a dash light directly. Refer to section 3.14.20, "Coolant Level Sensor," for additional information.

Parking Brake Interlock Operation

Several DDEC functions need an indication that the vehicle is stopped before the function can be engaged. By using the parking brake to switch a digital input to battery ground when in use, the ECM can determine that the vehicle is stopped and engage the function.

Air Compressor Load Switch Operation

The air compressor load switch digital input is used to activate the air compressor control in the ECM. This digital input controls when the ECM will run the engine up to speed to maintain the setpoint pressure. Refer to section 5.1, "Air Compressor Control," for additional information.

Throttle Kickdown Operation

In determining the throttle position, DDEC IV first determines a throttle position offset to ensure that when the throttle is fully released, the throttle position value is zero, and that it is forced to zero in error conditions as a precaution. However, if the throttle position sensor is configured, the throttle kickdown switch is on, and the throttle position is greater than 94.90%, then the throttle position is automatically considered to be 100%.

RPM Freeze Operation

The RPM Freeze feature allows the operator to request that the VSG governor maintain the current engine RPM. Locking onto a fixed engine RPM is desirable in applications where the input is subjected to electrical noise which in turn causes the engine RPM to fluctuate.

The operator can request that the VSG governor maintain the current engine speed by switching this digital input to battery ground.

Programming Requirements and Flexibility

The digital inputs listed in Table 4-12can be configured at the time of engine order, by VEPS or DRS.

Description	Function Number
Auxiliary Coolant Level Sensor	31
Parking Brake Interlock	5
Air Compressor Load Switch	35
Throttle Kickdown	7
RPM Freeze	11

Table 4-12 Additional Functions Digital Inputs

4.2 DIGITAL OUTPUTS

DDEC IV has three digital output ports (988,555,499) located on the Vehicle Interface Harness and three digital output ports (563, 564, 565) located on a pigtail off the Engine Sensor Harness. The digital output functions are listed in Table 4-13.

Digital Output Function	Function Number	Section
Air Compressor Load Solenoid	21	Refer to section 4.2.1, page 4-22
Cold Engine Operation * (Release 22.00 or later, Series 4000 only)	37	Refer to section 4.2.2, page 4-22
Coolant Level Low Light	10	Refer to section 4.2.3, page 4-23
Cruise Control Active Light (PSG Active Light)	11	Refer to section 4.2.4, page 4-23
Deceleration Light	15	Refer to section 4.2.5. page 4-24
Engine Brake Active	16	Refer to section 4.2.6, page 4-24
Engine Overspeed (Release 29.0 or later)	39	Refer to section 4.2.7, page 4-25
ESS Low Range (Release 5.06 or later)	28	Refer to section 4.2.8, page 4-25
ESS High Range (Release 5.06 or later)	29	Refer to section 4.2.9, page 4-26
Ether Injection (Release 3.00 or later only)	24	Refer to section 4.2.10, page 4-26
External Engine Brake Enable	8	Refer to section 4.2.11, page 4-27
External Engine Synchronization/Frequency Input Active*	4	Refer to section 4.2.12, page 4-27
Fan Control #1 & Fan Control #2	13 & 14	Refer to section 4.2.13 page 4-28
High Coolant Temperature Light (Release 2.00 or later only)	20	Refer to section 4.2.14, page 4-29
High Crankcase Pressure Light (Release 3.00 or later only)	22	Refer to section 4.2.15, page 4-29
High Oil Temperature Light (Release 2.00 or later only)	19	Refer to section 4.2.16, page 4-30
Low Coolant Pressure Light (Release 3.00 or later only)	23	Refer to section 4.2.17, page 4-30
Low DDEC Voltage Warning Light	3	Refer to section 4.2.18, page 4-31
Low Oil Pressure Light (Release 2.00 or later only)	18	Refer to section 4.2.19, page 4-31
Optimized Idle Active Light (Release 4.00 or later only)	26	Refer to section 4.2.20, page 4-32
Pressure Sensor Governor Pressure Mode Light	5	Refer to section 4.2.21, page 4-32
Service Now Lamp (Release 31.0 or later)	44	Refer to section 4.2.22, page 4-33
Starter Lockout	7	Refer to section 4.2.23, page 4-34
Top2 Shift Solenoid (Release 4.01 or later)	30	Refer to section 4.2.24, page 4-35
Top2 Lockout Solenoid (Release 4.01 or later)	31	Refer to section 4.2.25, page 4-36
Transmission Retarder	9	Refer to section 4.2.26, page 4-36
Vehicle Power Shutdown	6	Refer to section 4.2.27, page 4-37
VSG Active Indication	17	Refer to section 4.2.28, page 4-38

* Not supported by the Vehicle Electronic Programming System (VEPS)

Table 4-13 Digital Outputs

The Application Code System (ACS) sets the default function number for each of the six digital output ports. These digital outputs can be configured for various functions. These functions can be configured at the time of engine order, by VEPS or DRS.

A digital output function is activated by the ECM when the digital output wire is switched to battery ground, except fan controls #1 and #2. See Figure 4-3.

NOTE:
Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

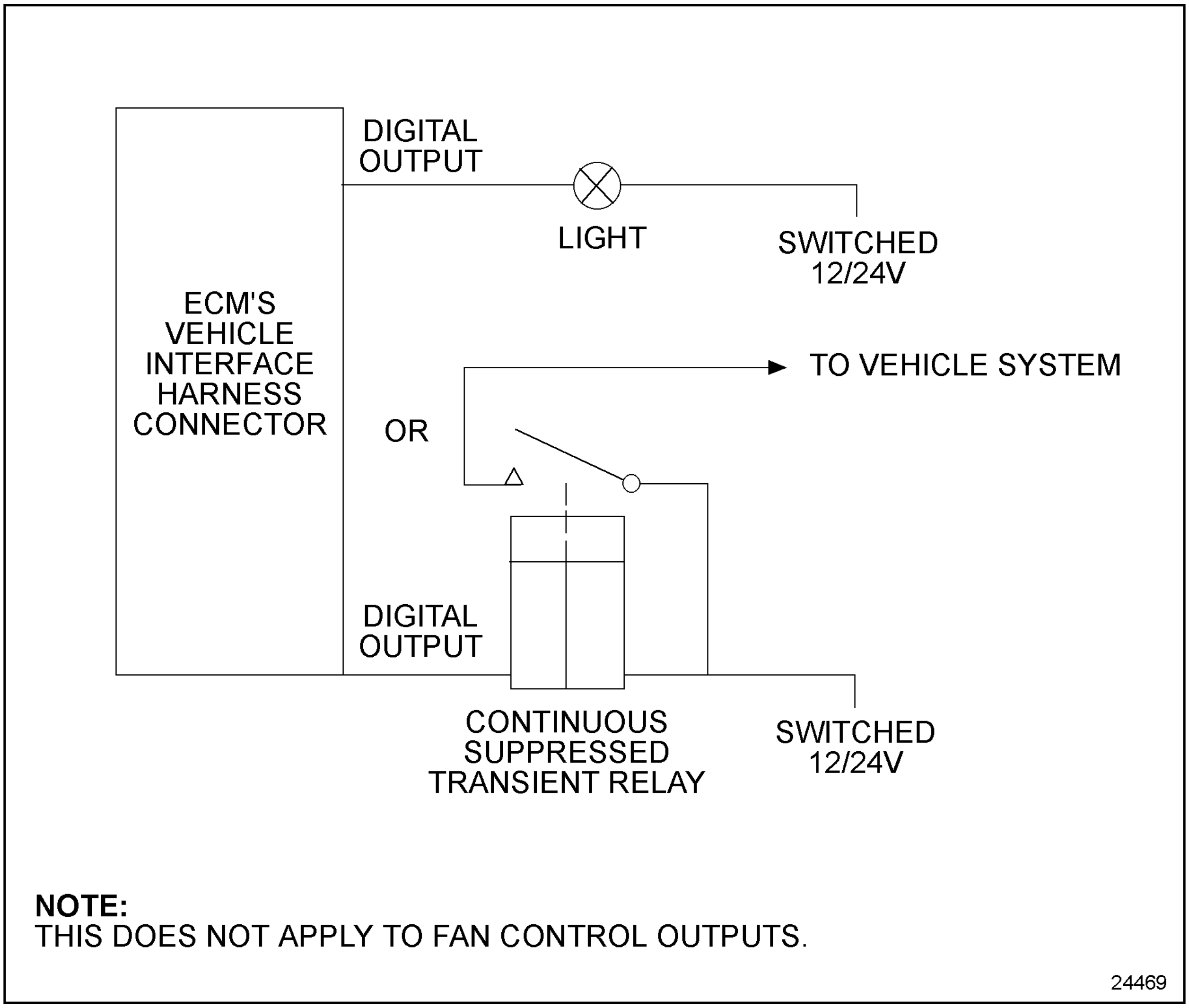

Figure 4-3 Two Methods to Use a Digital Output

4.2.1 AIR COMPRESSOR LOAD SOLENOID

The air compressor load solenoid digital output is switched to ground to open the air compressor outlet valve to begin loading the air compressor. The output is used to regulate the system pressure. When the output is open, the valve must be off. This digital output is available with DDEC III Release 4.00 or DDEC IV (any release). Refer to section 5.1, "Air Compressor Control," for additional information.

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 21) may be ordered at the time of engine order or configured by VEPS or DRS.

4.2.2 COLD ENGINE OPERATION (SERIES 4000 ONLY)

This digital output is switched to ground when either coolant, oil, intercooler, or air temperature falls below specified values. This feature can be used to activate coolant heating systems, extra parasitic loads, or shutters. This digital output is available with Release 22.00 or later. Temperature set points are set by ACS.

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six digital output ports. This digital output (function number 37) may be ordered at the time of engine order or configured by VEPS or DRS. ACS configures the coolant, oil, intercooler, and air temperature limits.

4.2.3 COOLANT LEVEL LOW LIGHT

This digital output is switched to battery ground when the coolant falls below the Coolant Level Sensor (CLS) or a digital input configured for an Auxiliary Coolant Switch is open for 30 seconds. This output is typically used to drive a light to warn the operator. The CEL and the SEL will illuminate with this output when the coolant level falls below the CLS.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 10) may be ordered at the time of engine order or configured by VEPS or DRS. Polarity can be set at order entry or by DDC Technical Service or DRS.

Interaction with other Features

This digital output could be used with a digital input configured as a Auxiliary Coolant Level Switch. Refer to section 4.1, "Digital Inputs," for additional information. The Auxiliary CLS acts as a digital switch. When the coolant level is below the Auxiliary CLS or analog CLS, the Coolant Level Low Light will illuminate.

4.2.4 CRUISE CONTROL ACTIVE LIGHT (PRESSURE SENSOR GOVERNOR ACTIVE LIGHT)

A digital output is switched to battery ground when Cruise Control, Cruise-switch VSG or the Pressure Sensor Governor is active. This digital output could be used to drive a light indicating the active state of the above.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

The ACS sets the default function number and polarity for each of the six ports. This digital output (function number 11) may be ordered at the time of engine order or configured by VEPS or DRS.

Interaction with other Features

For VSG operation, use the VSG Active indicator instead of the Cruise Control Active Light.

4.2.5 DECELERATION LIGHT

The Deceleration Light option is a light in the back of a vehicle to warn that the vehicle is slowing down. This digital output could be used to drive a Deceleration Light or, more typically, a relay which drives the deceleration lights. This digital output is switched to battery ground whenever the percent throttle is zero and Cruise Control is inactive.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 15) may be ordered at the time of engine order or configured by VEPS or DRS.

4.2.6 ENGINE BRAKE ACTIVE

The Engine Brake Active digital output is switched to battery ground whenever the engine brake is active. This digital output could be used to drive an engine brake active light or give an engine brake active indication to another vehicle system.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

The ACS sets the default function number and polarity for each of the six ports. This digital output (function number 16) may be ordered at the time of engine order or configured by VEPS or DRS. Polarity can be set at order entry or by DDC Technical Service.

4.2.7 ENGINE OVERSPEED

The Engine Overspeed digital output is switched to ground when a calibrated engine overspeed enable speed is exceeded. The output remains closed until the engine speed reaches or drops below another calibrated engine overspeed disable speed.

An option is available to log a fault code when the engine speed meets or exceeds the minimum of the overspeed enable speed and rpm overspeed calibrations. The fault that will be logged is PID 190 FMI 14, Flash Code 85 – Engine Overspeed Signal.

Installation

A low-side digital output circuit is capable of sinking less than or equal to 1.5A and have less than 85 mH of inductance.

Programming Requirements & Flexibility

ACS Sets the default function number and polarity for each of the six ports. This digital output (function number 39) may be ordered at the time of engine order or configured by DRS.

The enable and disable overspeed values can be set at the time of engine order or by the Application Code System (ACS).

The fault code option can be turned on at the time of engine order, ACS or DRS.

4.2.8 ENGINE SYNCHRO SHIFT LOW RANGE SOLENOID

The ESS Low Range digital output is used to control the low range solenoid on the Meritor® Engine Synchro Shift (ESS) transmission. The correct transmission type must be selected when this digital output is programmed. This digital output is available with Release 5.06 or later only.

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 28) may be ordered at the time of engine order or configured by VEPS or DRS. Polarity can be set at order entry or by DDC Technical Service.

Engine Synchro Shift™ and, ESS™ are trademarks of the Meritor Corporation.

4.2.9 ENGINE SYNCHRO SHIFT HIGH RANGE SOLENOID

The ESS High Range digital output is used to control the high range solenoid on the Meritor Engine Synchro Shift™ (ESS™) transmission. The correct transmission type must be selected when this digital output is programmed. This digital output is available with Release 5.06 or later only.

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 29) may be ordered at the time of engine order or configured by VEPS or DRS.

Diagnostics

A code is logged for an open or shorted circuit.

4.2.10 ETHER INJECTION

The Ether Injection digital output is switched to battery ground when ether should be injected into the engine for cold start purposes.

Installation

The digital output must be wired to the Ether Start Relay Module. Refer to section 5.12, "Ether Start," for additional information.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 24) may be ordered at the time of engine order or configured by VEPS or DRS.

Diagnostics

If the Ether Start digital output remains grounded for longer than a factory set time, the relay module will cause the inline fuse to blow. This prevents excess ether from being injected into the cylinders. If the output is shorted to battery (+), a code will be logged and the CEL will be illuminated.

4.2.11 EXTERNAL ENGINE BRAKE ENABLE

This output will be switched to battery ground when the retarder is enabled, Cruise Control is inactive, and the engine retarder level is not 0.

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 8) may be ordered at the time of engine order or configured by VEPS or DRS.

4.2.12 EXTERNAL ENGINE SYNCHRONIZATION/FREQUENCY INPUT ACTIVE

When the engine is in external engine synchronization mode this digital output is switched to ground. The output is cycled on and off at 2 Hz if all conditions for external engine synchronization are satisfied except the Sync RPM is less than the minimum Sync RPM. Refer to section 5.33.2 , "Variable Speed Governor - Nonroad."

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 4) may be ordered at the time of engine order or configured by VEPS or DRS.

4.2.13 FAN CONTROL #1 & #2

Two digital outputs provide fan control for three different fan configurations: one single-speed fan, two separate single-speed fans, or one two-speed fan. For additional information, refer to section 5.14, "Fan Control."

The first configuration, one single-speed fan, uses Fan Control #1 output to turn a single fan on/off. Fan Control #1 is opened to activate the fan and switched to battery ground to turn the fan off.

The second configuration, two separate single-speed fans, uses Fan Control #1 and Fan Control #2 to operate two separate fans independently. The fans are activated by opening Fan Control #1 or #2. The fans are turned off by switching the outputs to battery ground. Fan Control #1 is typically activated by high coolant or oil temperature. Fan Control #2 is typically activated by high intake air temperature.

The third configuration, one two-speed fan, uses both fan outputs to drive a two-speed fan. When Fan Control #1 output is opened, the low speed mode is activated. The fan operates in the high speed mode if Fan Control #2 is opened. The fan outputs are always in opposite states with ECM software release prior to R5.05. For R5.05 and after, both fan outputs must be opened for the fan to operate in high speed mode.

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function numbers 13 and 14) may be ordered at the time of engine order or configured by VEPS or DRS.

4.2.14 HIGH COOLANT TEMPERATURE LIGHT

This digital output is also switched to ground with the CEL and the SEL when the coolant temperature is above the stop engine code value and EOP is not enabled. This output will be grounded along with the CEL and the SEL when the ignition is cycled ON for the bulb check. This use for a digital output is for release 2.00 or later only.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 20) may be ordered at the time of engine order or configured by VEPS or DRS.

Diagnostics

A code is logged for high coolant temperature.

4.2.15 HIGH CRANKCASE PRESSURE LIGHT

This digital output is switched to ground with the CEL and the SEL when the crankcase pressure is above the stop engine code value. The output is grounded along with the CEL and the SEL when the ignition is cycled ON for the bulb check. This digital output is available with Release 3.00 or later only.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 22) may be ordered at the time of engine order or configured by VEPS or DRS. The stop engine pressure threshold is set by the application (6N4C) code.

Diagnostics

A code is logged for high crankcase pressure.

4.2.16 HIGH OIL TEMPERATURE LIGHT

This digital output is switched to battery ground with the CEL if Engine Overtemperature Protection (EOP) is enabled when the oil temperature is above the check engine code value. This digital output is also switched to ground with the CEL and the SEL when the oil temperature is above the stop engine code value and EOP is not enabled.. This output will be grounded along with the CEL and the SEL when the ignition is cycled ON for the bulb check. The output will be switched to ground. This use for a digital output is for Release 2.00 or later only.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 19) may be ordered at the time of engine order or configured by VEPS or DRS.

Diagnostics

A code is logged for high oil temperature.

4.2.17 LOW COOLANT PRESSURE LIGHT

This digital output is switched to battery ground with the CEL and the SEL when the coolant pressure is below the stop engine code value. The output is grounded along with the CEL and the SEL when the ignition is cycled ON for the bulb check. This use for a digital output is for Release 3.00 or later only.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 23) may be ordered at the time of engine order or configured by VEPS or DRS. The stop engine pressure threshold is set by the application (6N4C) code.

Diagnostics

A code is logged for low coolant pressure.

4.2.18 LOW DDEC VOLTAGE WARNING LIGHT

This digital output is switched to battery ground when the ECM battery voltage is below a factory set value. This digital output could be used to drive a low DDEC voltage light.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 3) may be ordered at the time of engine order or configured by VEPS or DRS.

Diagnostics

A code is generated when the ECM battery voltage falls below a factory set value.

4.2.19 LOW OIL PRESSURE LIGHT

This digital output is switched to battery ground with the CEL and SEL when the oil pressure is below the Stop Engine Code value. The output will be grounded along with the CEL and SEL when the ignition is cycled ON for the bulb check. The output will be switched to ground. This use for a digital output is for Release 2.00 or later only.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 18) may be ordered at the time of engine order or configured by VEPS or DRS.

Diagnostics

A code is logged for low oil pressure.

4.2.20 OPTIMIZED IDLE ACTIVE LIGHT

The Optimized Idle active light digital output will flash at a rate of once every half second while the idle timer is counting down, after the system has initialized. The output will be grounded after the idle timer has timed out and Optimized Idle has become active. The output will be grounded along with the CEL and the SEL when the ignition is cycled ON for the bulb check. This digital output is available with Release 4.00 or later only. For more information on Optimized Idle, refer to section 5.24.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 26) may be ordered at the time of engine order or configured by VEPS or DRS.

Diagnostics

A code is logged for an open or shorted circuit.

4.2.21 PRESSURE SENSOR GOVERNOR PRESSURE MODE LIGHT

This digital output is switched to battery ground when the PSG pressure mode is activated. This digital output can be used to drive the pressure mode light. For more information, refer to section 5.29, "Pressure Sensor Governor."

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 5) may be ordered at the time of engine order or configured by VEPS or DRS.

4.2.22 SERVICE NOW LAMP

The Service Now Lamp (SNL) digital output (function number 44) is switched to battery ground for certain engine critical faults as defined by the product engineers and the 6N4C settings of the Application Code System (ACS). This can be wired as a substitute for the Check Engine Lamp circuit, as a secondary indicator (which activates for fewer fault conditions) in addition to the standard CEL (which activates for all faults), or the normal CEL circuit can be configured to act as a SNL without the need to add a wire nor configure a digital output function.

This feature does not affect the engine protection reaction to a fault condition, such as those that provide a WARN/RAMP/STOP setting, because it does not disable any faults. It merely alters the behavior of the dash lamp. The SNL output will also be activated any time a Stop Engine fault is active.

Installation

If the output is to be used for a light, a 12 or 24 volt light of less than 1.5 A (DC) is needed depending on the ignition source. Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

When the "CEL Faults Excluded" parameter is ENABLED by ACS, the CEL circuit's operation is changed. The CEL will illuminate for an active fault ONLY if the bit corresponding to that FMI (Failure Mode Indicator) within the "fault group" is enabled in the base calibration. These groups are configured by the product engineers in such a way as to conceal alerts that do not require immediate operator action and are more productively serviced during scheduled periodic maintenance, yet maintaining comprehensive engine protection by alerting the operator for fault conditions that can cause immediate harm to the engine or vehicle. For FMIs that are excluded, faults are still logged, but the dash lamp is not activated. If the SNL digital output function is additionally configured, both lamps will illuminate for the same faults. Only the CEL circuit provides the "code flashing" features such as for Maintenance Alert System, however. In this ACS configuration, the CEL (and SNL if configured) will also activate if any inactive or active fault is present for more than programmable number of engine hours, typically equal to less than twice the maximum allowed oil change interval, and a new "SNL FAULT EXPIRED" fault (SID-151 FMI-11) will be logged.

When the "CEL Faults Excluded" parameter is DISABLED by ACS, the CEL will function normally while the SNL will not be turned on for those faults whose corresponding FMI within the Fault Group is disabled in the calibration. In this ACS configuration, the SNL (but not the CEL) will also activate if any inactive or active fault within that Fault Group, regardless of whether it activates the dash lamp or not, is present for more than the programmed number of engine hours.

The base calibration configurable Fault Groups are listed in Table 4-14. Also shown is an example of Fault Groups, which would typically have certain fault conditions excluded from activating the dash lamp and require the maintenance personnel to inspect and erase inactive codes each periodic maintenance interval. Those in **bold**typically have at least one FMI excluded from activating the dash lamp.

Fault Group	PID/SID	Expiration Applies (Typical Series 4000 Configuration)
Air filter Differential Pressure	PID107	—
Ambient Air Temperature	PID 171	—
Backup Battery	SID 214	—
Barometric Pressure	PID 48, PID 108	—
Battery Voltage	PID 168	—
Boost Pressure	PID 102	—
Calibration Memory	SID 253	—
Coolant Level	PID 111	—
Coolant Pressure	PID 20, PID 109	—
Coolant Temperature	PID 110	—
Crankcase Pressure	PID 101, PID 153	Yes
Engine Speed	PID 190	—
Exhaust Back Pressure	PID 81	Yes
Exhaust Temperature	PID 173	Yes
Fire Pump Pressure	PID 73	—
Fuel Filter Differential Pressure	PID 95	—
Fuel Pressure	PID 94, PID 18	Yes
Fuel Temperature	PID 174	Yes
Injection Pressure	PID 164	—
Injector Response Time	SID 1–16, 47–50, 72–75	
Intercooler Coolant Temperature	PID 52	—
J1708 Data Link Fault	PID 250	—
Manifold Air Pressure	PID 106	Yes
Manifold Air Temperature	PID 172	Yes
Oil Filter Differential Pressure	PID 99	Yes
Oil Pressure	PID 100, PID 19	—
Oil Temperature	PID 175	Yes
Percent Throttle	PID 91	—
Proprietary Data Link	SID 248	—
PTO Set Speed	PID 187	—
PWM #1	SID 57	—
PWM #2	SID 58	Yes
PWM #3	SID 59	—
SRS/TRS	SID 21	—
All Other Faults	—	—

Table 4-14 Base Calibration Configurable Fault Groups

4.2.23 STARTER LOCKOUT

This digital output is used to disable/enable the starter. This signal is used to inhibit starter reengagement while the engine is running. A battery ground signal means that the starter cannot be reengaged when the engine speed is above a programmable speed (typically 500 RPM). An open circuit means that the starter could be reengaged when the engine is below a programmable speed (typically 60 RPM). The RPM values can be set to any value. These values can be changed by Detroit Diesel Technical Service or on the mainframe.

This digital output can also be used to indicate that the engine is running.

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 7) may be ordered at the time of engine order or configured by VEPS or DRS. The RPM values can be set to any value. The values can be selected at time of engine order or selected after engine order by DDC Technical Service.

4.2.24 TOP2 SHIFT SOLENOID

The shift solenoid is used to command an automatic shift between the top two gears in a Eaton® Top2™ transmission. When the output is grounded, the shift solenoid commands a shift to the top gear position. When the output is not grounded, the shift solenoid commands a shift to the gear one lower than the top position. The correct transmission type must be selected when this digital output is programmed. This digital output is available with Release 4.01 or later only. For additional information on Top2, refer to section 5.34, "Transmission Interface."

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 30) may be ordered at the time of engine order or configured by VEPS or DRS.

Diagnostics

A code is logged for an open or shorted circuit.

Eaton® and Top2™ trademarks of the Eaton Corporation.

4.2.25 TOP2 SHIFT LOCKOUT SOLENOID

The shift lockout solenoid is used to disable the driver splitter position switch in an Eaton Top2 transmission. When this output is grounded, the splitter position control is taken away from the driver and controlled by the ECM. The correct transmission type must be selected. This digital output is available with Release 4.01 or later only. For additional information on Top2, refer to section 5.34, "Transmission Interface."

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 31) may be ordered at the time of engine order or configured by VEPS or DRS.

Diagnostics

A code is logged for an open or shorted circuit.

4.2.26 TRANSMISSION RETARDER

This digital output is switched to battery ground whenever the throttle is in at 0% position and cruise control is inactive. This signal in conjunction with a relay, may be used to control a transmission retarder. This output will also be enabled if a SAE J1922 or J1939 data link message is received requesting transmission retarder.

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 9) may be ordered at the time of engine order or configured by VEPS or DRS.

4.2.27 VEHICLE POWER SHUTDOWN

This digital output actuates a relay that shuts down the rest of the electrical power to the vehicle. See Figure 4-4. This illustration provides a method to turn OFF the ignition when vehicle electrical power is shutdown. Refer to section 5.18, "Idle Timer and Vehicle Power Shutdown."

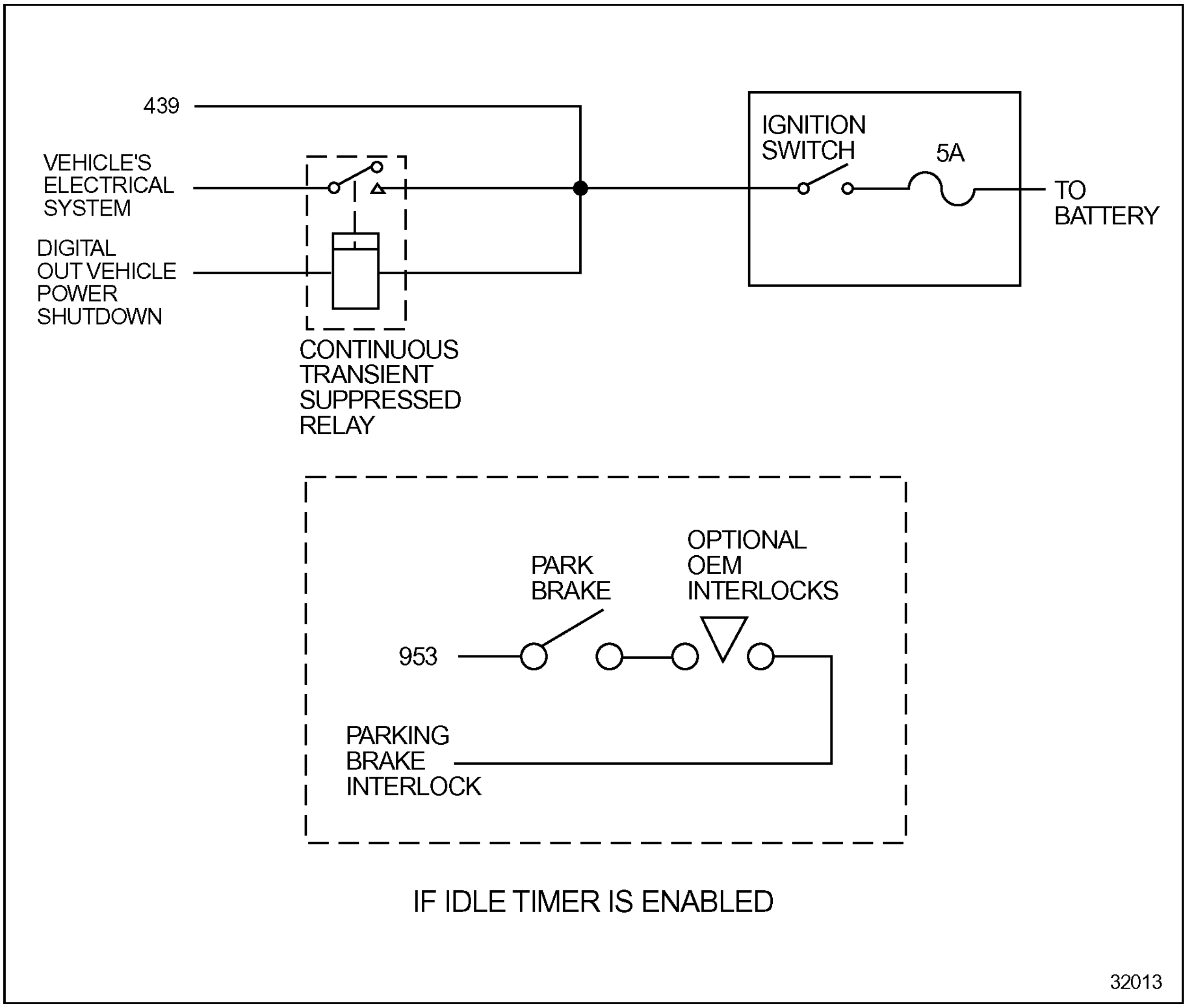

Figure 4-4 Vehicle Power Shutdown

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 6) may be ordered at the time of engine order or configured by VEPS or DRS.

Diagnostics

A code is logged for an open or shorted circuit.

Interaction with Other Features

Vehicle Power Shutdown is used with Idle Timer Shutdown, and required for Optimized Idle, or Engine Protection Shutdown.

4.2.28 VSG ACTIVE INDICATION

The VSG Active indication is used for electric drive vehicles. This digital output is used to keep the vehicle from creeping by disconnecting the wheel motor contacts while the vehicle is stopped and the engine is operating. When the ECM detects that the VSG counts are greater than 140, the output is switched to battery ground. If the VSG counts drop below 100, the output is opened.

Installation

Digital output circuits are designed to sink no more than 1.5 A (DC) current and have less than 85 mH of inductance.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the six ports. This digital output (function number 17) may be ordered at the time of engine order or configured by VEPS or DRS.

Interaction with Other Features

For Cruise Control state, use the Cruise Control Active Light instead of this output.

5 DDEC FEATURES

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5.1 AIR COMPRESSOR CONTROL

Air Compressor Controlis an optional DDEC feature that allows DDEC to regulate engine speed and load/unload a valve in order to maintain a requested compressor outlet air pressure for air compressor applications.

The DDEC Air Compressor Control Feature is available with the following software releases:

- ☐ DDEC III - Release 4.0 (only)
- ☐ DDEC IV - all software versions (Release 20.0 or later)

5.1.1 OPERATION

The ECM monitors the air outlet pressure while varying the engine speed and operating load/unload a valve. The valve will be opened or closed. The desired operating pressure may be varied by the operator, within limits preset by the OEM.

The ECM will activate the Air Compressor Governor Controls when the digital input "Air Compressor Load Switch" is grounded. Engine speed is governed based on the actual air compressor outlet pressure versus the desired output pressure. The Air Compressor Pressure Sensor provides a pressure signal to the ECM.

The engine response to various pressure conditions is listed in Table 5-1.

Pressure Set Point	Result
Current outlet pressure is below the pressure set point	Engine speed increases as required up to PTO maximum speed*
Pressure in the system continues to increase and a threshold pressure is exceeded	The air compressor solenoid digital output is enabled† (opened)
Current outlet pressure is above the pressure set point	Engine speed decreases as required down to the minimum PTO speed.

* The engine will continue to run at PTO maximumuntil the outlet pressure matches the sensor pressure.

† DDEC will open and close the loading valve as a function of pressure with hysteresis. When the pressure reaches a programmable limit above the pressure set point the DDEC digital output will be grounded. This output may be used to either open an air compressor vent or close the air inlet. Once the air pressure has dropped to a lower programmable limit, the digital output will be open circuited which will either close the vent

Table 5-1 Engine Operation with Air Compressor Controls

Each horsepower rating has an associated pressure range. Horsepower ratings are defined at time of order entry. The minimum and maximum pressure setting for each of the horsepower curves is set with the DDDL/DDR, Vehicle Electronic Programming System (VEPS), or DRS. The initial pressure set point is saved between ignition cycles.

Increase (Resume/Acceleration On)

Momentarily toggling and releasing the Increase Switch (grounding the "Resume/Acceleration On" digital input) increases set point pressure by 4% of the pressure range. Holding the switch in the increase position (grounding the digital input), will increase the set point pressure at a rate of two increments per second. Releasing the switch sets the compressor controls to the higher setting.

Decrease (Set/Coast On)

Momentarily toggling and releasing the decrease switch decreases set point pressure by 4% of the pressure range. See Figure 5-1. Holding the switch in the decrease position (grounding the digital input), will decrease the set point pressure at a rate of two increments per second. Releasing the switch sets the compressor controls to the lower setting.

Air Compressor Load Switch

Closing (grounding) the air compressor load switch digital input activates the air compressor control system. See Figure 5-1. Opening the air compressor load switch digital input deactivates the air compressor control system.

Air Compressor Solenoid

When the pressure reaches a programmable limit above the pressure set point the DDEC digital output will be grounded. This output may be used to either open an air compressor vent or close the air inlet. Once the air pressure has dropped to a lower programmable limit, the digital output will be open circuited which will either close the vent or open the air inlet.

Air Compressor Shutdown

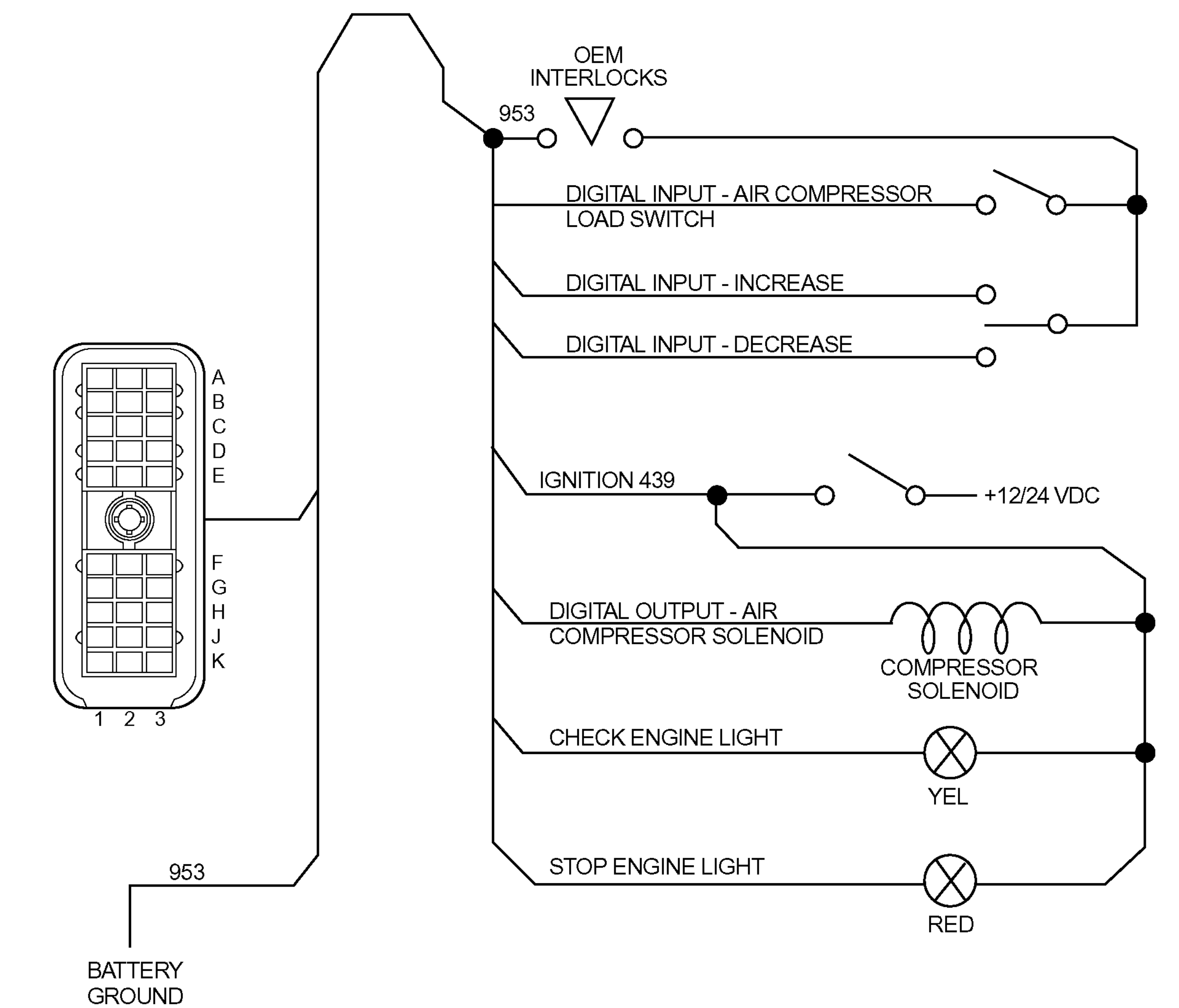
DDEC will respond to a proprietary immediate engine shut down message sent over the SAE J1587/J1708 data link by the Electronic Display Module (EDM). This feature requires both an EDM and an Auxiliary Information Module (AIM); refer to section 5.6 for addition information on EDM and AIM.

Multiple Pressure Ratings

The pressure ranges are linked to the engine ratings. A pressure range can be associated with each rating. The maximum number of engine ratings and pressure ranges is three. Choosing the rating, with the DDR/DDDL or rating switches will automatically select the associated pressure range. The proper 6N4D group with multiple 6N4M groups must be specified. For additional information, contact your DDC Applications Engineer.

5.1.2 INSTALLATION

See Figure 5-1 for the Air Compressor Control Harness.



DESCRIPTION	CAVITY	WIRE NO.
BATTERY GROUND	-	953
AIR COMPRESSOR LOAD SWITCH	DIGITAL INPUT	-
AIR COMPRESSOR SOLENOID	DIGITAL OUTPUT	-
CHECK ENGINE LIGHT	B-1	419
DECREASE (SET/COAST)	DIGITAL INPUT	-
IGNITION	B-3	439
INCREASE (RESUME/ACCEL)	DIGITAL INPUT	-
STOP ENGINE LIGHT	B-2	509

32026

Figure 5-1 Air Compressor Control Harness

5.1.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Air Compressor Controls must be specified at the time of engine order or added to the ECM calibration by Detroit Diesel Technical Service. An Application Code (6N4C) Group must be selected that is configured for Air Compressor Control at order entry or by contacting Detroit Diesel Technical Service.

The digital outputs and inputs listed in Table 5-2 are required for Air Compressor Controls and must be configured by order entry, VEPS, or the DRS.

Description	Type	Function Number
Set/Coast On (Decrease)	Digital Input	20
Resume/Acceleration On (Increase)	Digital Input	22
Air Compressor Load Switch	Digital Input	35
Air Compressor Solenoid	Digital Output	21

Table 5-2 Air Compressor Control Required Digital Inputs and Outputs

At order entry, the Application Code System (ACS) sets the default values for the parameters listed in Table 5-3. These parameters may be modified using either VEPS or DRS.

Parameter	Description	Choice/Display
Air Compressor Integral Gain	Integral Gain	0-128 RPM/(PSI x SEC)
Air Compressor Proportional Gain	Proportional Gain	0-128 RPM/PSI
Air Compressor Pressure Increment	Percent Pressure Increment	0-50% (of fuel scale pressure range)

Table 5-3 Air Compressor Control Parameters

Multiple pressure ratings can be selected with the use of rating switches. The proper 6N4D groups with multiple 6N4M groups must be specified at engine order or by Detroit Diesel Technical Service. The digital inputs listed in Table 5-4 are required.

Description	Type	Function Number
Rating Switch #1	Digital Input	12
Rating Switch #2	Digital Input	13

Table 5-4 Multiple Pressure Ratings Required Digital Inputs

The VSG maximum and minimum RPM can be set with VEPS, DRS, DDR or DDDL as listed in Table 5-5.

Parameter	Description	Choice/Display
VSG Minimum RPM	Sets the VSG minimum speed.	Idle to VSG, Maximum RPM
VSG Maximum RPM	Sets the VSG maximum speed.	VSG Minimum RPM to (Rated Speed + LSG Droop)

Table 5-5 Variable Speed Governor Maximum and Minimum RPM

The minimum and maximum pressure is set with the DDDL/DDR, DRS or VEPS as listed in Table 5-6. There is a minimum and maximum pressure setting for each of the horsepower curves.

Parameter	Description	Range
LOAD PSI	Indicates the delta value above the current air pressure set point that will initiate the air compressor governor to reload the system.	0 to UNLOAD PSI
UNLOAD PSI	Indicates the delta value above the current air pressure set point that will initiate the air compressor governor to unload the system.	LOAD PSI to 31 PSI
MAX RAT#1 PSI	Indicates the maximum allowable air pressure set point for engine rating #1	MIN RAT#1 to 999 PSI
MIN RAT#1 PSI	Indicates the minimum allowable air pressure set point for engine rating #1.	0 to MAX RAT#1
MAX RAT #2 PSI	Indicates the maximum allowable air pressure set point for engine rating #2.	MIN RAT#2 to 999 PSI
MIN RAT#2 PSI	Indicates the minimum allowable air pressure set point for engine rating #2.	0 to MAX RAT#2
MAX RAT#3 PSI	Indicates the maximum allowable air pressure set point for engine rating #3.	MIN RAT#3 to 999 PSI
MIN RAT #3 PSI	Indicates the minimum allowable air pressure set point for engine rating #3.	0 to MAX RAT#3

Table 5-6 Air Compressor Parameters

5.1.4 INTERACTION WITH OTHER FEATURES

Air Compressor Control may not be used with Cruise Control or the Pressure Sensor Governor. A proprietary immediate engine shut down message for immediate air compressor shutdown is sent over the SAE J1587/J1708 data link by the EDM. This feature requires both an EDM and an AIM; refer to section 5.6 for addition information on EDM and AIM.

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5.2 ANTI-LOCK BRAKE SYSTEMS

Anti-lock Brake Systems (ABS) are electronic systems that monitor and control wheel speed during braking. The systems are compatible with standard air brake systems. The system monitors wheel speed at all times, and controls braking during emergency situations. Vehicle stability and control are improved by reducing wheel lock during braking.

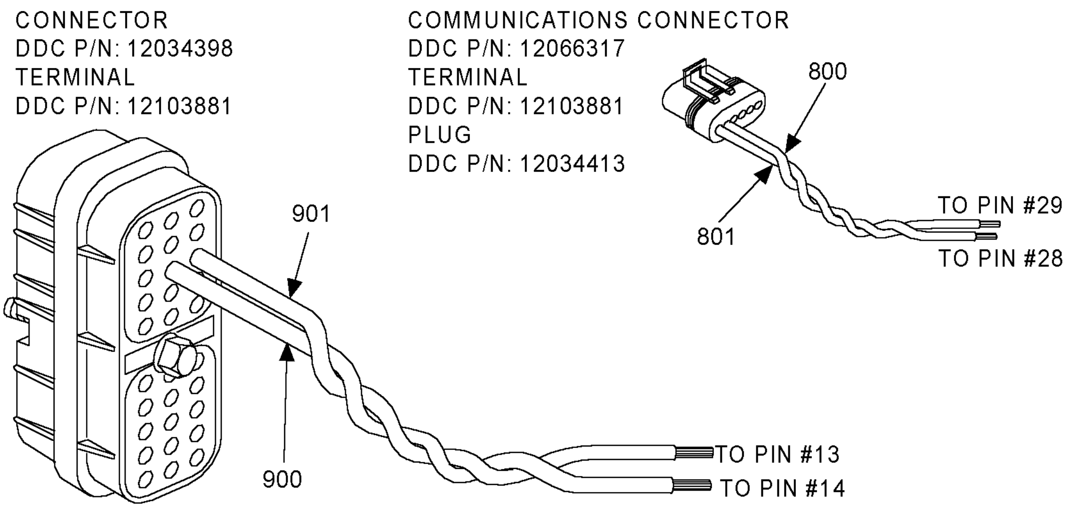
5.2.1 OPERATION

The ECM transmits engine data via SAE J1587, SAE J1922, or SAE J1939. Anti-lock brake systems monitor data on one or more of these communication links. In the event that an excessive wheel spin is detected, the ECM receives a message from the ABS requesting a 0% output torque limit. The message is transmitted on SAE J1922 or SAE J1939.

SAE J1922 and SAE J1939 both implement the same message set. The difference being hardware and performance. SAE J1922 transmits and receives data at 9.6 K baud while SAE J1939 transmits/receives data at 250 K baud. SAE J1939 has a much higher bit rate so messages reach their destination very quickly nearly eliminating the latency found with SAE J1922.

SAE J1922 is enabled on all DDEC IV ECMs. SAE J1939 is enabled on all DDEC IV ECMs (Release 24.0 or later). ECMs prior to Release 24.0 must be configured if SAE J1939 is required.

See Figure 5-2 and Figure 5-3 for interface with Meritor/WABCO and Bosch respectively.

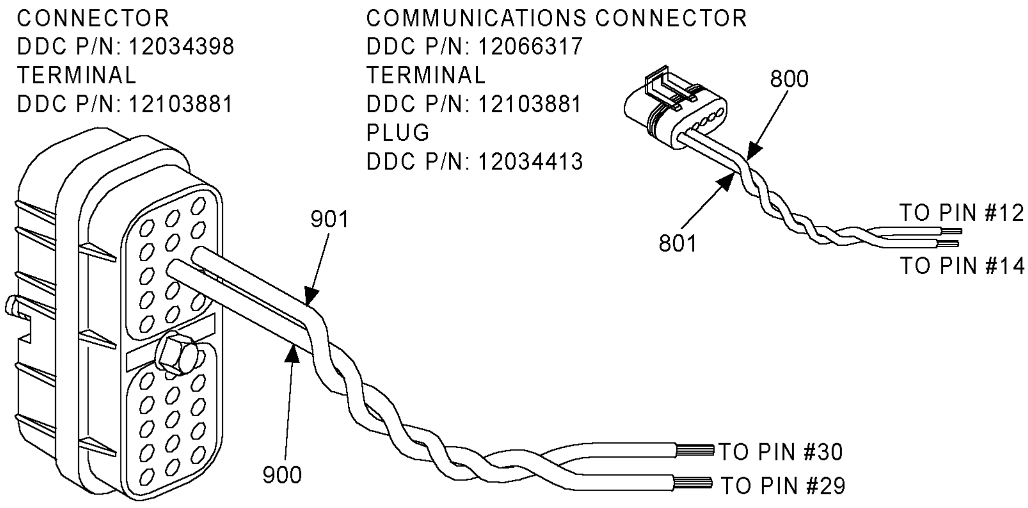


NOTE: WIRE PAIRS MUST BE TWISTED A MINIMUM OF 12 TURNS PER FOOT.

LABEL	WIRE NO.	VIH-TO-ECM CONNECTOR CAVITY	COMMUNICATION CONNECTOR CAVITY	WIRE COLOR	MERITOR/WABCO INTERFACE CONNECTOR
J1587 DATA LINK (+)	900	C2	-	DK GRN/YEL	14
J1587 DATA LINK (-)	901	C1	-	DK GRN	13
J1922 DATA LINK (+)	800	-	A	TAN/WHT	29
J1922 DATA LINK (-)	801	-	B	TAN	28

37003

Figure 5-2 Meritor/WABCO ABS/ATC Interface



NOTE: WIRE PAIRS MUST BE TWISTED A MINIMUM OF 12 TURNS PER FOOT.

LABEL	WIRE NO.	VIH-TO-ECM CONNECTOR CAVITY	COMMUNICATION CONNECTOR CAVITY	WIRE COLOR	BOSCH INTERFACE CONNECTOR
J1587 DATA LINK (+)	900	C2	-	DK GRN/YEL	29
J1587 DATA LINK (-)	901	C1	-	DK GRN	30
J1922 DATA LINK (+)	800	-	A	TAN/WHT	12
J1922 DATA LINK (-)	801	-	B	TAN	14

37004

Figure 5-3 Bosch ABS/ATC Interface

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5.3 CRUISE CONTROL

Cruise Control is available with any DDEC engine. Cruise Control will operate in either Engine or Vehicle Speed Mode and maintain a targeted speed (MPH or RPM) by increasing or decreasing fueling. The targeted speed can be selected and adjusted with dash-mounted switches. Up to five digital inputs are required (four for automatic transmission) for Cruise Control operation and a digital output is optional (refer to section 4.1.1 for additional information on digital inputs). A Vehicle Speed Sensor (VSS) is required for Vehicle Speed Cruise Control.

5.3.1 OPERATION

There are two types of Cruise Control: Engine Speed Cruise Control and Vehicle Speed Cruise Control.

Engine Speed Cruise Control

Power is varied under Engine Speed Cruise Control to maintain constant engine speed. Vehicle speed will vary depending on powertrain components. Engine Speed Cruise Control does not need a VSS. Engine Speed Cruise Control cannot be used with automatic transmissions.

Vehicle Speed Cruise Control

Vehicle Speed Cruise is enabled when "Enable Cruise" and a Vehicle Speed Sensor (VSS) are installed. Engine speed and power are varied under Vehicle Speed Cruise Control to maintain the set vehicle speed. The maximum Cruise Control speed cannot exceed the programmed maximum Vehicle Speed Limit (when programmed). The vehicle speed must be above 20 MPH and the engine speed above 1,100 RPM (1,000 RPM for on-highway 1999 model year or later engines) to set Cruise Control.

This type of Cruise Control is required when either of the following conditions exists:

- ☐ Vehicle Speed Limiting -- Vehicle Speed Cruise Control is mandatory if the vehicle speed limit is programmed and Cruise Control is desired. This will prevent the ECM from fueling the engine at speeds greater than the vehicle speed limit.
- ☐ Automatic Transmissions -- Vehicle Speed Cruise Control must be selected if the vehicle is equipped with an automatic transmission. This will ensure proper transmission upshifts while in Cruise Control. Refer to the transmission manufacturer's manual for more information and see the Vehicle Interface Harness schematic.

Cruise control can be overridden at any time with the foot pedal if the vehicle is not operating at the programmed Vehicle speed Limit.

Smart Cruise

The Eaton® Smart Cruise™ system will send a "heart beat" message on the SAE J1939 Data Link. Manual Cruise Control and Smart Cruise will be disabled if the message is not received over the data link or the message indicates that there is a failure in Smart Cruise. To regain manual control, the driver must toggle the Cruise Master Switch twice within 10 seconds.

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This feature is available with Release 27.0 or later. Smart Cruise must be configured by VEPS (Release 27.0 or later), WinVeps (Release 2.0 or later) or the DRS. For additional information on Smart Cruise, contact Eaton Corporation.

Cruise Enable

Cruise Control is enabled, but not active when the Cruise Control Enable digital input is switched to battery ground.

Set / Coast On

Set: Cruise Speed is set by momentarily contacting the switch to the ON position (switching the digital input to battery ground). Cruise Control will become active and maintain the engine or vehicle speed present at the time.

Coast: When Cruise Control is active, the Set/Coast input can be used to reduce power and speed by toggling the switch. Momentarily toggling and releasing the Set/Coast switch will decrease the set point by 1 MPH increments for Vehicle Speed Cruise Control and 25 RPM increments for Engine Speed Cruise Control. Holding the Set/Coast will decrease the set point by 1 MPH per second (Vehicle Speed CC) or 25 RPM per seconds (Engine Speed CC). When released the Cruise Control set point will be at the new speed.

Resume / Accel On

Resume: If Cruise Control has been disabled with the service brake or the clutch switch, momentary contact to the ON position (switching the input to battery ground) restores the previously set cruise speed.

Accel: When Cruise Control is active, the Resume/Accel input can be used to increase power and speed by toggling the switch. Momentarily toggling and releasing the Resume/Accel switch will increase the set point by 1 MPH increments for Vehicle Speed Cruise Control and 25 RPM increments for Engine Speed Cruise Control. Holding the Resume/Accel will increase the set point by 1 MPH per second (Vehicle Speed CC) or 25 RPM per seconds (Engine Speed CC). When released the Cruise Control set point will be at the new speed.

Clutch Released (Manual Transmissions)

This input indicates that the clutch is released and is used for suspending Cruise Control and Auto Resume.

When the clutch is released, the input is at battery ground. Cruise Control is suspended if the clutch is depressed once. If the clutch is depressed twice within three seconds, Cruise Control is automatically resumed.

NOTE:
When engine brake is configured and auto resume is enabled, the first time the clutch is depressed to suspend Cruise Control, the engine brakes will be delayed for three seconds.

The digital input logic for the Clutch Switch disables Cruise Control in the unlikely event of a broken clutch switch wire.

Service Brake Released (Automatic and Manual Transmissions)

This input indicates that the brake is released when switched to battery ground. If the brake is activated, then the input is not grounded and Cruise Control is suspended. Cruise Control is resumed by using the Resume/Accel Switch.

The input logic for the Brake Switch disables Cruise Control in the unlikely event of a broken brake switch wire.

5.3.2 INSTALLATION

The following is a list of switches that are required for Cruise Control operation.

- ☐ Cruise Enable Switch
- ☐ Brake Switch
- ☐ Clutch Switch -- optional for automatic transmissions
- ☐ Set/Coast Switch
- ☐ Resume/Accel Switch
- ☐ Cruise Active Light -- optional

See Figure 5-4 for a diagram of the Cruise Control circuit.

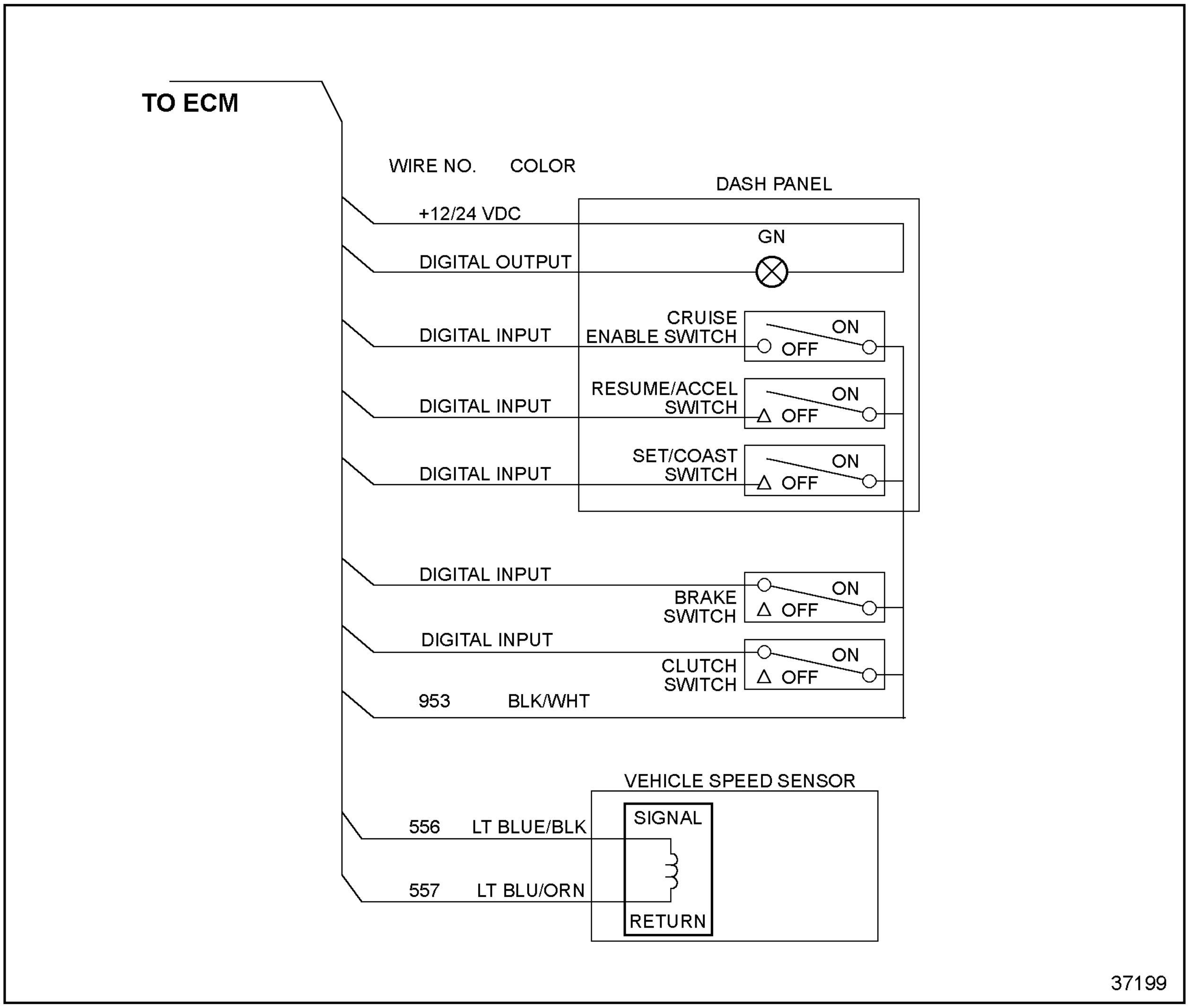

Figure 5-4 Cruise Control Circuit

5.3.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

To configure an engine for Cruise Control, the digital inputs, output and VSS settings listed in Table 5-7 must be selected either with the Vehicle Electronic Programming System (VEPS), the DDEC Reprogramming System (DRS) or on engine order entry. The required and optional digital inputs and outputs are listed in Table 5-7.

Description	Type	Function Number
Service Brake Released	Digital Input	17
Set/Coast	Digital Input	20
Resume/Accel	Digital Input	22
Cruise Control Enable	Digital Input	23
Clutch Released (required for manual transmissions)	Digital Input	18
Cruise Control Active Light (optional for Cruise Control)	Digital Output	11

Table 5-7 Cruise Control Related Digital Input and Output Signals

A Vehicle Speed Sensor must be configured for Vehicle Speed Cruise Control.
Refer to section 3.14.25, "Vehicle Speed Sensor," for additional information.

If Eaton Smart Cruise is installed on the vehicle, the feature as listed in Table 5-8 must be enabled by VEPS or DRS.

Parameter	Description	Choice
Adaptive Cruise Control (Smart Cruise)	Enables or disables the Smart Cruise Control feature.	YES, NO

Table 5-8 Smart Cruise Parameter

The Cruise Control parameters listed in Table 5-9 can be set by order entry, DDR, DDDL, the DRS, or VEPS.

Parameter	Description	Range
CRUISE CONTROL	Enables or disables the vehicle speed Cruise Control feature.	YES, NO
MIN CRUISE SPEED	Sets the maximum cruise speed in MPH or KPH.	20 MPH to MAX CRUZ SPD
MAX CRUISE MPH or KPH	Sets the maximum cruise speed in MPH or KPH.	MIN CRUZ to Vehicle Speed Limit or 127 mph if VSL = NO
AUTO RESUME	Enables or disables the automatic Cruise Control set speed resume feature.	YES, NO
CRUISE SWITCH VSG	Enables or disables the cruise switch VSG set speed feature.	YES, NO
INITIAL VSG SET SPEED	Sets the cruise switch VSG initial set speed.	VSG MIN RPM to VSG MAX RPM
RPM INCREMENT	Sets the cruise switched VSG RPM increment.	1 to 255 RPM
CRUISE/ENGINE BRAKE FEATURE	Enables or disables the feature that allows the engine brake to be used while on Cruise Control if the vehicle exceeds the cruise set speed.	YES, NO
CRUISE/ENGINE BRAKE ACTIVATION SPEED	Sets the additional speed before the engine brake is applied to slow down the vehicle. The engine brake is activated at low level unless the operator has turned off the engine brakes with the dash board switches.	0 to 10 MPH
ENG BRAKE INCREMENT MPH or KPH	Sets the additional incremental speed that must be reached before the engine brake will activate the medium and/or high level of retardation.	1 to 5 MPH
MAX OVERSPEED LIMIT	Sets the vehicle speed above which a diagnostic code will be logged if the driver fuels the engine and exceeds this limit. Entering a 0 will disable this option.	0 to 127 MPH
MAX SPEED NO FUEL	Sets the vehicle speed above which a diagnostic code will be logged if the vehicle reaches this speed without fueling the engine. Entering a 0 will disable this option.	0 to 127 MPH

Table 5-9 Cruise Control Parameters

5.3.4 DIAGNOSTICS

Two faults (SID 216 FMI 14 and PID 86 FMI 14) will be logged simultaneously if Smart Cruise is enabled and the data is not being received, the received data is bad or the Smart Cruise unit has been removed.

If these faults are received in addition to an SAE J1939 Data Link failure (SID 231 FMI 12), then the problem is with the SAE J1939 Data Link itself.

5.3.5 INTERACTION WITH OTHER FEATURES

The Cruise Control logic is also used with the DDEC Pressure Sensor Governor in fire trucks. Both systems cannot be configured on the same engine. Refer to section 5.29 for more information on the Pressure Sensor Governor. DDEC can be configured to allow the engine brakes to activate during Cruise Control operation.

NOTE:
Cruise Control maximum speed cannot exceed the vehicle speed limit.

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5.4 CRUISE CONTROL FOR DRILLING/PUMPING APPLICATIONS WITH OPTIONAL DUAL STATION CONTROL

Cruise control for drilling/pumping applications is an optional DDEC feature that allows the setting of a targeted engine speed and a easy return to the targeted speed from idle.

For example, petroleum mud pumps are used to supply fluid to a drilling bit when a well is being drilled. The operator will carefully adjust engine speed until he/she achieves the desired pumping rate. The optimum speed will vary from job to job. The operator will continue until a new section of drilling pipe must be added. At that point, the engine must be brought back to idle and the transmission or clutch disengaged while new pipe is threaded in place. The operator can then bring the engine back up to operating speed and continue the drilling and pumping operation.

5.4.1 OPERATION

This feature allows the operator to set an engine speed during the drilling and pumping process, drop to idle speed, and then return to the original speed. Returning to the original set speed is desirable since it has been carefully dialed in by the operator and is ideal for the particular job. The Engine Speed Cruise Control feature would work to provide the desired engine set speed for the pumping operation, but it is not configured to resume speed from engine idle.

This process operates as follows:

1. Start the engine, idle, and warm up.
2. Engage the ALT_MIN_VSG Switch - engine goes to ALT_MIN_VSG speed (e.g. 650 rpm).
3. Engage the Cruise Enable Switch.
4. Adjust the hand throttle to the desired speed, e.g. 1700 rpm.
5. Engage set/coast - sets speed to the desired speed, 1700 rpm.
6. Adjust the hand throttle back to idle position.
7. When the need to add pipe arises, engage the brake switch. The engine drops to 650 rpm.
8. When ready to continue, engage Resume/Accel and the speed returns to 1700 rpm.

5.4.2 PROGRAMMING REQUIREMENTS & FLEXIBILITY

The hardware and software configuration include the proper 6N4C group for VSG engine governing such as 06N04C0720 and customer selectable parameters.

The customer selectable parameters settings are listed in Table 5-10.

Parameter	Description	Setting
Cruise Control Enable	Enables the engine speed cruise control feature.	YES
Alternate Minimum VSG	Sets the Alternate Minimum VSG speed	650 RPM (set above the idle speed)

Table 5-10 Customer Selectable Parameters

The digital inputs listed in Table 5-11 must be programmed.

Description	Type	Function Number
Cruise Enable	Digital Input	23
Set/Coast	Digital Input	20
Resume/Accel	Digital Input	22
Service Brake	Digital Input	17
Alt Min VSG	Digital Input	16

Table 5-11 Digital Inputs

5.4.3 DUAL STATION CONTROLS

This feature will also work with dual control stations. The operator has the capability of starting the engine at Station 1 mounted near the engine, follow the operation procedure above, and while at the desired operating speed, switch to throttle Station 2 and adjust engine speed remotely, if desired. The operator could then switch back to Station 1 when pipe was to be added.

For dual station controls, the digital inputs listed in Table 5-10 are required in addition to the digital inputs listed in Table 5-12.

Description	Type	Function Number
VSG Station Change	Digital Input	33
VSG Station Change Complement	Digital Input	34

Table 5-12 Additional Dual Station Control Digital Inputs

For additional installation information on VSG Dual Station Controls, refer to section, 4.31 "Throttle Controls/Governors".

5.5 DIAGNOSTICS

Diagnostics is a standard feature of the DDEC system. The purpose of this feature is to provide information for problem identification and problem solving in the form of a code. The ECM continuously performs self diagnostic checks and monitors the other system components. Information for problem identification and problem solving is enhanced by the detection of faults, retention of fault codes and separation of active from inactive codes.

5.5.1 OPERATION

The engine-mounted ECM includes control logic to provide overall engine management. System diagnostic checks are made at ignition on and continue throughout all engine operating modes.

Sensors provide information to the ECM regarding various engine and vehicle performance characteristics. The information is used to regulate engine and vehicle performance, provide diagnostic information, and activate the engine protection system.

Instrument panel warning lights (see Figure 5-5), the Check Engine Light (CEL) and the Stop Engine Light (SEL), warn the engine operator. The CEL is an amber light and the SEL is a red light.

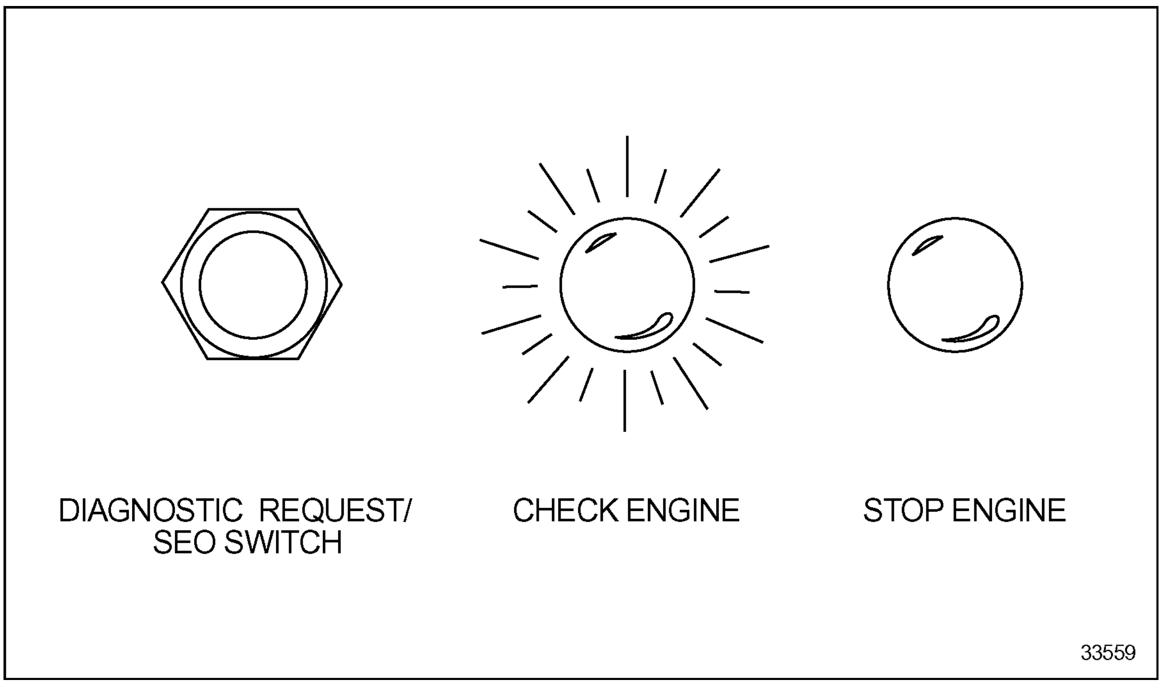

Figure 5-5 Typical Diagnostic Request/SEO Switch and Warning Lights

The CEL is illuminated and a code is stored if an electronic system fault occurs. This indicates the problem should be diagnosed as soon as possible. The ECM illuminates the CEL and SEL and stores a malfunction code if a potentially engine damaging fault is detected. These codes can be accessed in one of four ways:

- ☐ Using the Diagnostic Data Reader (DDR)
- ☐ Flashing the CEL and SEL with the Diagnostic Request Switch (may be combined with Stop Engine Override switch, see Figure 5-5)
- ☐ Using the Detroit Diesel Diagnostic Link™ (DDDL) PC software package
- ☐ By ProDriver®, Electronic Fire Commander™, Electronic Display Module (EDM), or other display

There are two types of diagnostic codes:

- ☐ An *active code* - a fault present at the time when checking for codes
- ☐ An *inactive code* - a fault which has previously occurred; inactive codes are logged into the ECM and time stamped with the following information:
  - ☐ First occurrence of each diagnostic code in engine hours
  - ☐ Last occurrence of each diagnostic code in engine hours
  - ☐ Total time in seconds that the diagnostic code was active

Diagnostic Request Switch

The Diagnostic Request Switch is used to activate the CEL/SEL to flash codes. Active codes are flashed on the SEL and inactive codes are flashed on the CEL (see Figure 5-6). Inactive codes are flashed in numerical order, active codes are flashed in the order received, most recent to least recent. The Diagnostic Request Switch can also be used as the Stop Engine Override (SEO) Switch. The codes are flashed out of the ECM connected to the switch.

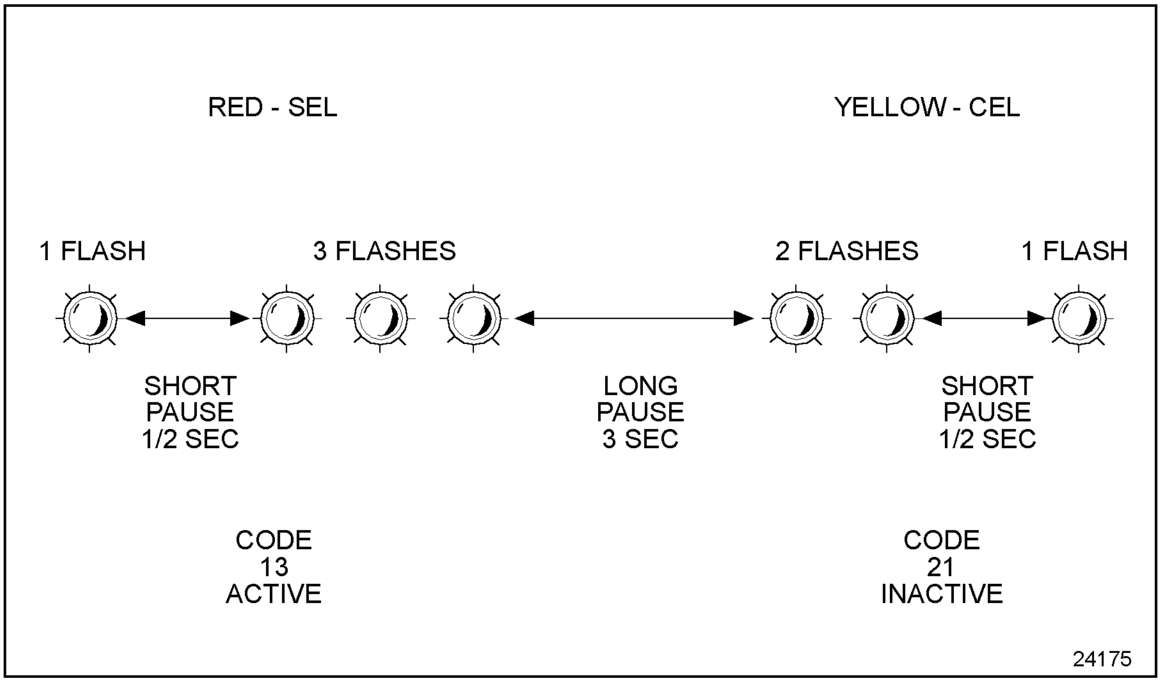

Figure 5-6 Flash Codes

NOTE:
For multi-ECM installations, the Diagnostic Request Switch and SEO are combined on the master ECM. All receiver ECMs have a separate Diagnostic Request Switch.

The Diagnostic Request Switch is used to flash codes in the following circumstances:

- ☐ The engine is not running and ignition is ON
- ☐ The engine is idling

In both circumstances, activating and holding the Diagnostic Request Switch will flash out the diagnostic codes.

Diagnostic Request Switch/Stop Engine Override

If no separate Diagnostic Request Switch is configured, the SEO Switch serves as both a Diagnostic Request Switch and an SEO Switch.

The Diagnostic Request/Stop Engine Override Switch is used to flash codes in the following circumstances:

- ☐ The engine is not running and ignition is on
- ☐ The engine is idling

In both circumstances, activating and releasing the switch will flash out the diagnostic codes; activating and releasing the switch a second time will stop the ECM from flashing the diagnostic codes. Codes will also cease flashing if the engine is no longer at idle. The codes are flashed out of the ECM connected to the switch.

NOTE:
For multi-ECM installations, the Diagnostic Request Switch and SEO Switch are combined on the master ECM. All receiver ECMs have a separate Diagnostic Request Switch.

5.5.2 DEFINITIONS AND ABBREVIATIONS

Parameter Identification Character (PID): A PID is a single byte character used in SAE J1587 messages to identify the data byte(s) that follow. PIDs in the range 0-127 identify single byte data, 128-191 identify double byte data, and 192-253 identify data of varying length.

Subsystem Identification Character (SID): A SID is a single byte character used to identify field-repairable or replaceable subsystems for which failures can be detected or isolated. SIDs are used in conjunction with SAE standard diagnostic codes defined in SAE J1587 within PID 194.

Failure Mode Identifier (FMI): The FMI describes the type of failure detected in the subsystem and identified by the PID or SID. The FMI and either the PID or SID combine to form a given diagnostic code defined in SAE J1587 within PID 194.

Flashing Codes: Provides a two digit number (see Figure 5-6). This code may cover several specific faults. It is provided to advise the operator of the general severity of the fault so the operator can decide if engine operation can continue without damaging the engine.

Refer to Appendix A for a list of codes, the code number when flashed, the SAE J1587 number and a description of each code.

5.6 EDM AND AIM

The Construction and Industrial Electronic Display Module (EDM) and Auxiliary Information Module (AIM) are the two components which comprise the Detroit Diesel Construction and Industrial Electronic Display system for engine and equipment parameters.

5.6.1 OPERATION

The EDM (see Figure 5-7) may be used alone to display engine parameters or in conjunction with the AIM to display additional equipment parameters. AIM cannot be used without the EDM.

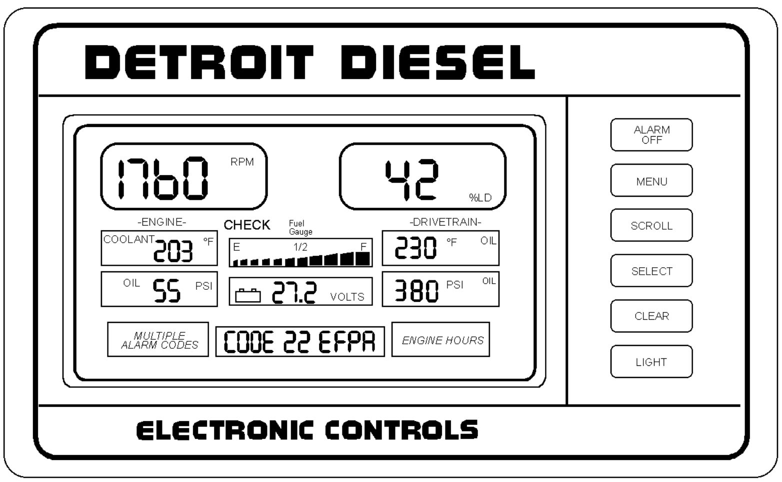

Figure 5-7 Electronic Display Module

The EDM will display the following parameters at all times if the sensor is installed on the equipment:

- ☐ Engine RPM
- ☐ Engine Coolant or Oil Temperature
- ☐ (Oil Temperature only when coolant temperature is unavailable from the ECM)
- ☐ Engine Oil Pressure
- ☐ ECM Battery Voltage or Auxiliary Current (Requires AIM) - (Battery Voltage display)
- ☐ Vehicle Speed or Auxiliary Pump Pressure or Engine Load
- ☐ Equipment Temperature or Pressure (Requires AIM)
- ☐ Equipment Temperature or Pressures (Requires AIM) or Engine Turbo Boost Pressure
- ☐ Fuel Level (Requires AIM)

- ☐ Check and Stop Indicators

The AIM (see Figure 5-8) is used in conjunction with the EDM to display additional equipment parameters.

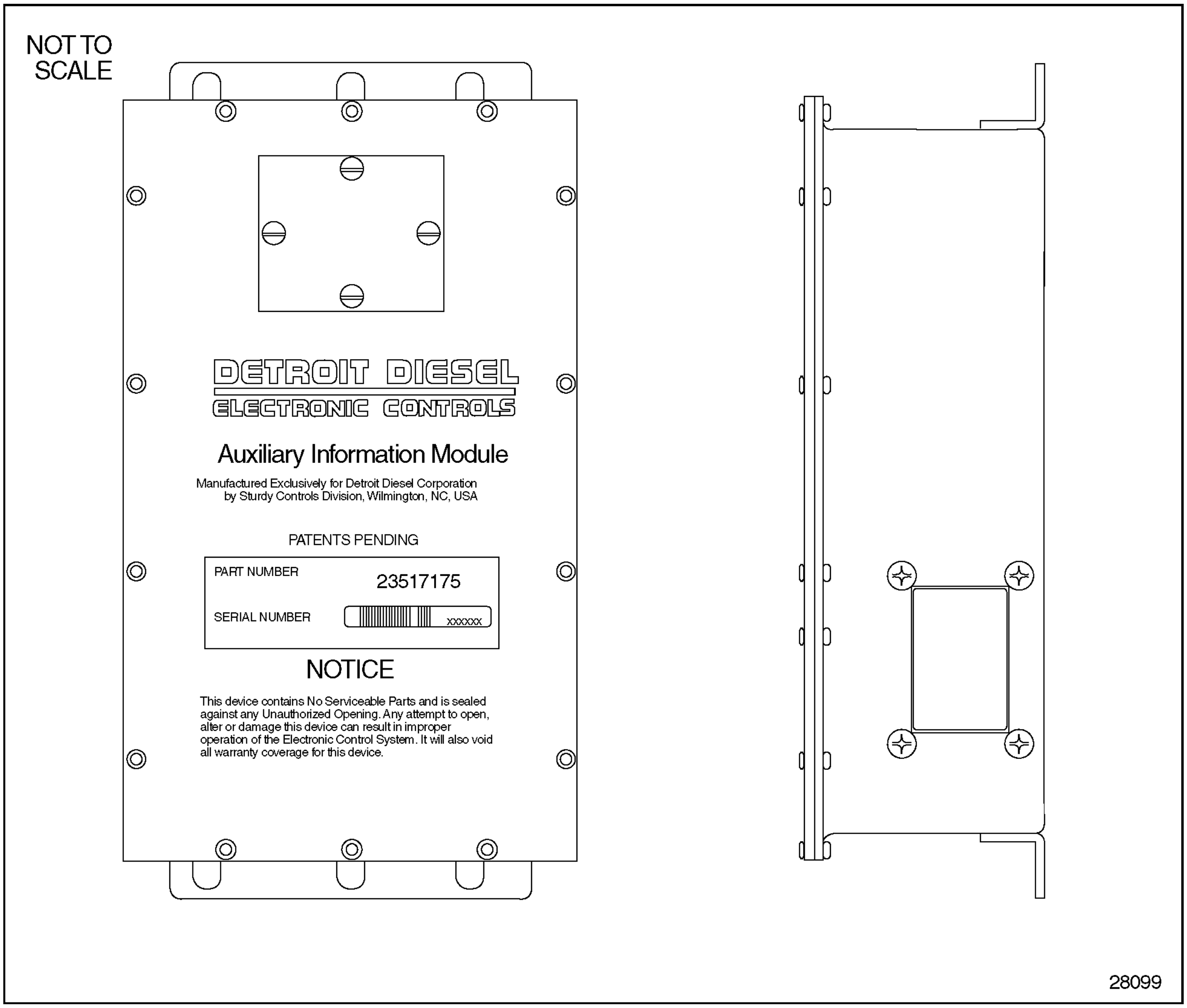

Figure 5-8 Auxiliary Interface Module

5.6.2 INSTALLATION

For information on installing the Construction and Industrial EDM and AIM refer to the *Construction & Industrial EDM and AIM Installation and Troubleshooting* manual (7SA801).

5.6.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Refer to *Construction & Industrial EDM and AIM Installation and Troubleshooting* manual (7SA801).

5.6.4 INTERACTION WITH OTHER FEATURES

DDEC installations equipped with both the EDM and AIM may initiate engine shutdowns based on equipment parameters. The shutdown option include the standard 30 second shutdown as well as an option for an immediate engine shutdown.

5.6.5 DIAGNOSTICS

Refer to the *Construction & Industrial EDM and AIM Installation and Troubleshooting* manual (7SA801).

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5.7 ELECTRONIC FIRE COMMANDER

The Detroit Diesel Electronic Fire Commander™ (EFC) is designed to support DDEC III and DDEC IV engines in the fire fighting and emergency services market. It combines the DDEC Pressure Sensor Governor (PSG), a system monitor, and a pump panel display for vital engine operating parameters into one compact, durable package (see Figure 5-9).

EFC replaces the PSG switches, as well as many pump panel gauges as it provides complete control and monitoring of both DDEC III and DDEC IV systems on the fire truck.

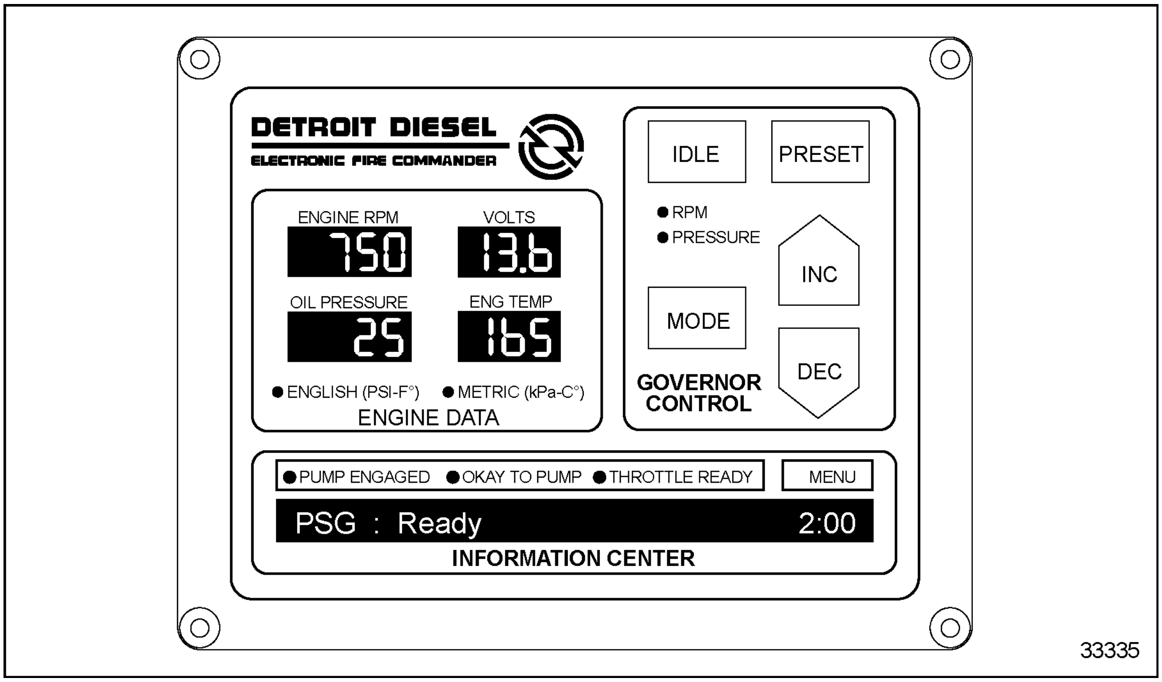

Figure 5-9 Electronic Fire Commander Pump Panel Display

RPM, Oil Pressure, Oil or Coolant Temperature, and ECM Voltage are displayed continuously in the Engine Data section of the EFC.

Messages and any known diagnostic code accompanying a Check Engine or Stop Engine condition will be displayed on the Information Center message display. The external alarm output will also be activated. The EFC displays the PSG status in the Information Center whenever the OEM interlocks are met. The real time of day will also be displayed. The EFC logs the time that the pump is engaged and that time can be displayed using the Information Center.

5.7.1 OPERATION

The Electronic Fire Commander has two modes of operation:

- ☐ RPM Mode (engine speed)
- ☐ Pressure Mode (water pump pressure, psi)

RPM Mode controls engine speed to a desired RPM and Pressure Mode controls engine speed to maintain a desired discharge manifold pressure.

The operating modes are selectable and may be changed by pressing the MODE button providing the appropriate interlocks have been met. The engine will continue to run at the same speed when the mode switch is toggled between the RPM and Pressure modes.

The maximum preset pressure for EFC is 200 psi.

5.7.2 INSTALLATION

The Electronic Fire Commander Harness schematic shows the minimum requirements for the PSG to operate (see Figure 5-10). Additional functions and interlocks may be used. Refer to the *Electronic Fire Commander Installation and Troubleshooting* manual (6SE476).

EFC may be powered from a 12/24 V supply.

5.7.3 ORDERING EFC

The hardware listed in Table 5-13 is needed for Pressure Governor installation with EFC. The 6N4C group must be specified at engine order entry or through Detroit Diesel Technical Service.

Component	Part Number
Electronic Fire Commander	23519655
Pressure Sensor	23520795
Electronic Fire Commander Harness (see Figure 5-10)	OEM Supplied
OEM Interlocks	OEM Supplied

Table 5-13 Electronic Fire Commander and Pressure Sensor

Hardware available from the DDC Parts Distribution Center for installation of Electronic Fire Commander (EFC) is listed in Table 5-13 as a complete kit. The 6N4C group must be specified at engine order entry or through Detroit Diesel Technical Service.

Component	Part Number
Electronic Fire Commander Kit (contains Electronic Fire Commander and the pressure sensor)	23520139

Table 5-14 Electronic Fire Commander Kit

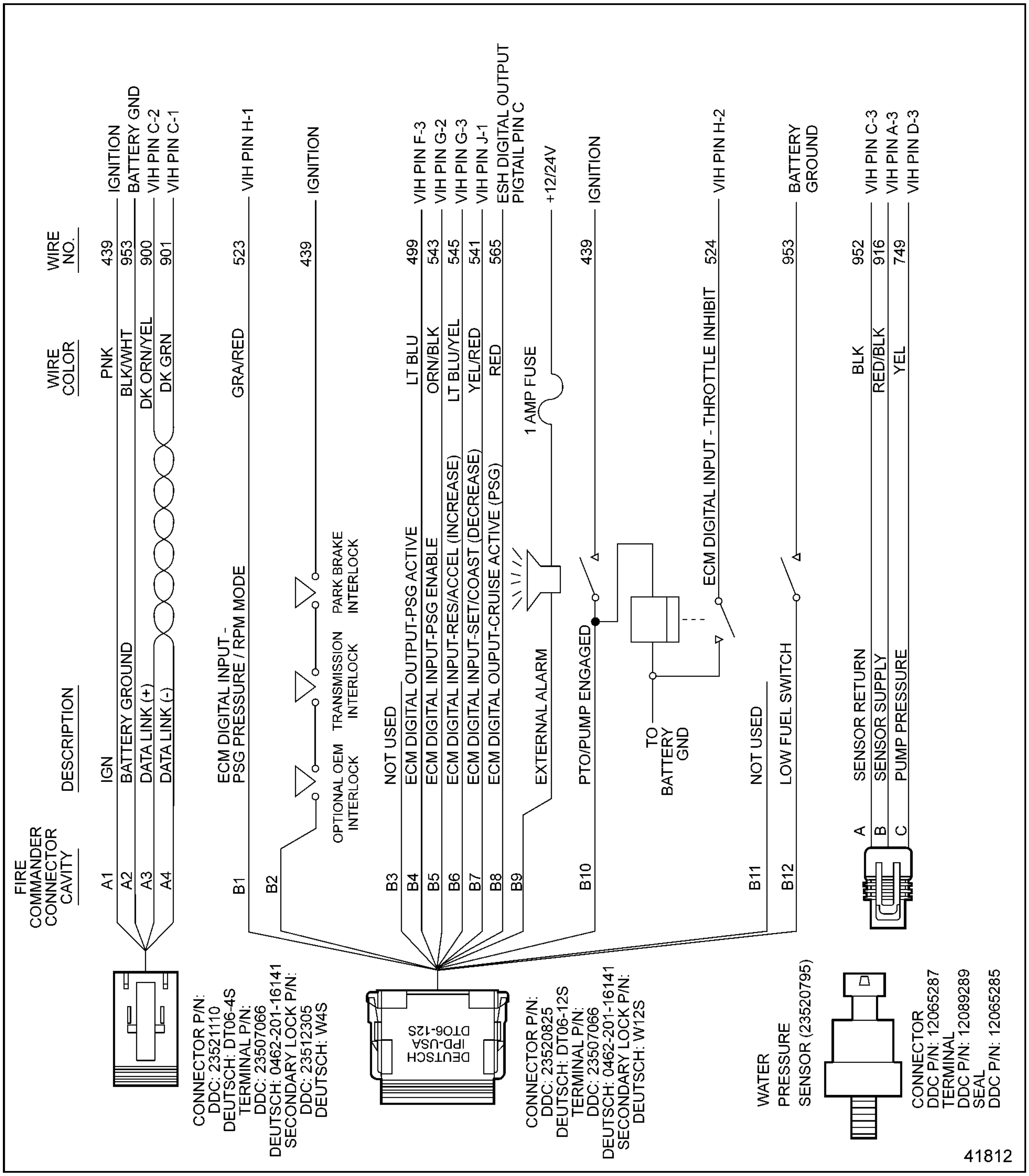

Figure 5-10 Electronic Fire Commander Harness

5.7.4 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The digital inputs listed in Table 5-15 are required for use with EFC and can be configured at order entry, by VEPS, or DRS. Refer to section 4.1, "Digital Inputs," for additional information.

Description	Function Number	Circuit Number*	VIH-to-ECM Connector Assignment*
Pressure/RPM Mode	8	523	H1
PSG Enable	24	543	G2
Resume/Accel On (increase)	22	545	G3
Set/Coast On (decrease)	20	541	J1

* DDC circuit numbers and port assignments shown are default settings but can differ from application to application.

Table 5-15 Required Digital Inputs for EFC

The digital outputs required for use with EFC are listed in Table 5-16 and can be configured at order entry, by VEPS, or DRS. Refer to section 4.2, "Digital Outputs," for additional information.

Description	Function Number	Circuit Number*	Connector Assignment*
PSG Active	5	499	VIH-to-ECM Connector - Cavity F3
Cruise Active	11	565	Pigtail off the Engine Sensor Harness - Cavity Y3

* DDC circuit numbers and port assignments shown are default settings but can differ from application to application.

Table 5-16 Required Digital Outputs for EFC

The correct 6N4C group must be specified at engine order entry or through Detroit Diesel Technical Service. More information is available in the manual *Electronic Fire Commander Installation and Troubleshooting* (6SE476).

5.8 ELECTRONIC SPEED SWITCH

The Electronic Speed Switch (ESSE-2) is a two channel electronic speed switch typically used in generator set applications. Two channels can be used for crank (starter motor) disconnect and overspeed protection, or for underspeed and overspeed warnings.

5.8.1 OPERATION

The switches on the cover of ESSE-2 are used for two conditions: no power and power applied with no signal present. When the engine reaches proper speed during cranking, Switch 1 will close causing the cranking motor to be disconnected. Switch 2 closes during an overspeed condition causing the engine to cease operation. by removing power from the fuel solenoid.

The setpoint for switch closing is determined by the two setpoint potentiometers.

There are four reset options available for resetting the speed switch: electrical latch, manual reset, automatic reset and adjustable reset.

Electrical Latch

After the setpoint has been reached, the switch will close and remain closed even if the input signal frequency has been lowered to 0 Hz. The only way to reset the unit is to remove power This switch is typically used for overspeed protection.

Manual Reset

The ESSE-2 is supplied with a reset button. The unit will be reset by pressing the reset button.

Automatic Reset

The switch automatically resets if the frequency of the input signal is lowered to 85 ± 5% of the setpoint. This switch is typically used for crank disconnect.

Adjustable (Automatic) Reset

The switch will automatically reset at the frequency determined by the setting of the supplied reset potentiometer. The reset can be selected anywhere between 25% and 95% by adjusting the potentiometer.

5.8.2 INSTALLATION

Four mounting holes are provided on the ESSE-2 case. Mount the unit in a location where vibration effects are minimized. Two conductor shielded cable should be used to connect the signal source, Mini-Gen, mag pickup, to ESSE-2. Single conductor shielded cable is recommended for alternator or ignition signal sources. The shield should be connected to ground only at one end. The shield is connected to Terminal 2 for the Mini-Gen or mag pickup connection and to Terminal 5 for the alternator connection.

Fuses or circuit breakers should be connected in series with the load to protect ESSE-2. The fuse should be a 10 Amp slow blow. The circuit breaker should be rated at 10 Amps. If load currents in excess of 10 Amps are expected, interface relays should be used. See Figure 5-11.

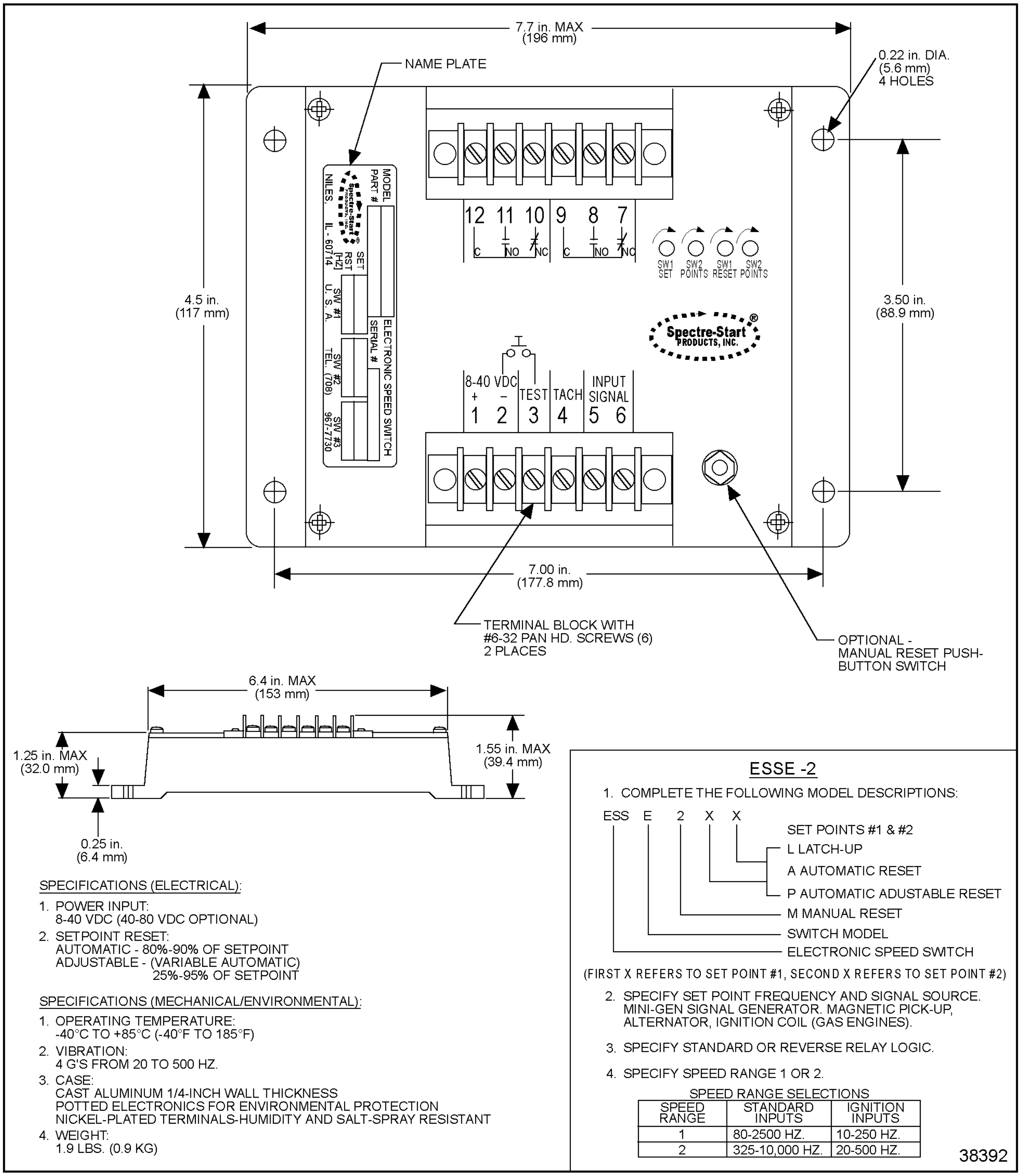

Figure 5-11 Electronic Speed Switch Installation

The pin definition for the connector, current, and wire gage are listed in Table 5-17.

Current	Terminals	Wire Gauge
Under 5 Amps	1-2, 7-12	16 AWG
5 - 10 Amps	1-2, 7-12	14 AWG
--	3-6	18 - 20 AWG

Table 5-17 Wire Gauge for ESSE-2

The electrical input voltage options for ESSE-2 are listed in Table 5-18.

Input Voltage Option	8 - 40 VDC	40 - 80 VDC
Max. Operating Current	At 40 V: 250 MA	At 80 V: 115 MA
	At 24 V: 220 MA	At 64 V: 100 MA
	At 12 V: 200 MA	At 40 V: 50 MA
Max. Standby Current	At 40 V: 70 MA	At 80 V: 75 MA
	At 40 V: 45 MA	At 64 V: 60 MA
	At 40 V: 30 MA	At 40 V: 50 MA
Relay Contact Ratings	0.1 to 10 Amps - 28 VDC Resistive Load	0.1 to 4 Amps - 75 VDC Resistive Load
	0.1 to 8 Amps - 28 VDC Inductive Load	0.1 to 3 Amps - 75 VDC Inductive Load
Power Supply Transient Protection	900 VDC for 100 microseconds Exponential Decay	900 VDC for 100 microseconds Exponential Decay
	140 VDC for 1 milliseconds Exponential Decay	140 VDC for 1 milliseconds Exponential Decay
	110 VDC for 0.45 seconds Exponential Decay	110 VDC for 0.45 seconds Exponential Decay
Reverse Polarity Protection	1000 VDC	1000 VDC

Table 5-18 ESSE-2 Electrical Input Voltage Options

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5.9 ENGINE BRAKE CONTROLS

The Engine Brake option converts a power-producing diesel engine into a power-absorbing air compressor. This is accomplished by opening the cylinder exhaust valves near the top of the normal compression stroke and releasing the compressed cylinder charge to exhaust. The release of the compressed air to atmospheric pressure prevents the return of energy to the engine piston on the expansion stroke, the effect being a net energy loss. Fueling is cut off when this occurs.

5.9.1 OPERATION

A dash mounted On/Off Switch is used to enable the Engine Brake option. DDEC IV will directly control the engine brake solenoids using an intensity switch to select two, four or six cylinders to produce low, medium, or high braking power on a Series 60. For Series 71/92, the intensity switch is used to select left bank or left and right bank cylinders to produce low or high braking power for 6V and 8V engines. Inline 6-71 engines use an intensity switch to select the front three or all cylinders to produce low or high braking power. The engine brakes are engaged every time the foot pedal is brought back to the idle position and Cruise Control is not active.

The following are six options for Engine Brake:

- ☐ Cruise Control with Engine Brake
- ☐ Engine Brake Disable
- ☐ Engine Brake Active
- ☐ Engine Fan Braking
- ☐ Clutch Released Input
- ☐ Service Brake Control of Engine Brakes
- ☐ Min. MPH for Engine Brakes

Cruise Control with Engine Brake

The Engine Brake option can also provide Engine Brake capability when the vehicle is in Cruise Control. For example, if the vehicle is going down hill in Cruise Control while the engine brake is selected, the ECM will control the amount of Engine Brake with respect to the Cruise Control set speed. The level of Engine Brake (low, medium, high) selected with the dash switches will be the maximum amount of engine braking the ECM allows. Cruise Control with Engine Brake can be set with DDDL/DDR, VEPS, and DRS.

Engine Brake Disable

The Engine Brake Disable option uses a digital input which is switched to ground whenever a vehicle system, such as a traction control device, does not allow engine braking to occur. This option is required for most automatic transmissions.

Engine Brake Active

The Engine Brake Active option uses a digital output that can be used to drive an Engine Brake Active Light. This output is switched to battery ground whenever the engine brake is active.

Engine Fan Braking

The Engine Fan Braking option turns on the cooling fan when the engine brake level is high and DDEC fan control is enabled. This creates about 20 to 40 hp additional engine braking power depending on the size of the cooling fan. This option is selected at the time of engine order or set by DDDL/DDR, VEPS or DRS. For additional information, refer to section 5.14, "Fan Controls."

Clutch Released Input

The Clutch Released digital input will prevent the engine brakes from being turned on when the clutch is pressed. This input is required for use with manual transmissions. Refer to section 4.1, "Digital Inputs," for additional information.

Service Brake Control of Engine Brakes

This option will allow the dash-mounted engine brake switch to be set to the ON position but not engage the engine brakes until the service brake pedal is pressed. A digital input must be programmed for service brake. Refer to section 4.1, Digital Inputs for additional information. VEPS, DDR/DDDL or DRS can set this function. This feature is available with Release 5.0 or later.

Min MPH for Engine Brakes

This option will disable the engine brakes until a minimum vehicle speed is reached. This parameter can be configured by VEPS, DRS, or DDR/DDDL. A Vehicle Speed Sensor is required. Refer to section 3.14.25, "Vehicle Speed Sensor," for additional information.

5.9.2 INSTALLATION

See Figure 5-12 for a schematic of the internal engine brake for the DDEC III/IV ECM and see Figure 5-13 for a schematic of the internal engine brake for the DDEC III/IV ECM World Transmission interface.

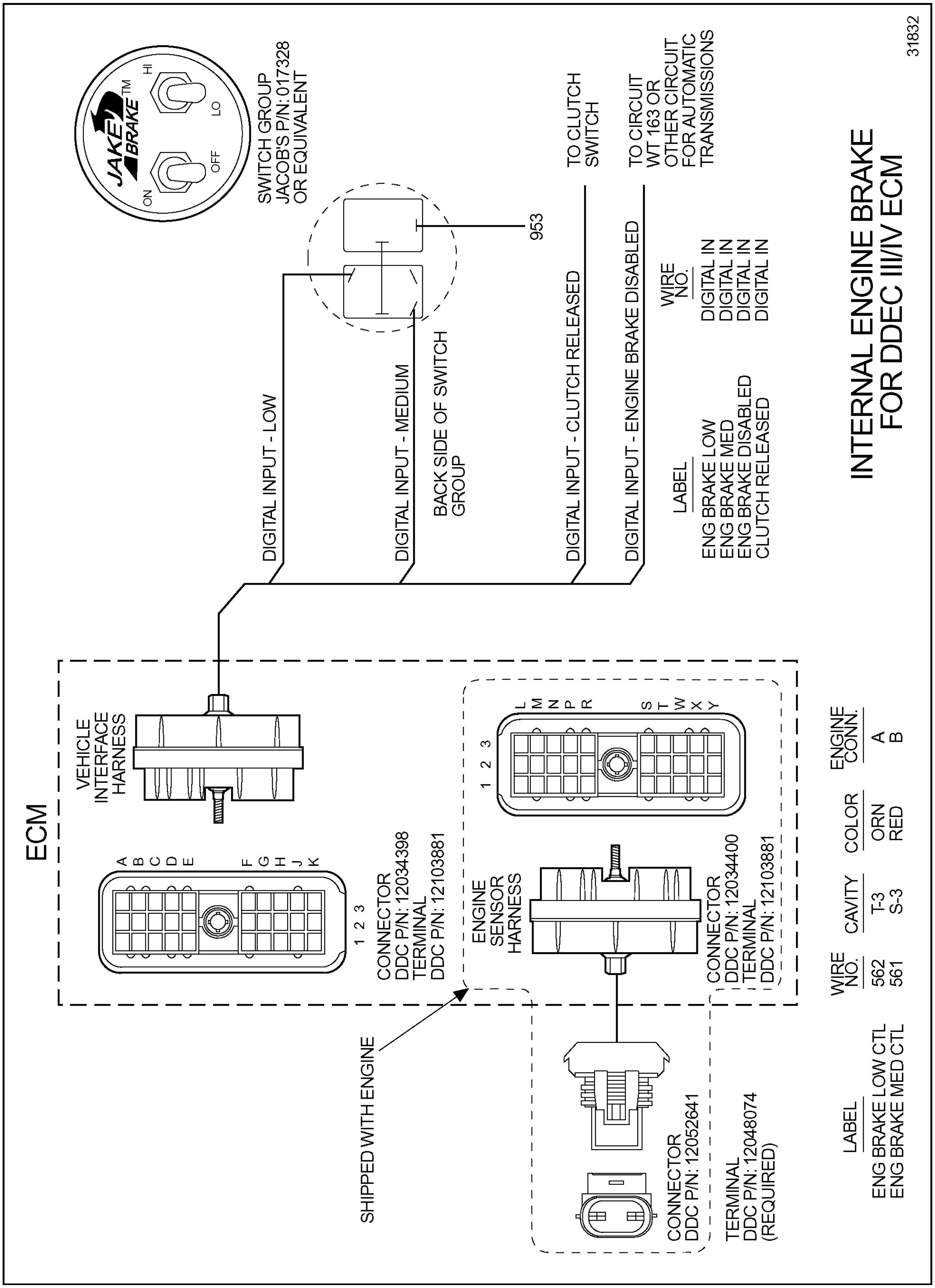


Figure 5-12 Internal Engine Brake for DDEC III/IV ECM

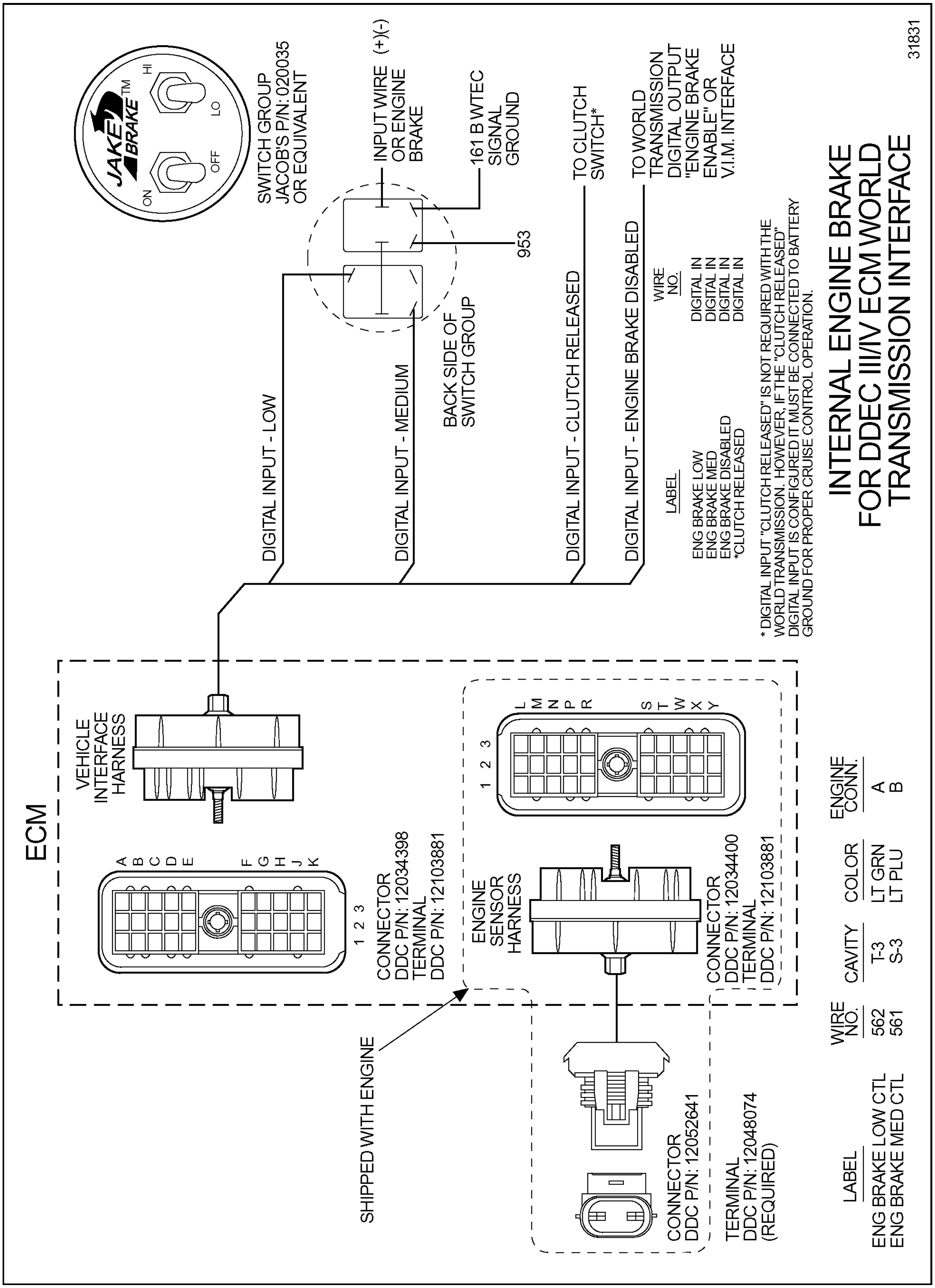


Figure 5-13 Internal Engine Brake for DDEC III/IV ECM World Trans Interface

5.9.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Engine Brake must be specified at the time of engine order or by contacting Detroit Diesel Technical Service. This enables the two digital outputs required.

The digital inputs listed in Table 5-19 must be configured by order entry, VEPS, DRS:

Description	Function Number
Engine Brake Low	1
Engine Brake Medium	2
Engine Brake Disable (required for most automatic transmissions)	26
Clutch Switch (required for manual transmissions)	18

Table 5-19 Required Digital Inputs for Engine Brake Controls

The parameters listed in Table 5-20 can be set by order entry, VEPS, DDDL/DDR or DRS for the Cruise Control Engine Brake option.

Parameter	Description	Choice / Display
CRUISE CONTROL ENGINE BRAKE	Enables or disables the feature that allows the engine brake to be used while on cruise control if the vehicle exceeds the cruise set speed.	YES, NO
CRUISE ENGINE BRAKE ACTIVATION SPEED	Sets the delta speed that the engine brake should be applied to slow the vehicle while in cruise control.	1 to 10 MPH
ENGINE BRAKE INCREMENT	Sets the additional incremental speed that must be reached before the engine brake will activate the medium and/or high level of retardation.	1 to 5 MPH

Table 5-20 Cruise Control Engine Brake Parameters

The optional digital output listed in Table 5-21 can be configured by order entry, VEPS or DRS. It can be used to drive an Engine Brake Active Light.

Description	Type	Function Number
Engine Brake Active	Digital Output	16

Table 5-21 Optional Digital Output for Engine Brakes

The Engine Fan Braking option as listed in Table 5-22 can be configured at the time of engine order, VEPS, DDR, DDDL or DRS.

Parameter	Description	Choice/Display
DYNAMIC BRAKING	Provides additional engine braking by activating the DDEC controlled fan whenever the engine brakes are active in high. This function requires both DDEC engine brake controls and DDEC fan controls.	YES, NO

Table 5-22 Optional Fan Braking for Engine Brakes

The parameter listed in Table 5-23 can be set by order entry, VEPS, DDDL/DDR or DRS for the Service Brake Control of the Engine Brakes option.

Parameter	Description	Choice / Display
SERVICE BRAKE ENABLE	When this function is enabled, an input from the service brake is required in order to activate the engine brake.	YES, NO

Table 5-23 Service Brake Control of Engine Brakes Parameter

The parameter listed in Table 5-24 can be configured by order entry, VEPS, DDR, and DDDL for the Minimum Vehicle Speed for engine braking to occur.

Parameter	Description	Choice/Display
ENGINE BRAKE MIN MPH	The minimum vehicle speed required before engine braking will occur.	0-40 MPH

Table 5-24 Minimum MPH for Engine Brakes Option

5.9.4 INTERACTION WITH OTHER FEATURES

DDEC will respond to requests from other vehicle systems via SAE J1939 data link or SAE J1922 data link to disable the engine brakes.

5.10 ENGINE PROTECTION

The DDEC engine protection system monitors all engine sensors and electronic components, and recognizes system malfunctions. If a critical fault is detected, the Check Engine Light (CEL) and Stop Engine Light (SEL) illuminate. The malfunction codes are logged into the ECM's memory.

The standard parameters which are monitored for engine protection are:

- Low coolant level
- High coolant temperature
- Low oil pressure
- High oil temperature

The additional parameters for Series 4000 and Series 2000 which are monitored for engine protection are:

- Low coolant pressure
- High crankcase pressure
- High intercooler temperature
- Low intercooler coolant pressure
- Auxiliary digital input(s)

5.10.1 OPERATION

Engine protection is a vital part of ECM programming and software. The ECM monitors coolant level, various pressures and temperatures, and compares these parameters against the allowable limits to determine when a critical fault is reached. The CEL is illuminated and a code logged if there is an electronic system fault. This indicates the problem should be diagnosed as soon as possible. The ECM illuminates the CEL and SEL and stores a malfunction code if a potentially engine damaging fault is detected. Once a critical fault is reached, the CEL and SEL are illuminated and a 30 second timer starts a countdown to the desired level of protection. Temperature and pressure limits are established in the engine's calibration and may differ slightly from one engine model to another.

Engine protection consists of different protection levels:

- Warning Only
- Rampdown
- Shutdown

Warning Only

The CEL and SEL will illuminate if a fault is detected. There is no power and/or speed reduction when "Warning Only" is selected. The resulting engine protection is at the discretion of the engine operator.

NOTE:
The operator has the responsibility to take action to avoid engine damage.

Some applications require two sets of warning lights for different control stations. The wiring for two sets of lights is in Chapter 3, refer to section 3.16.4.

NOTE:
A diagnostic switch is not required but applications using one, must have a separate diagnostic switch for each ECM on the engine.

The Diagnostic Request switch is used to activate the CEL and SEL to flash codes.

Rampdown

The CELand SEL will illuminate if a fault is detected. The ECM reduces torque and/or speed over a 30 second period after the SEL illuminates. The initial torque/speed, which is used for reduction, is the operating torque or speed prior to the SEL fault condition. See Figure 5-14.

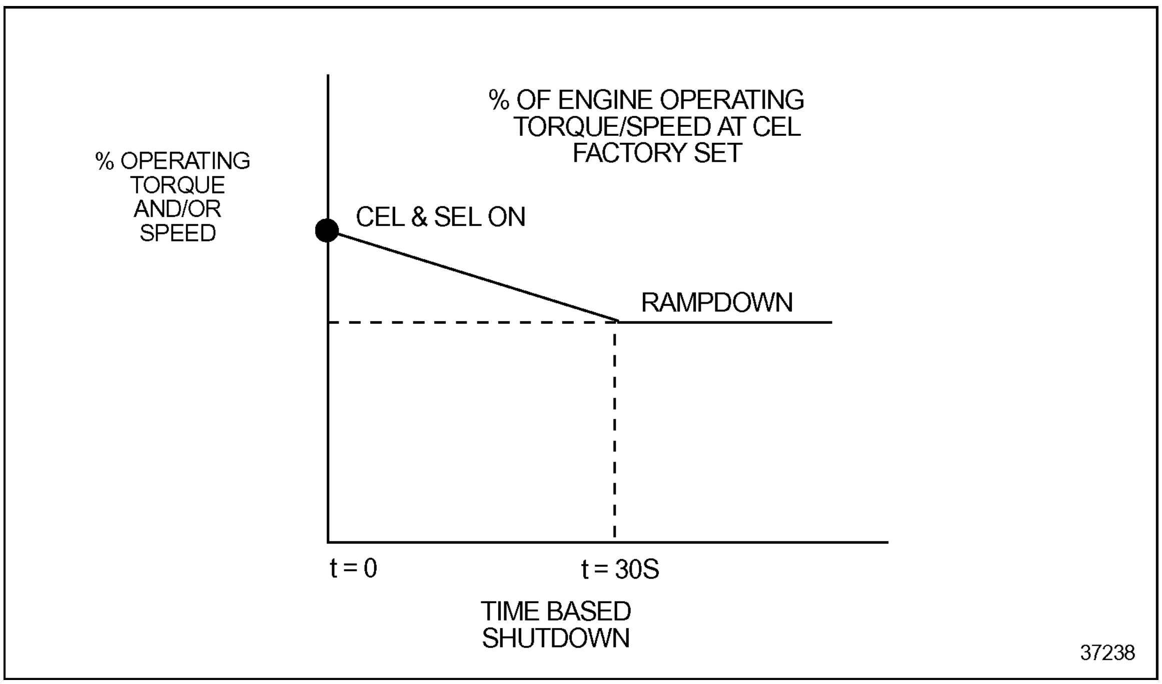


Figure 5-14 Rampdown

A Stop Engine Override (SEO)/Diagnostic Request switch is required when this engine protection option is selected. The SEO options are available to prevent engine shutdown at the operator's discretion.

Shutdown

This option operates in the same manner as rampdown, except the engine shuts down 30 seconds after the SEL is illuminated (see Figure 5-15). (The initial torque and/or speed which is used for reduction, is the torque and/or speed which occurred immediately prior to the fault condition.) The Stop Engine Override options are available to prevent engine shutdown at the operator's discretion.

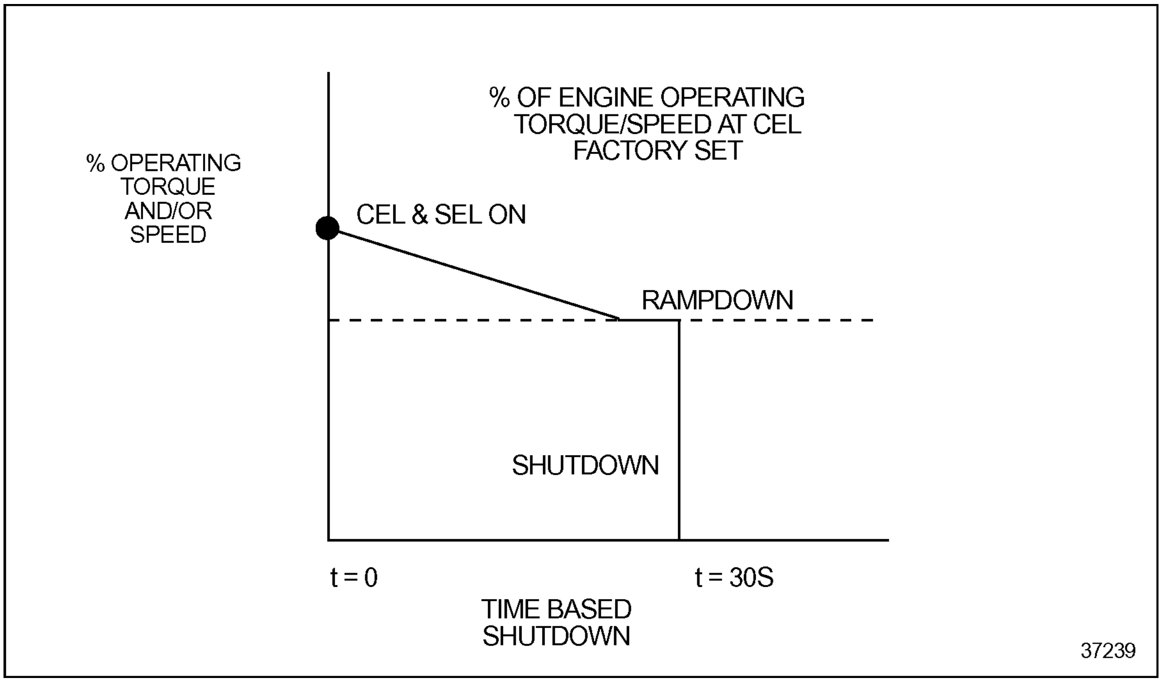


Figure 5-15 Engine Shutdown

A SEO/Diagnostic Request Switch is required when this engine protection option is selected. Refer to section 5.10.3. The SEO options are available to prevent engine shutdown at the operator's discretion.

5.10.2 ENGINE OVERTEMPERATURE PROTECTION

Engine Overtemperature Protection (EOP) is additional logic programmed into the ECM and used in conjunction with standard temperature protection. When EOP is part of the engine calibration, engine torque and/or speed is reduced as a function of temperature. The CEL illuminates and a fault code is logged when the EOP calibrated temperature is reached. If the temperature does not decrease as torque/speed is reduced, the SEL will illuminate when a still higher temperature is reached.

The subsequent action taken by the ECM depends on customer selection of one of the following:

- ☐ Warning only (see Figure 5-16)
- ☐ 30 second rampdown (see Figure 5-17)
- ☐ Shutdown (see Figure 5-18)

Torque reduction is based on the average torque/speed in use prior to the fault condition.

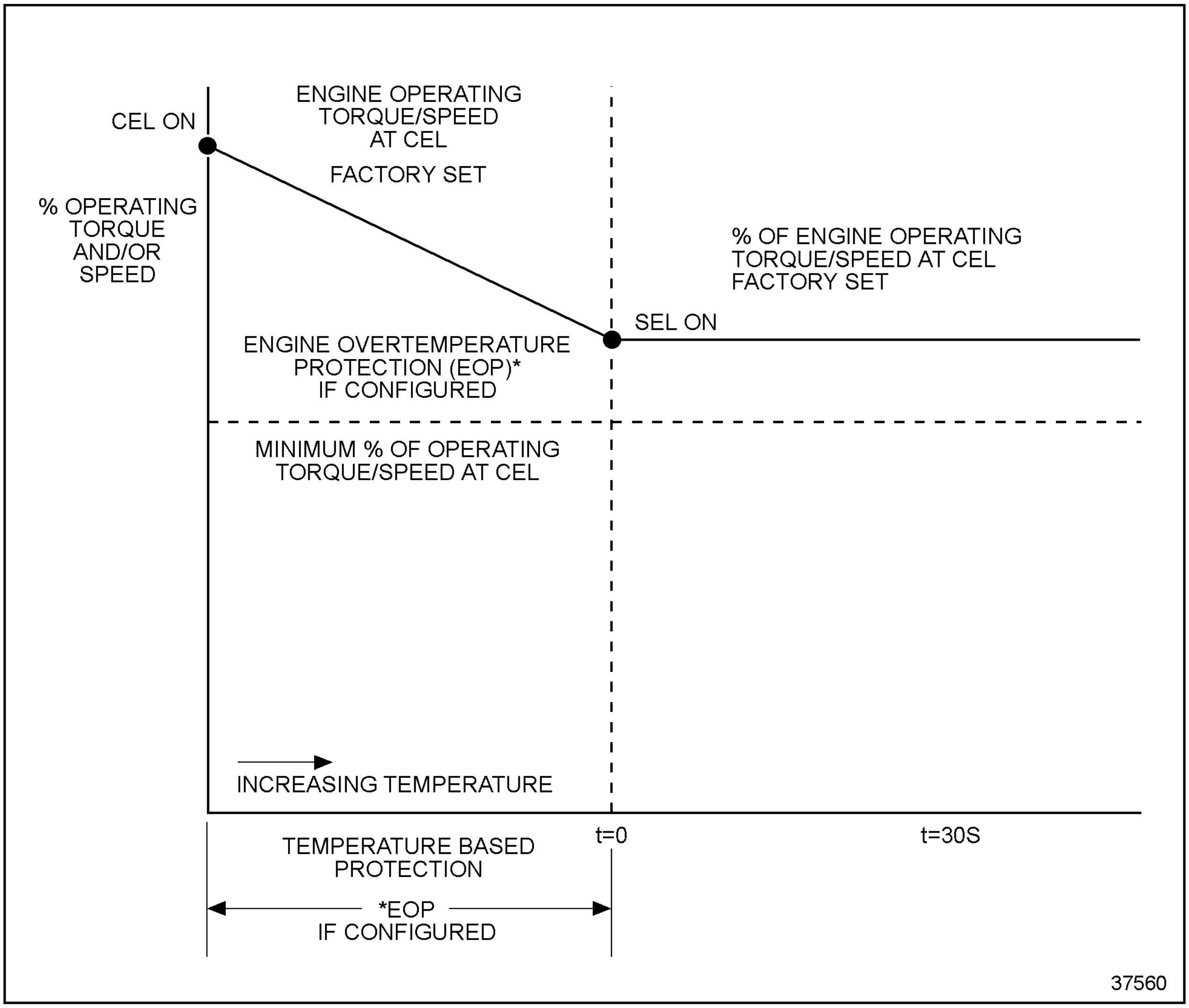


Figure 5-16 Engine Overtemperature Protection and Warning Only

EOP can be disabled when Warning Only is selected for engine protection (Release 22.00 or later only). This feature is based on the engine series as listed in Table 5-25.

Engine Series	Enabled/Disabled
Series 50, Series 60	Will not be disabled with Warning Only
Series 71, Series 92, Series 149	Will not be disabled with Warning Only
Series 2000	Will not be disabled with Warning Only
Series 4000	Will be disabled with Warning Only

Table 5-25 Warning Only Disabled

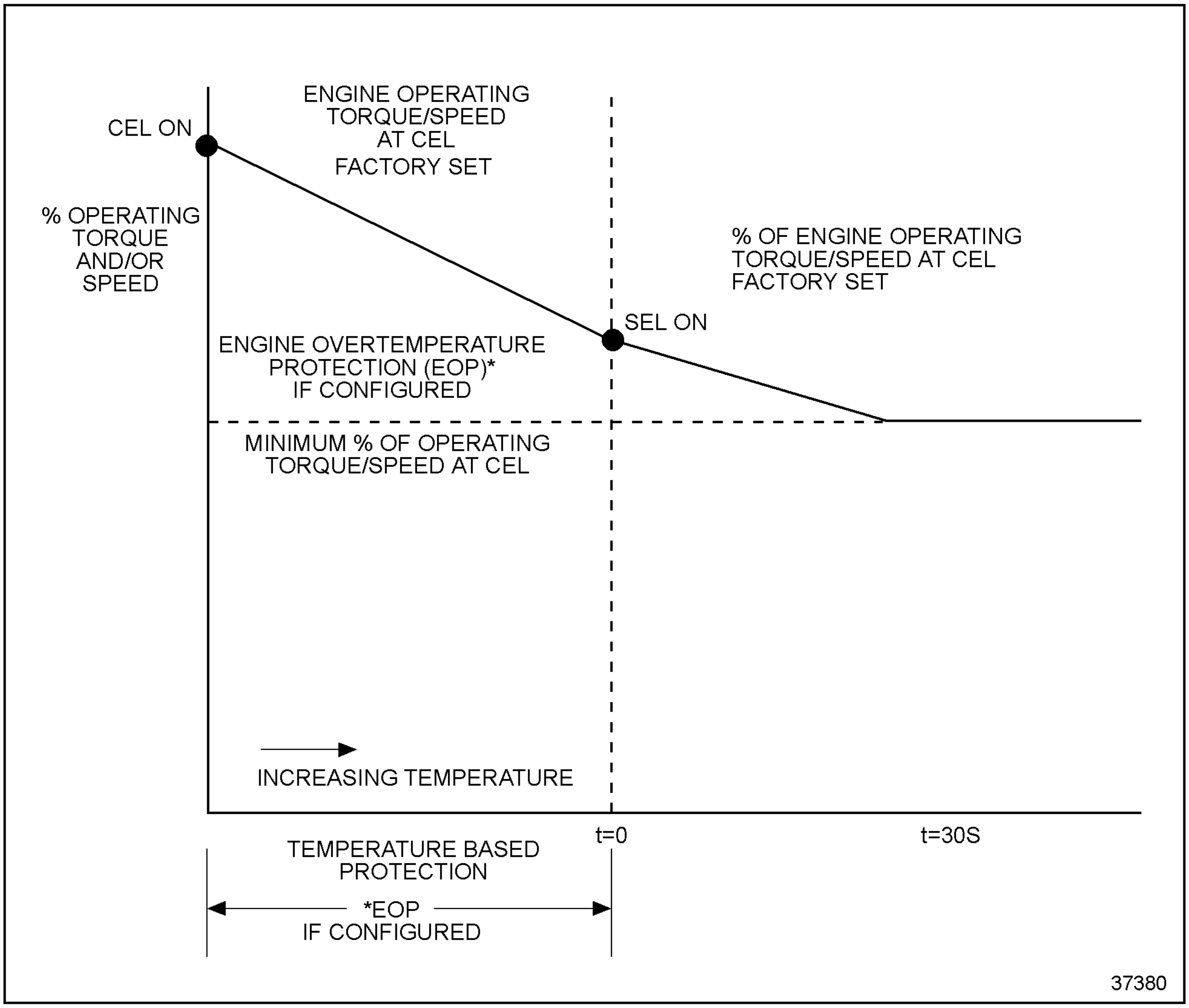


Figure 5-17 Engine Overtemperature Protection and Rampdown

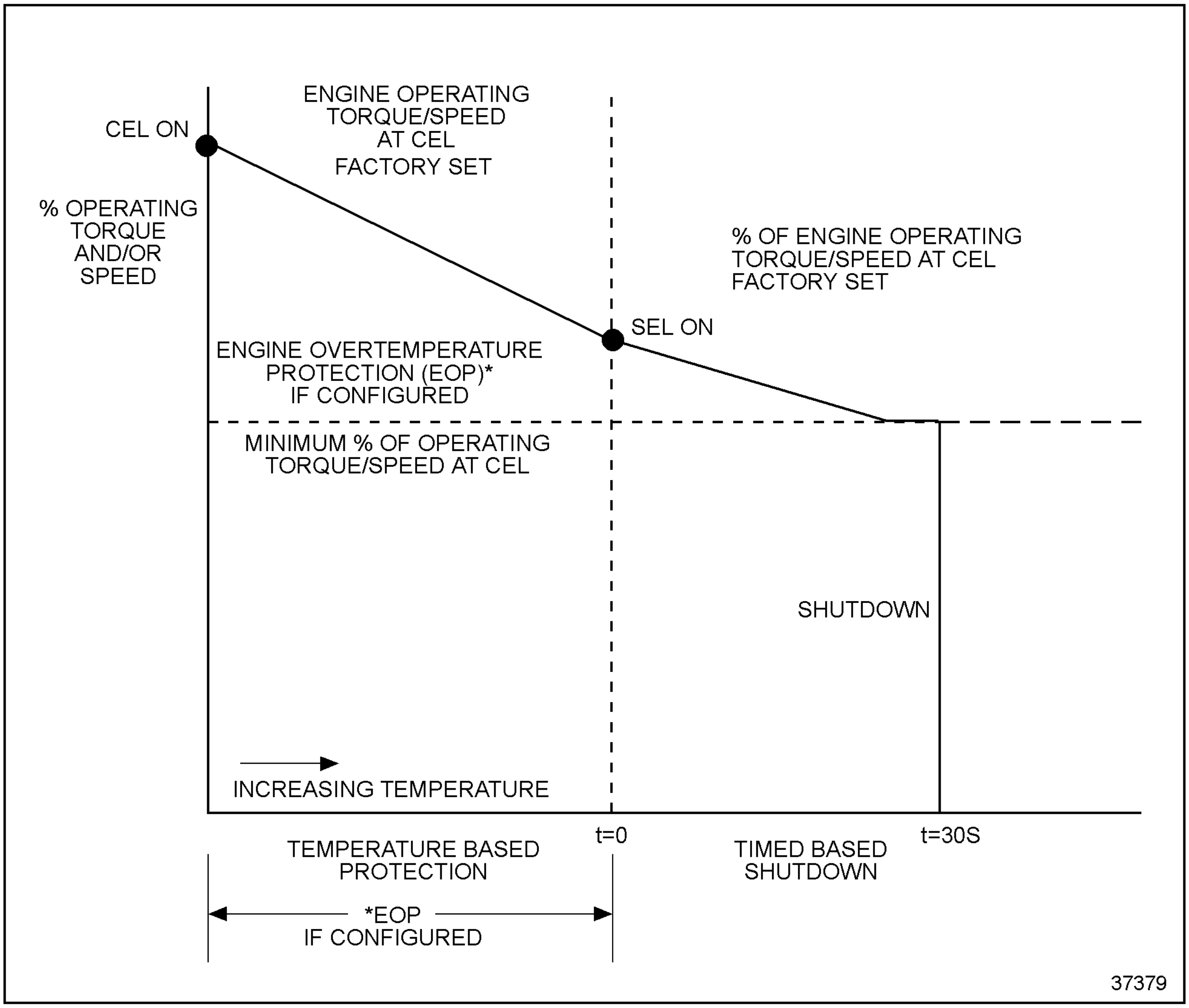


Figure 5-18 Engine Overtemperature Protection and Shutdown

Some 1999 Model Year Series 60 engines and later (DDEC Release 26.0 or later) have additional logic to start the overtemperature torque reduction logic earlier without alerting the driver. Engine torque and/or speed is reduced as a function of temperature. A code will be logged and torque reduction will begin when the first EOP calibrated temperature is reached. The CEL will illuminate and a fault code is logged when the second higher temperature limit is reached. If the temperature does not reduce as torque/speed is reduced, the SEL will illuminate when a still higher temperature is reached.

The subsequent action taken by the ECM is the 30 second rampdown (see Figure 5-19) or shutdown (see Figure 5-20) depending on the customer selection. Torque reduction is based on the average torque/speed in use prior to the fault condition.

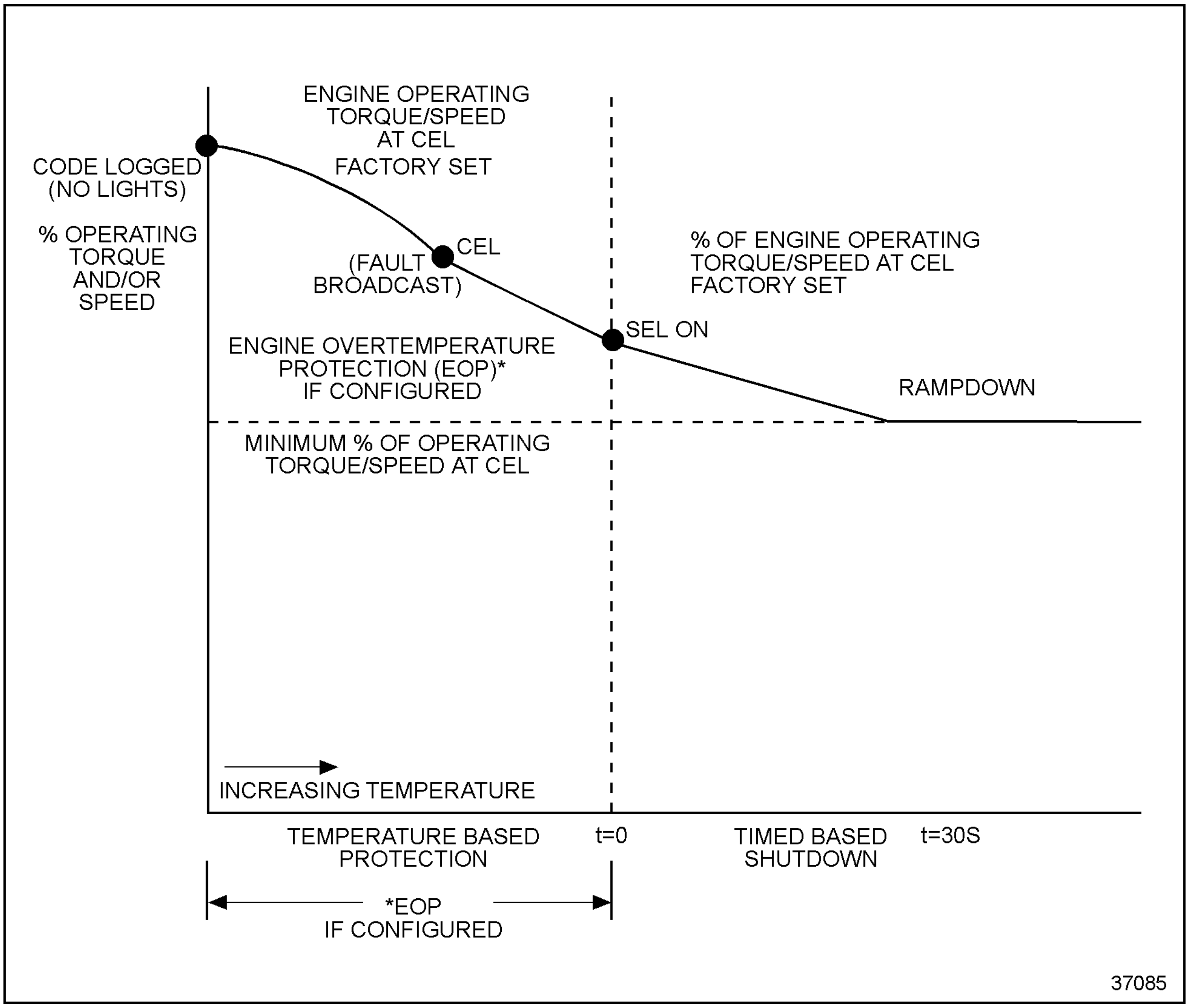


Figure 5-19 Series 60 1999 Model Year Engine Overtemperature Protection and Rampdown

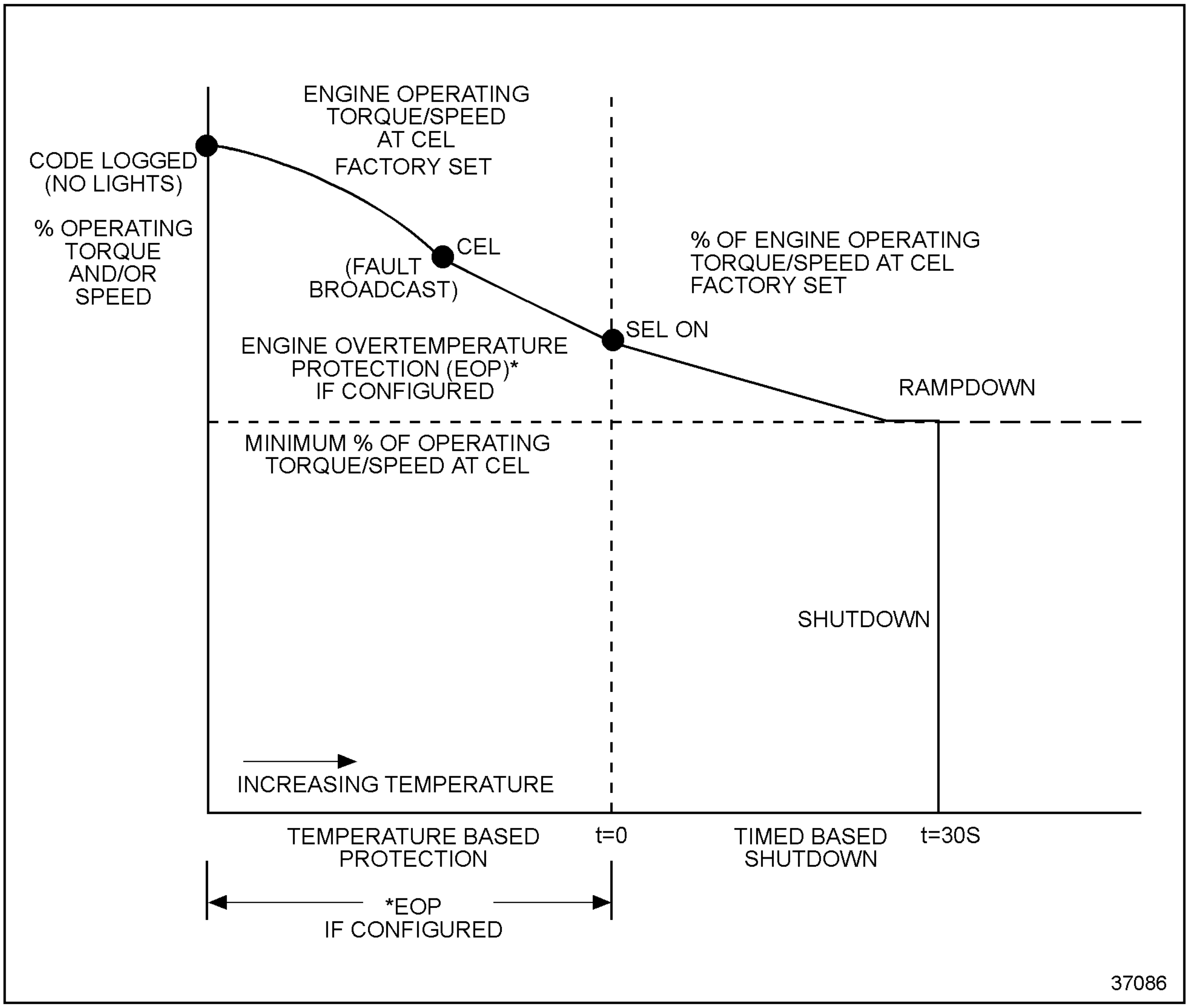


Figure 5-20 Series 60 1999 Model Year Engine Overtemperature Protection and Shutdown

5.10.3 ENGINE PROTECTION SWITCHES

The SEO/Diagnostic Request switch can be combined. A separate Diagnostic Request switch is an option.

NOTE:
EOP is active even if engine protection is configured for Warning only for the Series 60, Series 50, and Series 2000 engines.

Diagnostic Request Switch

The Diagnostic Request switch is used to activate the CEL and SEL to flash codes (see Figure 5-21). The SEL will flash the active codes and the CEL will flash the inactive codes. Refer to section 4.1.3.

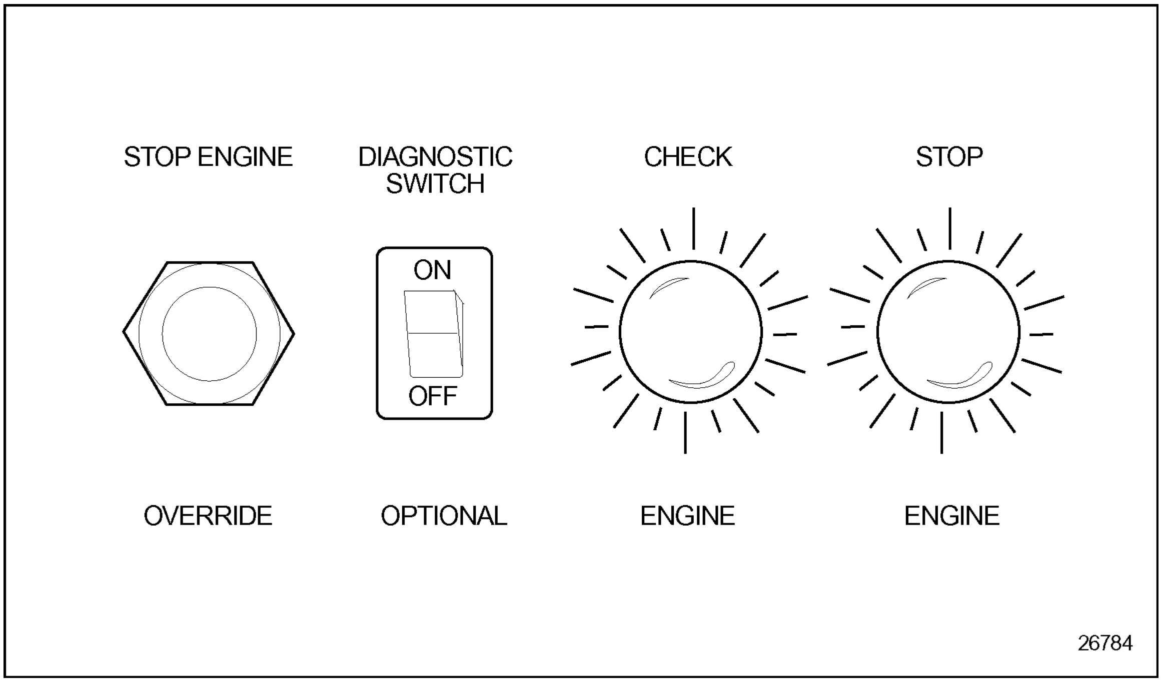


Figure 5-21 Typical SEO Switch, Diagnostic Request Switch and Warning Lights

The Diagnostic Request switch is used to flash codes when:

- ☐ The engine is not running and ignition is on
- ☐ The engine is idling and not in an "engine protection" condition

Activating and releasing the switch will flash out the diagnostic codes for either condition. Activating and releasing the switch a second time will stop the ECM from flashing the diagnostic codes. Codes will also cease flashing if the engine is no longer at idle.

The codes are flashed out of the ECM connected to the switch. For multi-ECM installations, the Diagnostic Request Switch and SEO switchare combined on the master ECM. All receiver ECMs use a separate Diagnostic Request Switch.

5.10.4 STOP ENGINE OVERRIDE OPTIONS

Two types of stop engine overrides are available, Momentary Override and Continuous Override. Continuous Override has two options. These types are dependent upon specific engine applications. The ECM will record the number of times the override is activated after a fault occurs.

Momentary Override - An SEO switch is used to override the shutdown sequence. This override resets the 30 second shutdown timer, restoring power to the level when the SEL was illuminated. The switch must be recycled after five seconds to obtain a subsequent override. See Figure 5-22.

NOTE:
The operator has the responsibility to take action to avoid engine damage.

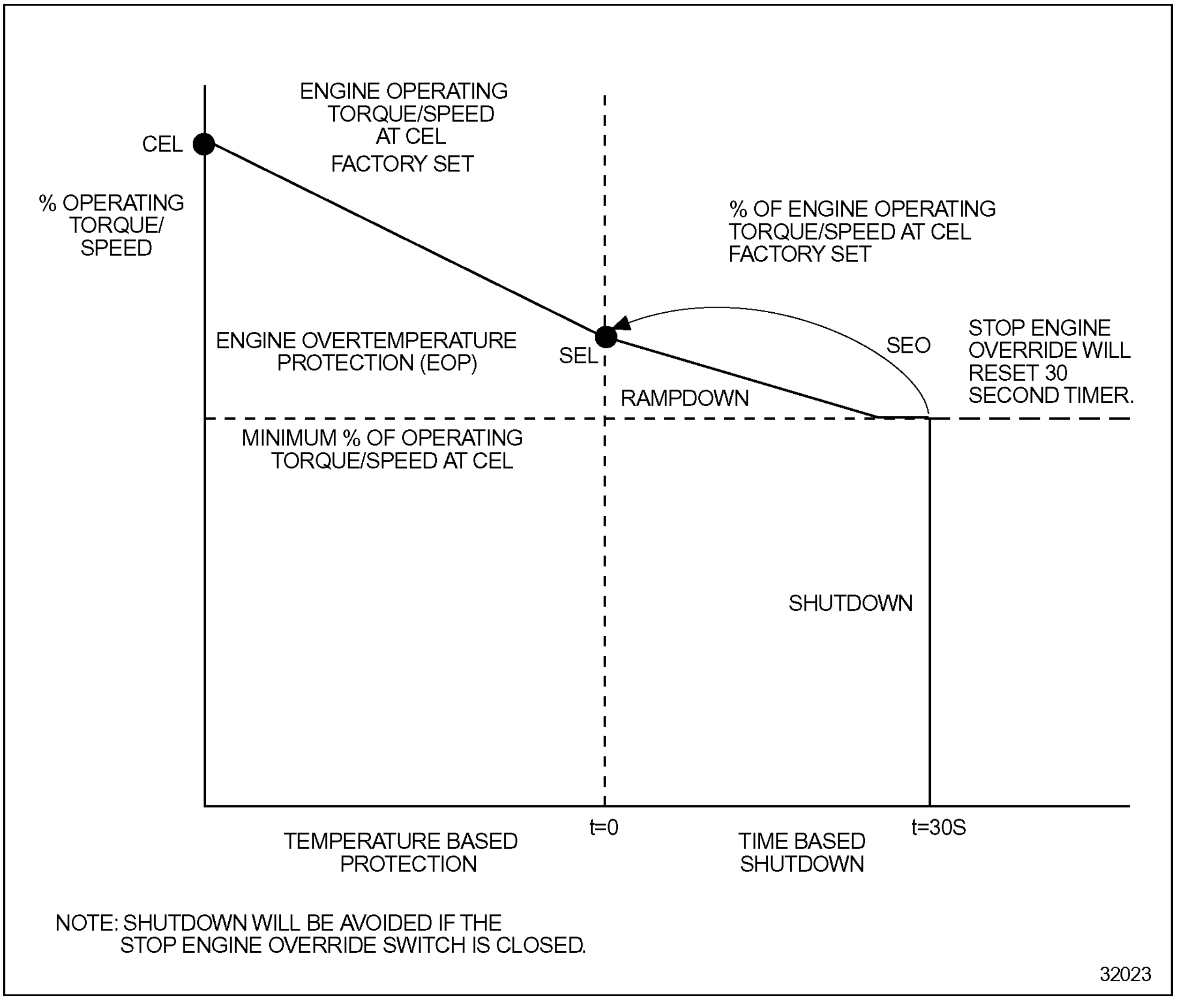


Figure 5-22 Engine Overtemperature Protection and Shutdown Protection with Stop Engine Override

Continuous Override, Option 2- This option is used when the vehicle needs full power during a shutdown sequence. Full torque capability is maintained as long as the override switch is pressed. This is intended for Coach applications only.

Continuous Override, Option 2- This option is used for a one time continuous override of the shutdown sequence. This is primarily used in construction and industrial applications. The engine protection system is disabled until the ignition key is cycled. See Figure 5-23.

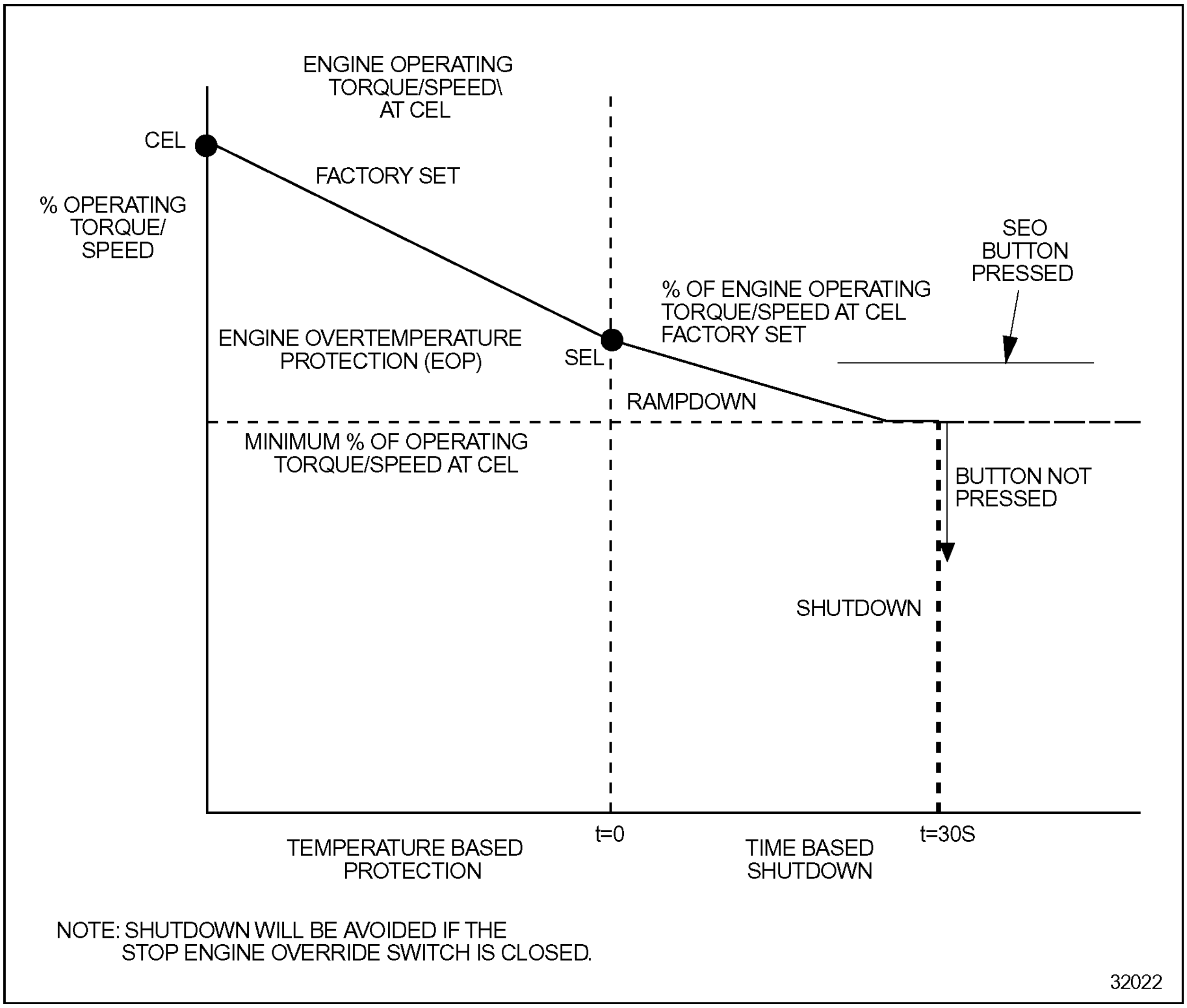


Figure 5-23 Engine Overtemperature Protection and Shutdown Protection with Continuous Override, Option 1

5.10.5 INSTALLATION

Some application require two sets of warning lights (CEL and SEL) at different control stations (refer to section 3.16.4).

5.10.6 PROGRAMMING FLEXIBILITY

All ECMs are programmed with pressure, temperature, and level protection limits. The level of protection can be any of the three engine protection features (Warning, Rampdown, or Shutdown) for each parameter monitored by the ECM. These can be set at time of order entry or with any of the available service tools, VEPS, DRS, DDR, or DDDL.

The DDEC engine protection system monitors all engine sensors and electronic components, and recognizes system malfunctions. The choices listed in Table 5-26 are available for reprogramming Engine Protection.

Parameter	Definition	Range
RECEIVER 1 OIL TEMPERATURE	Determines the type of engine protection with high oil temperature on the Receiver ECM #1	N/A; WARN, RAMP,SHTDWN
OIL PRESSURE	Determines the type of engine protection with low oil pressure. N/A will be displayed if the sensor is not present.	N/A; WARN, RAMP,SHTDWN
CRANKCASE PRESSURE	Determines the type of engine protection with high crankcase pressure. N/A will be displayed if the sensor is not present.	N/A; WARN, RAMP,SHTDWN
COOLANT PRESSURE	Determines the type of engine protection with low coolant pressure. N/A will be displayed if the sensor is not present.	N/A; WARN, RAMP,SHTDWN
RECEIVER 1 COOLANT PRESSURE	Determines the type of engine protection with low coolant pressure on the Receiver ECM #1	N/A; WARN, RAMP,SHTDWN
OIL LEVEL	Determines the type of engine protection with low oil level. N/A will be displayed if the sensor is not present.	N/A; WARN, RAMP,SHTDWN
COOLANT LEVEL	Determines the type of engine protection with low coolant level. N/A will be displayed if the sensor is not present.	N/A; WARN, RAMP,SHTDWN
AUXILIARY SHUTDOWN #1	Determines the type of engine protection with an active auxiliary switch #1 input. N/A will be displayed if auxiliary switch #1 has not been configured as a switch input.	N/A; WARN, RAMP,SHTDWN
RECEIVER 1 AUXILIARY SHUTDOWN #1	Determines the type of engine protection with an active auxiliary switch #1 INPUT on the Receiver ECM #1	N/A; WARN, RAMP,SHTDWN
AUXILIARY SHUTDOWN #2	Determines the type of engine protection with an active auxiliary switch #2 input. N/A will be displayed if auxiliary switch #2 has not been configured as a switch input.	N/A; WARN, RAMP,SHTDWN

Table 5-26 Engine Protection

5.10.7 INTERACTION WITH OTHER FEATURES

Cruise Control operation, Optimized Idle, and PSG are disabled when the SEL is illuminated. For Applications with LSG and VSG, the governor will revert to the primary governor when Engine Protection is enabled.

5.11 ENGINE RATINGS

Engine ratings are designated by horsepower rating and engine speed. For on-highway applications, three independent engine ratings and an additional dependent rating (cruise power) are provided. For construction and industrial applications, up to three independent ratings are provided. Although multiple ratings are stored in the ECM, only one rating is in operation at any time.

5.11.1 OPERATION

The engine rating may be selected with the DDR, DDDL or OEM supplied rating switches. Detroit Diesel's method of designating engine ratings is listed in Table 5-27.

Example #1		Example #2	
430 bhp @ 2100 RPM	Rating #0	470 bhp @ 2100 RPM	Rating #0
400 bhp @ 2100 RPM	Rating #1	470 bhp @ 1800 RPM	Rating #1
370 bhp @ 2100 RPM	Rating #2	430 bhp @ 1800 RPM	Rating #2
370/430 bhp @ 2100 RPM	Rating #3	430/370 bhp @ 1800 RPM	Rating #3

Table 5-27 Examples of Engine Ratings

Detroit Diesel can provide additional security to prevent the ECM rating selection from being modified with the DDR or DDDL. The additional security is not available with the use of rating switches. The Maximum Rating Security or the Rating Password (if configured) will protect DDEC III/IV engine ratings.

Engine Rating Switches

Engine rating switches may be used to select any of the individual ratings (maximum of three) and the dependent rating. Engine rating switches are only offered on select horsepower group ratings. The rating switches must be used in conjunction with up to two digital inputs, Rating Switch #1 and Rating Switch #2.

Rating Switch #1 selects between Engine Rating #0 and Engine Rating #1 when used without Rating Switch #2 as listed in Table 5-28.

Rating	Switch #1 Position
Engine Rating #0	OFF
Engine Rating #1	ON

Table 5-28 Rating Selections with One Rating Switch

Rating Switch #2, in conjunction with Rating Switch #1, is used to select any of the four engine ratings (three independent and one dependent) as listed in Table 5-29.

Rating	Switch #1	Switch #2
Engine Rating #0	OFF	OFF
Engine Rating #1	ON	OFF
Engine Rating #2	OFF	ON
Engine Rating #3	ON	ON

Table 5-29 Rating Selections with Two Rating Switches

Cruise Power

Cruise Power is an optional engine rating which operates on a higher horsepower curve during Cruise Control operation. The ECM provides the higher horsepower when Cruise Control is ON and not being overridden with the foot pedal. The additional power provides an incentive for the driver to operate in Cruise Control.

Limiting Torque Curve Option (Digital Torque Limiting)

The Limiting Torque Curve option provides the ability to operate the engine on a reduced torque curve when the appropriate digital input is enabled. Limiting torque curve tables are generated by Applications Engineering and can either be selected at the time of engine order or selected after engine order by DDC Technical Service.

The Limiting Torque Curve option use is shown in the following examples:

- Articulated Coach - The Limiting Torque Curve option is used to limit torque in an extreme articulated condition, which could occur during reverse operation.
- Transmission - The Limiting Torque Curve option provides a customized reduced torque curve during conditions which would otherwise exceed the maximum allowable torque limit set by the transmission manufacturer.
- Locomotive - The Limiting Torque Curve option provides a reduced torque to reduce wheel slip at low vehicle speed.

The following must be considered when using the Limiting Torque Curve option:

- The DDEC system cannot detect or display a malfunction of the digital input wiring.
- Limiting vehicle speed is best accomplished by utilizing DDEC's Vehicle Speed Limiting feature. Refer to section 5.36.
- The % Load display on the DDR / DDDL is a function of the main rating torque curve.

5.11.2 INSTALLATION

The rating switches must be used in conjunction with up to two digital inputs, Rating Switch #1 and Rating Switch #2. Refer to section 4.1, "Digital Inputs," for additional information.

See Figure 5-24 for an installation using one rating switch.

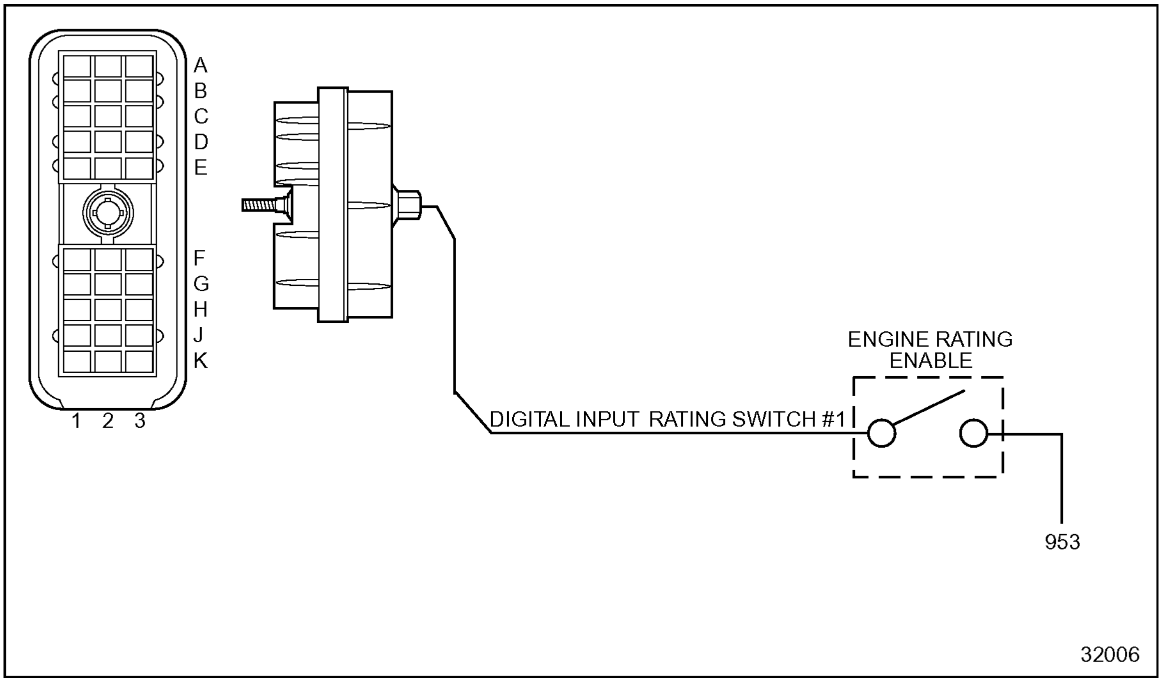


Figure 5-24 Simple Engine Rating Switch

See Figure 5-25 for an installation using two rating switches.

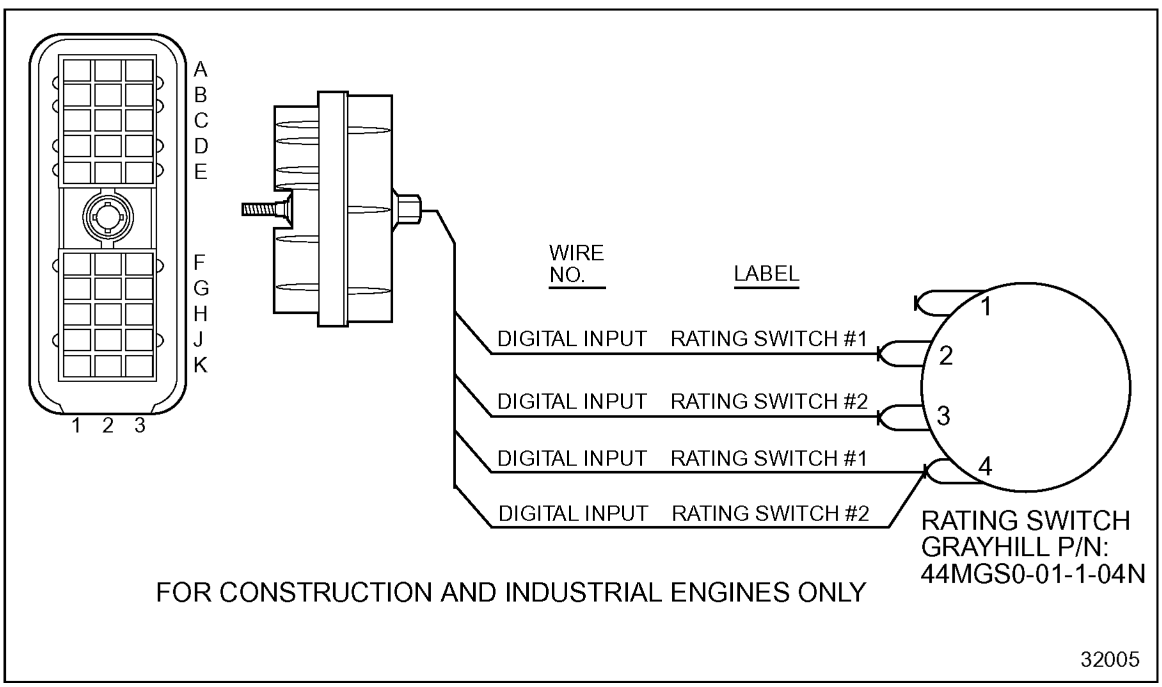


Figure 5-25 Rotary Switch for Multiple Engine Ratings

5.11.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The Maximum Rating Security to protect DDEC III/IV engine rating must be enabled at the time of engine order. Maximum Rating Security locks out all other ratings and will only operate on the rating selected at order entry. The DDR or DDDL cannot change a rating selection if the rating is maximum security protected.

The Rating Password is a four digit alphanumeric password that may be set at the time of engine order, by the DDR, DDDL, or VEPS. This offers additional protection above and beyond the standard DDR, DDDL password protection.

Rating Switches

The Rating Switches option and the digital inputs listed in Table 5-30 must be configured by order entry, VEPS, or DRS.

Description	Type	Function #
Rating Switch #1	Digital Input	12
Rating Switch #2	Digital Input	13

Table 5-30 Rating Switches Digital Input Requirements

Cruise Power

Cruise Power may be selected at the time of engine order, by VEPS, DDR, DDDL or using the engine rating switches.

Limiting Torque Option

Limiting Torque Curves must be selected at the time of engine order or selected after engine order by Technical Service.

The digital input listed in Table 5-31 must be configured by order entry, VEPS, or DRS.

Description	Type	Function Number
Limiting Torque Curve	Digital Input	14

Table 5-31 Limiting Torque Curve Option Digital Input Requirements

5.12 ETHER START

The DDEC Ether Start™ System is a fully-automatic engine starting fluid system used to assist a Series 50, Series 60 or Series 2000 diesel engine in cold starting conditions. The amount of ether is properly controlled to optimize the starting process and prevent engine damage. DDEC will control ether injection using standard sensors to control the ether injection hardware.

5.12.1 OPERATION

Ether Start will occur in two modes, preload (before cranking) and block load (during and after cranking). The mode and duration of injection is determined by DDEC based on engine speed and coolant, air and oil temperatures. Since excessive preloading could be harmful to engine components, DDEC will not allow multiple preloads. The engine speed must exceed 1500 RPM to reset the preload.

The system is composed of the DDEC ECM, Ether Injection Relay Module, ether canister, Dieselmatic valve, injection nozzle, metering orifice, nylon tubing, harness and miscellaneous hardware (see Figure 5-26).

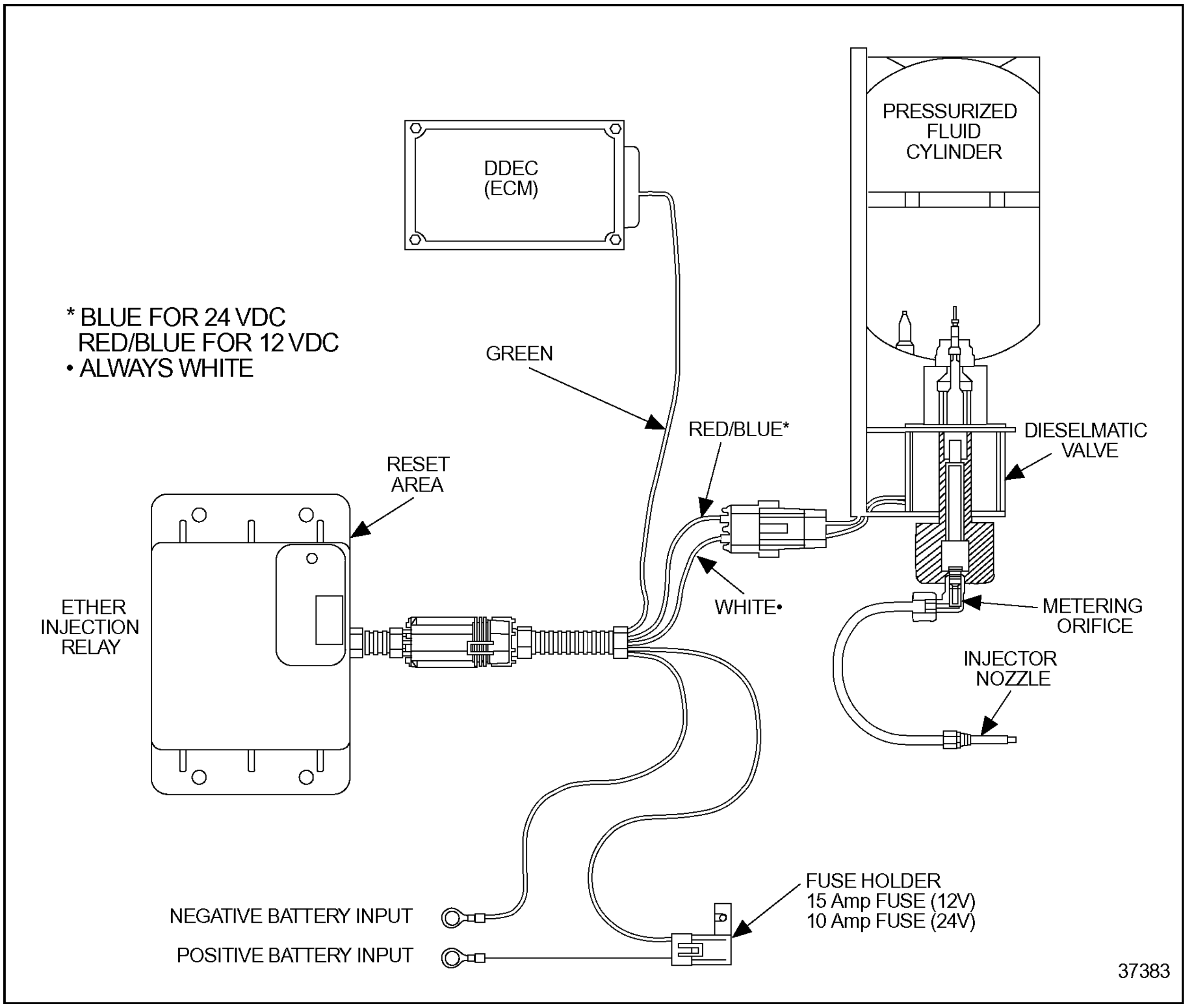


Figure 5-26 DDEC Ether Start System

It will be necessary to configure a DDEC digital output to control the relay module. Battery power and ground must also be supplied to the module.

CAUTION:

To avoid injury from flames, explosion, and toxicants when using ether, the following precautions must be taken:

- ☐ **Do not smoke when servicing ether system.**
- ☐ **Work in well-ventilated area.**
- ☐ **Do not work near open flames, pilot flames (gas or oil heaters), or sparks.**
- ☐ **Do not weld or carry an open flame near the ether system if you smell ether or otherwise suspect a leak.**
- ☐ **Always wear goggles when testing.**
- ☐ **If fluid enters the eyes or if fumes irritate the eyes, wash eyes with large quantities of clean water for 15 minutes. A physician, preferably an eye specialist, should be contacted.**
- ☐ **Contents of cylinder are under pressure. Store cylinders in a cool dry area. Do not incinerate, puncture or attempt to remove cores from cylinders.**

The relay module performs a number of important functions. The module will not allow ether injection unless it receives a signal from DDEC, it will prevent ether injection in the event of a faulty signal, and it will illuminate a light on the module when the ether canister is 90% consumed.

If the digital output remains grounded for longer than a factory set time, the relay module will cause an inline fuse to blow to prevent excessive ether from being injected into the cylinders. If the output is shorted to ground, a code will be logged by DDEC and the CEL will be illuminated. The system does not operate without the fuse in place. The cause of the digital output short must be fixed before replacing the fuse.

5.12.2 INSTALLATION

The injector nozzle is installed in the intake manifold (see Figure 5-27).

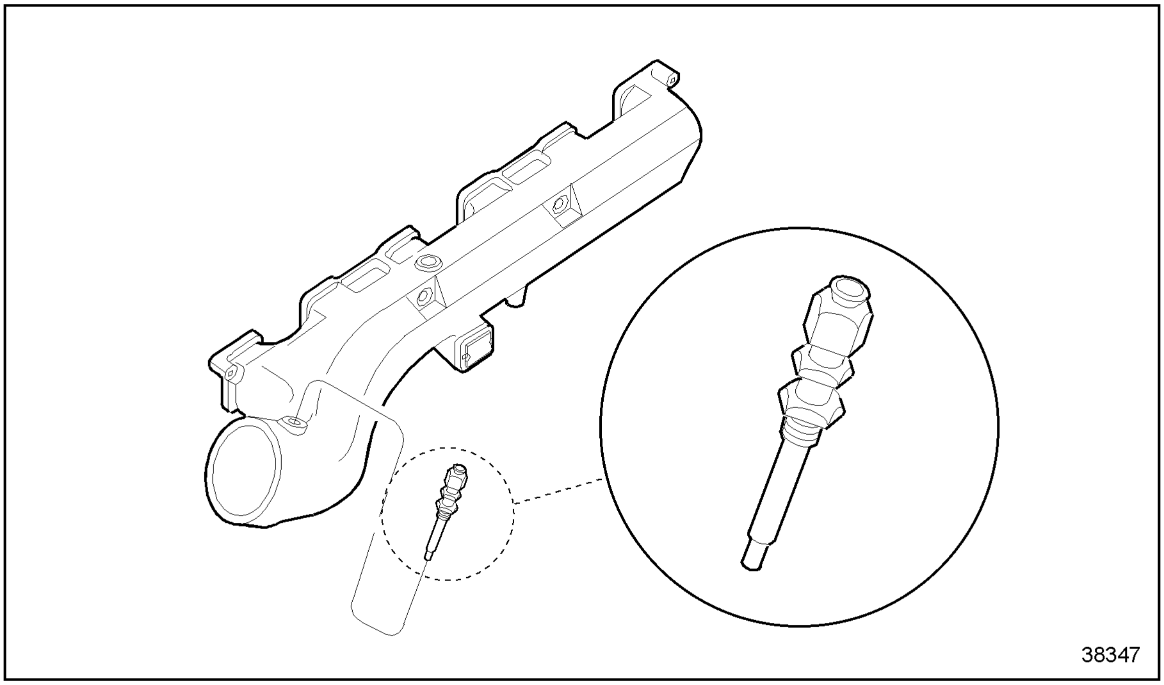
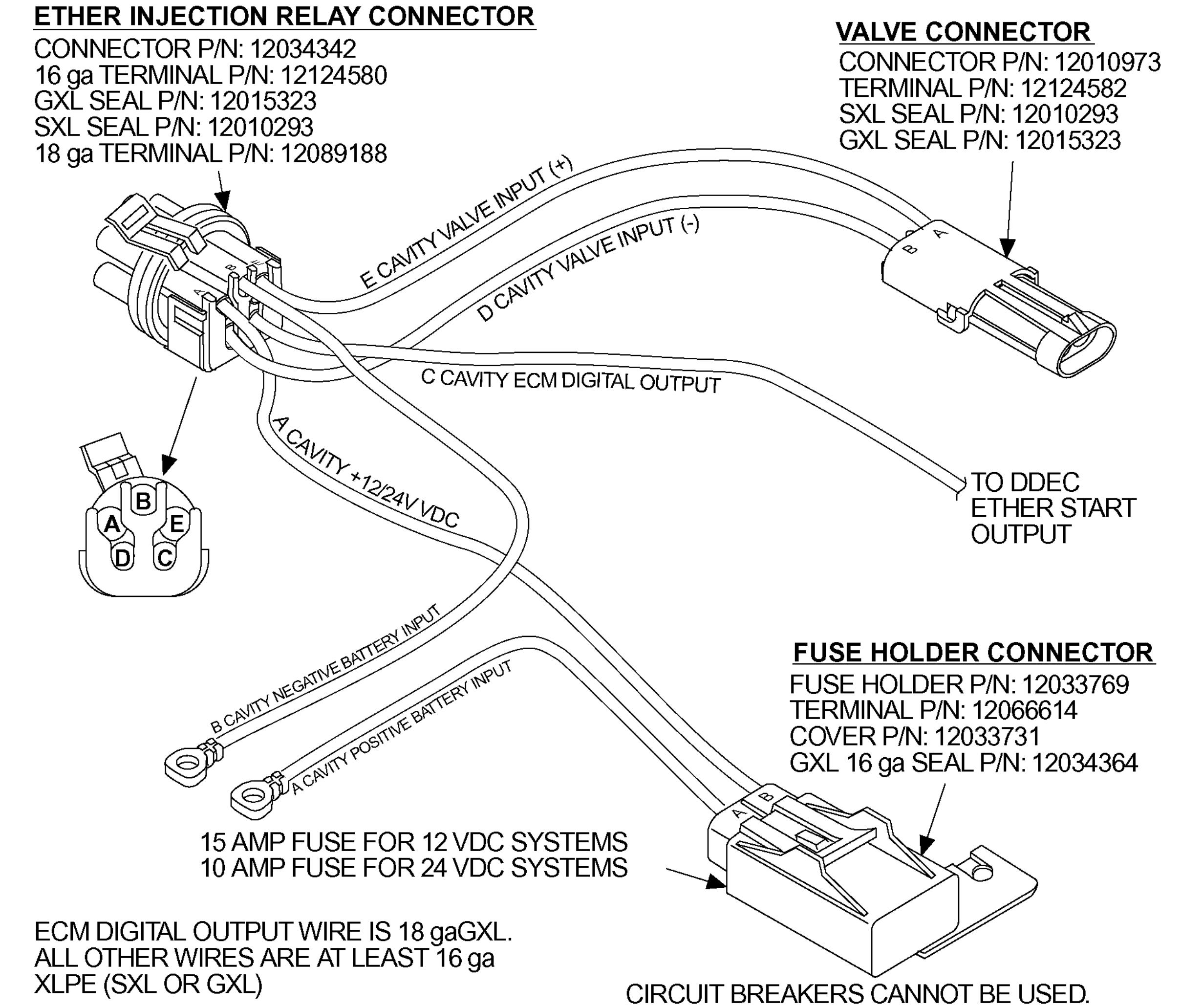


Figure 5-27 Series 60 Intake Manifold - Injector Nozzle Location

A red dot indicates the direction of spray, which should be pointed against the airflow. The cylinder assembly should be mounted vertically in an accessible location away from extreme heat such as the exhaust system and protected from road dirt, ice and snow. If protected, it can be mounted in the engine compartment on the firewall, frame or any other convenient location. The Ether Injection Relay (EIR) should be located near the valve and cylinder assembly.

The DDEC Ether Start system requires a harness (see Figure 5-28) to supply battery power, receive a signal from DDEC and control the ether injection valve. A fuse is required on the battery input (15 amp for 12 V systems, 10 amps for 24 V systems). Circuit breakers cannot be used.

For complete information on installing Ether Start and other details of the Ether Start system, refer to the *DDEC Ether Start Installation Manual* (7SA0727).



DESCRIPTION	ETHER INJECTION RELAY CONNECTOR	WIRE COLOR	VALVE CONNECTOR	FUSE HOLDER CONNECTOR
12/24 VDC	A	RED	–	–
BATTERY POSITIVE (+)	–	RED	–	B
BATTERY GROUND (-)	B	BLK	–	A
ETHER START DIGITAL OUTPUT	C	GREEN	–	–
VALVE INPUT (-)	D	RED/BLUE*	B	–
VALVE INPUT (+)	E	WHT	A	–

* NOTE: BLUE - 24 VDC, RED/BLUE - 12 VDC

37046

Figure 5-28 DDC Ether Start Harness

Programming Requirements and Flexibility

To configure an engine for Ether Injection, digital output function # 24 must be selected with VEPS, DRS, or on order entry. This feature does not have any reprogrammable parameters.

5.13 EXTERNAL ENGINE SYNCHRONIZATION

External Engine Synchronization (EES) provides a method of synchronizing the engine RPM of two or more engines using a frequency signal generated by an external vehicle controller or the tach drive output of another engine.

5.13.1 OPERATION

ESS is configured in an Application Code (6N4C group). To use EES, the ECM must be programmed with the same Application Code (6N4C group). The engine must be running and the digital input “Engine Synchronization” (function # 10) must be configured and enabled. When in EES mode, the external engine synchronization RPM is limited to the PTO maximum RPM.

Engines operating in ESS mode must be operating with 100 RPM of each other to exit ESS. If the engine speed differential between the follower and master engines is greater than 100 RPM, the follower engine will not exit ESS.

However, it is possible to disable the engine synchronization input (function # 10) and remain in ESS until the engine speed differential is less than 100 RPM.

5.13.2 INSTALLATION

See Figure 5-29 for a schematic for wiring engines for EES.

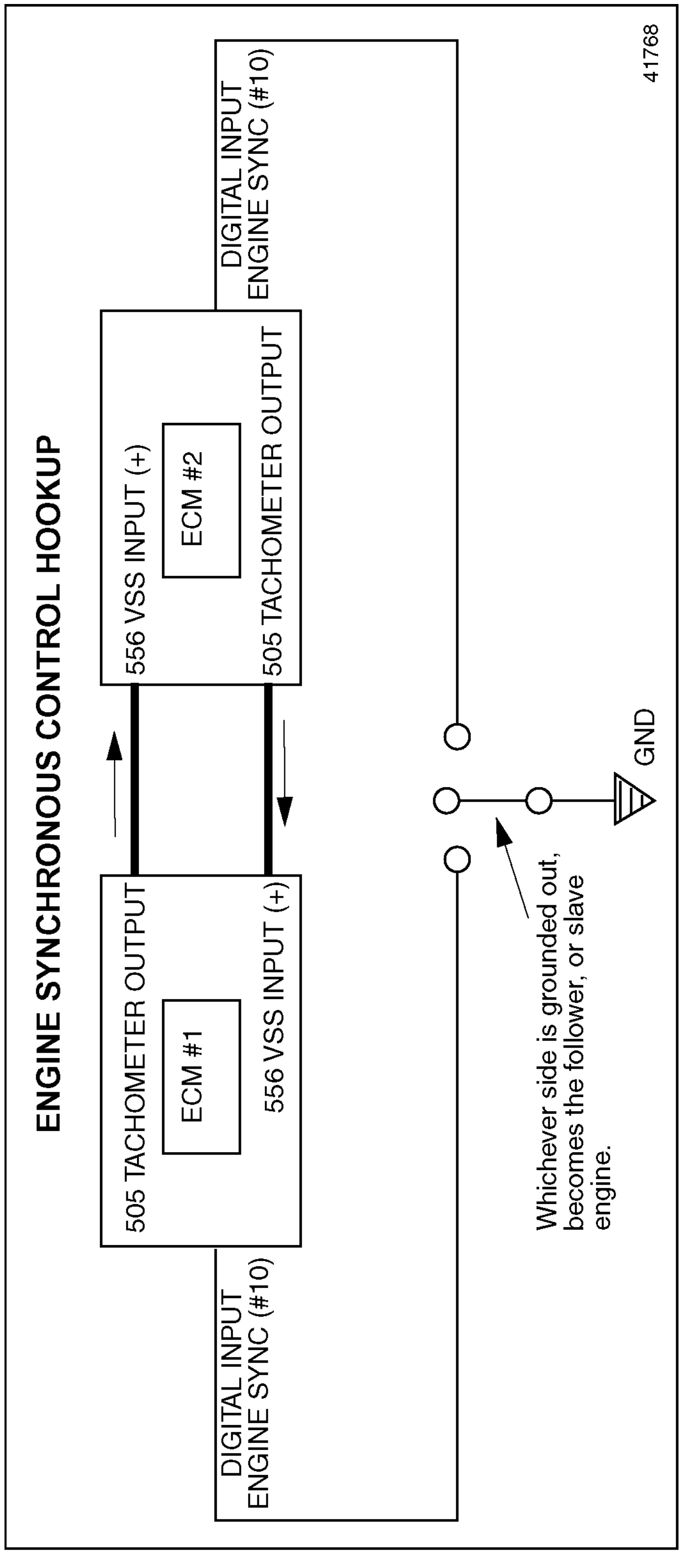


Figure 5-29 External Engine Synchronization Schematic

The tach output from the controlling engine's ECM is wired to the VSS input or the ATI port on the follower engine's ECM. Both ECMs can be programmed as followers to provide flexibility. Be sure to only have one engine follow at a time by having one of the digital inputs open.

Establish a switchable ground to the digital input “External Engine Sync.” Connect the tach output (wire #555) to the VSS (+) input (wire #556) or the ATI port (wire #973) between the two ECMs. Now you can ground one of the assigned digital input wires through the switch and that engine will become the follower to the other. Avoid the possibility of having both switches closed at the same time otherwise you won't have proper control of the master RPM.

5.13.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Engine Sync must be specified at the time of engine order with the correct Application Code (6N4C group) that enables this feature. For existing units in the field, contact Detroit Diesel Technical Service.

The digital input listed in Table 5-32 must be configured by order entry, VEPS, or the DRS.

Description	Function Number
External Engine Synchronization Enable	10

Table 5-32

The Vehicle Speed Sensor parameters listed in Table 5-33 can be programmed with the DDR, DDDL, VEPS, DRS, or on order entry.

Parameter	Choice/Display
VSS ENABLED	YES
VSS SIGNAL VSS TEETH	SWITCHED
	Appropriate Pulses/rev

Table 5-33 Vehicle Speed Sensor Parameters

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5.14 FAN CONTROL

The purpose of the Fan Control feature is to electronically control engine cooling fan activation and to provide a load for vehicle retardation, when required. DDEC Fan Controls are designed to optimally control the engine cooling fan(s) based on engine cooling requirements. Fan Controls are designed to use other system inputs such as A/C pressure switches, transmission retarder status, and operator requested fan operation. Transmission Retarder Status may be received via the Transmission Retarder Digital Input or on demand by a data link.

NOTE:
Fan Controls are required for some on-highway truck and on-highway bus applications.

5.14.1 OPERATION

The DDEC IV ECM continuously monitors and compares the coolant, oil, and air temperature, engine torque, engine operation mode, and various optional inputs to calibrated levels stored within the ECM. These limits are factory configured based on application.

When these temperature levels exceed the preset fan ON temperature value, the ECM will enable the fan control digital output(s) that activate the fan. The fan will remain on, cooling the engine with the increased air flow until the temperature levels reach the preset fan OFF temperature. At this point, the ECM will switch fan control to battery ground, which will deactivate the fan, effectively maintaining the coolant temperature between the two preset levels.

DDEC IV provides fan control for four different fan configurations:

- ☐ Single fan (refer to section 5.14.3, page 5-70)
- ☐ Dual fans (refer to section 5.14.4, page 5-75)
- ☐ Two-speed fan (refer to section 5.14.5, page 5-76)
- ☐ Variable speed single fan (PWM) (refer to section 5.14.6, page 5-80)

In accordance with the proposed Truck Maintenance Council (TMC) Standard, the minimum fan-on time for on-highway applications is 30 seconds.

5.14.2 INSTALLATION

This section provides a schematic of the specific connection from the ECM to the fan. See Figure 5-30 and Figure 5-31 for the input and outputs used for fan control.

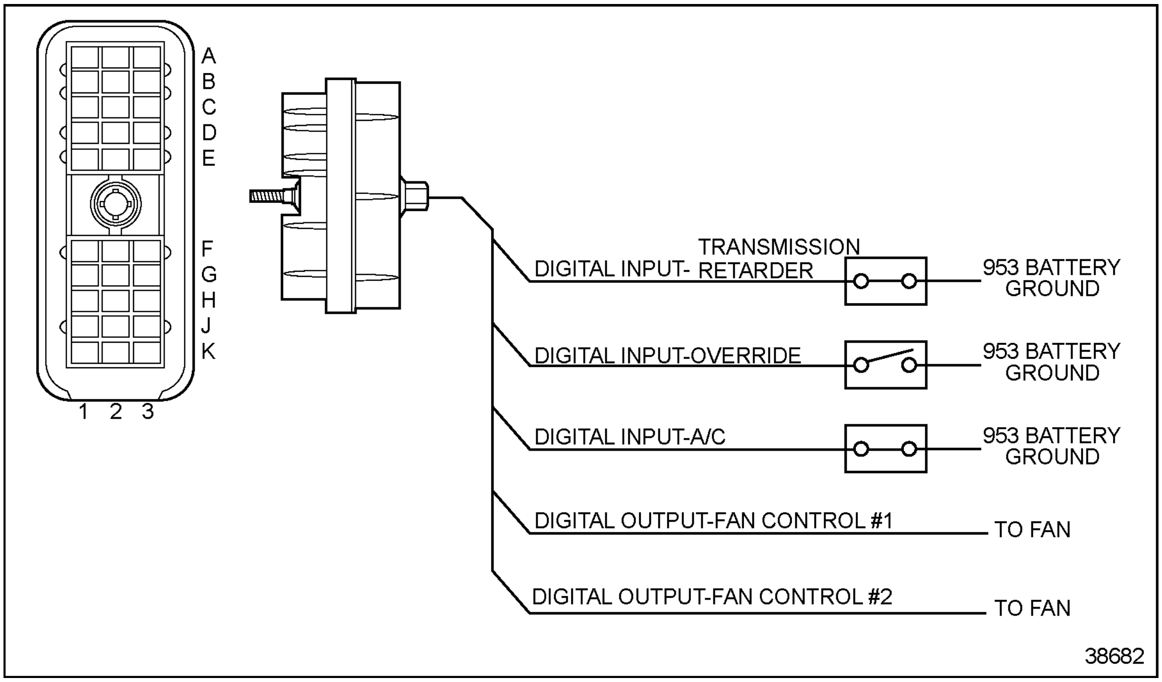

Figure 5-30 Fan Control Inputs with Two Digital Outputs

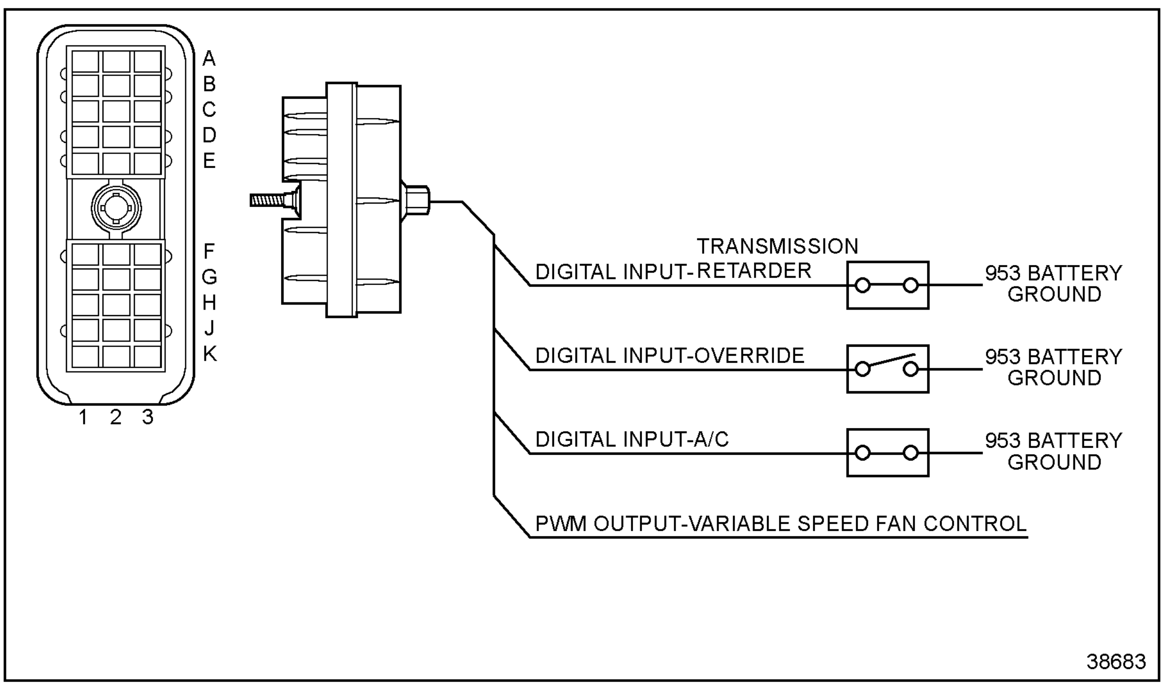

Figure 5-31 Fan Control Inputs with PWM Output for Variable Speed Fan Control

Compatible fans may be obtained from several vendors.

5.14.3 SINGLE FAN

The single-fan control uses one digital output to drive a single-speed fan. The digital output is called Fan Control #1. Fan Control #1 is deactivated to turn the fan OFF. The fan remains ON for 30 seconds when turned ON. The fan output will not be enabled until five seconds after the engine has started.

NOTE:
Digital output circuits are designed to sink no more than 1.5 A (DC) current.

Fan Control #1 is enabled (opened) when at least one of the following conditions occur:

- ☐ Oil or coolant temperature above DDC factory set levels
- ☐ Air temperature and engine torque above DDC factory set levels
- ☐ Air conditioner is active (OEM supplied A/C switch is opened), the fan remains ON for three minutes (the default) after the switch is grounded if vehicle speed is less than 20 MPH
- ☐ Oil, coolant, or air temperature sensor fails
- ☐ Fan engine brake enabled and engine brake is active at high level for a minimum of five seconds and air temperature is above factory set levels
- ☐ Transmission retarder is active and coolant temperature above DDC factory set level (Release 2.00 or later only)
- ☐ Fan Control Override Switch is enabled
- ☐ Pressure Sensor Governor is active

NOTE:
If either the A/C or transmission retarder inactive digital input is configured, the input must be grounded to prevent continuous fan operation.

The digital inputs and outputs for a single fan are listed in Table 5-34.

Fan State	Fan Control Output 1	A/C Input	Override Input	Jake Brake Status	Primary Control
On	Open	Grounded	Open	Not in High Mode	Engine Temperature Sensors
Off	Grounded	Grounded	Open	Not in High Mode	Engine Temperature Sensors
On	Open	Open	Don't Care	Not in High Mode	OEM A/C Switch
On	Open	Don't Care	Grounded	Not in High Mode	OEM Override Switch
On	Open	Don't Care	Don't Care	High Mode	Jake Brake in High Mode and Air Temperature Above Limit
On	Open	Don't Care	Don't Care	Not in High Mode	Transmission Retarder Active and Coolant Temperature Above Limit

Table 5-34 Single Fan Digital Inputs and Outputs

Installation

See Figure 5-32 for the specific connection from the ECM to the fan.

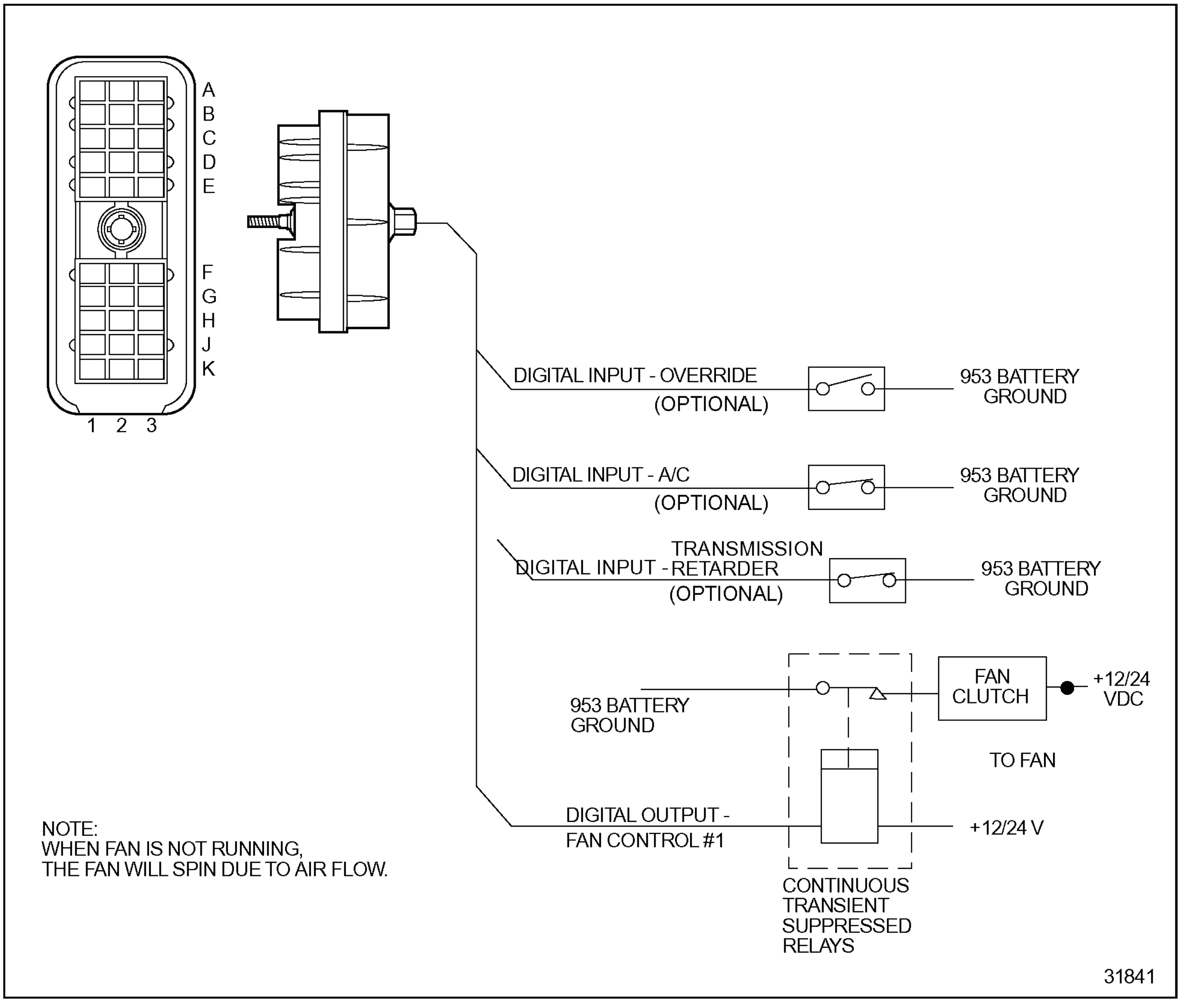

Figure 5-32 Fan Control Inputs and Outputs Electro Magnetic Single-Speed Digital Fans (Linnig)

For additional information, contact the fan vendor:

Linnig Corp.
P.O. Box 2002
Tucker, GA 30084
Phone: (770) 414–9499

See Figure 5-33 for the specific connection from the ECM to the fan.

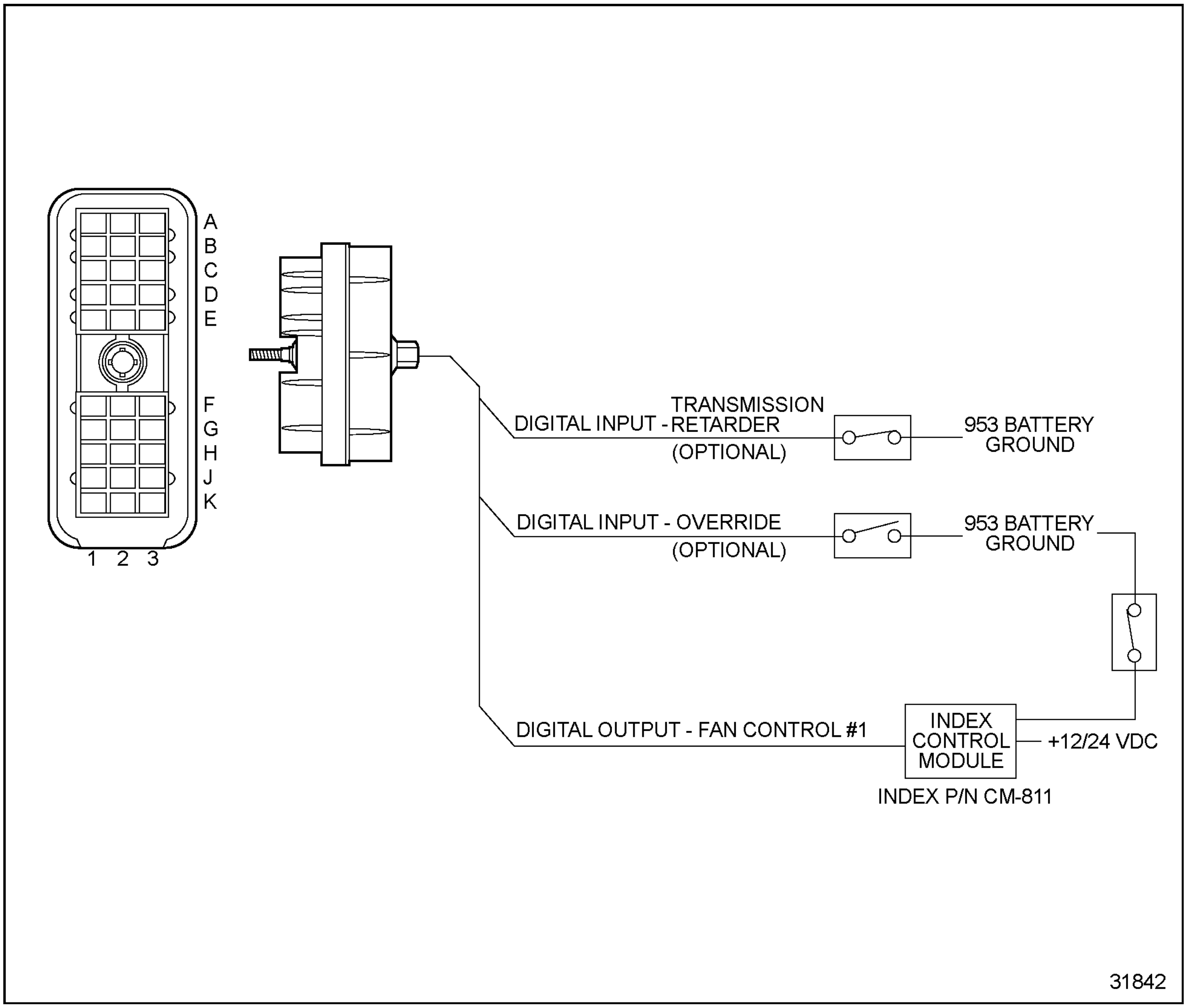

Figure 5-33 Fan Control Inputs and Outputs Index Control Module

For additional information, contact the fan vendor:

Index Sensors and Controls, Inc.
12335 134th Court NE
Redmond, WA 98052
Phone: 1-800-726-1737
Fax: 425-821-4112

See Figure 5-34 for the specific connection from the ECM to the control module.

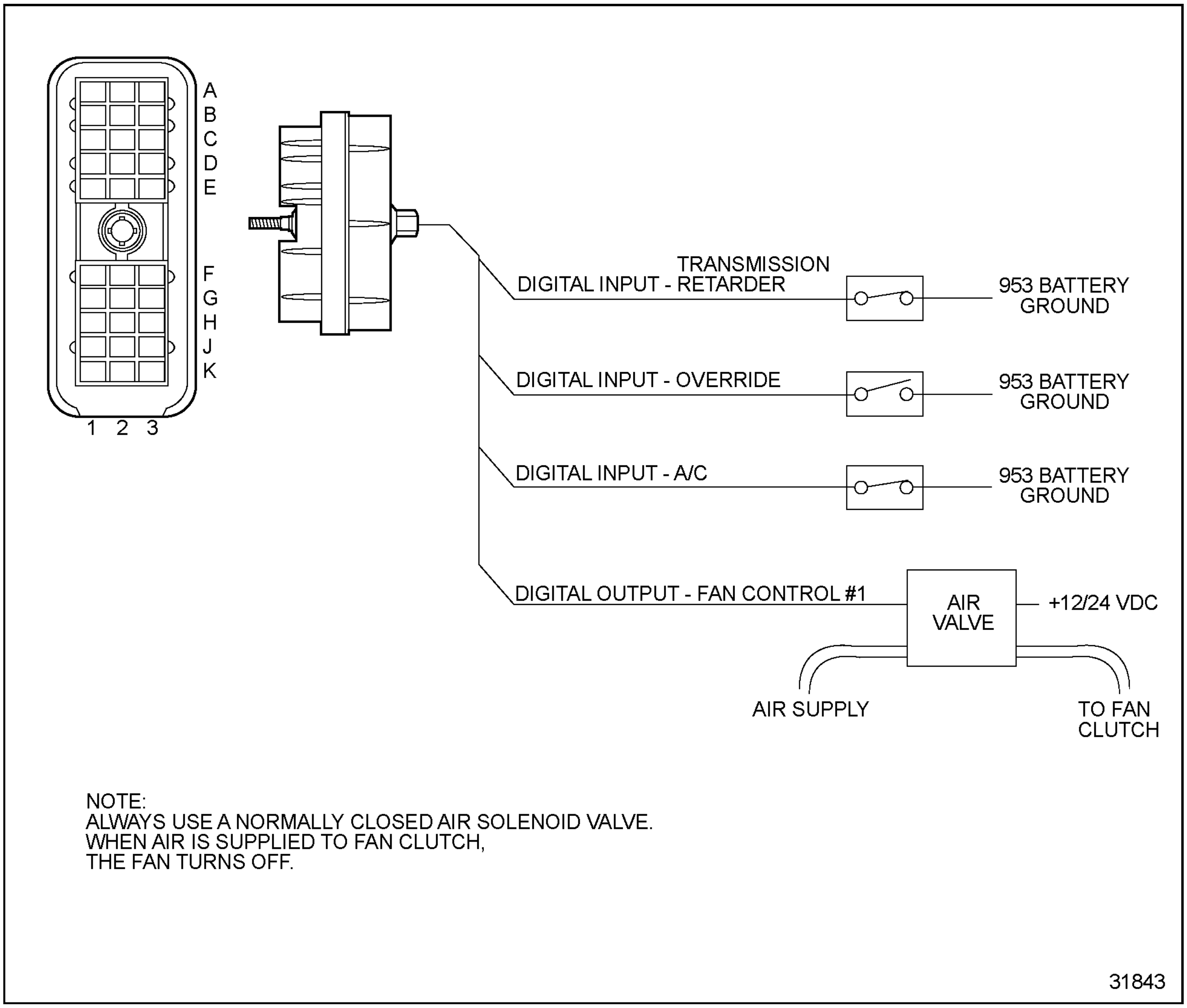

Figure 5-34 Fan Control Inputs - Normally Closed Air Solenoid Single-Speed Fan (Kysor, Bendix, and Horton)

For additional information, contact the fan vendors:

Kysor
1100 Wright Street
Cadillac, MI 49601
Phone: (616) 779-7528

Bendix Truck Brake Systems
901 Cleveland Street
Elyria, OH 44036
Phone: 1-800-AIR-BRAKE

Horton, Inc
2565 Walnut Street
Roseville, MN. 55113
Phone: 1–800–621–1320
Fax: 1–651–361–3801
www.hortoninc.com

5.14.4 DUAL FANS

This configuration uses two digital outputs, Fan Control #1 and Fan Control #2, to drive two separate single-speed fans. Fan Control #1 and Fan Control #2 are opened (switched to battery ground) to turn OFF each fan respectively. The fan remains on for 30 seconds whenever it is turned ON. The fan outputs will not be enabled until five seconds after the engine has started.

The two fans are independent of one another and are controlled by different conditions. Both fans will be activated when either the Fan Control Override is enabled or when the conditions are met for Fan Engine Brake.

Fan Control #1 is enabled (opened) when at least one of the following conditions occur:

- ☐ Air temperature and engine torque above DDC factory set levels
- ☐ Air temperature sensor fails
- ☐ Air conditioner is active (OEM supplied A/C switch is opened), the fan remains ON for three minutes (the default) after the switch is grounded if vehicle speed is less than 20 MPH
- ☐ Fan engine brake enabled and engine brake level is active at high level and air temperature is above DDC factory set levels
- ☐ Fan control override switch is enabled
- ☐ Pressure governor system is active

Fan control #2 is enabled (opened) when one of the following conditions occur:

- ☐ Oil or coolant temperature above DDC factory set levels
- ☐ Oil or coolant temperature sensor fails
- ☐ Fan engine brake enabled and engine brake level is active at high level and air temperature is above DDC factory set levels
- ☐ Fan control override switch is enabled
- ☐ Transmission retarder is active and coolant temperature above DDC factory set level (Release 2.00 or later only)

NOTE:
If either the A/C or transmission retarder inactive digital input is configured, the input must be grounded to prevent continuous fan operation.

The digital inputs and outputs for dual fans are listed in Table 5-35.

Fan State	Fan Control Output 1	Fan Control Output 2	A/C Input	Override Input	Jake Brake Status	Primary Control
1-On 2-On	Open	Open	Grounded	Open	Not in High Mode	Engine Temperature Sensors
1-On 2-Off	Open	Grounded	Grounded	Open	Not in High Mode	Engine Temperature Sensors
1-Off 2-On	Grounded	Open	Grounded	Open	Not in High Mode	Engine Temperature Sensors
1-Off 2-Off	Grounded	Grounded	Grounded	Open	Not in High Mode	Engine Temperature Sensors
1-On 2-Off	Open	Grounded	Open	Don't Care	Not in High Mode	OEM A/C Switch
1-On 2-Off	Open	Grounded	Don't Care	Grounded	Not in High Mode	Override Switch
1-On 2-Off	Open	Grounded	Don't Care	Don't Care	High Mode	Jake Brake in High Mode
1-Off 2-On	Open	Grounded	Don't Care	Don't Care	High Mode	Transmission Retarder Active and Coolant Temperature Above Limit

Table 5-35 Dual Fans Digital Inputs and Outputs

Installation - Dual Fans

The compatible fan manufacturers are the same as the manufacturers for the single fan. Follow the wiring diagrams for single fans for the first fan. See Figure 5-35 for the specific connection from the ECM to the second fan.

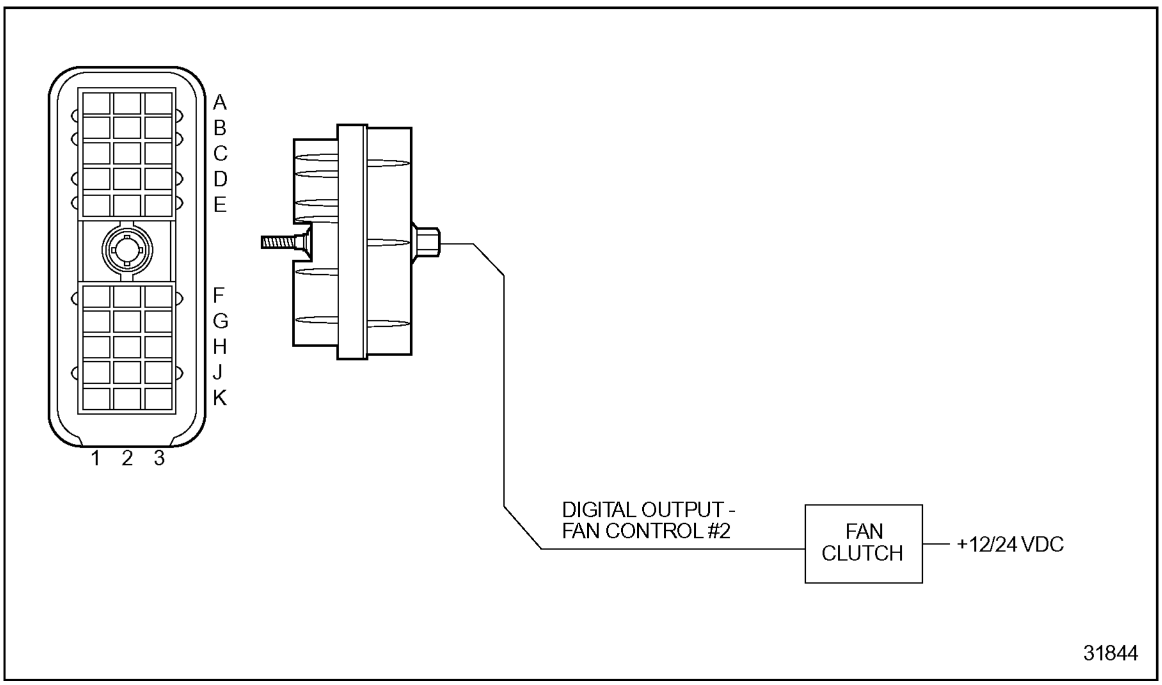

Figure 5-35 Fan Control Inputs and Outputs - Second Fan

5.14.5 TWO-SPEED FAN

This configuration uses two digital outputs, Fan Control #1 and Fan Control #2, to drive a two-speed fan. When Fan Control #1 output is opened, the fan operates in low-speed mode. When Fan Control #1 and Fan Control #2 are both open, the fan operates in high-speed mode.

Fan Control #1 is enabled (opened) when at least one of the following conditions occur:

- Oil or coolant temperature above DDC factory set levels
- Air temperature and engine torque above DDC factory set levels

Fan control #2 is enabled (opened) when one of the following conditions occur:

- Oil or coolant temperature above DDC factory set levels
- Air temperature and engine torque above DDC factory set levels
- Oil, coolant, or air temperature sensor fails
- Air conditioner is active (OEM supplied A/C switch is opened), the fan remains ON for three minutes (the default) after the switch is grounded when vehicle speed is less than 20 MPH
- Fan engine brake enabled and engine brake level is active at high level and air temperature is above DDC factory set levels
- Fan control override switch is enabled
- Pressure governor system is active
- Transmission retarder is active and coolant temperature above DDC factory set level (Release 2.00 or later only)

Once the fan has been enabled due to the Transmission Retarder, the fan will remain on high speed until the Transmission Retarder is deactivated. The Fan will remain on high speed for a minimum of 30 seconds.

NOTE:
If either the A/C or transmission retarder digital input is configured and not used, they should be deconfigured.

The digital inputs and outputs for a two-speed fan are listed in Table 5-36.

Fan State	Fan Control Output 1	Fan Control Output 2	A/C Input	Override Input	Jake Brake Status	Primary Control
Off	Grounded	Grounded	Grounded	Open	Not in High Mode	Engine Temperature Sensors
Low	Open	Grounded	Grounded	Open	Not in High Mode	Engine Temperature Sensors
High	Open	Open	Grounded	Open	Not in High Mode	Engine Temperature Sensors
High	Open	Open	Open	Don't Care	Not in High Mode	OEM A/C Switch
High	Open	Open	Don't Care	Grounded	Not in High Mode	Override Switch
High	Open	Open	Don't Care	Don't Care	High Mode	Jake Brake in High Mode
High	Open	Open	Don't Care	Don't Care	Not in High Mode	Transmission Retarder Active and Coolant Temperature Above Limit

Table 5-36 Two-speed Fan Digital Inputs and Outputs

Installation - Two-speed Fans

See Figure 5-36 for the specific connection from the ECM to the fan.

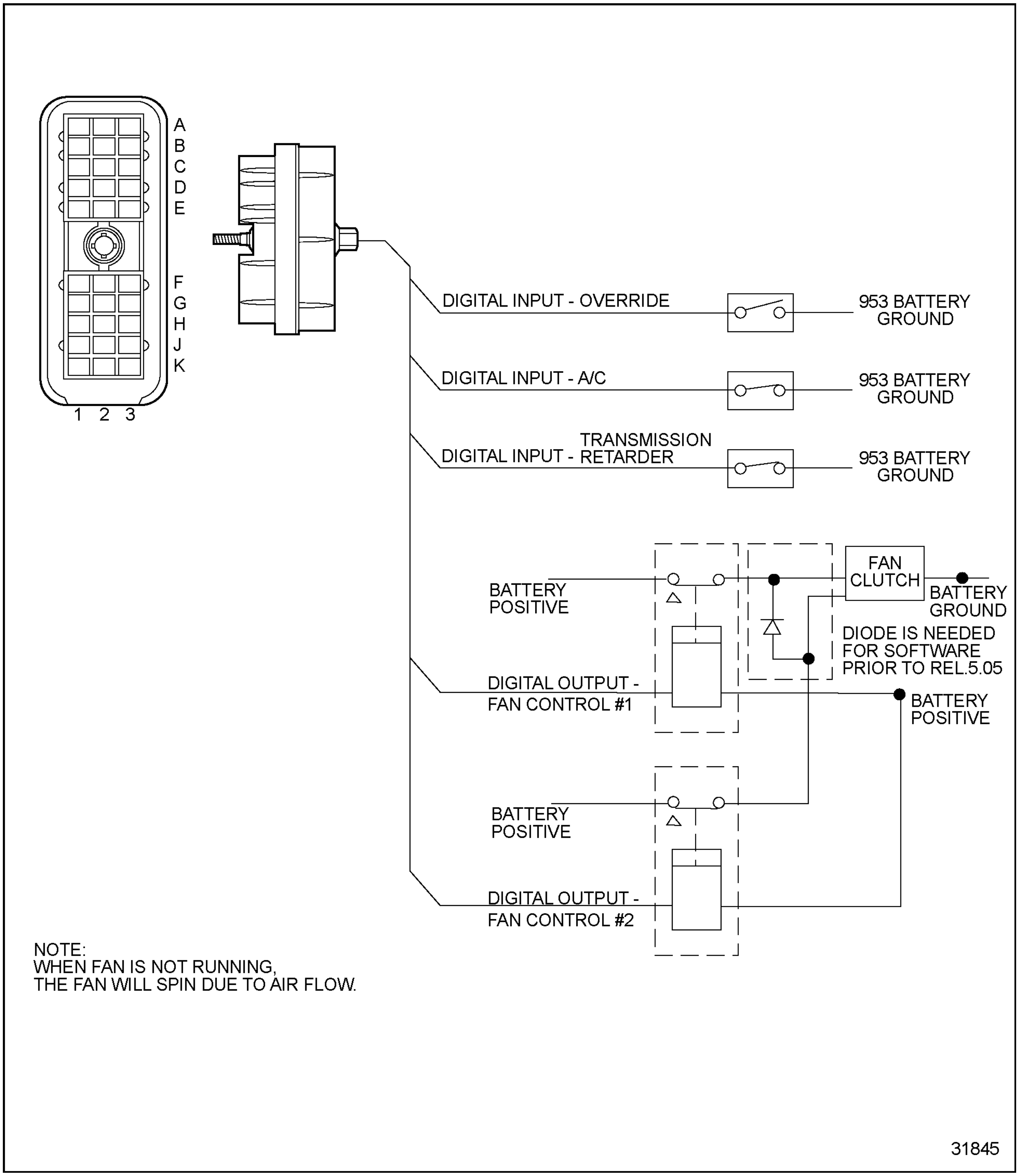

Figure 5-36 Fan Control Inputs and Outputs - Electro Magnetic Two-Speed Fans (Linnig)

For additional information, contact the fan vendor:

Linnig U.S.A.
P.O. Box 670
Mineola, NY 11501-0670
Phone: (516) 742-1900

5.14.6 VARIABLE SPEED SINGLE-FAN

DDEC uses a pulse width modulated (PWM) output to drive a variable speed fan. Presently available PWM outputs and specifications are listed in Table 5-37.

Engine Series	PWM Output	Frequency	Duty Cycle @ Minimum Fan Speed	Duty Cycle @ Maximum Fan Speed
Series 4000	PWM #2	10 Hz	80%	5%
All Others	PWM #4	50 Hz	90%	10%

Table 5-37 PWM Outputs and Specifications

The fan may be enabled by specific engine temperature sensors and various other inputs. The fan will ramp up to the requested speed in order to reduce noise, shock-loading, and belt slippage. If the fan is turned on for any reason other than high temperature, it will ramp up to the full fan speed (i.e. 5% or 10% duty cycle, application dependent). The ramp rate is set by the Application Code System (ACS). A decrease in fan speed will occur after a short time delay and will step down to the value dictated by the highest sensor request. If the A/C switch is opened, the fan will increase speed at the ramp rate until it is at a maximum. After the A/C switch is grounded the fan will remain on for a short time delay and then turn off. If the oil temperature (Series 4000 only), intercooler temperature or jacket coolant temperature are not received from the receiver ECM, the master ECM requests the maximum fan speed.

The PWM output is initiated when at least one of the following conditions occur:

- ☐ Air, oil, coolant, or intercooler temperatures above DDC factory set limits
- ☐ Air conditioner is active (OEM supplied A/C switch is opened), the fan remains on for 3 minutes (the default) after the switch is grounded when vehicle speed is less than 20 mph
- ☐ Jacket coolant temperature above DDC factory set limits
- ☐ Oil, coolant, intercooler, or air temperature sensor fails
- ☐ Fan Control Override Switch is enabled

NOTE:
If A/C input is configured and not used, that input must be deconfigured.

The Series 4000 DDEC system uses a PWM output to control the oil pressure governing solenoid for the Rockford variable speed fan clutch. The PWM signal to the solenoid operates at a frequency of 10 Hz. Several engine temperatures are monitored to determine the required fan speed.

The fan is off when the PWM signal is at or above 80%. Maximum fan speed is requested when the PWM2 signal is at 5% or below. The fan speed will ramp up to the required speed at a set rate to prevent belt slippage. If the A/C switch is closed the fan will ramp up to maximum speed. In the event that the fan governing solenoid loses the PWM signal the fan will operate at maximum speed.

The digital inputs and outputs for PWM fan control are listed in Table 5-38.

Fan State	PWM Output	A/C Input	Override Input	Jake Brake Status	Primary Control
On	Modulated	Grounded	Open	Not in High Mode	Engine Temperature Sensors
Off	Open	Grounded	Open	Not in High Mode	Engine Temperature Sensors
Full On	Grounded	Open	Don't Care	Not in High Mode	OEM A/C Switch
Full On	Grounded	Don't Care	Grounded	Not in High Mode	OEM Override Switch
Full On	Grounded	Don't Care	Don't Care	High Mode	Jake Brake in High Mode and Air Temperature Above Limit
Full On	Grounded	Don't Care	Don't Care	Not in High Mode	Transmission Retarder Active and Coolant Temperature Above Limit

Table 5-38 PWM Fan Control Digital Inputs and Outputs

Installation - Variable Speed Single-Fan

See Figure 5-37 for the specific connection from the ECM to the fan.

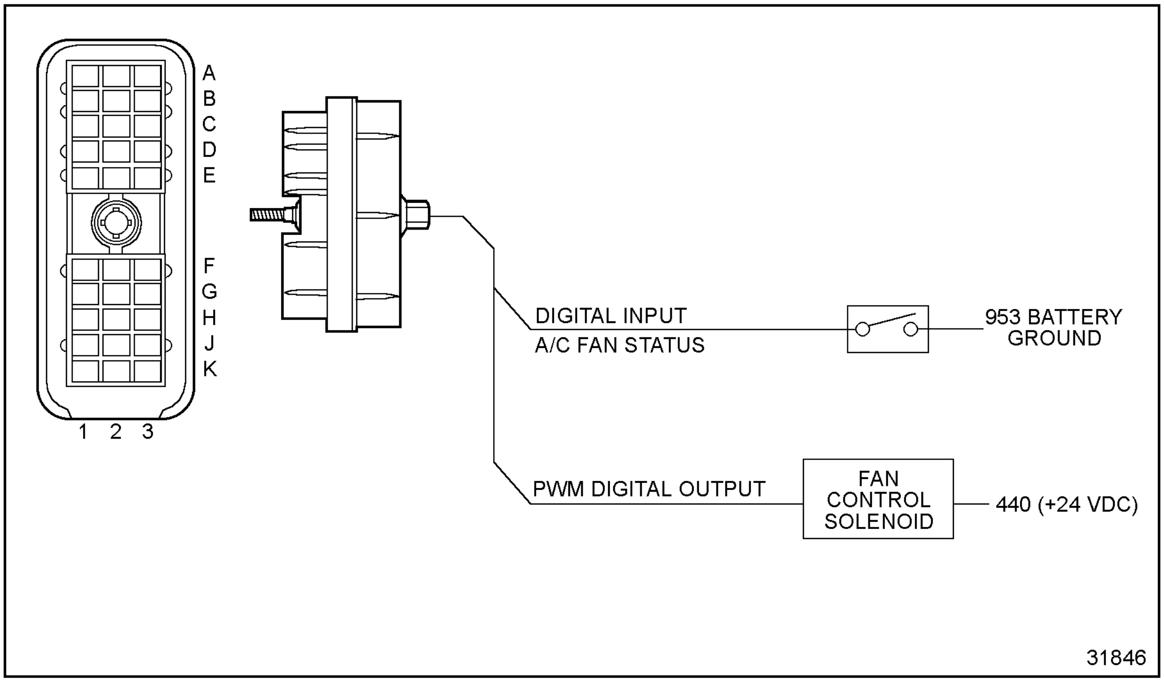

Figure 5-37 Series 4000 Fan Control Inputs and Outputs

For additional information, contact the clutch manufacturer:

Rockford Powertrain, Inc.
1200 Windsor Road,
Rockford, Il 61132-2908
Phone: (815) 633-7460

5.14.7 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

To have fan control for single, dual, or two-speed fans, fan control must be enabled and a fan type defined at engine order entry or by DDC Technical Service.

For single, dual, and two-speed speed fans the digital inputs and outputs listed in Table 5-39 may be required based on the fan vendor's requirements. The digital inputs and outputs can be configured by order entry, VEPS or DRS.

Function Number	Type	Description
13	Digital Output	Fan Control #1
14	Digital Output	Fan Control #2
27	Digital Input	Transmission Retarder
32	Digital Input	Fan Control Override
29	Digital Input	Air Conditioner Status

Table 5-39 Fan Control Digital Input and Outputs - Single and Dual Speed Fans

For variable speed fans, the PWM output is enabled at the time of engine order or by ACS. The digital inputs and outputs listed in Table 5-40 may be required based on fan vendor's requirements. The digital inputs and outputs can be configured by order entry, VEPS or DRS.

Function Number	Type	Description
27	Digital Input	Transmission Retarder
32	Digital Input	Fan Control Override
29	Digital Input	Air Conditioner Status

Table 5-40 Fan Control Digital Input and Outputs - Variable Speed Fans

VEPS or the DRS can set the A/C Fan time. The default for the parameter listed in Table 5-41 is three minutes.

Parameter	Description	Choices
AC Fan Timer	The minimum duration of time the fan will remain ON after the AC status digital input has indicated that the AC unit has turned OFF. The timer starts when the input is grounded after being open.	0-255 seconds

Table 5-41 Fan Timer Parameter

5.15 FUEL ECONOMY INCENTIVE

Fuel Economy Incentive is a standard DDEC feature for on-highway Detroit Diesel engines. The purpose of this feature is to allow the fleet manager to set a target fuel economy while providing the driver an incentive to meet the target.

5.15.1 OPERATION

Using the Fuel Economy Incentive option, a fleet manager can set a target fuel economy for each engine. If this fuel economy is exceeded, the driver will be given a slightly increased vehicle speed limit.

Target fuel economy, road speed limit, maximum MPH increase, conversion factor for MPH/MPG and the option of total average fuel economy or trip fuel economy are all calibrated using the DDR, DDDL, VEPS, DRS or at engine order entry. The feature is enabled by setting the Maximum MPH to a non-zero value.

In this example the following limits are set as listed in Table 5-42.

Item	Set Limit
Vehicle Speed Limit	60 MPH
Maximum MPH - the maximum allowable increase in vehicle speed	5 MPH
Conversion Factor	20 MPH/MPG
Target Fuel Economy	7 MPG

Table 5-42 Fuel Economy Limits

If the driver has an average fuel economy of 7.1 MPG then the new vehicle speed limit is 62 MPH. (60 MPH + (7.1-7.0 MPG) x (20 MPH/MPG) = 62 MPH)

The maximum vehicle speed obtainable regardless of the fuel economy is 65 MPH.

5.15.2 PROGRAMMING FLEXIBILITY

The parameters listed in Table 5-43 can be set using the DDR, DDDL, VEPS, or DRS.

Parameter	Definition	Choice
MINIMUM ECONOMY	Indicates the minimum economy for fuel economy incentive.	5 to 10 MPG, 50.8 to 23.3 L/100 K
MAXIMUM MPH or MAXIMUM KPH	Indicates customer set maximum vehicle speed increase for vehicle.	0 to 10 MPH, 0.0 to 16.1 KPH
CONVERT FACTOR MPH/MPG or CONVERT FACTOR KPH/KPL	The miles per hour you want to allow for each full mile per gallon above the minimum MPG.	0.1 to 20 MPH/MPG, 0.4 to 75.8 KPH/KPL
CALC TYPE	FILT ECON bases the calculations on the fuel information, by periodic sampling of fuel consumption, recorded in the ECM. TRIP ECON bases the calculation on the trip portion of the fuel usage information.	TRIP ECON, FILT ECON

Table 5-43 Fuel Economy Incentive Parameters

5.15.3 INTERACTION WITH OTHER FEATURES.

Fuel Economy Incentive will increase the Cruise Control and vehicle speed limits.

A vehicle can be have with both PasSmart and Fuel Economy Incentive, but the extra speed increments provided by the two features do not add together. For example, if Fuel Economy Incentive is set for 7 MPH of extra speed when the driver hits the maximum fuel economy target and the same vehicle has a 5 MPH PasSmart increase, the resulting speed increase is 7 MPH, not 12 MPH.

5.16 GLOW PLUG CONTROLLER

The Glow Plug Controller is used for warm-up for alcohol fueled engine applications.

5.16.1 OPERATION

Alcohol engines are similar to standard diesel engines. A metered amount of fuel is injected into the cylinder after the air is compressed. Ignition is accomplished by the heat of compression. Glow plugs are used to aid in combustion during starting and warm-up. The alcohol engine is equipped with several unique components not found on the diesel engine. These components are designed using alcohol compatible materials. Fuel, glow plug, air induction and catalytic converter systems are unique to alcohol engines.

5.16.2 INSTALLATION

The Glow Plug Controller requires a direct battery +12/24 VDC supply into the stud on the side of the glow plug controller (see Figure 5-38).

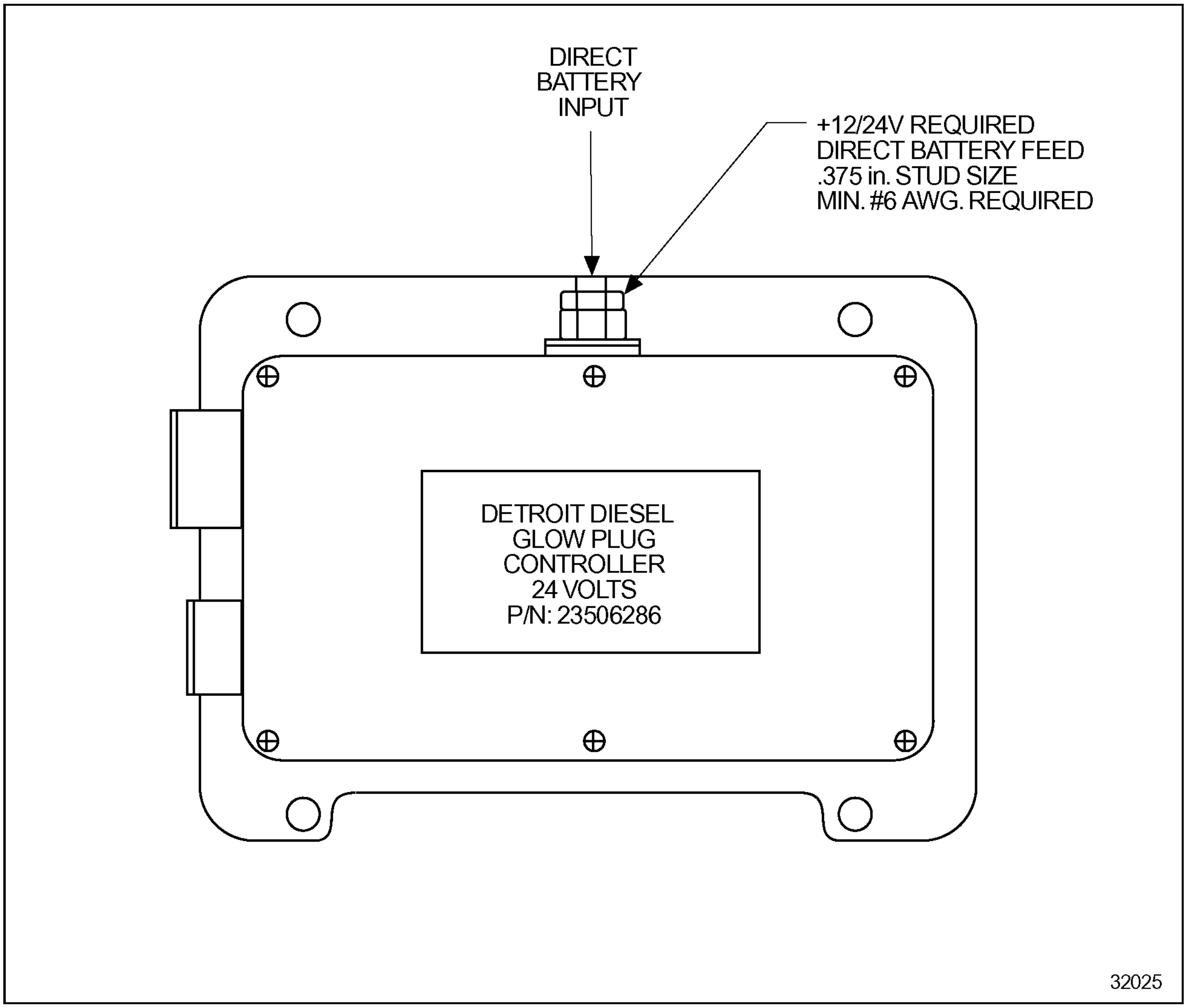

Figure 5-38 Glow Plug Controller Power Supply

A #6 AWG wire or larger is required. This stud and exposed wire must be covered with a rubber boot to prevent shorting. No other accessories can be sourced from this line.

5.16.3 OEM CONNECTIONS

Several OEM connections are required involving the engine sensor harness and the glow plug controller.

Switched +12 VDC Ignition (Circuit 50)

Circuit 50 is a dedicated +12 VDC ignition wire to activate the glow plug controller. No other accessories should be sourced from this line.

Ground (Circuit 151)

Circuit 151 from the glow plug controller must be connected directly to the negative battery post. No splices, chassis grounds, or other intermediate connections are permitted.

Starter Inhibit Circuit (Circuit 968)

The starter inhibit circuit is required. Typically, the starter inhibit circuit (Circuit 968) uses a continuous, transient suppressed relay placed in the starter solenoid system. The starter wire is connected to the normally open contacts. The relay coil is connected to a power source and grounded by circuit 968. No ground exists on circuit 968 when the glow plugs light is illuminated. The relay contacts to the starter are open, preventing the starter from operating. Circuit 968 is grounded when the glow plug circuit 968 is grounded when the glow plug light is not illuminated thus permitting the starter to operate. The glow plug controller enables/disables the Starter Inhibit circuit.

An override circuit must be provided to allow starting if the glow plug lamp is illuminated. This circuit should be incorporated into the stop engine override switch. The starter inhibit circuit must be installed to protect the catalytic converter during engine startup.

Glow Plug Panel Light

The glow plug controller provides ground for the glow plug light on circuit 905. A switched +12/24 VDC source must be provided for the light. This light is OEM supplied and must be integrated into the instrument panel. The lens color must be blue and the words GLOW PLUG must appear to identify the display. The light will be illuminated for 60 seconds each time the ignition is cycled. The lamp will also illuminate to in indicate an electrical problem in the glow plug system. This lamp does not necessarily indicate glow plug operation.

Fire Suppression System Interface/Catalytic Converter High Temperature (Circuit 906 & 416)

This optional circuit interfaces with DDEC and will provide engine shutdown with a diagnostic code if the fire suppression system is activated. The fire suppression system must also shut off the electric fuel pump.

A 27 kΩ resistor must be connected if the fire suppression circuit is not utilized.

See Figure 5-39 for an installation schematic.

5.16.4 DIAGNOSTICS

The glow plug controller illuminates the glow plug light for startup. The light is also illuminated when one or more of the following faults are detected:

- ☐ Open circuit in either a glow or glow plug output circuit
- ☐ Short circuit in either a glow plug or glow plug output circuit
- ☐ Short or open circuit in the glow plug activation circuit 910 (PWM #3) from the ECM

5.16.5 FUEL SYSTEM REQUIREMENTS

An electrically driven fuel pump is required for alcohol engines.

A fuel pressure switch must be incorporated into the fuel pump power supply. This switch must interrupt the power to the fuel pump if the fuel pressure drops below 45 psi (approximately

310 kPa). A low fuel pressure light must be incorporated into the circuit and integrated into the instrument panel. The lens color must be red and the words LOW FUEL PRESSURE must appear to identify the display. A fuel pump override must be incorporated with the SEO switch.

A high fuel temperature lamp must be incorporated into the instrument panel. The light must illuminate when the fuel temperature on the discharge side of the fuel cooler reaches 150°F (approximately 132°C). The lens color must be orange and the words HIGH FUEL TEMP must appear to identify the display.

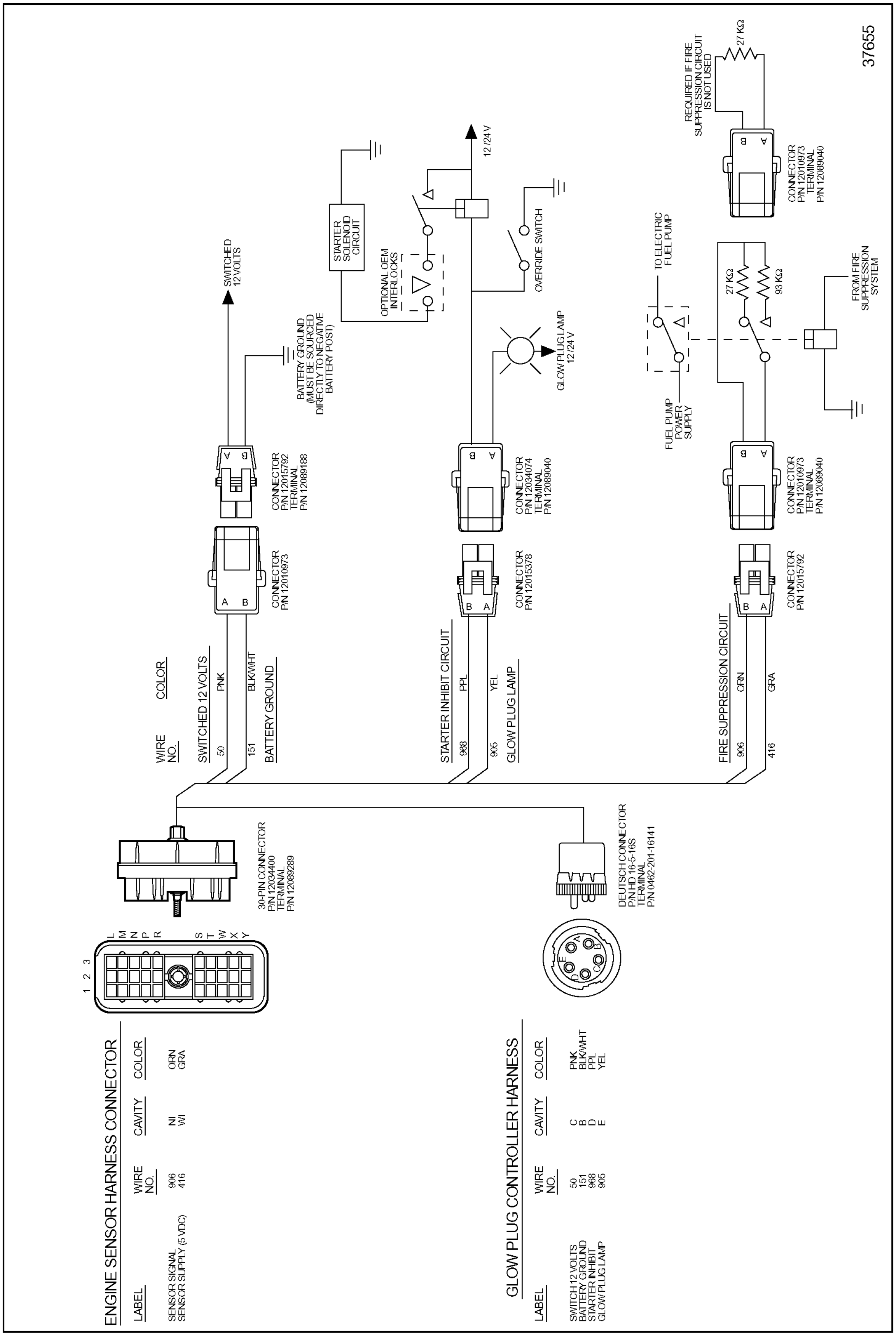

Figure 5-39 Glow Plug Controller Installation Schematic

5.17 HALF ENGINE IDLE

Half Engine Idle (HEI) mode allows the engine to run on half the cylinders. Running in HEI significantly reduces white smoke in cold engine operation, after startup or during extreme cold weather operation. The HEI logic continuously reviews several engine conditions to determine if it should be deactivated.

5.17.1 OPERATION

HEI can be set to three modes of operation: disabled, enabled or enabled-cold. If disabled, HEI will not function. The conditions necessary for the engine to run in HEI mode set to "enabled" are listed in Table 5-44. If HEI is set to "enabled-cold" mode, the conditions necessary for operation in enabled mode must be met in addition to certain engine temperatures being below limits.

Engine	HEI Allowed	DDR Configuration Allowed	Parking Brake Required	Vehicle Speed Limit	Default
Series 50	No	--	--	--	--
Series 60	Yes	Yes	Yes	5 MPH	--
Series 71	Yes	No	No	None	Enabled - Cold
Series 92	Yes	No	No	None	Enabled - Cold
Series 149	Yes	No	No	None	Enabled - Cold
Series 2000	Yes	No	No	5 MPH	Enabled - Cold
Series 4000	Yes	No	No	None	Enabled - Cold

Table 5-44 Conditions for HEI

HEI can be deactivated and reactivated if certain conditions are met. This is likely only during extended idle if HEI is in the enabled-cold mode.

5.17.2 INSTALLATION

HEI was not released for Series 60 engines prior to DDEC Release 5.0. Series 60 engines require a park brake input to run in HEI.

5.17.3 PROGRAMMING FLEXIBILITY

DDEC Release 5.0 software or higher requires that HEI be calibrated by DDC and will not support DDR HEI configuration. For Series 60 engines, DDR calibration of HEI requires DDEC Release 7.0. On select engines, DDDL/DDR may configure HEI mode (enabled/disabled). The rest of the parameters are factory set and cannot be changed. VEPS is not capable of setting the HEI mode.

5.17.4 DIAGNOSTICS

The DDR or DDDL display will tell the user if the engine is running in HEI. This display is part of the Data List menu.

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5.18 IDLE SHUTDOWN TIMER AND VEHICLE POWER SHUTDOWN

The Idle Shutdown Timer will shutdown the engine if it remains idling for a specified period of time. There are four options that can operate with Idle Shutdown Timer.

- Idle Shutdown Override
- Vehicle Power Shutdown
- Variable Speed Governor (VSG) Shutdown
- Ambient Air Temperature Override Disable

5.18.1 OPERATION

There are two types of idle shutdown:

- The engine has been idling for a specified time period.
- The engine has been idling for a specified time period and the ambient temperature is within a specified range.

Certain conditions must be met for the entire time-out period for shutdown to occur. These conditions include:

- Engine temperature above 104°F (40°C)
- Engine operation at idle or VSG minimum
- The parking brake interlock digital input switched to battery ground
- OEM supplied interlocks enabled
- Ignition ON (Circuit 439)

Fueling is stopped after the specified idle time; the ignition circuit 439 remains active after the engine shuts down. The ignition switch must be cycled to OFF (wait 10 seconds) and back to ON before the engine will restart, if shutdown occurs. The CEL will blink until the ignition is turned off to indicate shutdown has occurred. If the ignition is not turned off within 20 minutes, the ECM will begin its low power mode. This will cause the CEL to turn off. In low power mode, the ignition cycle will be considered over. All steps which normally occur after the ignition cycle was turned off will take place even though the ignition switch is still on. This prevents excessive battery drain by the ECM.

A Park Brake Switch must be installed (see Figure 5-40). Idle Shutdown Timer operates with a digital input configured as a park brake and switched to battery ground. The time can range from 1 to 100 minutes in one minute intervals. An optional digital output can be programmed for vehicle power shutdown. This is used with idle timer shutdown or the engine protection shutdown features to shut off any electrical loads on the vehicle.

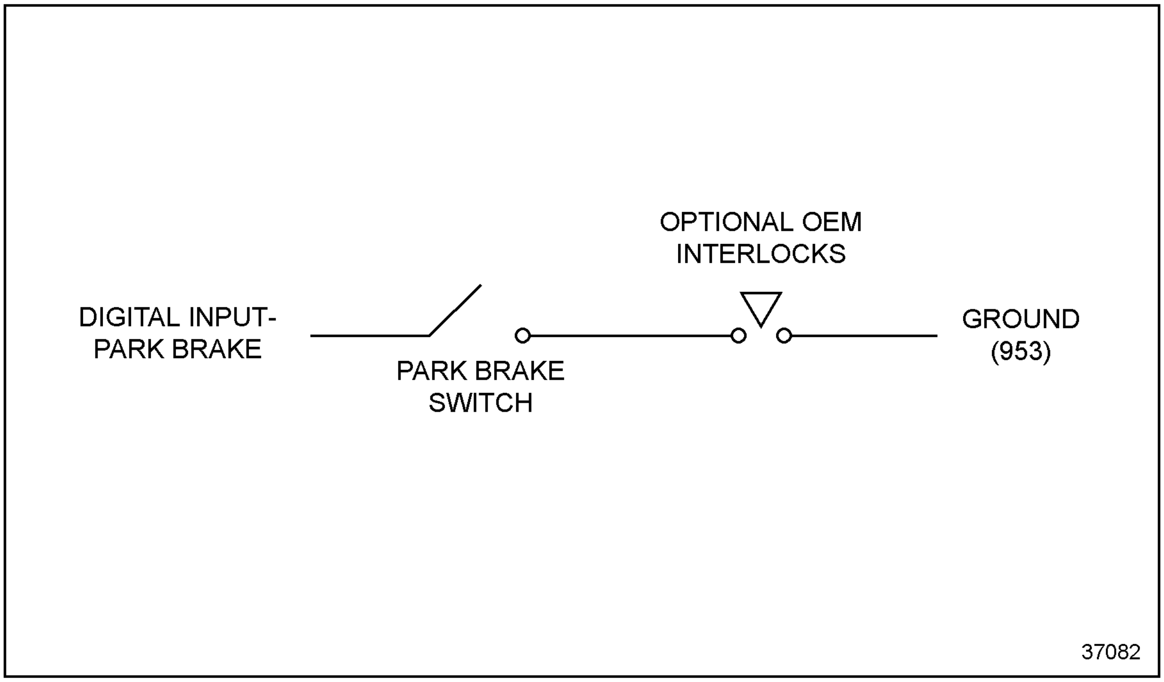

Figure 5-40 Park Brake Digital Input

Idle Shutdown Override - Optional

Idle Shutdown Override allows the operator to override the idle shutdown to keep the engine idling if this feature is enabled.

Ninety seconds before the specified idle time is reached, the CEL will begin flashing. The idle timer can be disabled if the percent throttle is increased to greater than 1%. This will allow the idle timer to be overridden if longer engine idling is desired. The timing sequence can be re-initiated by disengaging and reapplying the parking brake, by cycling the ignition OFF (waiting 10 seconds) and back to ON or by once again increasing the percent throttle greater than 1%.

Vehicle Power Shutdown - Optional

Vehicle Power Shutdown is used with Idle Timer Shutdown or Engine Protection Shutdown. After the idle timer times out or engine protection shuts the engine down, the Vehicle Power Shutdown relay shuts down the rest of the electrical power to the vehicle.

A Vehicle Power Shutdown relay can be installed to shutdown all electrical loads when the engine is shutdown (see Figure 5-41). This figure also provides a method to turn OFF the ignition while the idle timer is active. The engine will shutdown after the specified idle time and will reset the relay (ignition circuit).

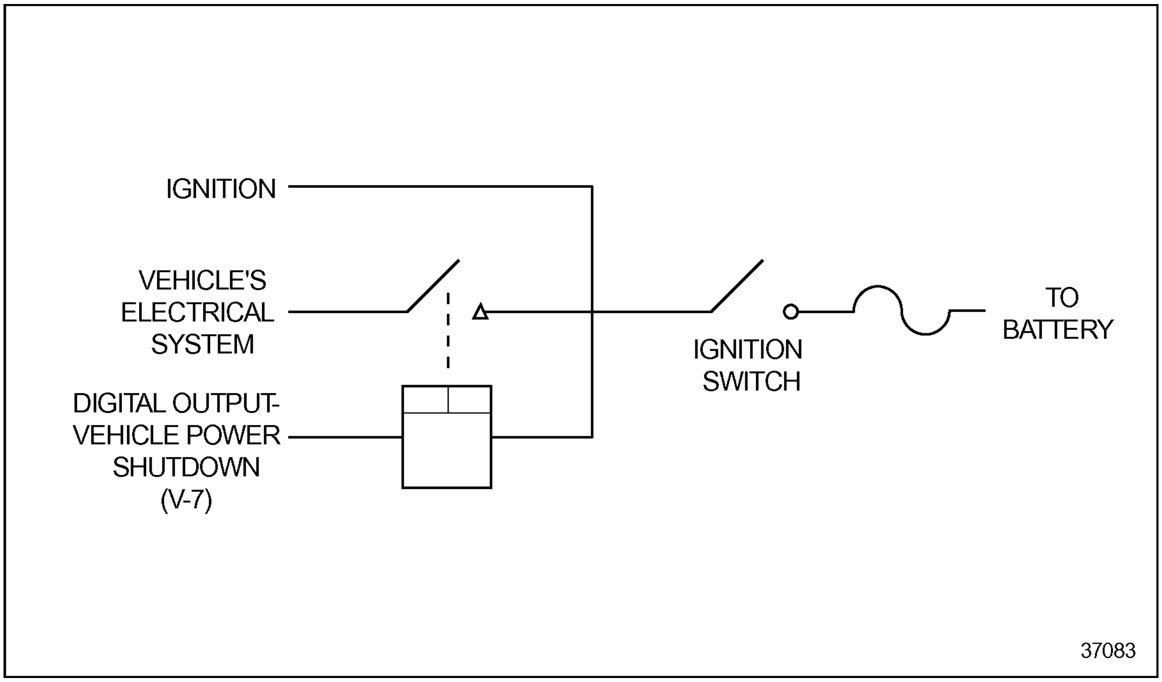

Figure 5-41 Vehicle Power Shutdown Relay

All electrical loads that should be turned OFF when the engine shuts down should be wired through this relay.

Refer to section 4.2, "Digital Outputs" for additional information.

Enabled on Variable Speed Governor (VSG) - Optional

This option, when enabled, allows the engine to be shutdown when operating on the VSG when the conditions are met for the Idle Timer Shutdown.

Ambient Air Temperature Override Disable - Optional

This option allows the override to be disabled based on ambient air temperature. If the upper and lower temperature limits are set and the ambient temperature is within the specified limits, the override will be disabled and the engine will be shutdown after the specified time limit is met. To disable this feature, the upper and lower limits must be set to 167°F.

For example, if the upper limit is set to 80°F and the lower limit is set to 65°F, the override would be disabled if the ambient air temperature was between 65°F and 80°F (see Figure 5-42).

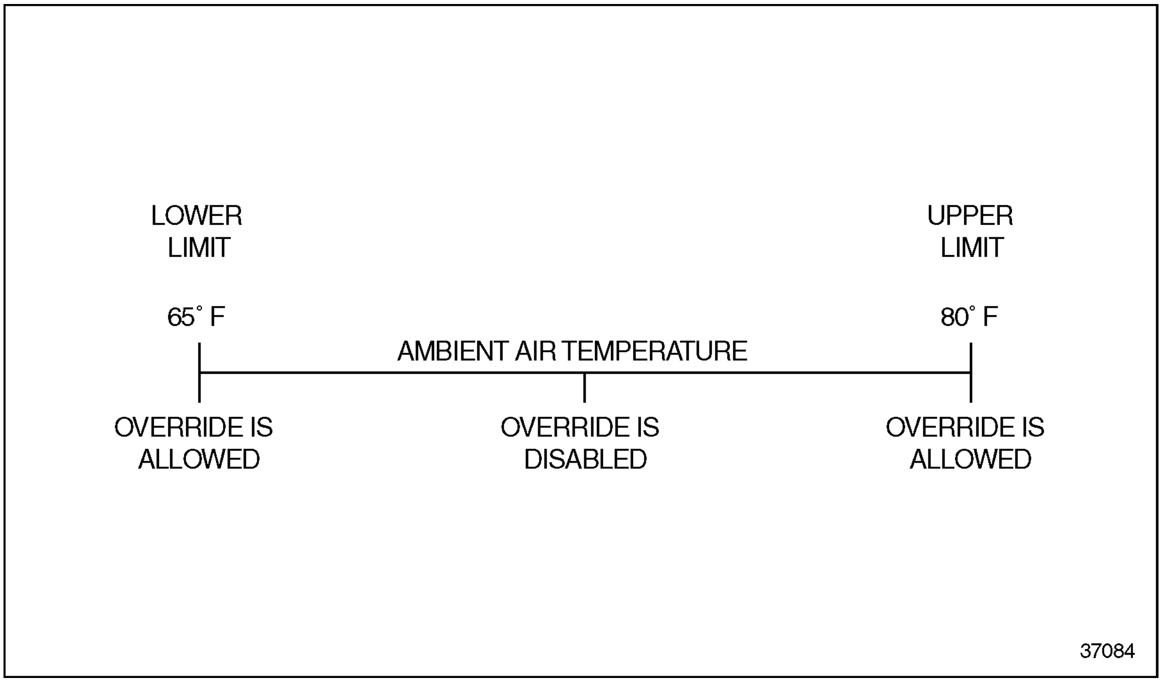

Figure 5-42 Ambient Air Temperature Override Disabled

Inactive Shutdown

The Idle Shutdown Timer can be defeated by holding down the throttle or by not setting the park brake. The inactive timer will shutdown the engine after 20 minutes if the fueling is not sufficient to accelerate the vehicle

To improve the accuracy of ambient air temperature sensor readings, an ambient air temperature sensor can be installed. This installation is recommended if the ambient air temperature shutdown feature is enabled.

Refer to section 3.14.27, "Ambient Air Temperature Sensor," for additional information.

5.18.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

To program the Idle Shutdown timer, the digital inputs listed in Table 5-45 must be configured by order entry, VEPS or DRS.

Description	Function #	Type
Park Brake/ISD	5	Digital Input
Vehicle Power Shutdown - optional	6	Digital Output

Table 5-45 Idle Shutdown Timer Digital Input

The Idle Shutdown timer options listed in Table 5-46 can be programmed by the DDR, DDDL, VEPS or DRS.

Parameter	Description	Choice / Display
ENABLED	Enables or Disables the Idle Shutdown feature. N/A will be displayed if the parking brake has not been configured as a digital input.	YES, NO
TIME (MIN)	The amount of engine idle time that is allowed before the Idle Shutdown feature stops fueling the engine.	1 to 100 minutes
OVERRIDE	The override will flash the CEL 90 seconds before shutdown to allow the driver to cancel the shutdown by pressing the throttle.	YES, NO
ENABLED ON VSG	Enables or disables the Idle Timer Shutdown feature when operating on the Variable Speed Governor.	YES, NO
OVERRIDE TEMP DISAB	Allows choice between lower or upper limit to disable the Idle Shutdown Override feature based on ambient air temperature.	LOWER LIMIT, UPPER LIMIT
☐ LOWER LIMIT	The lower limit of the ambient air temperature range that will disable the Idle Shutdown Override feature.	-40 to "UPPER LIMIT" °F
☐ UPPER LIMIT	The upper limit of the ambient air temperature range that will disable the Idle Shutdown Override feature.	"LOWER LIMIT" to 167°F

Table 5-46 Idle Shutdown Timer Programming Options

5.18.3 INTERACTION WITH OTHER FEATURES

The Idle Shutdown Timer is required for Optimized Idle. Refer to section 5.24, "Optimized Idle," for additional information.

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5.19 IRIS

The Infrared Information System (IRIS) is an optional feature that provides for infrared two-way communication between a vehicle and a PC.

Detailed IRIS installation information can be found in the *IRIS User and Installation Guide*(6SE0036).

5.19.1 OPERATION

All data which is currently transmitted via cable, can now be sent using IRIS. This includes downloading of all information in the ECM, ProDriver DC, ProDriver, engine diagnosis, and complete engine reprogramming. IRIS replaces direct hook-up via cables with an infrared beam (see Figure 5-43).

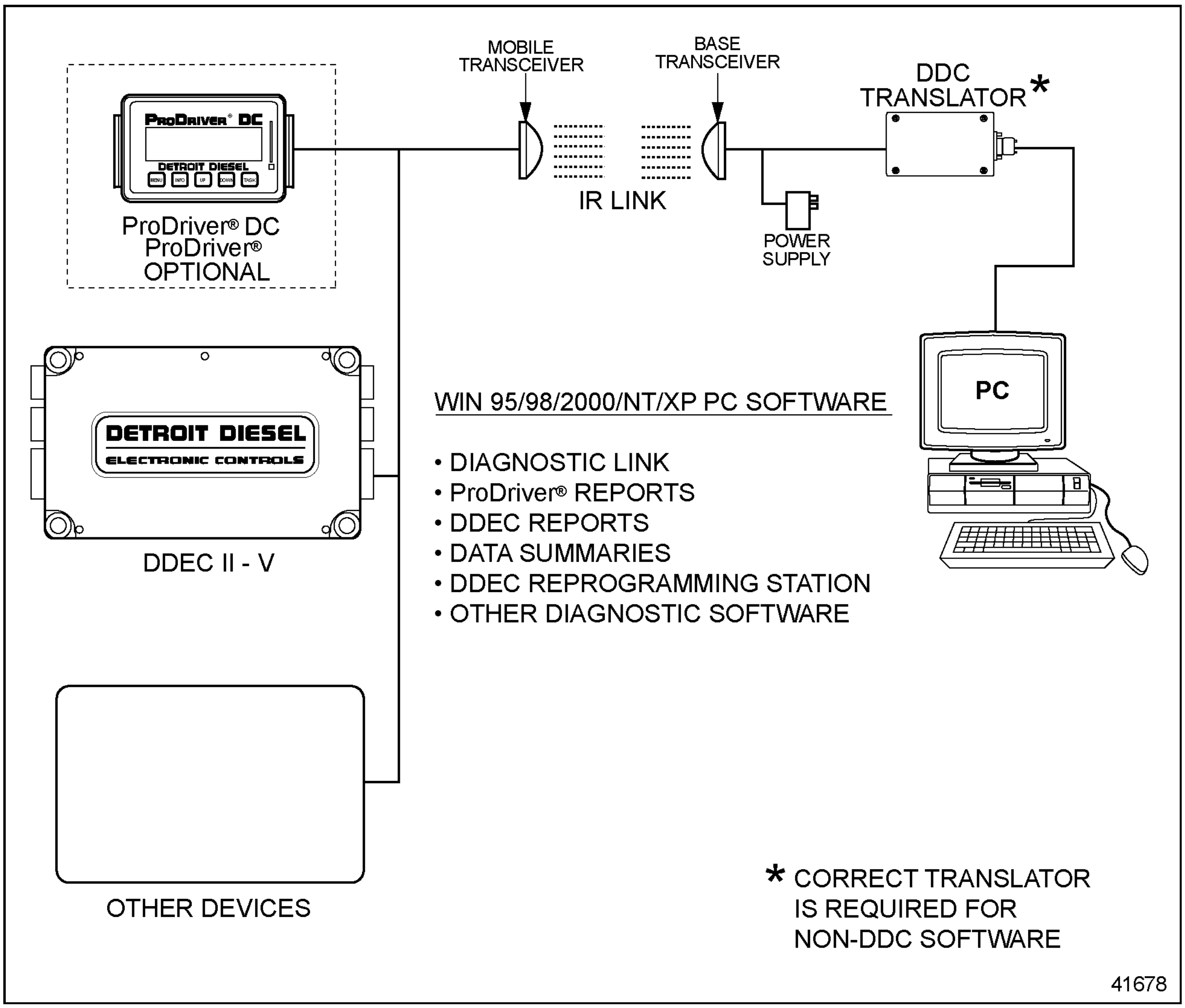

Figure 5-43 IRIS Configuration

Downloading and uploading time takes place with IRIS at the same high speed as a direct cable connection.

IRIS eliminates the need for the driver to exit the vehicle, locate a cable and plug into the vehicle. No physical connections are required. IRIS can also be used in a service bay with diagnostic equipment, eliminating the need to bring the computer cart to the vehicle.

IRIS works with most devices communicating via the J1708 Data Link.

One transceiver, the Mobile Unit, is mounted on the vehicle and the other, the Base Unit, is located where the vehicle owner wants to extract information, such as the entrance to the shop or the fuel island. The base transceiver is continuously polling for a vehicle, while the mobile transceiver is silent until it receives a message from the base transceiver. When the mobile transceiver on the vehicle is in general alignment to the base transceiver, handshaking will take place and establish the infrared link. (see Figure 5-44).

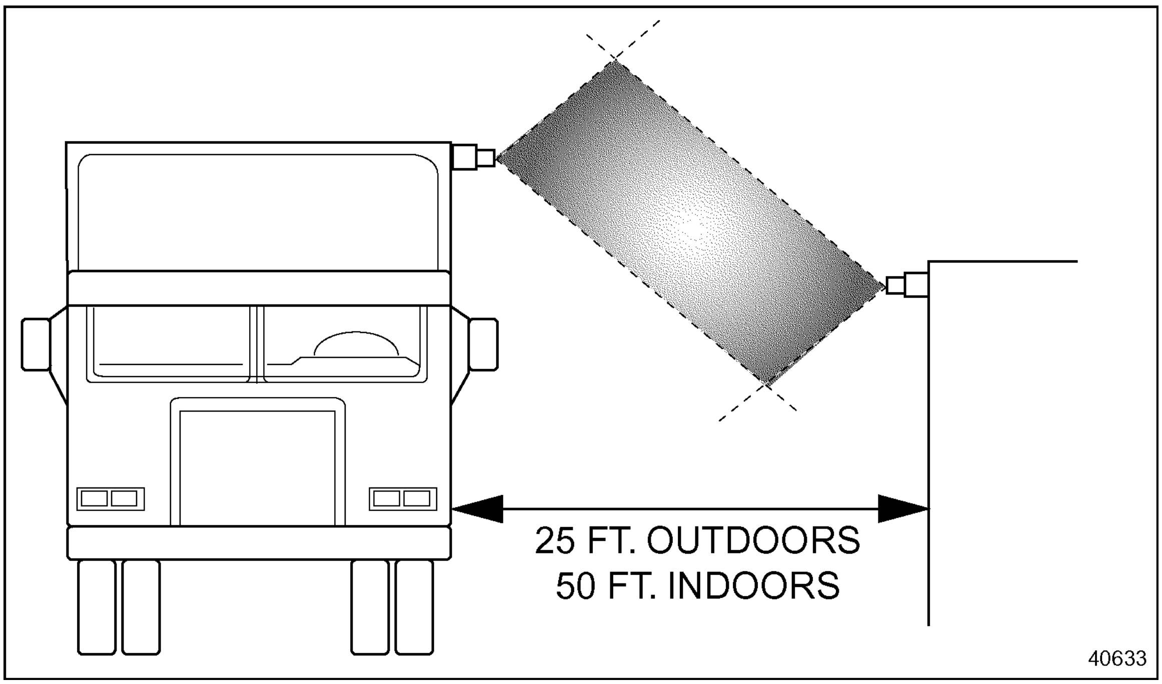

Figure 5-44 IRIS - Infrared Two-way Communication

The base transceiver will only communicate with one mobile transceiver at a time. The vehicle must be moved out of the infrared connection area for the base transceiver to start polling for another vehicle.

The IRIS dash light will flash during the handshaking communication between the two transceivers. Once the infrared link is established the light will be solidly illuminated until the connection is broken.

If the remote Data Interface (RDI) is used with IRIS, the RDI lights will indicate when the extraction has been completed. For installations without RDI, the service technician will need to indicate to the driver that the reprogramming or extraction has been completed.

5.19.2 INSTALLATION

As long as the two transceivers are in general alignment, IRIS will function up to a distance of 25 ft outdoors to 50 ft indoors (see Figure 5-45).

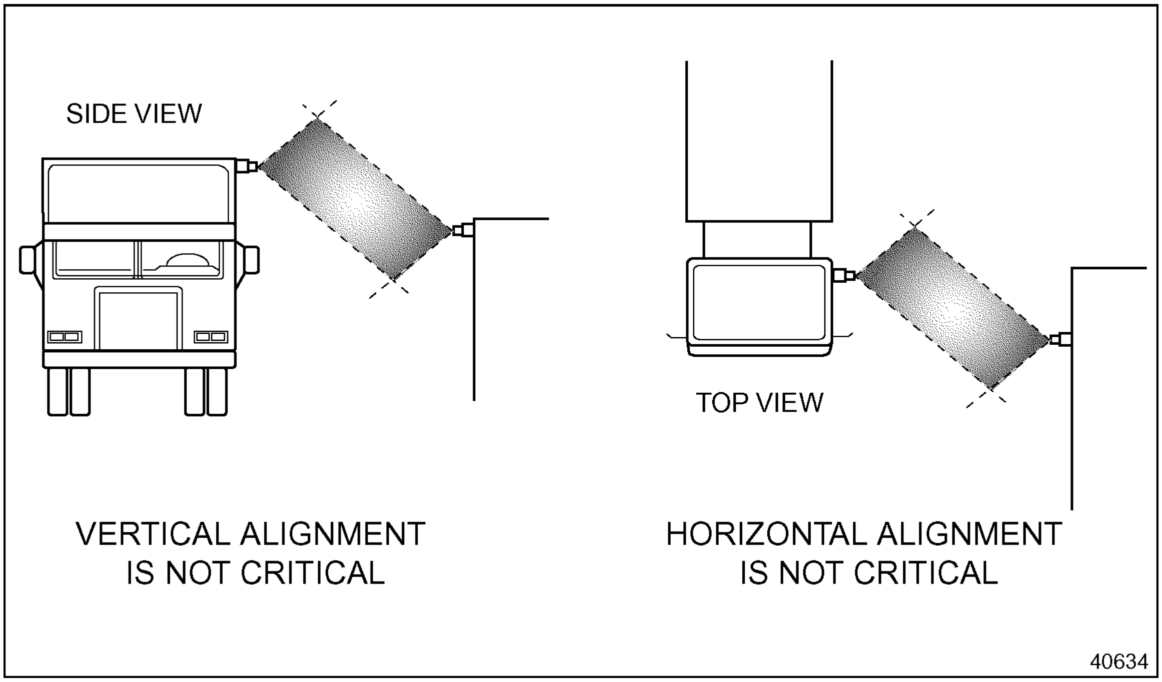

Figure 5-45 Horizontal and Vertical Alignment is not Critical

Use the following guidelines when installing IRIS:

- ☐ The control module should be mounted in a cab environment.
- ☐ The transceiver can be shaded to obtain more distance.
- ☐ Do not shine electronic ballast fluorescent lights into the transceiver.
- ☐ Do not install transceivers where they are exposed to strobe lights.
- ☐ Do not add more than two transceivers with one control module.

Mobile Unit Installation

The Mobile Unit installation consists of an transceiver and the Mobile Unit Module (see Figure 5-46). The transceiver should be mounted outside either on the side or the front of the vehicle at least seven feet above the ground for optimal performance.

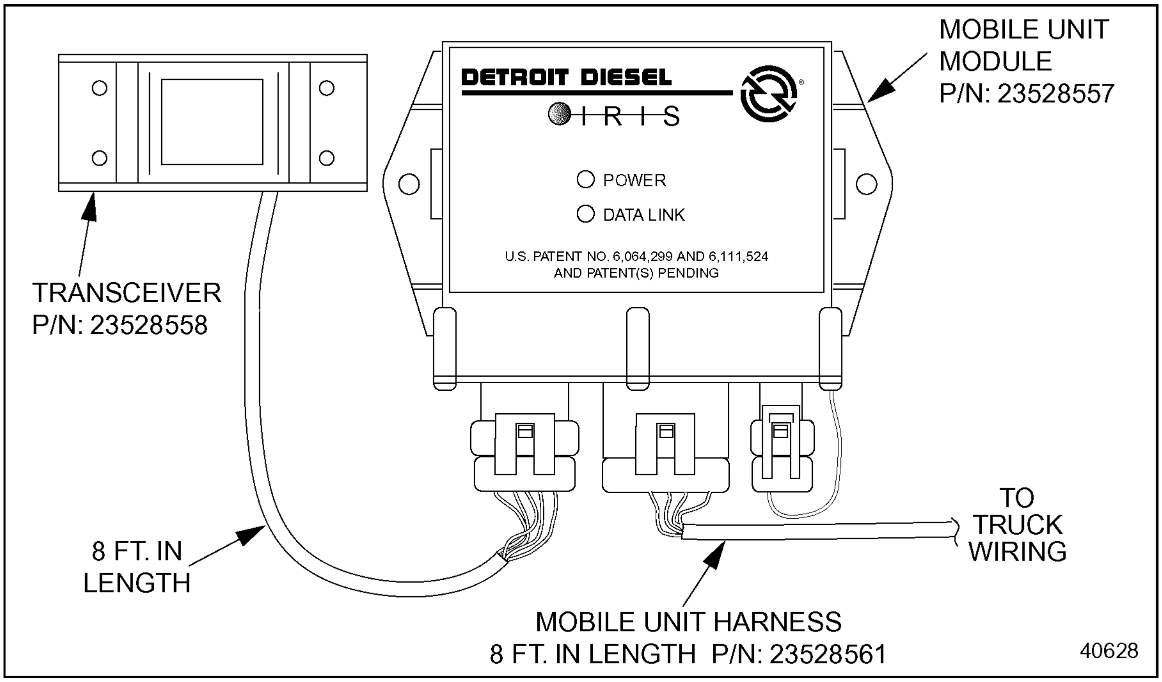

Figure 5-46 IRIS Mobile Unit

The Mobile Unit Module can be mounted anywhere inside the vehicle. It can be hidden behind the dash, but should be accessible for the transceiver and vehicle harness connection and for troubleshooting purposes.

Base Unit Installation

The Base Unit consists of a transceiver and the Base Unit Module. Refer to Figure 5-47.

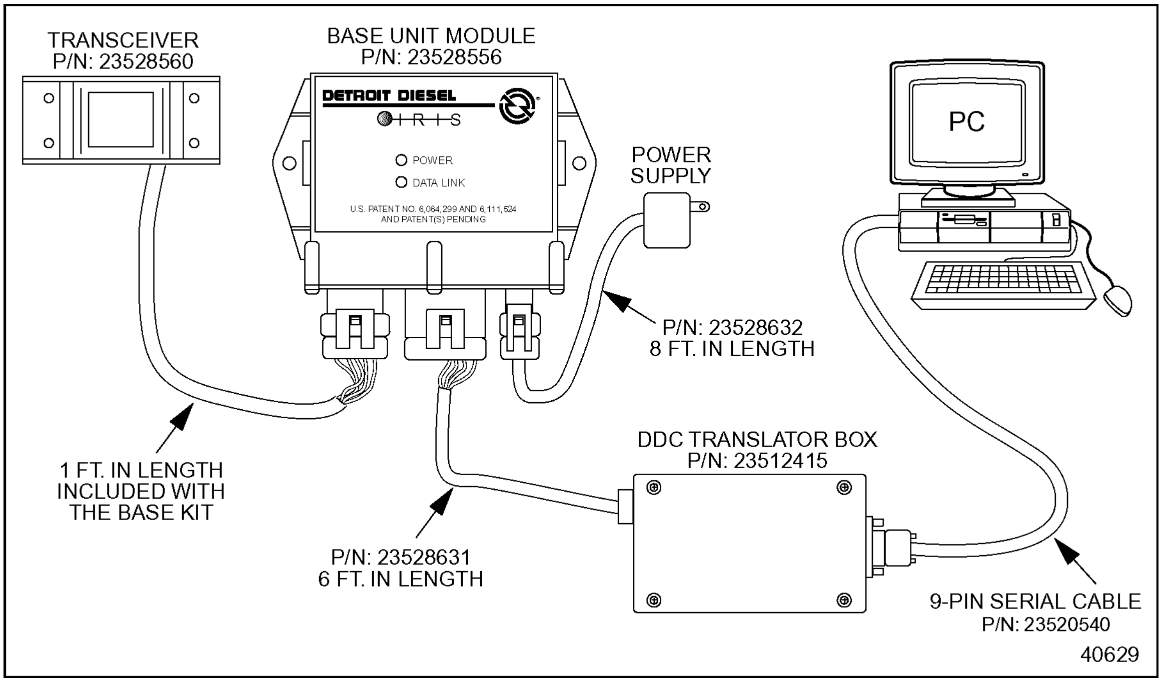

Figure 5-47 Base Unit Installation

The Base Unit Module can be near the PC running the programming or extraction software programs. A DDC Translator Box is between the base unit and the PC. The cable length between the base unit and the translator box can be as long as 100 ft. This is the same translator box used when data communication occurs using a direct cable. Refer to the *IRIS User and Installation Guide* (6SE0036) for more installation information.

Base Unit Installation with Remote Data Interface (RDI)

The Base Unit installation with an Remote Data Interface (RDI) consists of an eyeball and the Base Unit Module (see Figure 5-48).

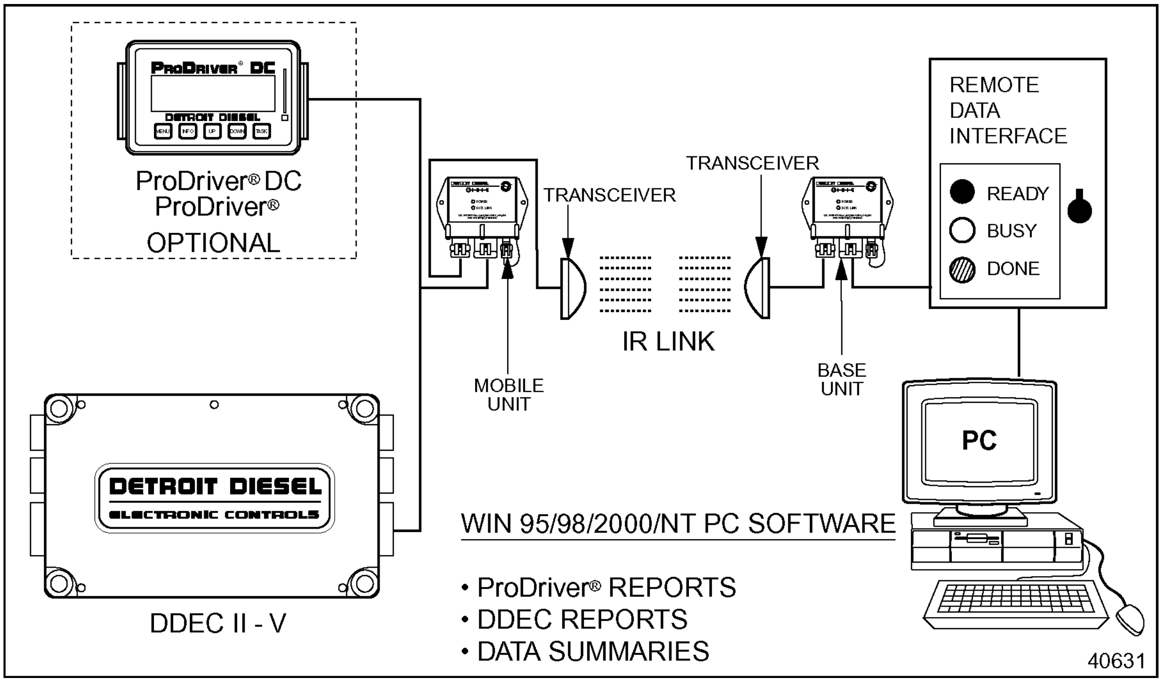

Figure 5-48 Base Unit Module with RDI Installation

The IRIS bracket should be located near the RDI where extractions will be done. To assemble the eyeball and module on to the bracket. Bolts, screws, and other hardware for mounting the IRIS bracket to a wall, post, or fence is required to complete the installation. These parts are not included in the kit.

The Standard IRIS Harness (P/N: 23528635) is used for this installation. Its wires are routed into the RDI case via one of the cable entry bushings; the power connection wires are routed to the RDI power connection on the RDI circuit board and the J1708 date link wires are spliced with the RDI data link wires. Refer to the *IRIS User and Installation Guide* (6SE0036) for detailed installation information.

IRIS Mobile Service Kit Installation

The IRIS Mobile Service Kit (P/N: 23528563) provides a temporary installation of IRIS that can be removed and used on multiple vehicles.

The bracket hangs on the window of the vehicle and plugs directly into the diagnostic connector (see Figure 5-49).

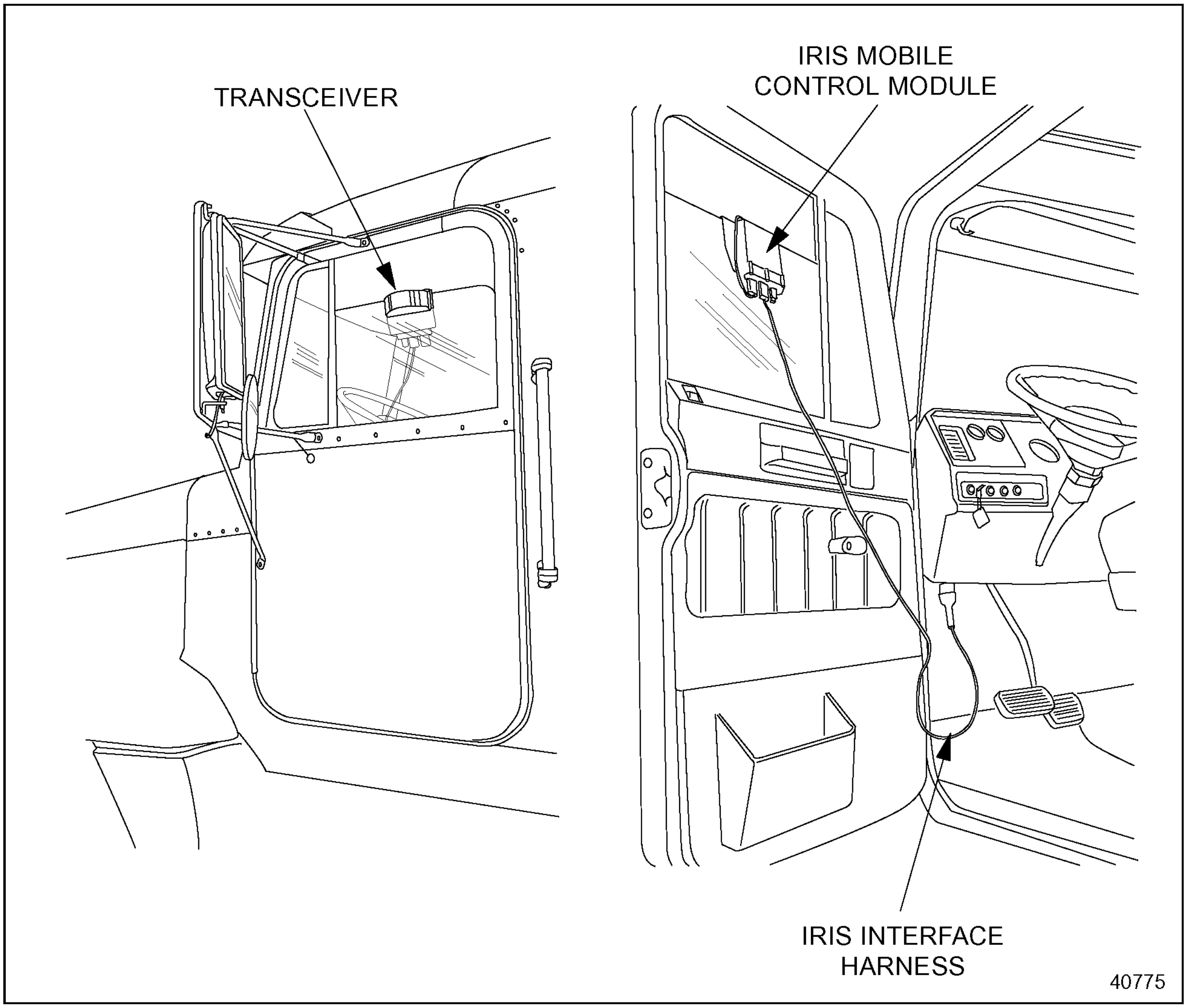

Figure 5-49 IRIS Mobile System on Vehicle

Detailed IRIS installation information can be found in the *IRIS User and Installation Guide*(6SE0036).

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5.20 LOW GEAR TORQUE LIMITING

Low Gear Torque Limiting is an optional feature that allows a transmission to be used with engines capable of producing more torque than the transmission's peak torque rating.

5.20.1 OPERATION

Low Gear Torque Limiting provides a limit on the available torque if the ratio of vehicle speed to engine speed is below a set point. This limits full torque in lower gears and allows a transmission to be used with engines above the transmission's regular torque rating.

For example, the customer wants to hold the torque to 1400 ft lbs up to 8th gear. The transmission operates with the ratios listed in Table 5-47.

Gear	Ratio
5	3.57
6	2.79
7	2.14
	<< Threshold
8	1.65
9	1.27
10	1.00

Table 5-47 Transmission Ratios

Under Low Gear Torque Limit, set the "torque limit" (actual maximum torque you want to limit to) to 1400 and "threshold" to 1.89 (value between the gear you want to limit and the previous gear's ratio).

To summarize, the customer wants to limit torque up to the 8th gear to 1400. Find the ratio between 7th and 8th (1.89). From 8th gear on up, the full rated torque will be available.

5.20.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

A VSS or output shaft speed message over SAE J1939 is required (refer to section 3.14.25, "Vehicle Speed Sensor"). VEPS or DRS can enable the parameters listed in Table 5-48.

Parameter	Description	Choice / Display
LOW GEAR TORQUE LIMITING	Provides a limit on the available torque if the ratio of vehicle speed to engine speed is below a set point.	0 to 65535 ft lbs 65535 ft lbs disables this feature.
LOW GEAR THRESHOLD	The gear ratio below which torque is limited.	0.047 to 300

Table 5-48 Low Gear Torque Limiting Parameters

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5.21 MAINTENANCE ALERT SYSTEM

The Maintenance Alert System (MAS) is an optional feature that monitors engine fluid levels and filter restrictions and notifies the driver and/or technician when maintenance is required. MAS parameters that can be monitored are:

- ☐ Air Filter Restriction - OEM installed sensor
- ☐ Add Coolant Level - OEM installed sensor
- ☐ Oil Level - factory installed sensor
- ☐ Fuel Restriction - factory installed sensor

The Oil Level Sensor and Fuel Restriction Sensor are standard MAS sensors.

The CEL and SEL may be used to indicate the codes or an optional MAS display, ProDriver, Diagnostic Data Reader (DDR) or Detroit Diesel Diagnostic Link (DDDL) may be used.

MAS is available with DDEC IV software Release 27.0 or later.

5.21.1 OPERATION

DDEC continuously monitors the various sensors and logs and displays a code when a fault occurs. MAS faults do not engage any Engine Protection features (rampdown or shutdown).

DDEC will notify the operator/technician of maintenance requirements by one or more of the following methods:

- ☐ CEL/SEL indication
- ☐ ProDriver
- ☐ Maintenance Alert System Display Module
- ☐ DDR
- ☐ DDDL

For mobile applications, the DDR, DDDL, or MAS display must be used by personnel other than the vehicle operator.

CAUTION:
To avoid injury from loss of vehicle/vessel control, the operator of a DDEC equipped engine must not use or read any diagnostic tool while the vehicle/vessel is moving.

The vehicle operator must maintain control of the vehicle while an assistant performs the diagnostic evaluations.

Oil level can only be determined when the engine is not running (i.e. after the ignition is turned off and after the drain down period or before the engine has been started). There is a minimum of four minutes and a maximum of 15 minutes (based on oil temperature) to determine the oil level after the engine has shutdown.

The Air Filter Restriction Sensor (AFRS) has two trip points, one at 18 in.H_2O and the second at 25 in.H_2O. An air filter is considered to be restricted if the AFRS reads 18 in.H_2O and the engine is operating below 1500 RPM or the AFRS reads 25 in.H_2O at any engine speed. The air filter restriction logic will look for either of these two restrictions that have occurred at least 24 engine hours apart but no more than 72 hours apart. When this condition is met, the ECM will activate an air filter restriction fault.

The air filter restriction fault and fuel restriction fault will remain active for the entire ignition cycle. If the MAS display is used, the fault will be latched in the display until a FILTER RESET is done.

ECM Power Down Behavior

If the Add Coolant Level Sensor (ACLS) or Oil Level Sensor (OLS) are configured, the ECM will go into a reduced activity mode after ignition off. In this mode, the ECM will not continuously broadcast data, but will still accept and respond to requests for two hours. The ECM will continue to monitor all the sensors, but the injectors will not fire. Just before the reduced activity mode ends, the ECM will broadcast the fluid levels, all faults (active and inactive) and preventative maintenance status. After the ECM has powered down, it will not respond to data link requests.

CEL/SEL Flashing

There are four options for using the CEL and SEL for MAS, which may be set with the DDR (Release 24.0 or later), DDDL (Release 3.0 or later), VEPS (Release 24.0 or later), or DRS.

1. CEL and SEL will not illuminate or flash for MAS Warnings - sensor faults will still be logged (recommended for vehicles equipped with the optional display modules).
2. CEL will illuminate continuously while the warning is active, i.e. low fluid levels (oil or coolant), filter restrictions.
3. Blinking CEL and SEL for 15 seconds when the ignition is first turned ON and warnings have been present.
4. Both 2 and 3.

The DDR, DDDL, or VEPS can set options for filter restriction and fluid levels independently. For example, filter restrictions can be set so the CEL/SEL do not flash, but the sensor code is logged and the fluid levels can be set so that CEL will turn on when the warning is active. The factory set default is listed in Table 5-49.

Parameters	Default
Fluid Levels	CEL and SEL flash for 15 seconds when the ignition is first turned on.
Filter Restrictions	CEL will illuminate while the warning is active.

Table 5-49 Factory Set Defaults for CEL and SEL

ProDriver

ProDriver(Release 2.03 or later) will display any active faults and descriptions as they occur. The active faults listed in Table 5-50 will be displayed (PID and FMI) without description.

DDC Code # (Flashed)	SAE J1587 Code # (PID)	FMI	Description
13	111	6	Add Coolant Level Sensor (ACLS) Circuit Failed Low
16	111	5	Add Coolant Level Sensor (ACLS) Circuit Failed High
89	111	12	Maintenance Alert System Coolant Level Fault*
37	95	3	Fuel Restriction Circuit Failed High
38	95	4	Fuel Restriction Circuit Failed Low
89	95	0	Fuel Restriction High

* This fault will be logged when the Add Coolant Level Circuit (ACLS) reports the coolant level is OK and the Engine Protection Coolant Level Circuit (CLS) reports that coolant is low.

Table 5-50 Active Faults Displayed by ProDriver Without Description

Maintenance Alert System Display Module

The MAS display is cab mounted to easily display the current maintenance conditions. The display (see Figure 5-50) has seven tricolor LEDs and two switches (FILTER RESET and CHECK), each labeled for their function.

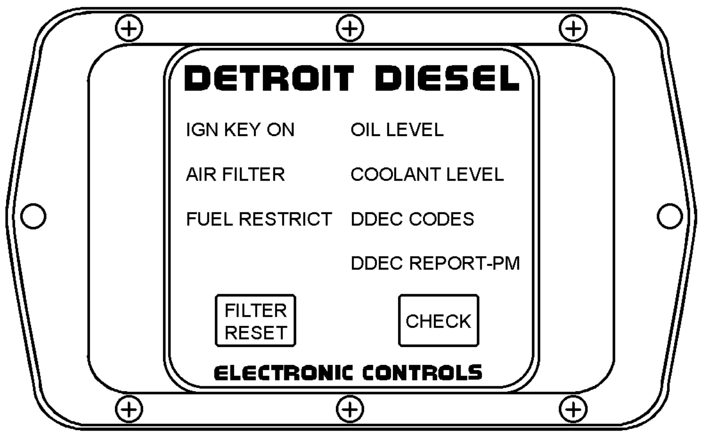


Figure 5-50 Maintenance Alert System Display (P/N: 23525655)

To display the current status of MAS parameters (listed in Table 5-51), press the CHECK button at any time to start the bulb check sequence.

Parameter	Green	Amber	Flashing Red	Blank
Air Filter	OK	N/A	Filter restriction is high.	Sensor fault or not configured.
Coolant Level	OK	N/A	Coolant Level is low. (Add coolant)	Sensor fault or not configured.
DDEC Codes	No sensor fault codes	Inactive sensor fault codes present; No Active sensor fault codes	Active sensor fault code is present.	N/A
DDEC Reports	Preventive Maintenance configured, no maintenance required	N/A	Preventive Maintenance configured and needs service.	Preventive Maintenance not configured.
fuel RESTRICT	OK	N/A	Filter restriction is high.	Sensor fault or not configured.
IGN Key ON	N/A	N/A	ECM asleep, memory data displayed.	ECM active, current data displayed.
Oil Level	OK	Oil is still draining to the oil pan.	Low oil level (minimum of 4 quarts)	Sensor fault or not configured.

Table 5-51 Maintenance Alert System Display Light Status

During the bulb check the display will request the current Preventative Maintenance (PM) data and update its memory with the received information. The LEDs will go through the following bulb check sequence:

1. All of the LEDs turn on and are green for approximately one (1) second.
2. All LEDs turn off very briefly.
3. All LEDs turn on and are red for approximately one (1) second.
4. All LEDs turn off very briefly.
5. The current information from memory will turn the LEDs to their appropriate color.
6. The LEDs will turn off after approximately 10 seconds with no switch activity.

The display will latch the fault for filter restrictions until cleared from the display. To reset the faults, press and hold the FILTER RESET button for three (3) seconds while the data is displayed. This will initiate the reset sequence for filters. This reset will only clear the display memory for each of the configured filters. FILTER RESET will change the flashing red filter LEDs to green until new and/or differing data is received and stored. If a filter LED is off and stays off after a reset this indicates that a problem other than Filter Restriction High (FMI 0) exists for that filter. The other LEDs (not used for filters) will still display the current data as they did before the reset sequence was initiated.

The MAS display will also perform minor diagnostics to inform the operator if the connection to the data link has been broken while the ignition is on. When this condition occurs, the display will flash all LEDs red at roughly two times/second while the ignition is on and until the FILTER RESET button is pushed, at which time the display will go blank. If the MAS display is energized via the CHECK button before the link connection has been repaired, the LEDs will again flash red in place of the normal service item status until the 10 second "no activity" timer has expired. After the display sees data bus activity, it will revert back to normal operation with the currently stored data and normal updates to the stored data.

Diagnostic Data Reader

The DDR (Release 24.0 or later) Maintenance Status menu will display the current status of MAS parameters, as listed in Table 5-52.

Parameter	Description	Choices
OIL LEVEL	Indicates the engine oil level. NOTE: While the engine is running, or for a maximum of 15 minutes after shutting down, the engine oil level will be UNKNOWN.	OK, ADD, N/A, UNKNOWN, FAIL
COOL LEVEL	Indicates the coolant level in the reservoir.	FULL, ADD, LOW, N/A, FAIL
AIR FILTER	Indicates the condition of the air inlet filter.	OK, PLUGGED, ERROR, N/A
FUEL FILTER	Indicates the condition of the fuel filter.	OK, PLUGGED, ERROR, N/A

Table 5-52 DDR Maintenance Status Menu List of MAS Parameters

The DDR (Release 24.0 or later) main data list will display the MAS parameters, as listed in Table 5-53.

Parameter	Description	Choices
OIL LEVEL	Indicates the engine oil level. NOTE: While the engine is running, or for a maximum of 15 minutes after shutting down, the engine oil level will be UNKNOWN.	OK, ADD, N/A, UNKNOWN, FAIL
COOL LEVEL	Indicates the coolant level in the reservoir.	FULL, ADD, LOW, N/A, FAIL
AIR FILT RS "H2O or kPa	Indicates the relative amount of restriction measured at the air inlet filter.	0.0 to 99.9 "H2O 0.0 to 99.9 kPa FAIL, N/A
FUEL IN RES "HG or kPa	Indicates the restriction measured at the fuel pump inlet.	0.0 to 99.9 "Hg 0.0 to 99.9 kPa FAIL, N/A

Table 5-53 DDR Main Data List MAS Parameters

NOTE:
After replacing the filter, PLUGGED will be displayed on the DDR until inactive codes or maintenance codes are cleared.

Maintenance codes can be cleared by the DDR under the Maintenance Alert menu. Only the MAS faults listed in Table 5-54 will be cleared under the Maintenance Alert menu.

PID	FMI	Description
98	1	Oil Level Low
111	1	Coolant Level Low
107	0	Air Filter Restriction High
95	0	Fuel Restriction High

Table 5-54 Maintenance Codes that Can Be Cleared by the DDR

Detroit Diesel Diagnostic Link

The DDDL (Release 3.0 or later) Maintenance Alert menu will display the current status of the MAS parameters and preventative maintenance status as listed in Table 5-55.

Parameter	Description	Choices
OIL LEVEL	Indicates the engine oil level. NOTE: While the engine is running, or for a few minutes after shutting down, the engine oil level will be UNKNOWN.	OK, ADD, N/A, UNKNOWN, FAIL
COOLANT LEVEL	Indicates the coolant level in the reservoir.	FULL, ADD, LOW, N/A, FAIL
AIR FILTER RESTRICTION	Indicates the relative amount of restriction measured at the air inlet filter.	OK, PLUGGED, ERROR, N/A
FUEL FILTER RESTRICTION	Indicates the restriction measured at the fuel pump inlet.	OK, PLUGGED, ERROR, N/A
PREVENTATIVE MAINTENANCE STATUS SERVICE A	Indicates the status of preventative maintenance limits.	EXPIRED, NOT EXPIRED, NOT CONFIGURED
PREVENTATIVE MAINTENANCE STATUS SERVICE B	Indicates the status of preventative maintenance limits.	EXPIRED, NOT EXPIRED, NOT CONFIGURED
PREVENTATIVE MAINTENANCE STATUS SERVICE C	Indicates the status of preventative maintenance limits.	EXPIRED, NOT EXPIRED, NOT CONFIGURED

Table 5-55 DDDL Maintenance Alert Menu List of MAS Parameters

The DDDL (Release 3.0 or later) Instrumentation menu will display the MAS parameters as listed in Table 5-56 under the "User ^6" tab.

Parameter	Description	Choices
OIL LEVEL	Indicates the engine oil level. NOTE: While the engine is running, or for a few minutes after shutting down, the engine oil level will be UNKNOWN.	OK, ADD, N/A, UNKNOWN, FAIL
COOLANT LEVEL	Indicates the coolant level in the reservoir.	FULL, ADD, LOW, N/A, FAIL
AIR FILTER DIFFERENTIAL PRESSURE	Indicates the relative amount of restriction measured at the air inlet filter.	0.0 to 99.9 "H2O 0.0 to 99.9 kPa FAIL, N/A
FUEL FILTER DIFFEREN-TIAL PRESSURE	Indicates the restriction measured at the fuel pump inlet.	0.0 to 99.9 "Hg 0.0 to 99.9 kPa FAIL, N/A

Table 5-56 DDDL Instrumentation Menu List of MAS Parameters

NOTE:
After replacing the filter, DDDL will display PLUGGED until the inactive or maintenance codes are cleared.

Maintenance Codes can be cleared by DDDL under the Diagnostic Maintenance Alert menu. Only the MAS faults listed in Table 5-57 will be cleared under the Maintenance Alert menu.

PID	FMI	Description
98	1	Oil Level Low
111	1	Coolant Level Low
107	0	Air Filter Restriction High
95	0	Fuel Restriction High

Table 5-57 MAS Maintenance Codes DDDL Can Clear Under the Maintenance Alert Menu

5.21.2 INSTALLATION

The Oil Level Sensor (OLS) and the Fuel Restriction Sensor (FRS) are factory installed. The Air Filter Restriction Sensor (AFRS), the Add Coolant Level Sensor (ACLS), and the MAS Display Module are installed by the OEM using the MAS pigtail on the ESH (see Figure 5-51).

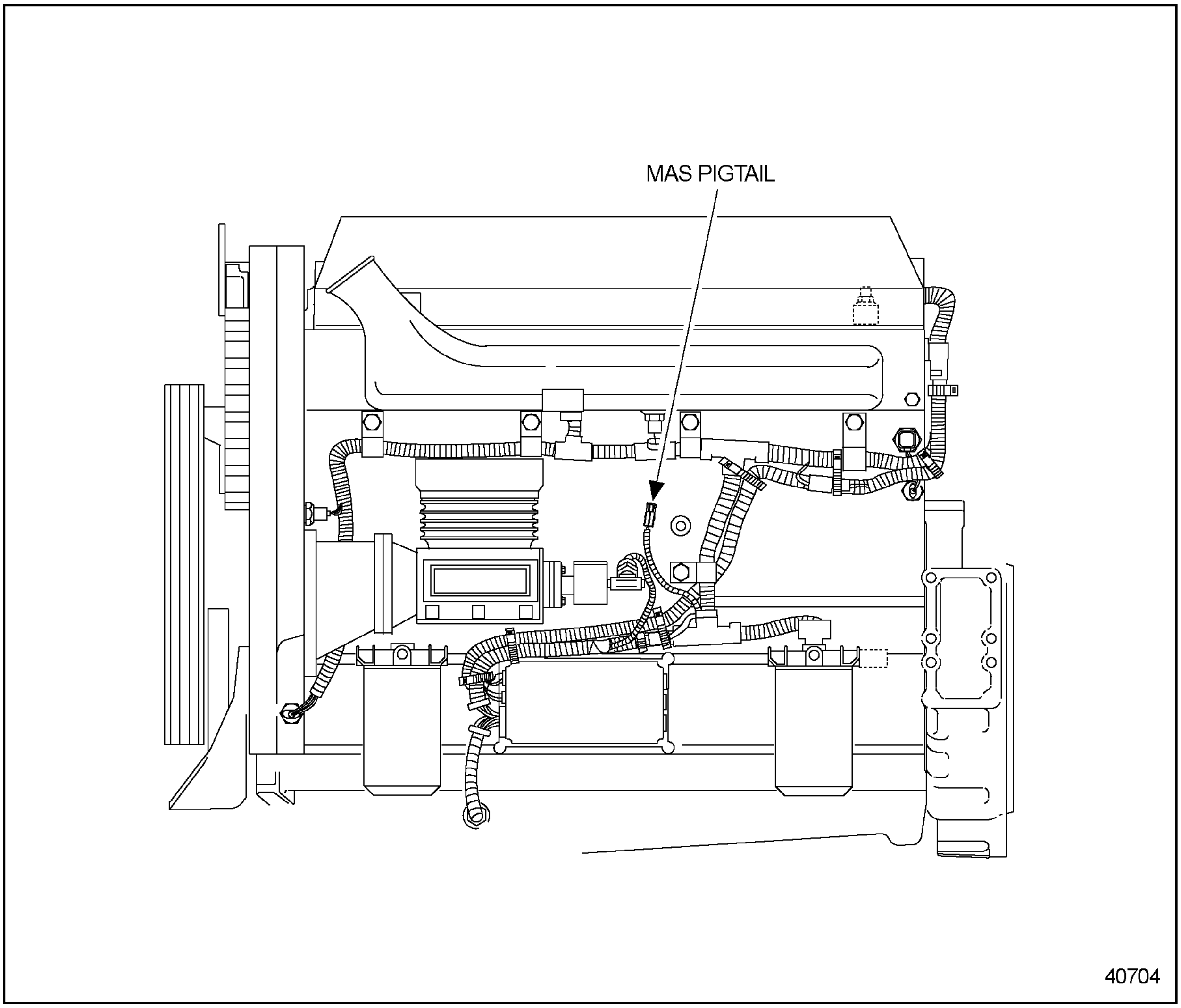
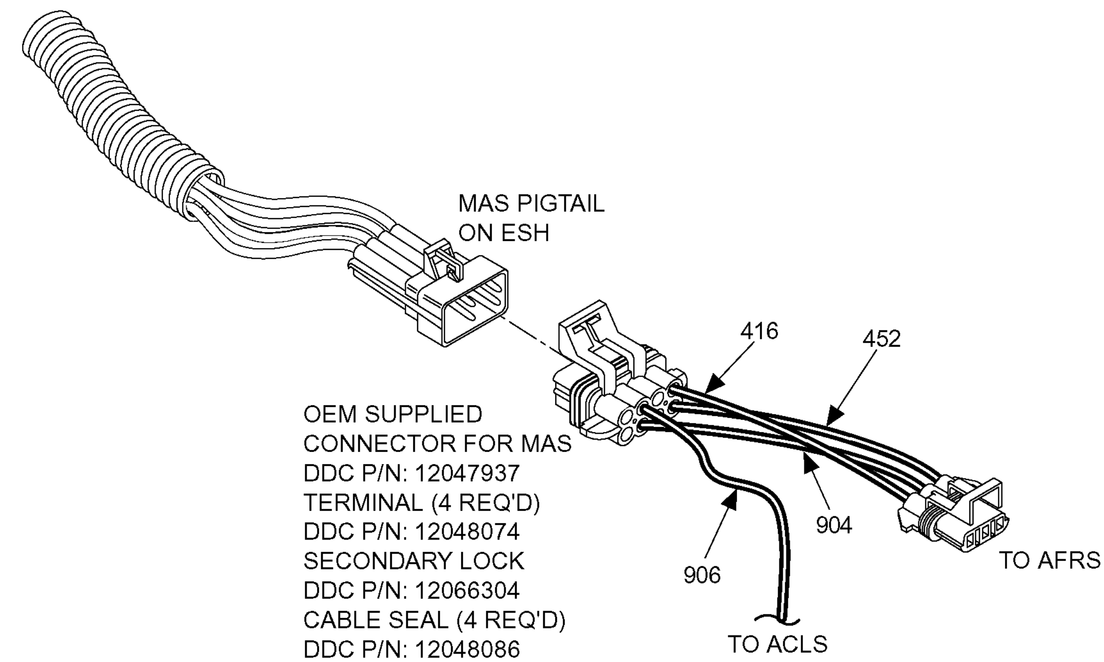


Figure 5-51 Location of MAS Pigtail

The MAS pigtail (see Figure 5-52) on the DDC installed Engine Sensor Harness will be used to wire the AFRS and ACLS (see Figure 5-54).



LABEL	WIRE NO.	CAVITY	WIRE COLOR
PLUGGED	-	A	-
AFRS	904	B	PPL/WHT
PLUGGED	-	C	-
SENSOR GROUND	452	D	BLK
SENSOR SUPPLY	416	E	GRA
PLUGGED	-	F	-
ACLS	906	G	ORN

41671

Figure 5-52 MAS Pigtail Connection to the Air Filter Restriction Sensor

Air Filter Restriction Sensor

The AFRS (see Figure 5-53) is mounted downstream of the air filter and upstream of the turbocharger.

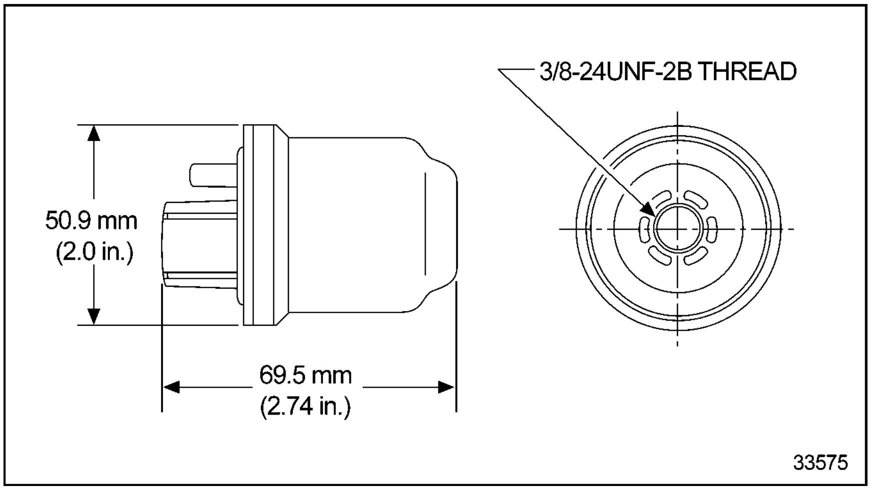
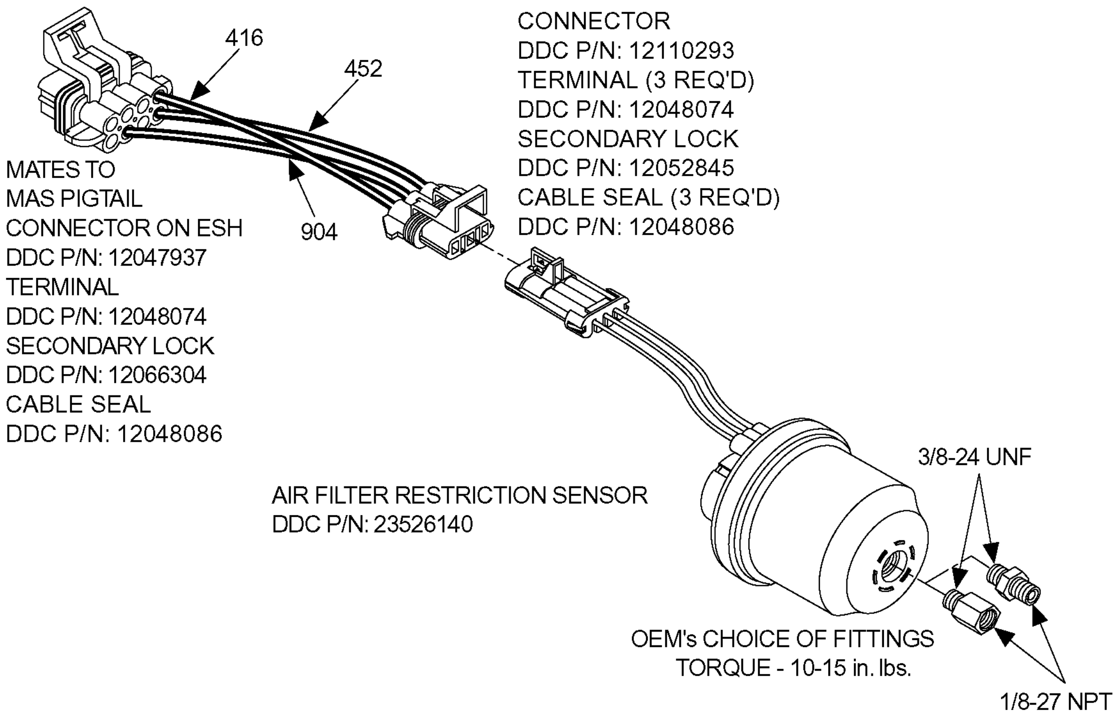


Figure 5-53 Air Filter Restriction Sensor

The AFRS must be in a straight section of pipe or where the OEM mechanical unit is normally mounted. This sensor must be enabled with VEPS (Release 24.0 software or later) or DRS.

NOTE:
The AFRS sensor and associated wiring is OEM installed.

Two fittings are provided with the sensor (see Figure 5-54). Each OEM can pick the application appropriate fitting.



LABEL	WIRE NO.	MAS PIGTAIL MATING CONNECTOR	WIRE COLOR	AFRS CONNECTOR	ESH-TO-ECM CONNECTOR CAVITY
AFRS	904	B	PPL/WHT	B	L1
SENSOR GROUND	452	D	BLK	A	Y2
SENSOR SUPPLY	416	E	GRA	C	W1

41673

Figure 5-54 Air Filter Restriction Wiring Diagram

Add Coolant Level Sensor

is used to warn the driver that the coolant level is below the recommended level but engine damage is not imminent. If the tank is equipped with an "ADD" level, the sensor should be installed there. This sensor will be activated approximately mid-way between the cold full level and the level where the standard (engine protection) CLS is located (see Figure 5-55).

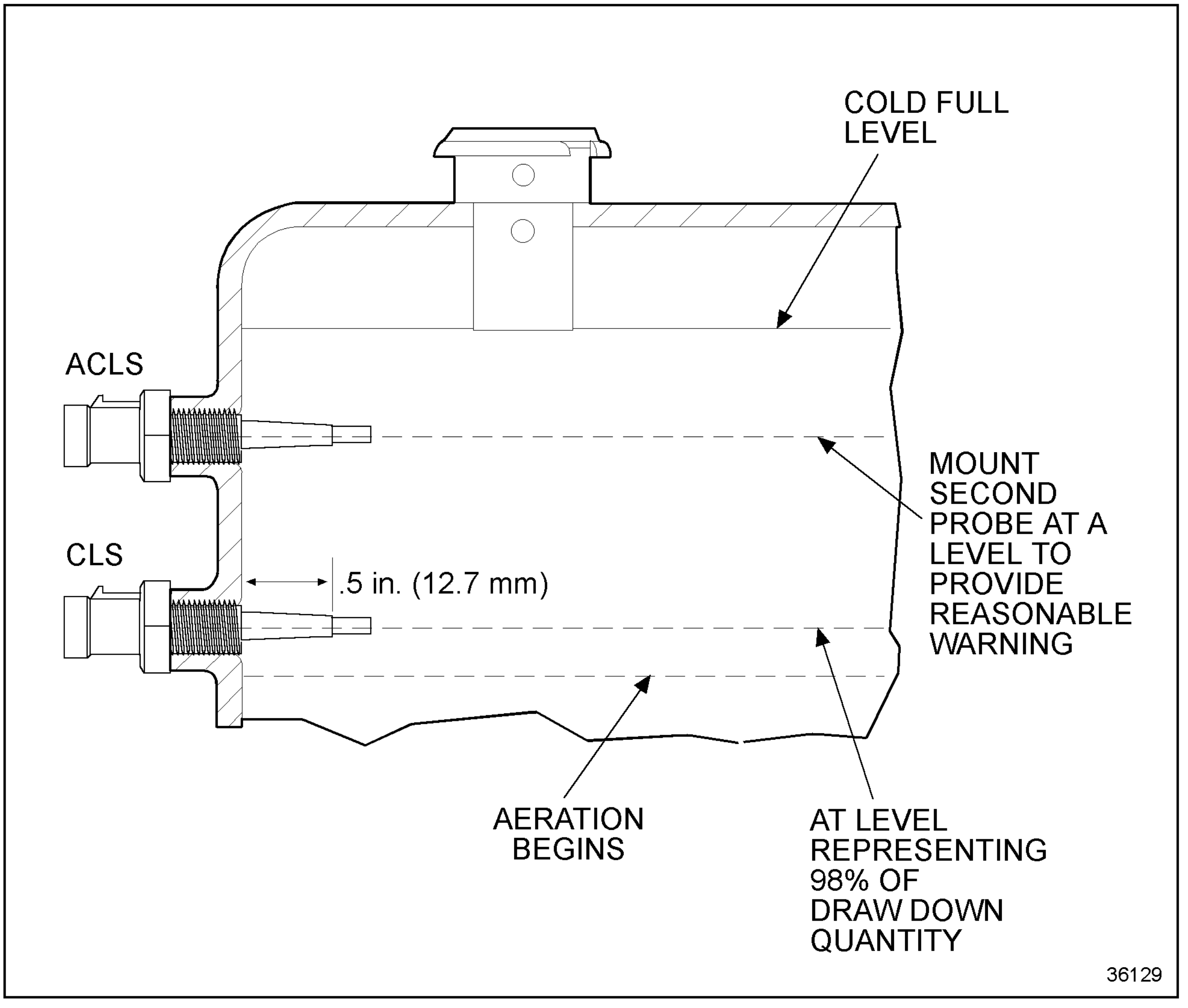
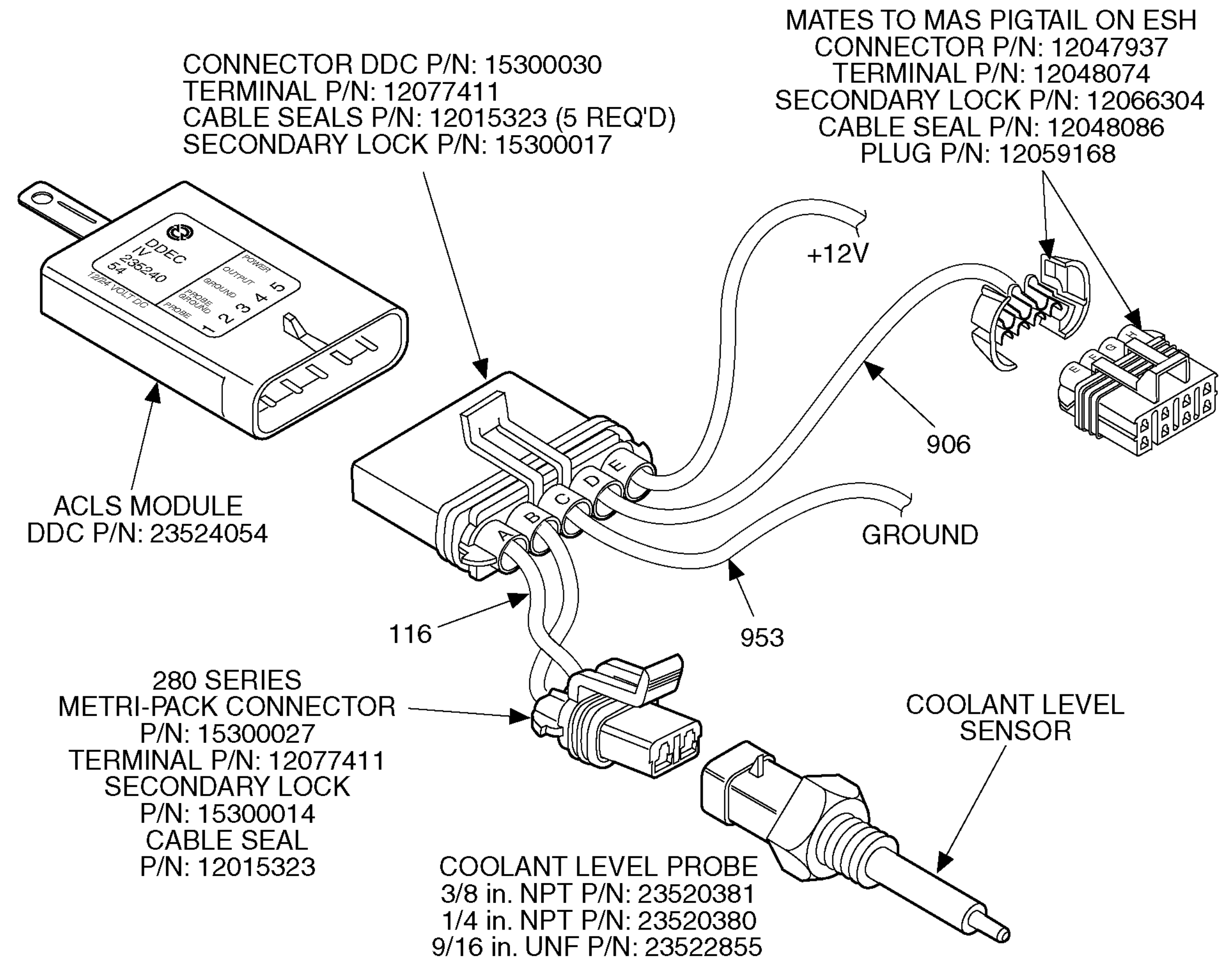


Figure 5-55 Add Coolant Level Sensor Location - Radiator Surge Tank

The ACLS must be enabled with VEPS (Release 24.0 or later) or DRS.

NOTE:
All ACLS components are OEM installed.

ACLS will require an additional module (P/N: 23524054) to condition the sensor signal. The module output will be connected to the MAS pigtail on the DDC supplied Engine Sensor Harness. See Figure 5-56 for wiring schematic.



LABEL	WIRE NO.	COOLANT LEVEL MODULE CONNECTOR CAVITY	WIRE COLOR	CLS CAVITY	ESH-MAS PIGTAIL CONNECTOR CAVITY	ESH-TO-ECM CONNECTOR CAVITY
ADD COOLANT LEVEL	116	A	ORN	A	–	–
GROUND	953	B	BLK/WHT	B	–	–
GROUND	953	C	BLK/WHT	–	–	–
ACLS	906	D	ORN	–	G	N1
BATTERY (+12V)	–	E	RED	–	–	–

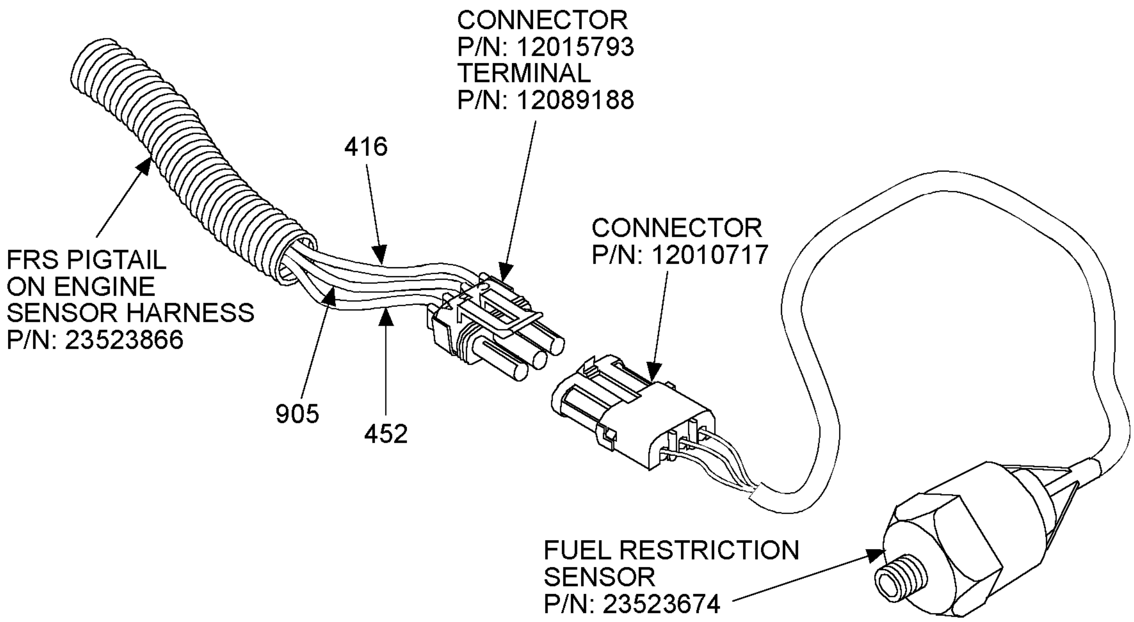
41668

Figure 5-56 Add Coolant Level Sensor Installation

Fuel Restriction Sensor

The FRS is factory installed at DDC and is incorporated into the DDC Engine Sensor Harness (see Figure 5-57). No OEM installation is required. The proper 6N4C and 6N4 groups must be specified.

The FRS will log a fault code at 12 in. Hg.



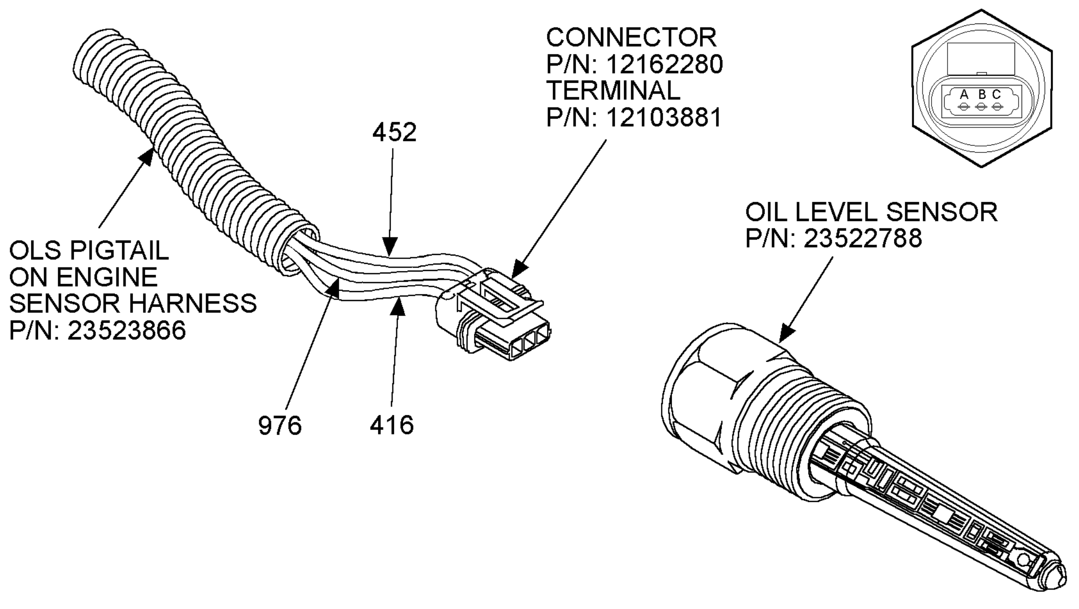
LABEL	WIRE NO.	ESH FRS PIGTAIL CONNECTOR CAVITY	ESH-TO-ECM CONNECTOR CAVITY	WIRE COLOR
FUEL RESTRICTION	905	B	M1	YEL
SENSOR GROUND	452	A	Y2	BLK
SENSOR SUPPLY	416	C	W1	GRA

37172

Figure 5-57 Fuel Restriction Sensor Installation

Oil Level Sensor

The OLS is factory installed at DDC and is incorporated into the DDC Engine Sensor Harness (see Figure 5-58). No OEM installation is required. The proper 6N4C and 6N4 groups must be specified. The OLS is mounted in the Series 60 engine oil pan at four quarts low.



LABEL	WIRE NO.	ESH OLS PIGTAIL CONNECTOR CAVITY	ESH-TO-ECM CONNECTOR CAVITY	WIRE COLOR
OIL LEVEL	976	B	L2	DK GRN
SENSOR GROUND	452	A	Y2	BLK
SENSOR SUPPLY	416	C	W1	GRA

37173

Figure 5-58 Oil Level Sensor Installation

Maintenance Alert System Display Module Installation

The display must be mounted in an interior location easily accessible from outside the vehicle for mechanics and other service personnel to view. It cannot be mounted in the engine compartment. The display may be installed in other enclosed areas such as a bus battery compartment. If the display is installed anywhere outside of the vehicle cab or passenger compartment, it must be completely sealed inside a protective enclosure to protect it from dirt and moisture.The part number for the MAS display is P/N: 23525655. See Figure 5-59 for the dimensions of the MAS display.

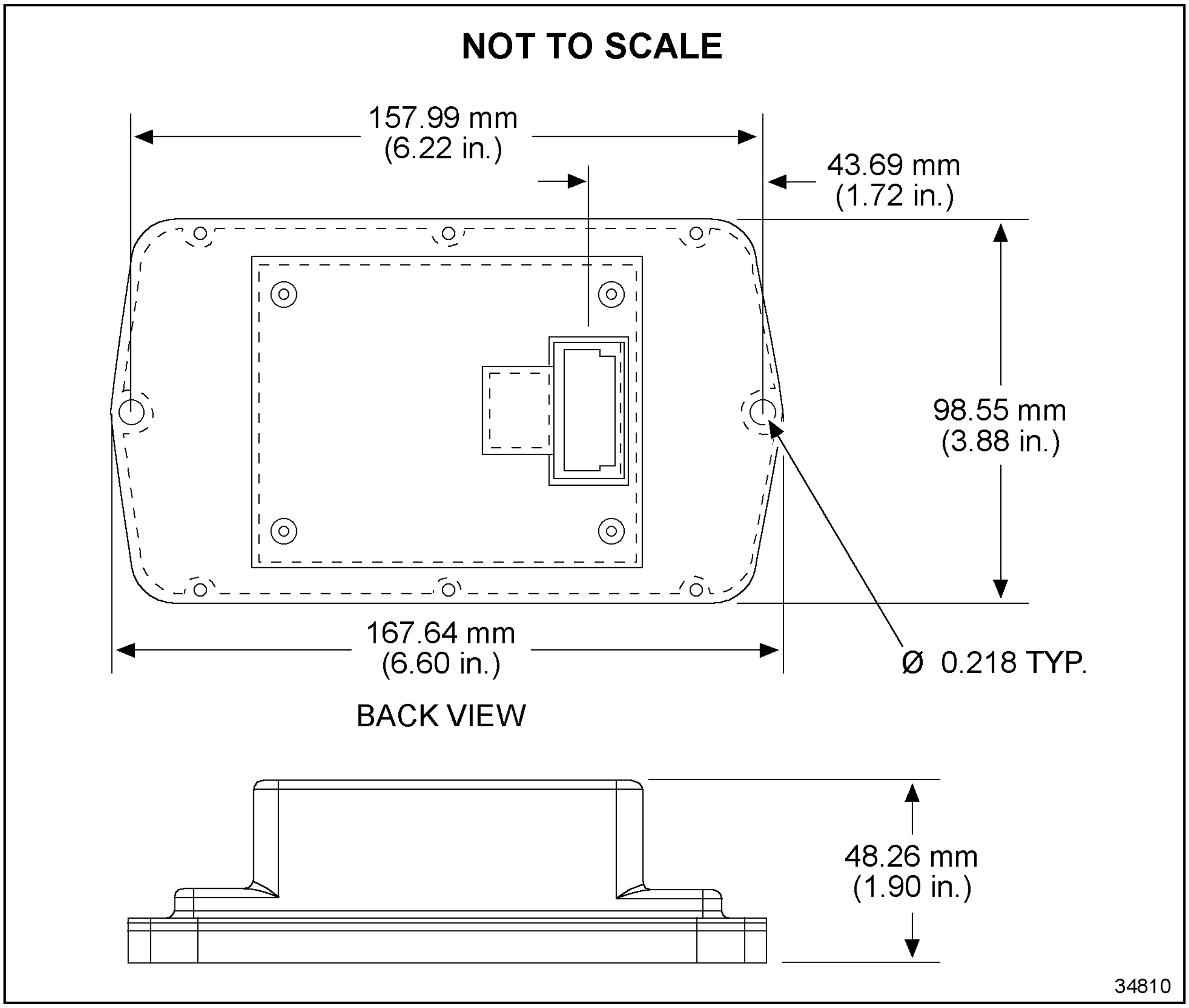


Figure 5-59 Maintenance Alert System Display Dimensions

An example of a typical bracket used to mount the MAS display in passenger compartment applications may be seen in the next two illustrations (see Figure 5-60 and Figure 5-61).

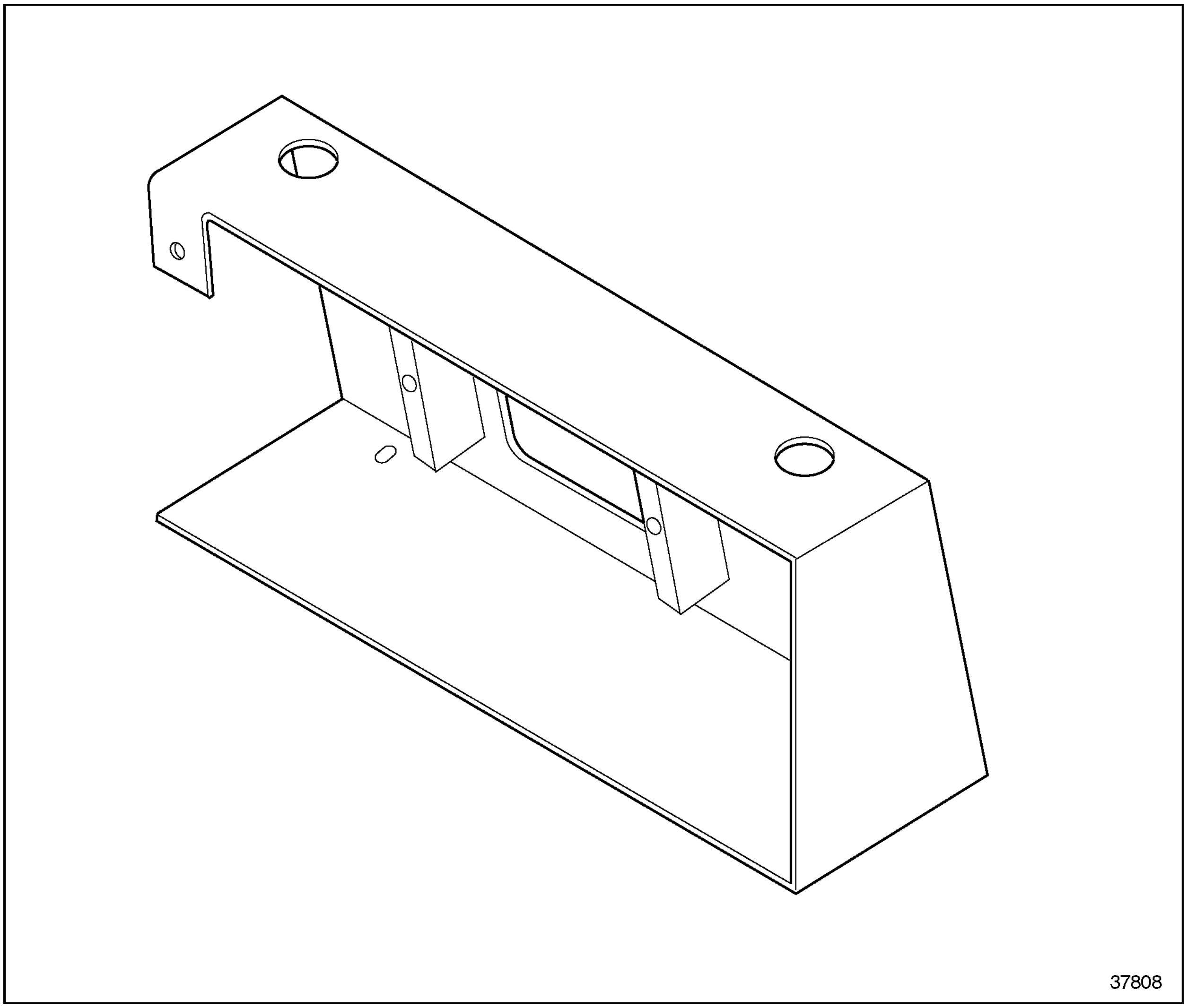


Figure 5-60 Maintenance Alert Display Bracket

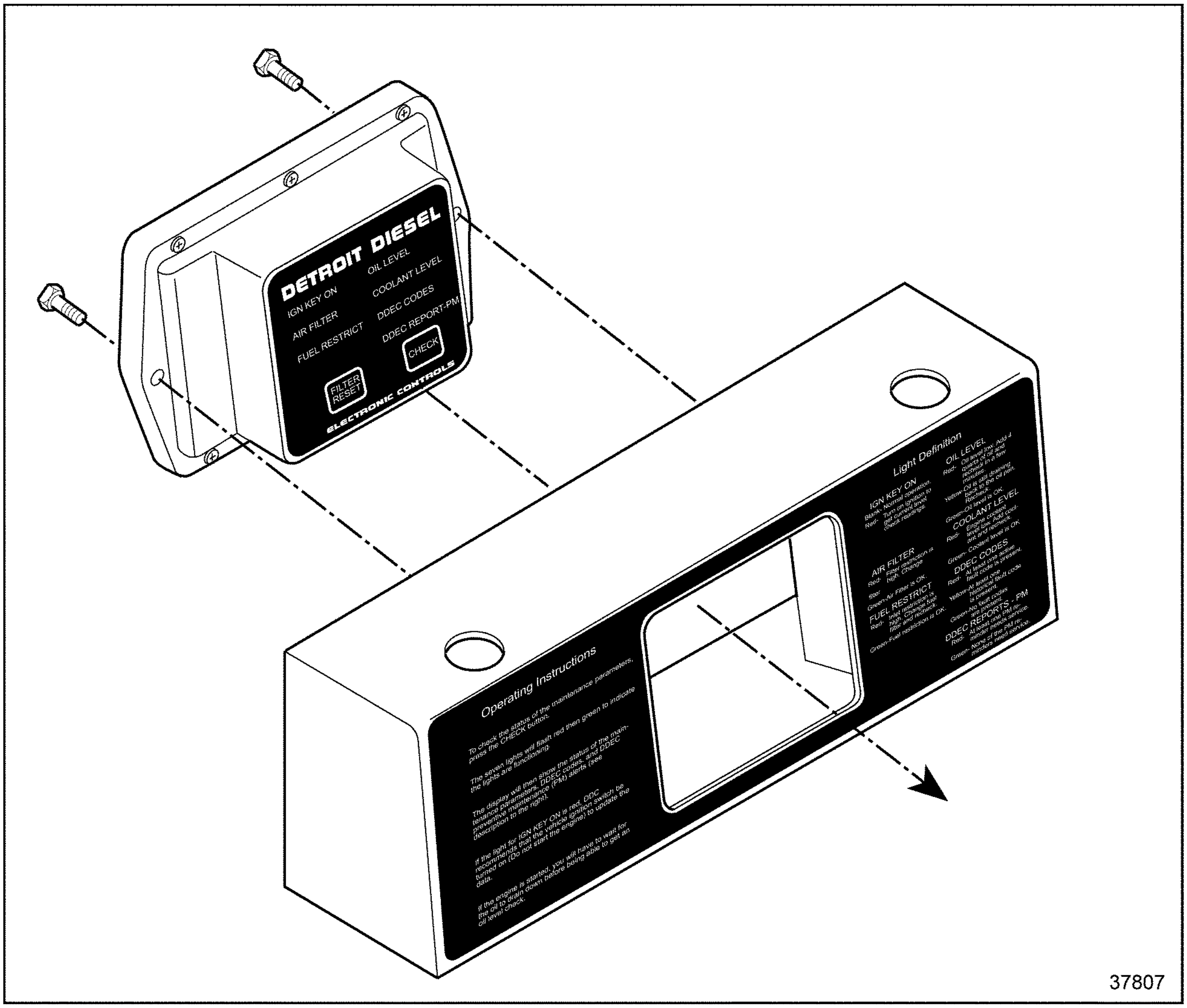


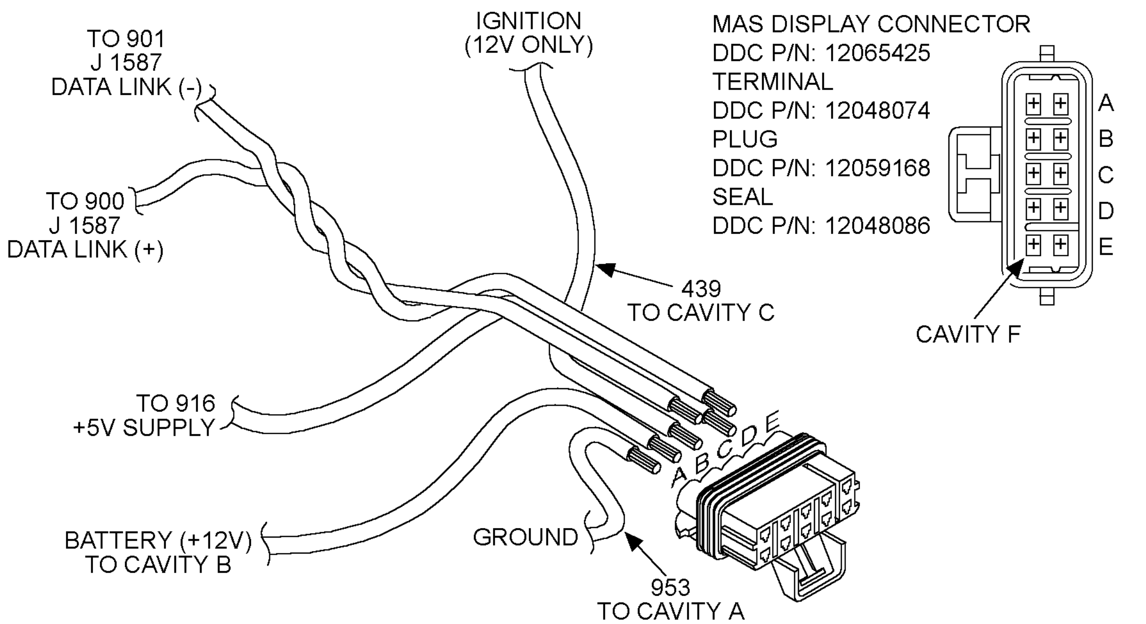
Figure 5-61 Maintenance Alert Display and Bracket

The bracket is the responsibility of the OEM. A label on the front face of the bracket should be used for operating instructions and light definition. See Figure 5-62 for an example.

Figure 5-62 Maintenance Alert Display Bracket with Label

Maintenance Alert System Display Harness

The connector for the MAS display is a molded integral connector that mates to Delphi Packard 12065425 with the connections shown in the following schematic. See Figure 5-63 for the wiring schematic.



NOTE: WIRE PAIRS MUST BE TWISTED A MINIMUM OF 12 TURNS PER FOOT.

LABEL	WIRE NO.	WIRE COLOR	MAS DISPLAY CONNECTOR CAVITY
GROUND	953	BLK/WHT	A
BATTERY (+12V)	–	RED	B
IGNITION (12V ONLY)	439	PNK	C
J 1587 DATA LINK (-)	901	DK GRN	D
J 1587 DATA LINK (+)	900	DK GRN/YEL	E
SENSOR SUPPLY	916	RED/BLK	F

34812

Figure 5-63 Maintenance Alert System Display Harness

5.21.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The OLS and FRS must be specified with the correct 6N4C and 6N4 groups.

The OEM installed sensors must be setup by VEPS or DRS. These sensors are the Air Filter Restriction Sensor, Add Coolant Level Sensor.

NOTE:
The MAS display must be wired to a 12 V battery and a 12 V ignition source only.

The DDR can set options for the CEL and SEL indication of MAS codes as listed in Table 5-58.

<table>
<tr><th>Parameter</th><th>Description</th><th>Choices</th><th>Action</th></tr>
<tr><td>Filters</td><td>Determines if the CEL/SEL will flash a maintenance alert for filters.</td><td>NO, FLASH, CONTINUOUS, BOTH</td><td rowspan="2">NO - no illumination or flashing
FLASH - flash at ignition on
CONTINUOUS - Light will stay on when there is an alert (CEL only)
BOTH - light will flash at ignition on, then stay on</td></tr>
<tr><td>Levels</td><td>Determines if the CEL/SEL will flash a maintenance alert for fluid levels.</td><td>NO, FLASH, CONTINUOUS, BOTH</td></tr>
</table>

Table 5-58 DDR Options

5.21.4 DIAGNOSTICS

The codes that will be logged are listed in Table 5-59.

DDC Code # (Flashed)	SAE J1587 Code # (PID)	FMI	Description
13	111	4	(Engine Protection) Coolant Level (CLS) Circuit Failed Low
13	111	6	Add Coolant Level (ACLS) Circuit Failed Low
16	111	3	(Engine Protection) Coolant Level (CLS) Circuit Failed High
16	111	5	Add Coolant Level (ACLS) Circuit Failed High
37	95	3	Fuel Restriction Circuit Failed High
38	95	4	Fuel Restriction Circuit Failed Low
43	111	1	Coolant Level (CLS or ACLS) Low
65	107	3	Air Filter Restriction Circuit Failed High
65	107	4	Air Filter Restriction Circuit Failed Low
73	107	0	Air Filter Restriction High
81	98	3	Oil Level Circuit Failed High
82	98	4	Oil Level Circuit Failed Low
84	98	1	Oil Level Low
89	111	12	Maintenance Alert System Coolant Level Fault*
89	95	0	Fuel Filter Restriction High

* This fault will be logged when the Add Coolant Level Circuit (ACLS) reports the coolant level is OK and the Engine Protection Coolant Level Circuit (CLS) reports that coolant is low.

Table 5-59 Maintenance Alert System Codes

NOTE:
Filter restrictions will latch a high restriction fault to active status for the entire ignition cycle.

5.21.5 INTERACTION WITH OTHER FEATURES

There are four options for using the CEL and SEL for MAS, which may be set with the DDR (Release 24.0). ProDriver (Release 2.30 or later) will display any active faults as they occur.

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5.22 MANAGEMENT INFORMATION PRODUCTS

The Management Information Products, formerly called Data Hub, comprise a modular system that provides monitoring of any DDEC-equipped engine. These products provide substantial storage capacity, flexible data extraction and communication capabilities. Members of the system that collect data include

- ☐ DDEC III Data Pages (refer to section 5.22.2)
- ☐ DDEC IV Data (refer to section 5.22.3)
- ☐ Data Logger (refer to section 5.22.8)
- ☐ ProDriver®(Release 3.0) (refer to section 5.22.9)
- ☐ ProDriver DC™ (refer to section 5.22.10)

PC software for data analysis and reporting include:

- ☐ DDEC Reports (refer to section 5.22.4)
- ☐ Detroit Diesel Data Summaries (refer to section 5.22.5)
- ☐ ProDriver Reports (refer to section 5.22.6)
- ☐ ProManager® Rel. 2.1 (refer to section 5.22.7)

5.22.1 OPERATION

The Management Information Products are designed to provide instantaneous feedback to the driver via the ProDriver or ProDriver DC display module. These driver-friendly features help provide an understanding of the effect of the driver's actions on the engine and vehicle performance.

The DDEC ECM provides engine control and monitoring as well as a stored summary of engine performance. The Data Logger compliments DDEC III Data Pages by extending the memory available to store detailed trip information.

Data in these devices can be extracted and analyzed with the PC software products as follows:

- ☐ DDEC Reports extracts data from all hardware devices and analyzes data from DDEC III Data Pages and DDEC IV Data.
- ☐ ProDriver Reports extracts and analyzes ProDriver (Release 3.0) data.
- ☐ ProManager Rel. 2.1 software extracts and analyzes the Data Logger data and DDEC III Data Pages.
- ☐ Data Summaries extracts data from all hardware devices and analyzes data from all but the Data Logger.

All these products allow printing of comprehensive reports for managing vehicle operation.

Additional diagnostic data available from Management Information includes:

- ☐ Instantaneous and average fuel economy
- ☐ Trip time, miles, fuel, total fuel used economy, and average speed

- ☐ Driving time, percentage, miles, fuel, and fuel economy
- ☐ Idle time, fuel and percentage
- ☐ Cruise time, percentage, miles, fuel, and fuel economy
- ☐ Top gear time, percentage, miles, fuel used, and fuel economy
- ☐ One gear down time, percentage, miles, fuel used, and fuel economy
- ☐ VSG time, fuel, and percentage
- ☐ Overspeed time and percentage for two speed thresholds
- ☐ Over-rev time and percentage
- ☐ Maximum speed and RPM
- ☐ Coasting time and percentage
- ☐ Driving average load factor (ProDriver 3.0 and DDEC IV Rel. 21 and higher)
- ☐ Automated oil change interval tracking
- ☐ Hard braking incident records
- ☐ Driver initiated incident records
- ☐ Stop and check engine code logs
- ☐ Optimized Idle™ active time, idle time, and estimated fuel savings
- ☐ SAE J1587 data link time-outs and power interruptions
- ☐ Leg time, distance, fuel used, fuel economy, average speed, and cruise time and percentage
- ☐ Last Stop records

5.22.2 DDEC III DATA PAGES

DDEC III Data Pages is an optional feature of the DDEC III ECM. When activated, it utilizes available memory and processing speed to record engine and vehicle operating information. Data is stored in daily records for a maximum of 14 working days. Information on engine performance trends, service intervals and ECM diagnostics are also stored.

5.22.3 DDEC IV DATA

DDEC IV Data is a standard part of the DDEC IV ECM. DDEC IV Data utilizes available memory and processing speed, along with a built-in, battery-backed clock/calendar to document the performance of the driver and vehicle. Data is stored in three monthly records and in a trip file that may be reset at extraction. Data on periodic maintenance intervals, hard brake incidents, last stop records, daily engine usage, and ECM diagnostics is also stored.

DDEC IV Data can be extracted onto a PC hard disk through a wide range of options:

- ☐ Direct extraction using a DDEC translator box and cables connected to a PC running DDEC Reports.
- ☐ A Remote Data Interface (RDI) which adds automation to the process. This weatherproof extraction module is usually located at a fuel island and the PC it connects to is remotely located. The PC will be operating the communications part of DDEC Reports called DDEC Communications.
- ☐ Wireless extraction via cellular telephone, satellite radio communications equipment. The PC can be operating DDEC Reports or DDEC Communications.

5.22.4 DDEC REPORTS

After the data is extracted from the ECM, DDEC Reports software produces a wide range of diagnostic and management reports. DDEC Reports produces comprehensive trip reports in both on-highway and nonroad markets. The on-highway reports are listed in Table 5-60.

Available Reports	DDEC III Data Pages	DDEC IV - R20	DDEC IV - R21 or Later	DDEC Reports Version Required
Trip Activity	X		X	2.0 or Later
Vehicle Speed/RPM	X	X	X	2.0 or Later
Overspeed / Over Rev		X	X	2.0 or Later
Engine Load/RPM		X	X	2.0 or Later
Vehicle Configuration	X	X	X	2.0 or Later
Periodic Maintenance	X		X	2.1 or Later
Hard Brake Incident			X	2.1 or Later
Last Stop			X	2.1 or Later
DDEC Diagnostic			X	2.1 or Later
Profile	X		X	2.1 or Later
Monthly Activity			X	2.1 or Later
Daily Engine Usage			X	2.1 or Later
Life to Date	X		X	2.1 or Later

Table 5-60 On-highway Reports Available from DDEC Reports

The nonroad reports are listed in Table 5-61.

Available Reports	DDEC III Data Pages	DDEC IV - R20	DDEC IV - R21 or Later	DDEC Reports Version Required
Period Activity		X	X	3.0 or Later
High RPM		X	X	3.0 or Later
Engine Load/RPM		X	X	3.0 or Later
Configuration		X	X	3.0 or Later
Periodic Maintenance		X	X	3.0 or Later
DDEC Diagnostic			X	3.0 or Later
Profile			X	3.0 or Later
Monthly Activity			X	3.0 or Later
Daily Engine Usage			X	3.0 or Later
Life to Date			X	3.0 or Later

Table 5-61 Nonroad Reports Available from DDEC Reports

See Figure 5-64, Figure 5-65, and Figure 5-66 for examples of on-highway DDEC Reports. See Figure 5-67, Figure 5-68, and Figure 5-69 for examples of nonroad DDEC Reports. This Windows® 95 compatible product is included as part of the Detroit Diesel Diagnostic Link (DDDL) service tool. DDDL is designed for the service technician and with the built-in troubleshooting manual it is ideal for extracting data, analyzing and printing information from the ECM. A set of Marine reports is now available in DDEC Reports 3.10.

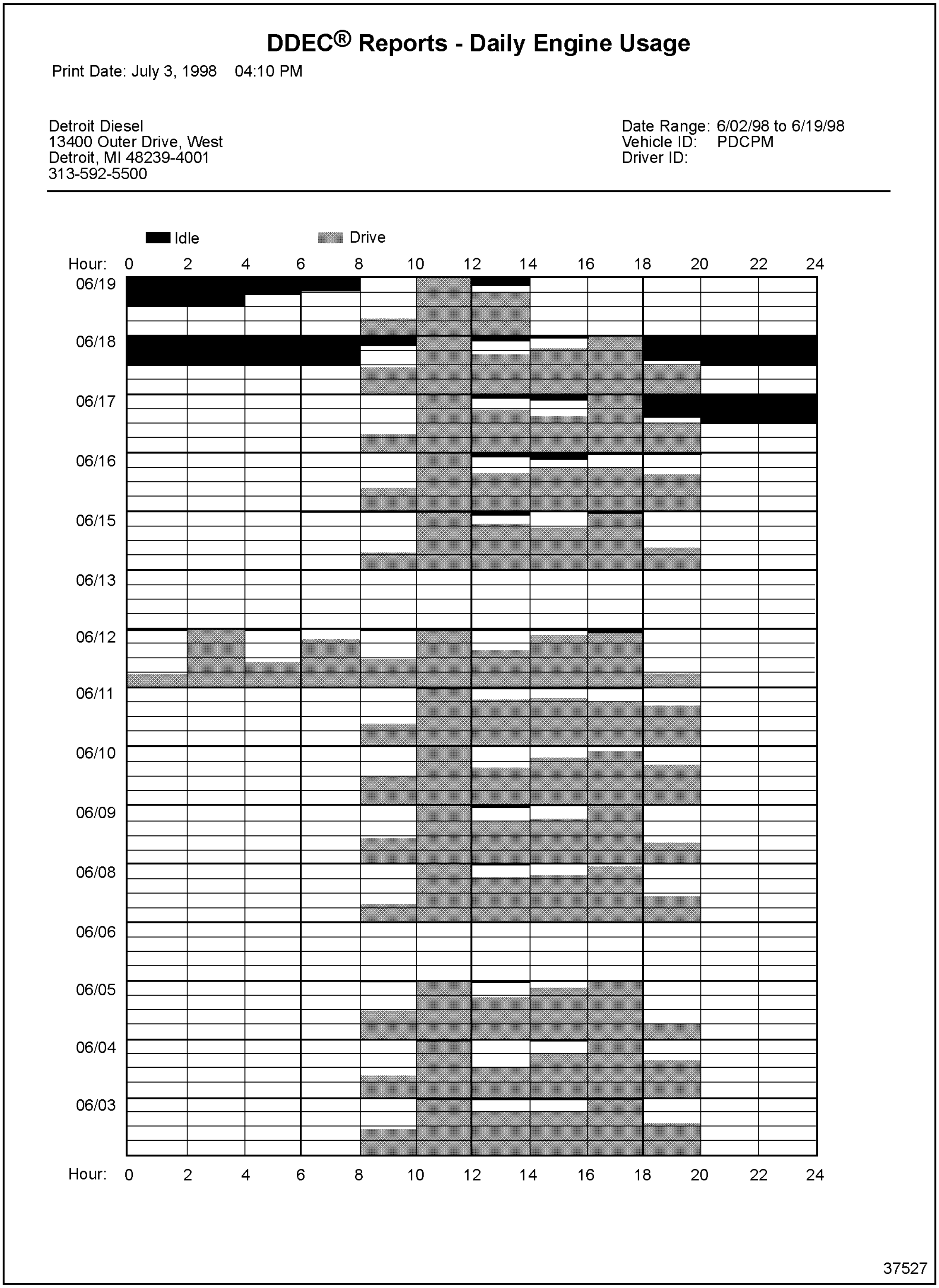

Figure 5-64 DDEC Reports, On-highway - Idle and Drive Time

DDEC® Reports - Daily Engine Usage

Print Date: July 3, 1998 08:27 AM

Detroit Diesel
13400 West Outer Drive
Detroit, MI 48239
313-592-5500

Date Range: 6/02/98 to 6/19/98
Vehicle ID: PDCPM
Driver ID:

Date:	6/19/1998	
Start Time:	01:00:00	(EST)
Odometer:	58068.5	mi
Distance:	205.1	mi
Fuel:	28.00	gal
Fuel Economy:	7.33	mpg
Average Speed:	49.4	mph

Total (hh:mm)	04:09	03:24	16:27
Hour (EST)	Drive (min)	Idle (min)	Off (min)
00:00-02:00	0	61	59
02:00-04:00	0	61	59
04:00-06:00	0	38	82
06:00-08:00	3	27	90
08:00-10:00	36	2	82
10:00-12:00	118	2	0
12:00-14:00	92	13	15
14:00-16:00	0	0	120
16:00-18:00	0	0	120
18:00-20:00	0	0	120
20:00-22:00	0	0	120
22:00-24:00	0	0	120

Date:	6/18/1998	
Start Time:	01:00:00	(EST)
Odometer:	57650.6	mi
Distance:	418.0	mi
Fuel:	66.50	gal
Fuel Economy:	6.29	mpg
Average Speed:	47.4	mph

Total (hh:mm)	08:49	07:37	07:34
Hour (EST)	Drive (min)	Idle (min)	Off (min)
00:00-02:00	0	61	59
02:00-04:00	0	61	59
04:00-06:00	0	61	59
06:00-08:00	0	61	59
08:00-10:00	56	20	44
10:00-12:00	117	3	0
12:00-14:00	80	10	30
14:00-16:00	95	6	19
16:00-18:00	119	1	0
18:00-20:00	62	51	7
20:00-22:00	0	61	59
22:00-24:00	0	61	59

Date:	6/17/1998	
Start Time:	08:55:59	(EST)
Odometer:	57233.0	mi
Distance:	417.6	mi
Fuel:	62.50	gal
Fuel Economy:	6.68	mpg
Average Speed:	48.8	mph

Total (hh:mm)	08:33	03:13	12:14
Hour (EST)	Drive (min)	Idle (min)	Off (min)
00:00-02:00	0	0	120
02:00-04:00	0	0	120
04:00-06:00	0	0	120
06:00-08:00	0	2	116
08:00-10:00	56	2	75
10:00-12:00	117	2	0
12:00-14:00	80	8	25
14:00-16:00	95	10	36
16:00-18:00	119	3	0
18:00-20:00	62	44	4
20:00-22:00	0	61	59
22:00-24:00	0	61	59

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Figure 5-65 DDEC Reports, On-highway - Daily Engine Usage

DDEC® Reports - Engine Load / RPM

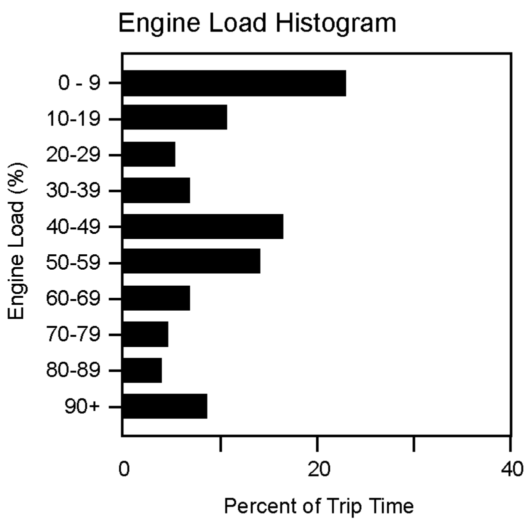
Print Date: July 3, 1998 08:26 AM

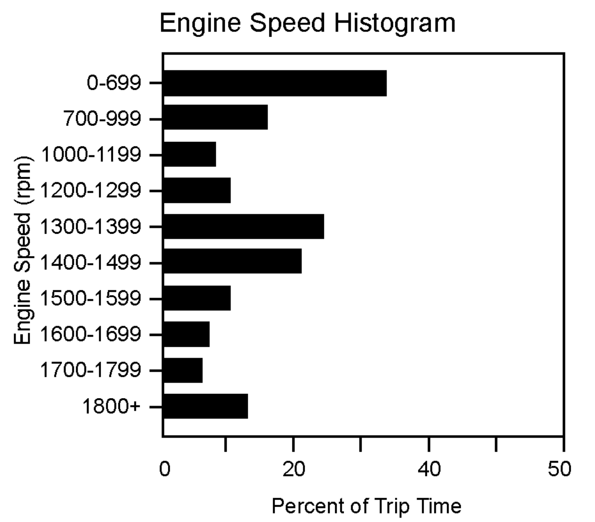
Detroit Diesel
13400 West Outer Drive
Detroit, MI 48239
313-592-5500

Trip: 6/02/98 to 6/19/98
Vehicle ID: PDCPM
Driver ID:
Odometer: 58273.6 mi

Trip Distance: 5698.9 mi
Trip Fuel: 831.13 gal
Fuel Economy: 6.86 mpg
Avg. Drive Load: 46 %
Avg. Vehicle Speed: 49.0 mph

Trip Time: 134:33:33
Fuel Consumption: 6.18 gal/h
Idle Time: 18:14:17
Idle Percent: 13.55 %
Idle Fuel: 7.63 gal





Percent of Trip Time in Load and RPM Table

Engine Load (%)

Engine RPM	0 -9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-100	TOTAL
0-699	0.5	5.4	0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1	7.2
700-999	8.1	0.7	0.4	0.3	0.2	0.1	0.1	0.4	0.4	0.2	10.8
100-1199	7.1	0.9	0.9	0.6	0.6	0.5	0.6	0.5	0.5	1.1	13.3
1200-1299	1.7	0.7	0.7	0.5	0.6	0.5	0.5	0.4	0.3	1.3	7.2
1300-1399	1.5	0.6	0.5	0.6	0.9	0.9	0.6	0.5	0.3	1.9	8.4
1400-1499	3.1	1.8	2.4	4.5	12.9	10.8	4.5	2.7	2.2	3.0	47.7
1500-1599	0.7	0.3	0.2	0.3	0.5	0.5	0.3	0.2	0.2	0.7	4.0
1600-1699	0.2	0.1				0.1	0.1			0.4	0.9
1700-1799	0.1									0.1	0.3
1800+											0.1
Total	22.9	10.4	7.0	7.0	15.9	13.5	6.8	4.9	4.1	8.7	

37525

Figure 5-66 DDEC Reports, On-highway - Engine Load/RPM

DDEC® Reports - Periodic Maintenance

Print Date: Apr 19, 1999 03:53 PM

DDC DDEC Lab - RDI
13400 Outer Drive West
Detroit, MI 48239
313-592-5959

Period: 04/09/1999 to 04/19/1999
Equipment ID: PDCPM
Operator ID:

Period Time	63:49:53	Idle Time	9:46:46
Period Fuel	446.00 gal	Idle Fuel	2.50 gal
Fuel Consumption	6.99 gal/h	Idle Percent:	15.32 %
Avg. Operating Load	51 %		

Maintenance Due

Name	Eng. Hrs. Left	Projected Date	Fuel Left (gal)
PMA	-1	04/24/1999	250.00
PMB	39	05/04/1999	550.00
PMC	79	05/14/1999	850.00

Maintenance Limits

Name	Engine Hours	Days	Fuel (gal)
PMA	40	10	300.00
PMB	80	20	600.00
PMC	120	30	900.00

Last Maintenance

Name	Eng. Hrs.	Date
PMA	3318	04/14/1999
PMB	3318	04/14/1999
PMC	3318	04/14/1999

37719

Figure 5-67 DDEC Reports, Nonroad - Periodic Maintenance

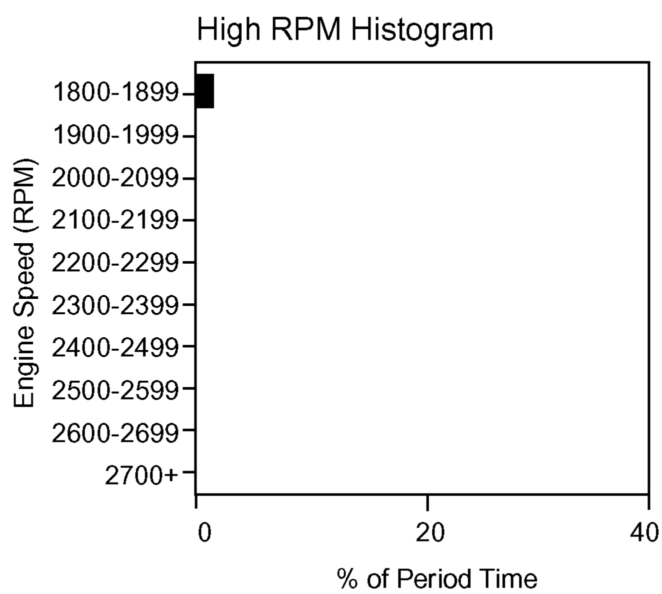
DDEC® Reports - High RPM

Print Date: Apr 19,1999 03:52 PM

DDC DDEC Lab - RDI
13400 Outer Drive West
Detroit, MI 48239
313-592-5959

Period: 04/09/1999 to 04/19/1999
Equipment ID: PDCPM
Operator ID:

Period Time	63:49:53	Idle Time	9:46:46
Period Fuel	446.00 gal	Idle Fuel	2.50 gal
Fuel Consumption	6.99 gal/h	Idle Percent:	15.32 %
Avg. Operating Load	51 %		



Percent of Time Spent in High RPM Bands

1800 1899	1900 1999	2000 2099	2100 2199	2200 2299	2300 2399	2400 2499	2500 2599	2600 2699	2700+
10.01	0.04								

37720

Figure 5-68 DDEC Reports, Nonroad - High RPM Detail

DDEC® Reports - Diagnostic Record #1

Print Date: Apr 19, 1999 03:53 PM

DDC DDEC Lab - RDI
13400 Outer Drive West
Detroit, MI 48239
313-592-5959

Period: 04/09/1999 to 04/19/1999
Equipment ID: PDCPM
Operator ID:

Period Time	63:49:53	Idle Time	9:46:46
Period Fuel	446.00 gal	Idle Fuel	2.50 gal
Fuel Consumption	6.99 gal/h	Idle Percent:	15.32 %
Avg. Operating Load	51 %		

Diagnostic Code: [43] - Coolant Level Low
Diagnostic Time: 01/17/00 09:34:18 (EST)

Time	Engine Speed (RPM)	Boost Press (PSI)	Fuel Press (PSI)	Fuel Temp (˚F)	Oil Press (PSI)	Oil Temp (˚F)
09:34:18	823	0.0	0.0	46.8	63.4	79.5
09:34:13	824	0.0	0.0	46.8	63.4	79.5
09:34:08	825	0.0	0.0	47.0	63.4	79.5
09:34:03	823	0.0	0.0	47.5	63.4	79.5
09:33:58	824	0.0	0.0	47.8	63.4	79.8
09:33:53	824	0.0	0.0	48.5	63.4	80.0
09:33:48	825	0.0	0.0	49.3	63.4	80.3
09:33:43	827	0.0	0.0	50.5	63.3	80.0
09:33:38	825	0.0	0.0	51.5	63.3	80.3
09:33:33	1021	0.0	0.0	53.3	1.9	78.3
09:33:28	0	0.0	0.0	-40.0	0.0	-40.0
09:33:23	0	0.0	0.0	-40.0	0.0	-40.0

Time	Coolant Temp (˚F)	Air Temp (˚F)	Engine Load (%)	Throttle (%)	Pulse Width (deg)	Eng. Brake (cylinders)
09:34:18	70.0	50.0	19.0	0.0	4.4	Off
09:34:13	69.0	50.0	18.5	0.0	4.2	Off
09:34:08	69.5	50.0	17.5	0.0	4.1	Off
09:34:03	68.8	51.3	19.5	0.0	4.4	Off
09:33:58	68.8	51.0	20.0	0.0	4.5	Off
09:33:53	68.5	53.3	21.0	0.0	4.6	Off
09:33:48	68.5	54.0	21.0	0.0	4.7	Off
09:33:43	69.5	59.5	22.5	0.0	4.9	Off
09:33:38	68.0	65.0	24.0	0.0	5.2	Off
09:33:33	67.8	66.5	28.0	0.0	6.8	Off
09:33:28	-40.0	-40.0	0.0	0.0	0.0	Off
09:33:23	-40.0	-40.0	0.0	0.0	0.0	Off

37721

Figure 5-69 DDEC Reports, Nonroad - Diagnostic Record

5.22.5 DETROIT DIESEL DATA SUMMARIES

This new PC program for Windows 95/98 is used to analyze and report trip data from DDEC Data, ProDriver and ProDriver DC. Data Summaries can report trip data one vehicle at a time, summary reports for the whole fleet, and reports of driver trip activity.

Trip extractions from individual vehicles are loaded into Data Summaries database. The database divides trip extractions into yearly files. New extractions are added to the current year database making it possible to run reports for any time period within the year. this make it possible for the user to form summary reports of the entire fleet, for a group of vehicles, or an individual vehicle. It is also possible to do the same for all drivers, groups of drivers, or individual drivers.

Data Summaries also supports ProDriver DC. Utilities in Data Summaries allow the user to format and setup the different data card types, such as the Driver Card, the Configuration Card, etc. A driver ID can be placed on Driver Cards. The extracted data is read from Driver Cards and placed into the database.

5.22.6 PRODRIVER REPORTS

This Windows® 95 compatible software sends set-up parameters to, extracts data and generates Activity and Incident reports from ProDriver (Release 3.0). ProDriver Reports replaces ProManager 1.02, the DOS version of ProDriver reporting software. ProDrivers containing firmware versions prior to Release 3.0 must be reprogrammed to Release 3.0. ProDriver reports cannot analyze data from these older versions. See Figure 5-70 and Figure 5-71.

ProDriver® Reports 1.00 - Activity Report

ProDriver® 3.00 - Trip Page
Report date: 6/18/98

Driver: 83		Extracted:	6/18/98 2:58 PM
Detroit Diesel		Vehicle ID:	2475
13400 West Outer Drive		Odometer:	5,389
Detroit, MI 48239		Engine Hr:	43

Trip Distance:	5,281.3	Miles	Speeding Time > 60 MPH:	1:29:07	
Trip Fuel:	766.38	Gal	Speeding Percentage:	0.0	%
Trip Time:	117:34:46				
Overall Economy:	6.89	MPG	Speeding Time > 62 MPH:	00:31:58	
Fleet Goal:	6.00	MPG	Speeding Percentage:	0.5	%
Driving Time:	106:06:12		Highest Speed:	68	MPH
Driving Percentage:	90.2	%	Average Speed:	49.8	MPH
Driving Fuel:	761.75	Gal			
Driving Economy:	6.93	MPG	Idle Time:	11:28:34	
Load Factor:	45.7	%	Idle Percentage:	9.8	%
			Idle Fuel:	4.63	Gal
Cruise Time:	57:14:46		Fleet Idle Goal:	15	%
Cruise Percentage:	54.0	%			
Cruise Distance:	3,384.9	Miles			
Cruise Fuel:	484.00	Gal	Over Rev Time > 1800 RPM:	00:20:05	
Cruise Economy:	6.99	MPG	Over Rev Percentage:	0.3	%
			Highest RPM:	2053	
Top Gear Time:	81:13:14				
Top Gear Percentage:	76.5	%			
Top Gear Distance:	4,653.3	Miles	VSG (PTO) Time:	6:57:02	
Top Gear Fuel:	637.75	Gal	VSG (PTO) Percentage:	5.9	%
Top Gear Economy:	7.30	MPG	VSG (PTO) Fuel:	3.00	Gal
Coasting Time:	00:00:00				
Coasting Percentage:	0.0	%	Total Alerts:	0	
Hard Braking > 5 MPH/Sec	60		Total Driver Incidents:	0	
Total Hard Braking Incidents:	5		Driver Incident Records:	0	
Power Interrupts:	0		J 1587 Timeouts:	0	
Engine Hour of Interrupt:	0		Engine Hour of Interrupt:	0	
Duration of Interrupts:	00:00:00		Duration of Interrupts:	00:00:00	
Optimized Idle			Oil Monitor		
Active Time:	3:40:06		Interval:	15,000	Miles
Opt. Idle Time:	1:00:02		Interval Left:	5,250	Miles
Idle Time Saved:	2:40:04		Percent Left:	35.0	%
Est. Fuel Savings:	1.50	Gal.			

37242

Figure 5-70 ProDriver Reports Trip Page

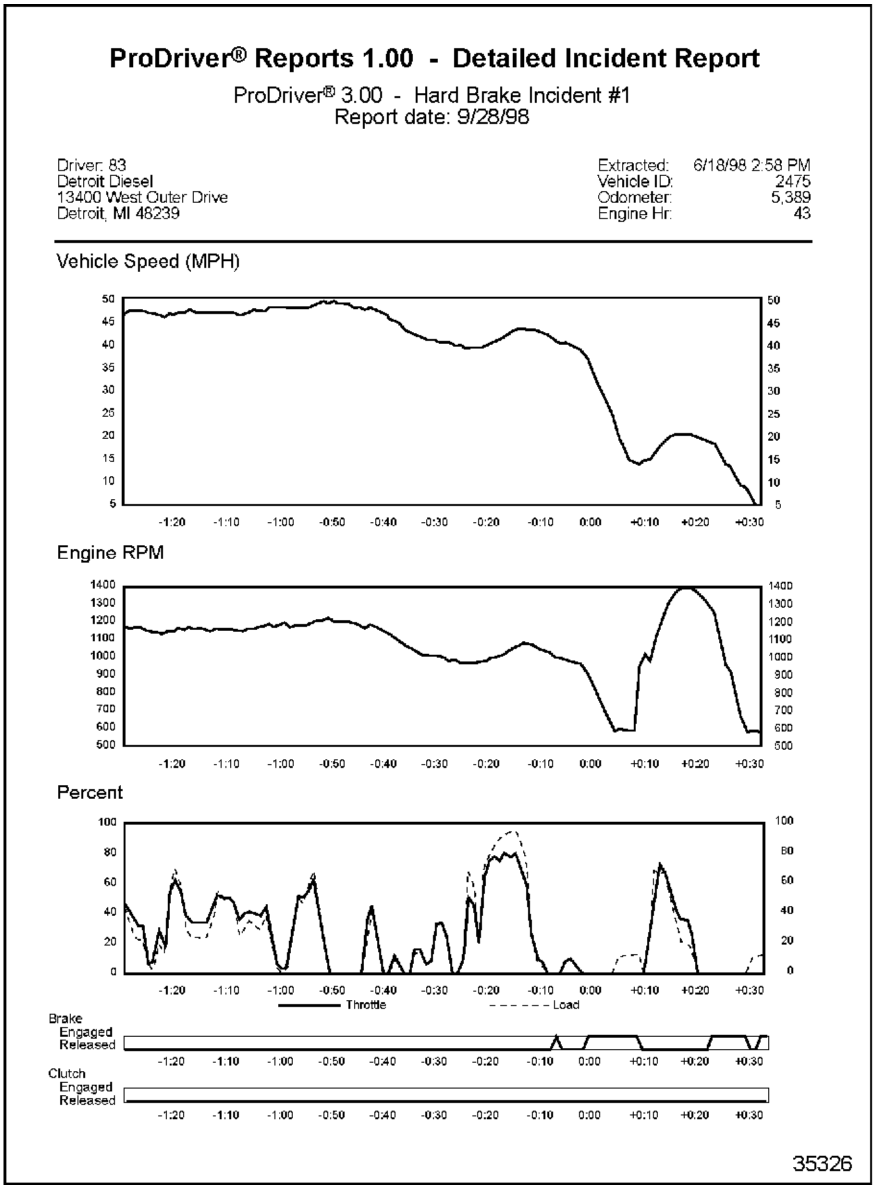


Figure 5-71 ProDriver Hard Brake Incident Report

5.22.7 PROMANAGER 2.10

ProManager 2.10 is a DOS-based fleet management software that extracts data from DDEC III Data Pages and the Data Logger to produce comprehensive trip, summary and exception reports for fleet managers. Several levels of data presentation are available, from management overviews to detailed analysis reports (see Figure 5-72). A custom reporting feature allows users to meet their specific needs.

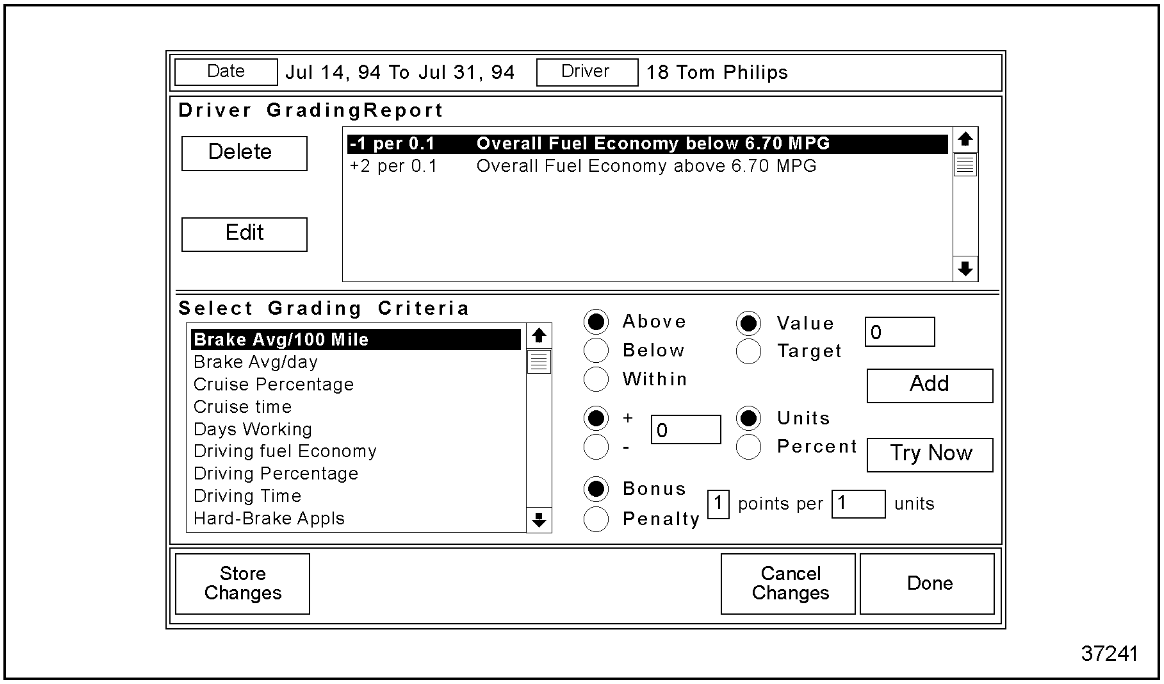


Figure 5-72 ProManager Screen

Reports available from ProManager 2.10 are listed in Table 5-62.

Available Reports	Data Pages	Data Logger	Logger + ProDriver
Operational Overview	X	X	X
Management Overview	X	X	X
Exceptions	X	X	X
Custom	X	X	X
Driver Grading			X
Driver Activity			X
User-defined	X	X	X
Event List		X	X
Leg/Stop List		X	X
Event Summary	X	X	X
Event Analysis		X	X
Detailed Incident Record		X	X
State Activity			X
Trends	X	X	X
Performance Trend Analysis	X	X	X
Detailed Alert		X	X
ECM Diagnostics	X	X	X
Service Interval Summary	X	X	X
Distance Left Graph	X	X	X
Service Schedule	X	X	X
Speed Histogram	X	X	X
RPM Histogram	X	X	X
Speed vs. RPM	X	X	X
Engine Usage Profile	X	X	X

Table 5-62 Reports Available from ProManager 2.10

5.22.8 DATA LOGGER

The Data Logger (see Figure 5-73) is a data storage module designed for DDEC III and other electronically controlled engines that communicate on the SAE J1708 diagnostic data link and follow the SAE J1587 protocol. Data is stored in daily records for a maximum of 100 days. Data on engine performance trends, service intervals, hard brake incidents, events, and ECM diagnostics is also stored.

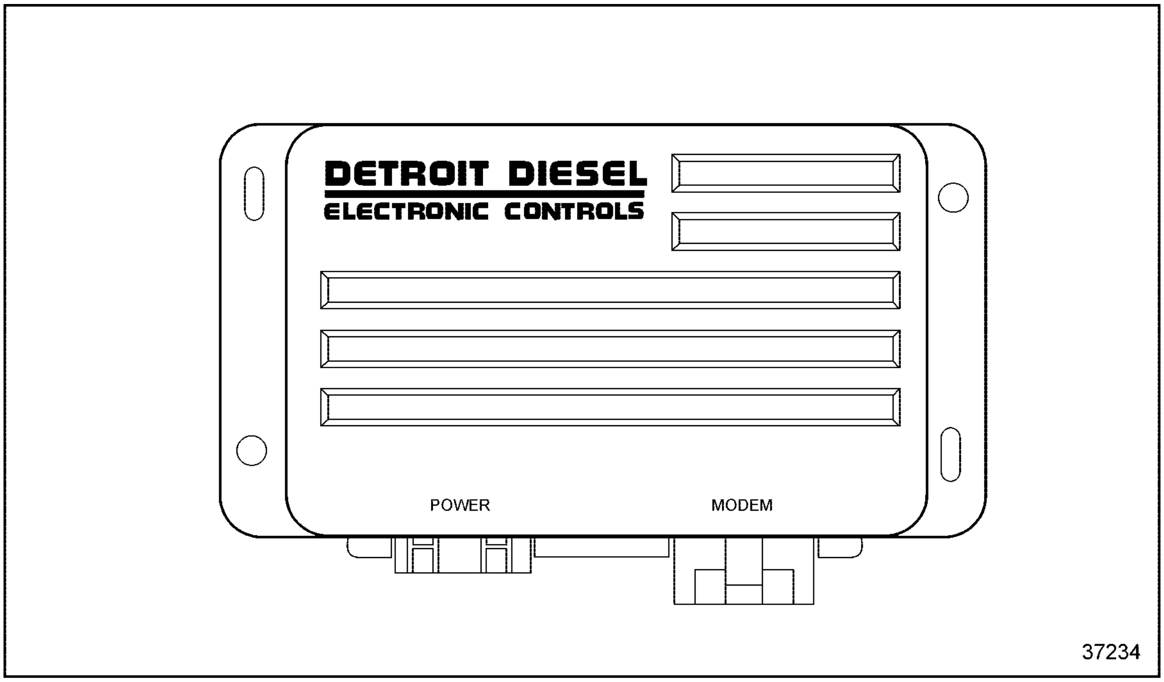


Figure 5-73 The Data Logger

The Data Logger can be used by itself or combined with a ProDriver display. When combined with a ProDriver, the Data Logger can record separate data for individual drivers, and accumulate data by state for tax purposes. Information stored in the Data Logger can be extracted to a PC using ProManager Rel. 2.1 software or DDEC Reports. Data Logger data is analyzed with ProManager Release 2.1.

Data Logger Installation

The Data Logger should be mounted in the cab of the vehicle. The Data Logger module is splash resistant, but not water tight, so the module must be mounted in a location that is not exposed to water. The Data Logger should NOT be mounted with connectors facing up. See Figure 5-74.

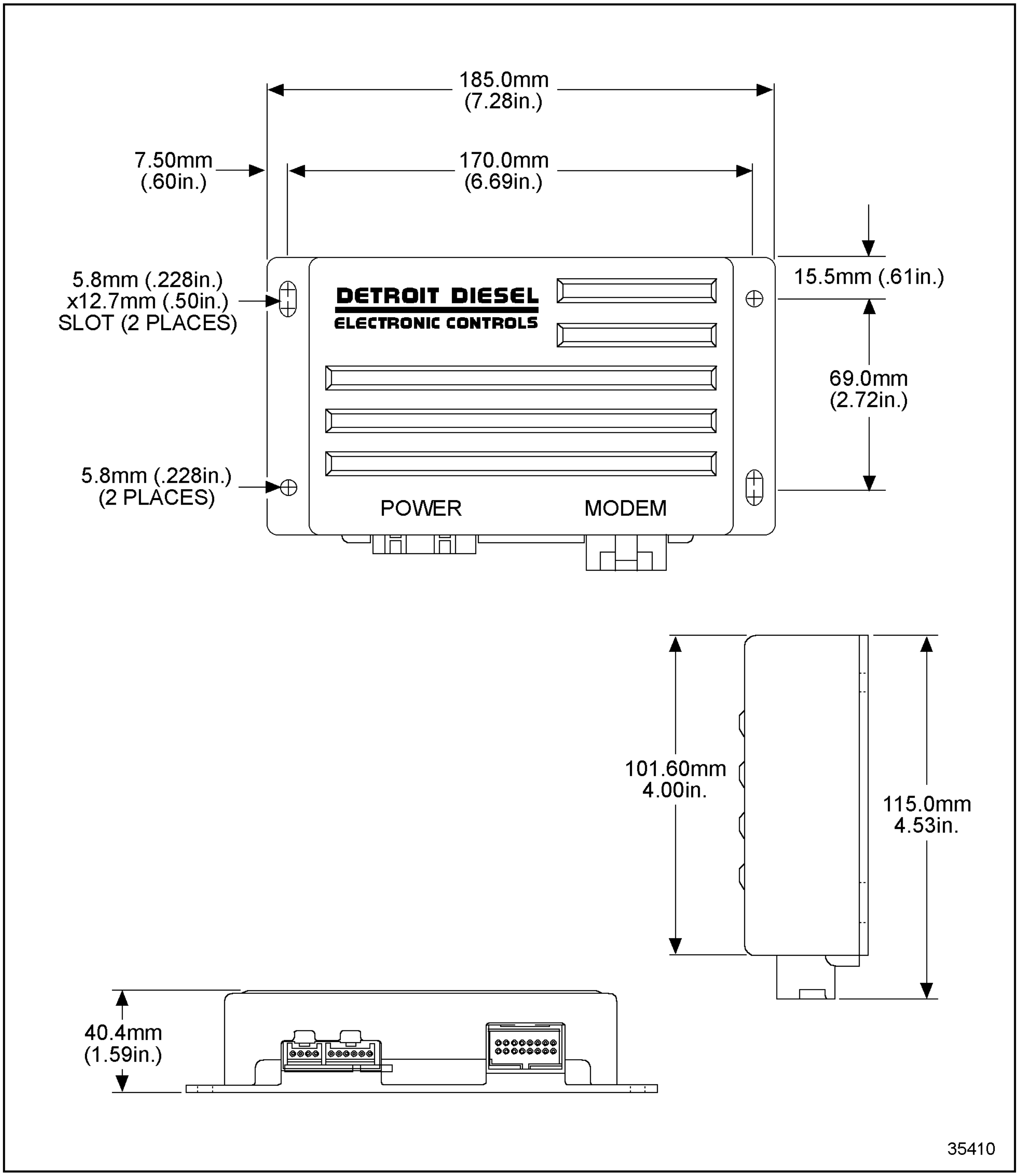
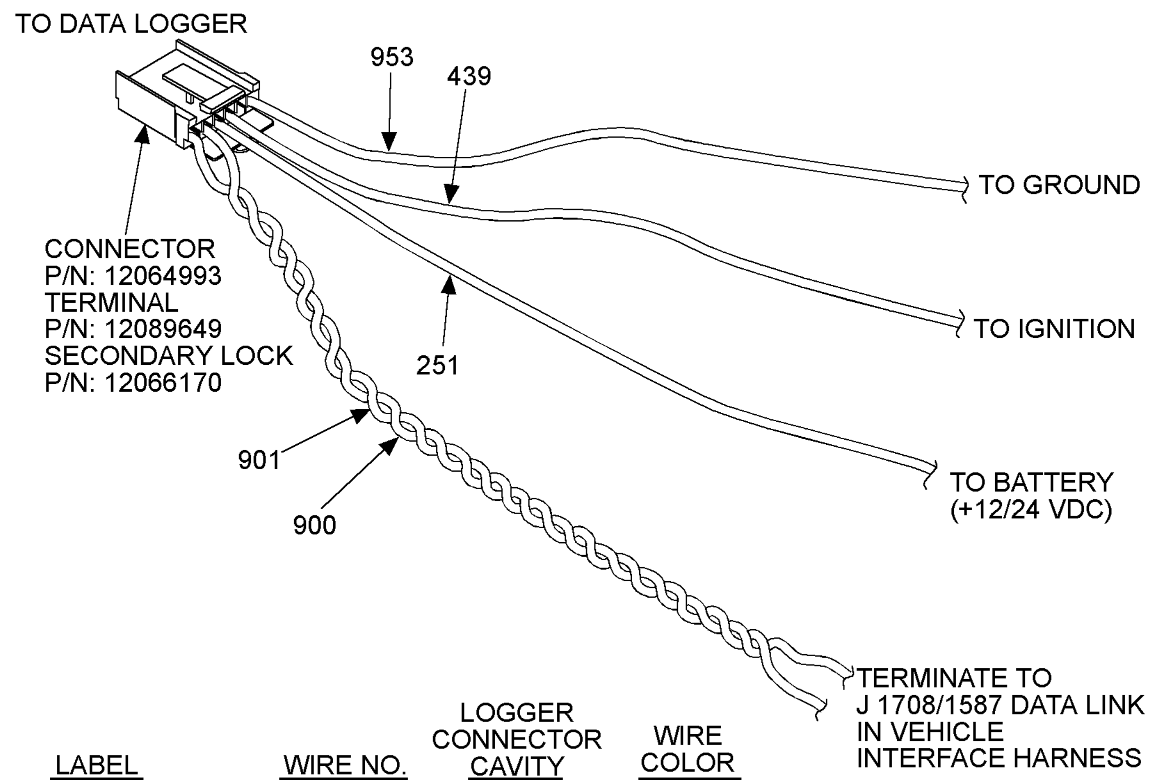


Figure 5-74 Data Logger Installation

The Data Logger has two harnesses, the Power Harness and the Modem Harness. The Power Harness provides both power and data link connections to the Data Logger. The Modem Harness is the connection from the Data Logger to all the external devices associated with the Management Information System.

See Figure 5-75 for the diagram to use for constructing a Power Harness for the Data Logger.



LABEL	WIRE NO.	LOGGER CONNECTOR CAVITY	WIRE COLOR
GROUND	953	10	BLK
IGNITION	439	8	PNK
BATTERY (+12/24V)	251	7	RED
J 1587 DATA LINK (-)	901	6	DK GRN
J 1587 DATA LINK (+)	900	5	DK GRN/YEL

37103

Figure 5-75 Data Logger Power Harness

The modem harness is the connection from the Data Logger to all the external devices associated with the Management Information. The harness branches from the Data Logger to the download connector. The download connector is used for a high-speed download of the stored data in the Data Logger. The download can also be done through the diagnostic connector at a much slower rate.

The download connector should be easily accessible, most likely near the engine diagnostic connector. The battery positive wire should be sourced from the same place as the Power harness battery positive wire. The remainder of the wires should run direct from the Data Logger to the download connector.

The Modem connector can be located anywhere in the cab of the vehicle. The Modem branch of the Modem harness is used for wireless extraction of the data from the Data Logger. A modem can be used with a cellular phone to extract data either by standard phone lines or by satellite. The communication from the Data Logger to the modem is done over a standard RS232 Serial port.

NOTE:
Battery positive must have a 3-amp fuse between the battery and the Data Logger.

The schematic for constructing the modem harness for the Data Logger is shown in the next illustration (see Figure 5-76). This harness is also available through DDC, P/N: 23515651.

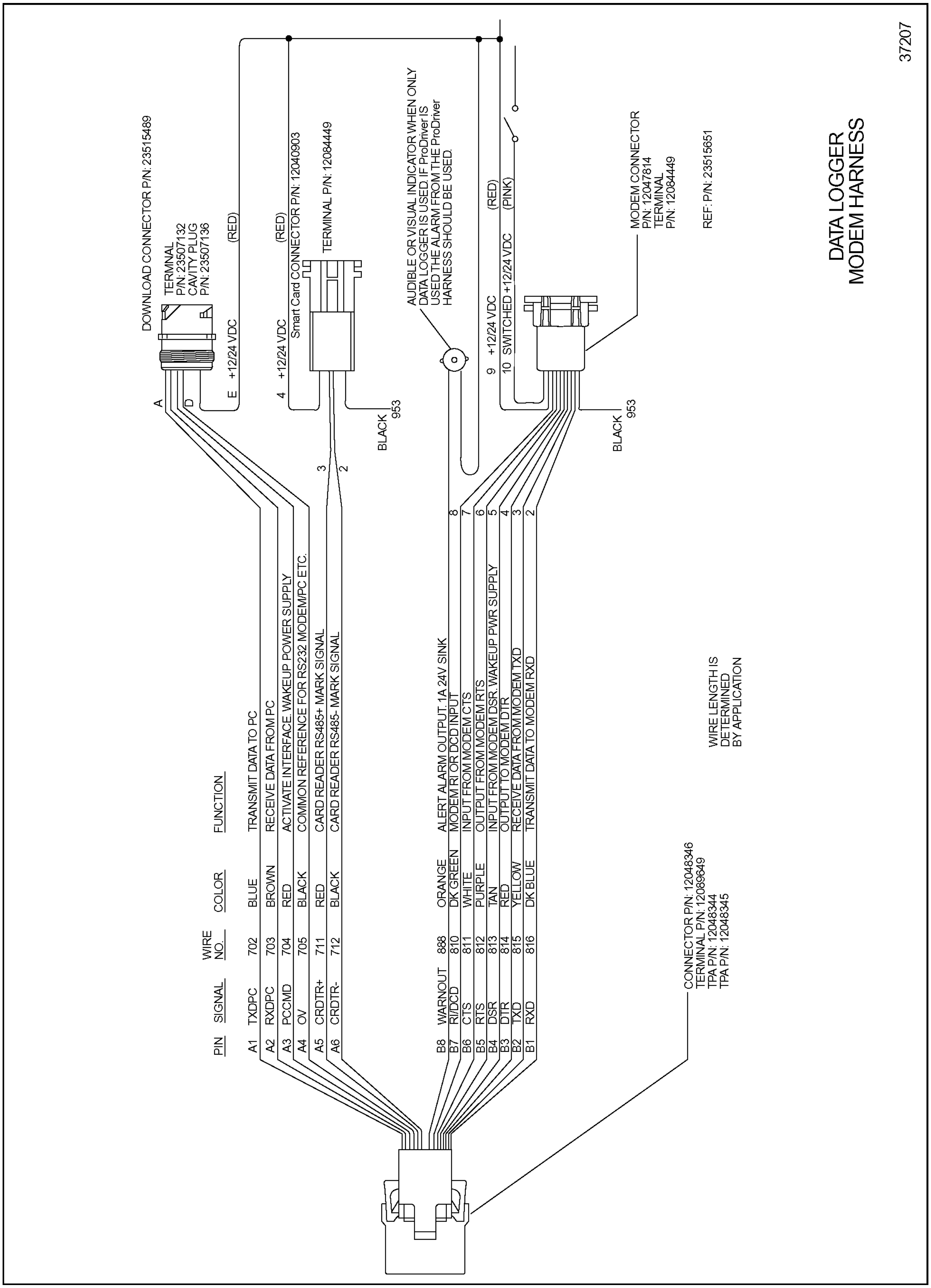


Figure 5-76 Data Logger Modem Harness

5.22.9 PRODRIVER

ProDriver is a dashboard-mounted graphic device that displays data stored in its memory. The display is a vacuum fluorescent (VF) display for wide viewing angles and excellent visibility in all ambient light conditions. It provides automated intensity control of the VF display, based on the dashboard instrument panel lights for improved driver convenience. There are two automatically shown display screens which offer real-time feedback based on vehicle activity, the ‘‘Fuel Economy" screen and the ‘‘Idle Percentage" screen (see Figure 5-77).

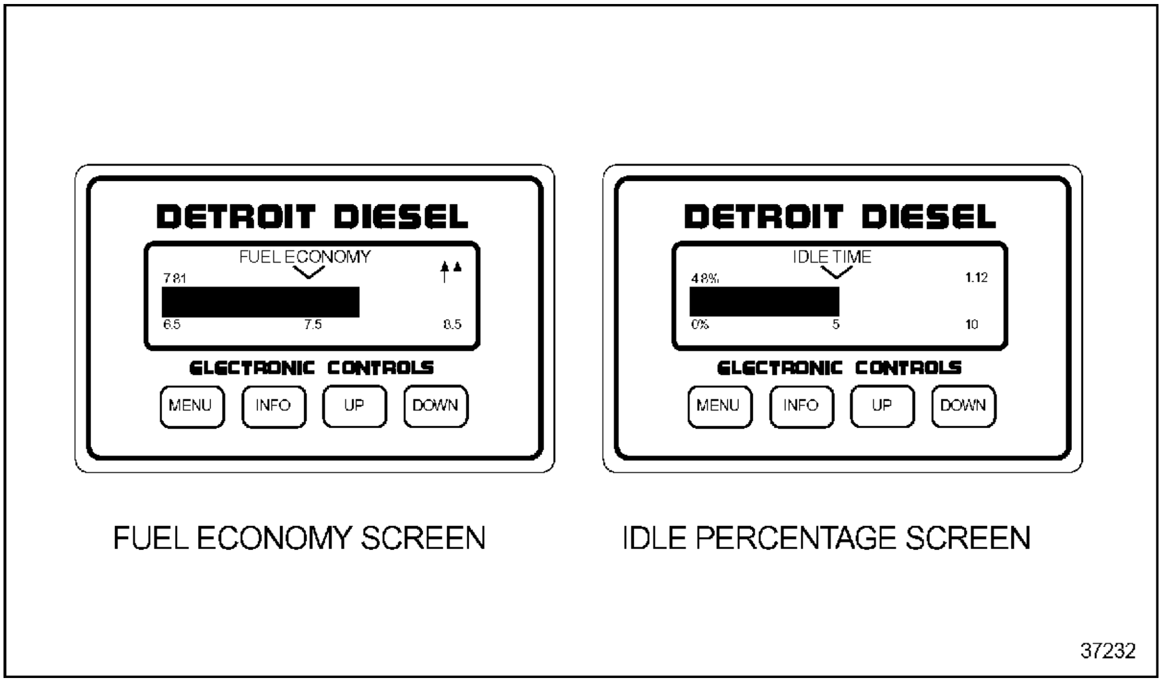


Figure 5-77 ProDriver Screens

The ‘‘Fuel Economy" screen displays MPG achieved versus the fleet's target when the truck is in motion and the ‘‘Idle Percentage" screen displays idle time and percentage achieved versus the fleet's target when the truck is stopped. Drivers use the information to improve their performance, especially fuel economy. Fleets use the data to evaluate driver and fleet performance.

ProDriver extracts data from all releases of ProDriver firmware. However, it produces reports only from ProDriver Release 3.0. Previous releases of ProDriver firmware were analyzed and reported by Promanager 1.0 PC software. This software operates under DOS and is not year 2000 compliant. Any users of ProManager 1.0 can obtain a free upgrade to ProDriver Reports 1.0. A free upgrade to ProDriver 3.0 firmware is included with ProDriver Reports 1.0.

ProDriver Installation

The ProDriver module should be dashboard mounted in a location that is easily seen so the driver's eyes do not have to leave the road for a long period of time.

ProDriver is available in two styles: flush mount and surface mount. The flush mount is intended to be mounted in the dash with only a bezel above the dash surface. See Figure 5-78.

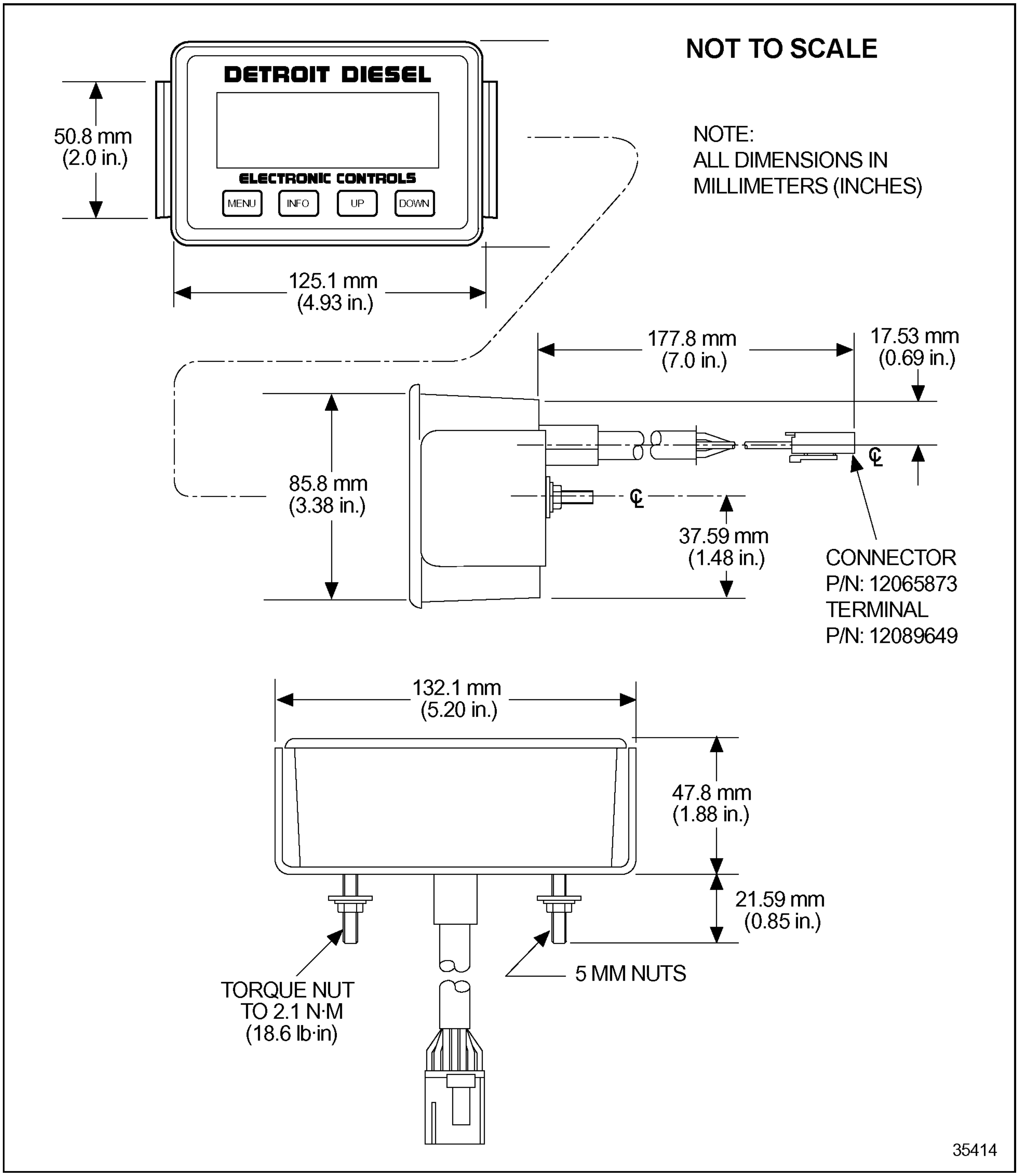


Figure 5-78 ProDriver Flush Mount

The mounting bracket for the flush mount ProDriver is shown in Figure 5-79.

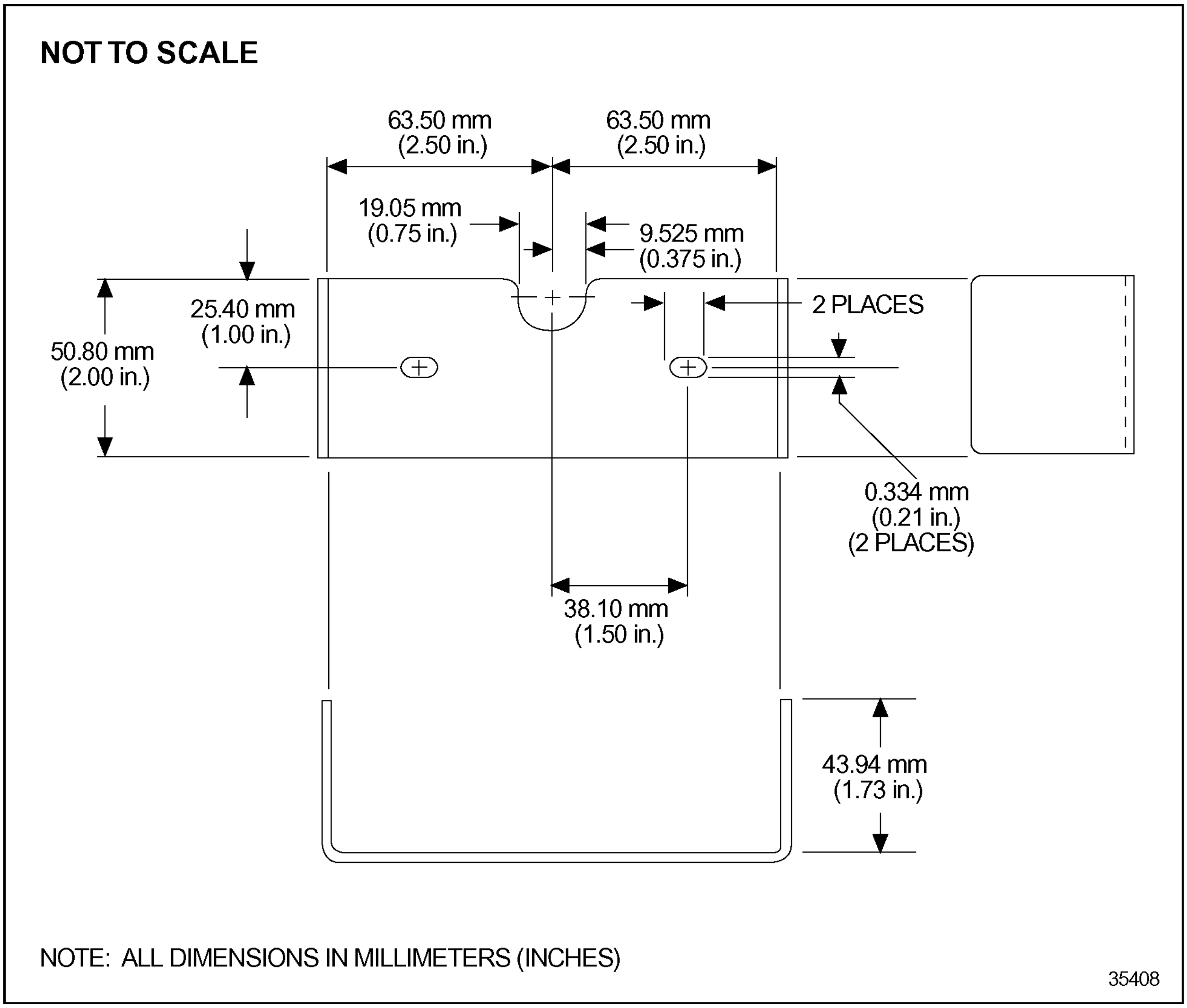


Figure 5-79 ProDriver Flush Mount Mounting Bracket

The flush mount display cutout template is shown in Figure 5-80.

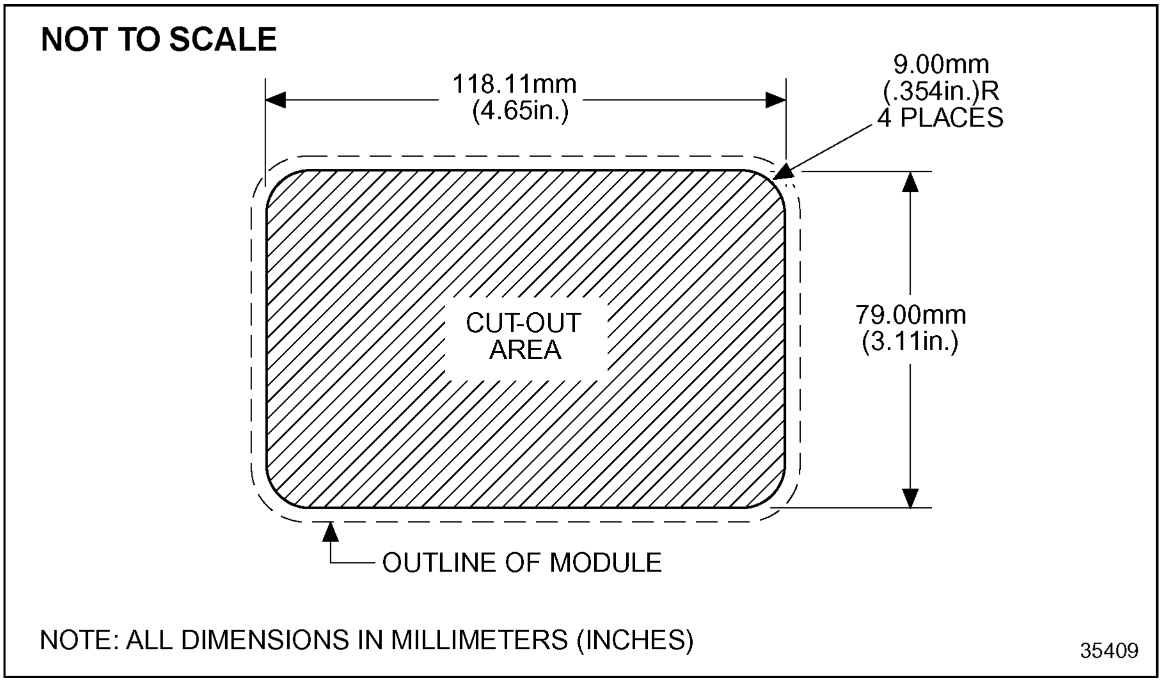


Figure 5-80 ProDriver Flush Mount Display Template

The surface mounted display is installed on top of the dash, the overhead or the face of the dash. Refer to Figure 5-81.

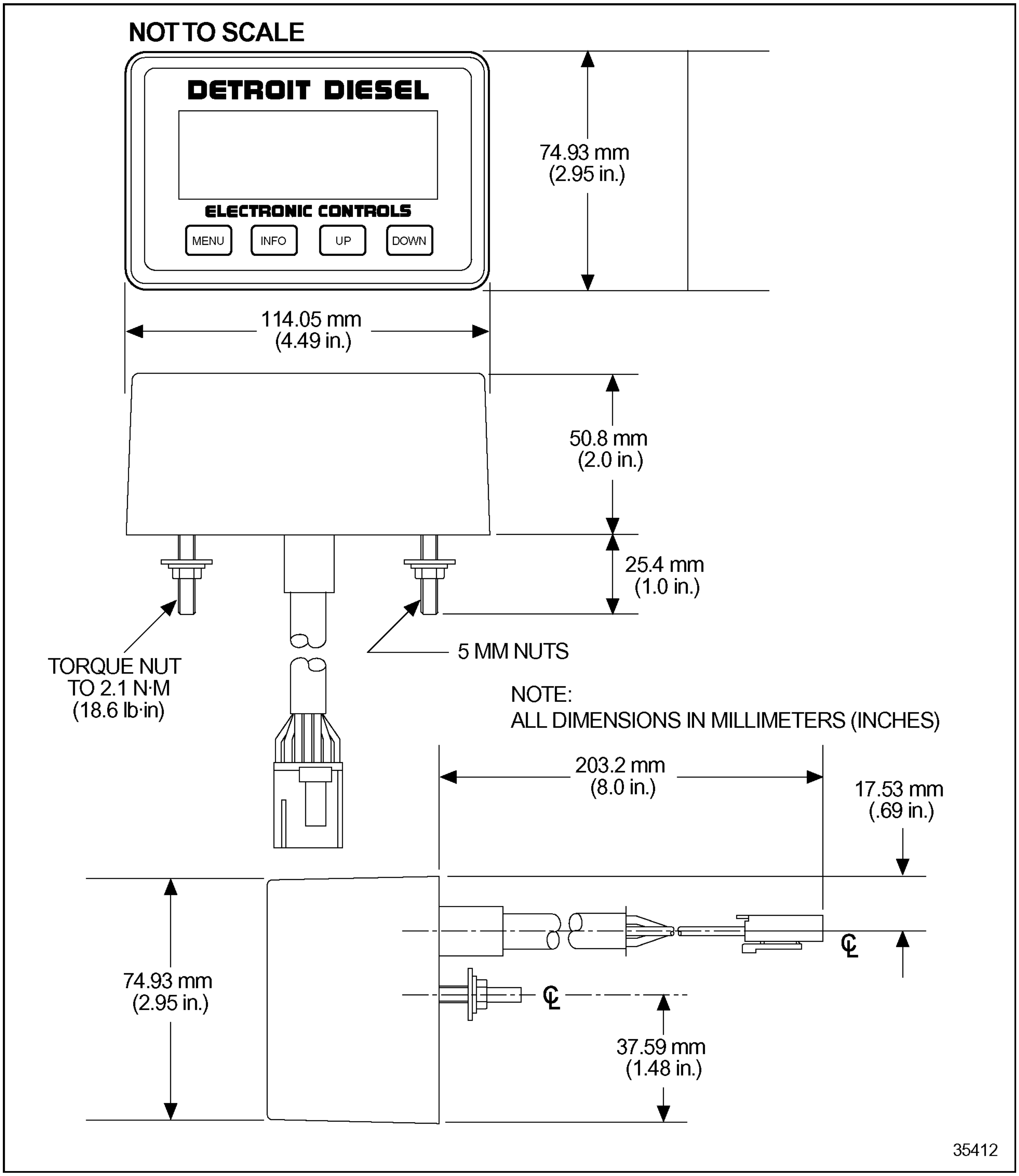


Figure 5-81 ProDriver Surface Mount

See Figure 5-82 for bracket dimensions and characteristics of the surface mount bracket.

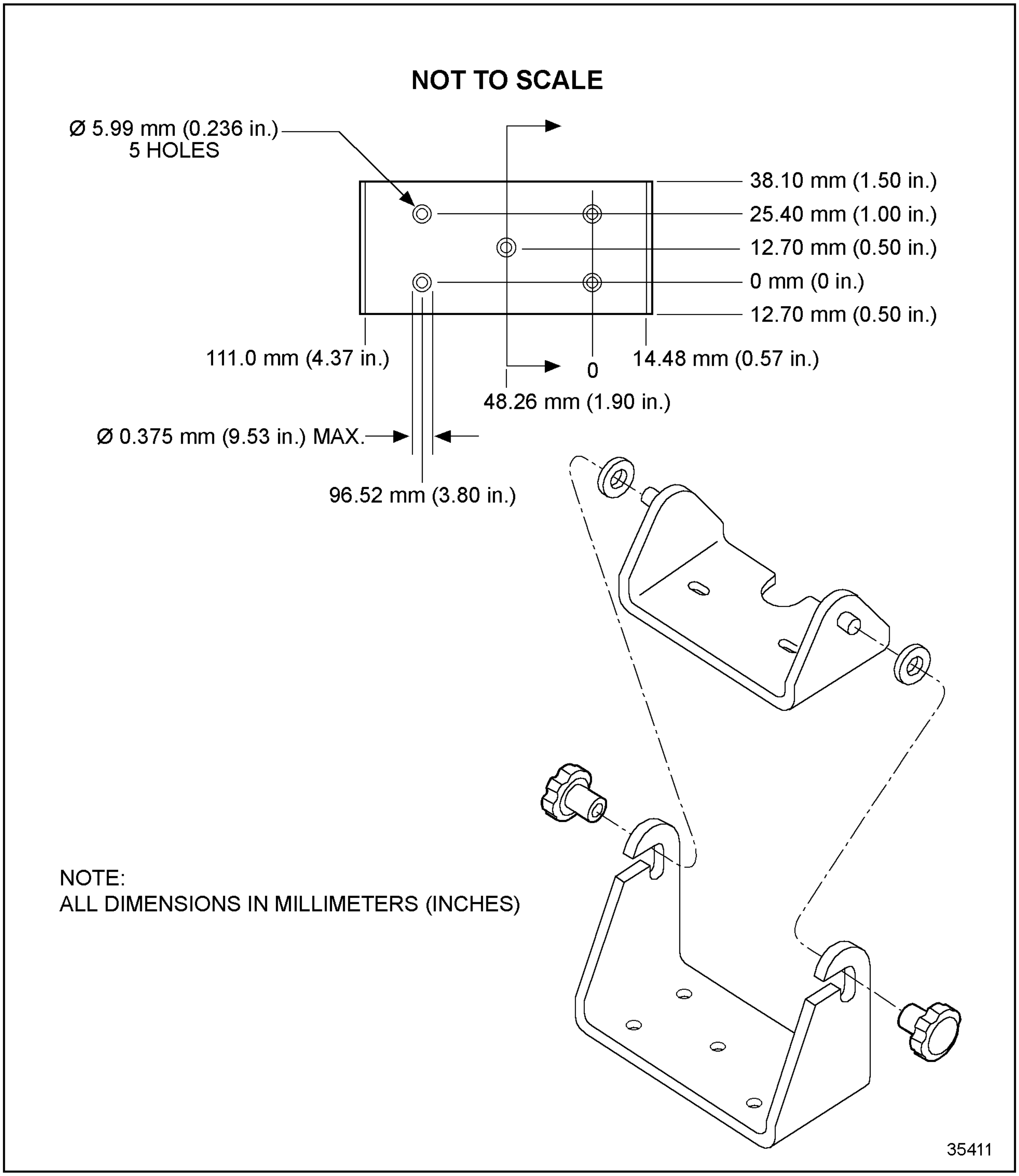


Figure 5-82 ProDriver Surface Mount Bracket

See Figure 5-83 for the bolt pattern layout, which defines mounting without the adjustable bracket.

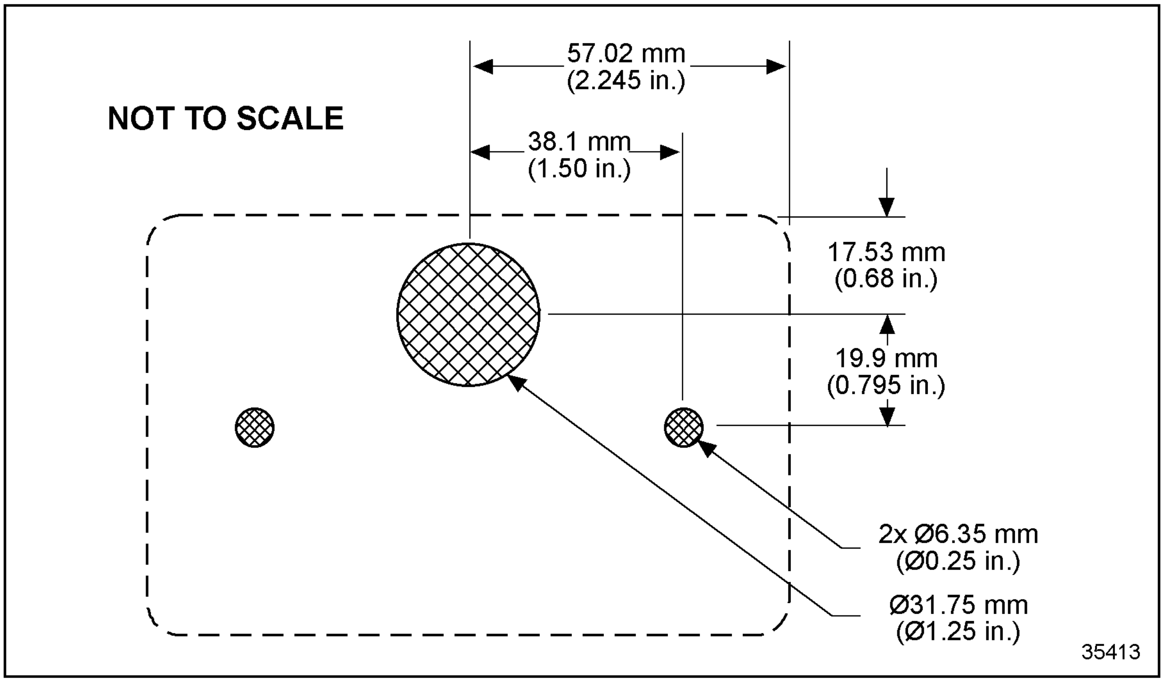


Figure 5-83 ProDriver Surface Mount Template

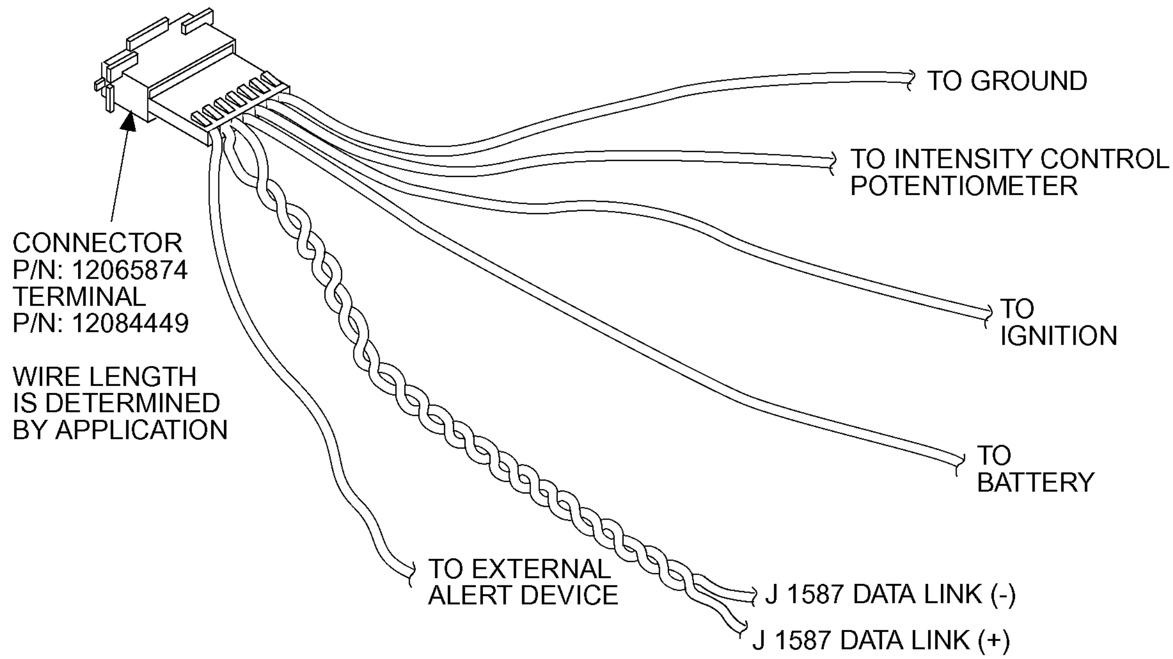
ProDriver has one harness for connection to the vehicle. The following paragraphs contain information that will be helpful in designing this harness.

Battery positive can be sourced from the same place as the Data Logger (if installed).

The panel light on/off wire detects when the instrument panel lights are on. It is recommended that the 12/24 volt signal be taken from the high side of the intensity control potentiometer. This will ensure that the display intensity will change when the running lights are on as well as when the headlights are on.

The external alert signal from the ProDriver can be used to drive either an audible or visual alert device. The output will provide a ground when there is an alarm and be open where there is no alarm. The external alert signal will be turned on when there is an engine diagnostic code or when one of the preset limits in the ProDriver is exceeded. The alarm will also be active when a button is pressed if this feature is enabled. The load on the output must not exceed 1 amp. Refer to the *ProDriver User Manual* (6SE701), for more detail on alarms. DDC offers an audible alarm, P/N: 23515915.

See Figure 5-84 for the diagram to use when constructing a harness for ProDriver.



LABEL	PRODRIVER CONNECTOR CAVITY	WIRE COLOR
EXTERNAL ALERT	1	ORN
J 1587 DATA LINK (+)	2	DK GRN/GRAY
J 1587 DATA LINK (-)	3	DK GRN
BATTERY (+12/24V)	4	RED
IGNITION	5	PNK
POTENTIOMETER	6	GRA
GROUND	7	BLK

39560

Figure 5-84 ProDriver Vehicle Harness

When the Data Logger and ProDriver are both installed in a vehicle, the harness schematic shown next applies (see Figure 5-85).

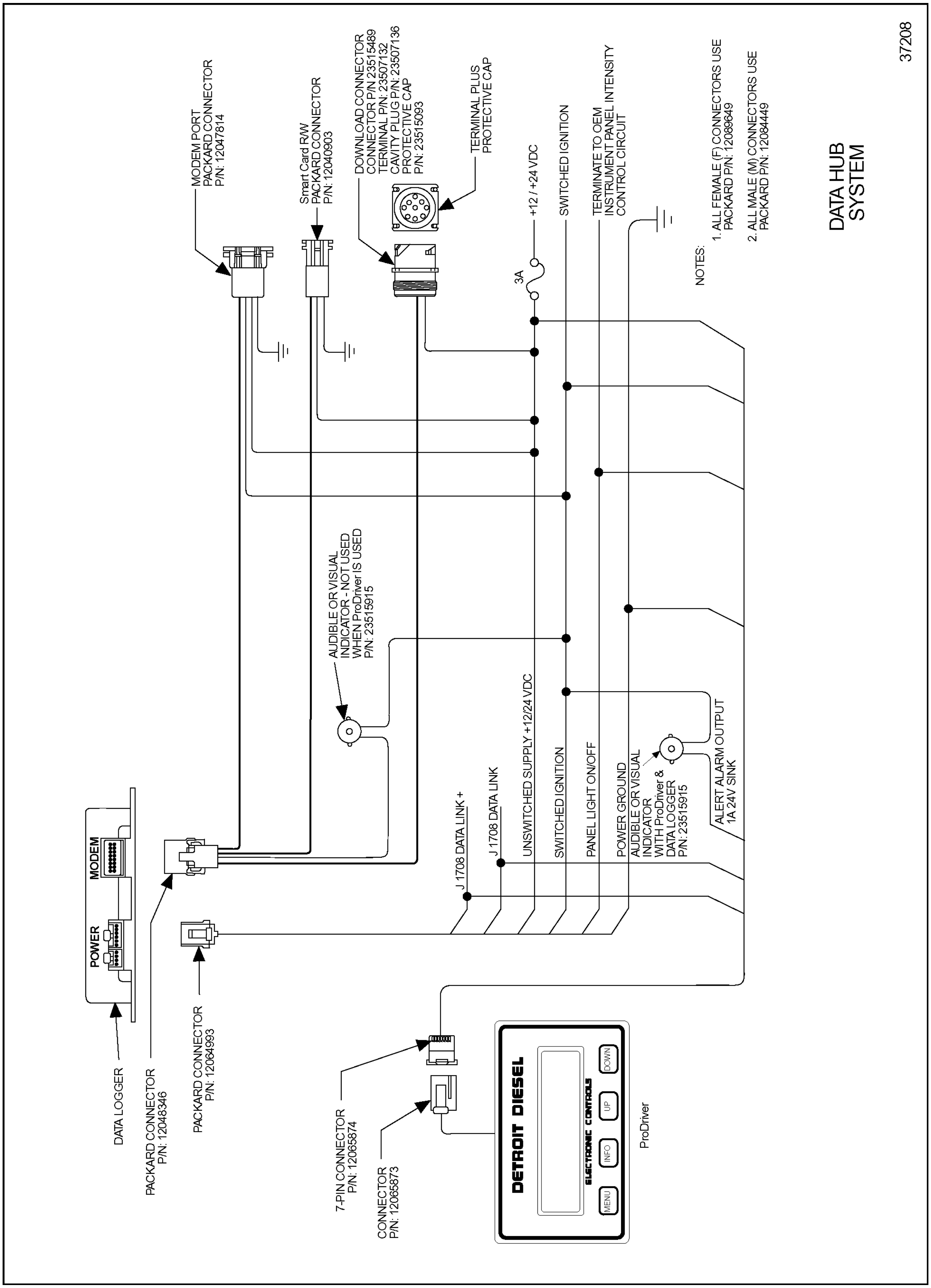


Figure 5-85 Management Information System

Programming Requirements and Flexibility

ProDriver configuration (user settings) can be viewed and changed with ProDriver Reports. Items that can be changed at any time are: Display Intensity, Measurement Units, Language, and Alarm Status. Other setup parameters such as Vehicle Overspeed Limits can be changed, but only if the trip information in the ProDriver memory has first been extracted and cleared.

ProDriver configuration can be reviewed at any time with ProDriver Reports without clearing trip information. The PC running ProDriver Reports must be connected to the vehicle diagnostic connector through the DDC Translator Box. The software then allows the user to retrieve and view the current settings in the ProDriver connected to the PC.

ProDriver has two access modes: Owner/Operator and Manager/Driver. The Owner/Operator mode does not require a password to change Setup. If the ProDriver access mode is set to Manager/Driver, a password is needed to enable changes to the ProDriver Setup menu. Refer to the *ProDriver User Manual* (6SE701), for more detail.

5.22.10 PRODRIVER DC

ProDriver DC (P/N: 23525745) is a dashboard-mounted display (see Figure 5-86) that provides real time and summary information on vehicle and engine operation. Real time graphic displays, shown when the engine is running, provide driver feedback on idle and driving performance relative to fleet goals. ProDriver DC also has a Fuel Economy Incentive status screen and a clock/calendar with battery backup. Engine alerts provide a descriptive message when the CEL and SEL are illuminated.

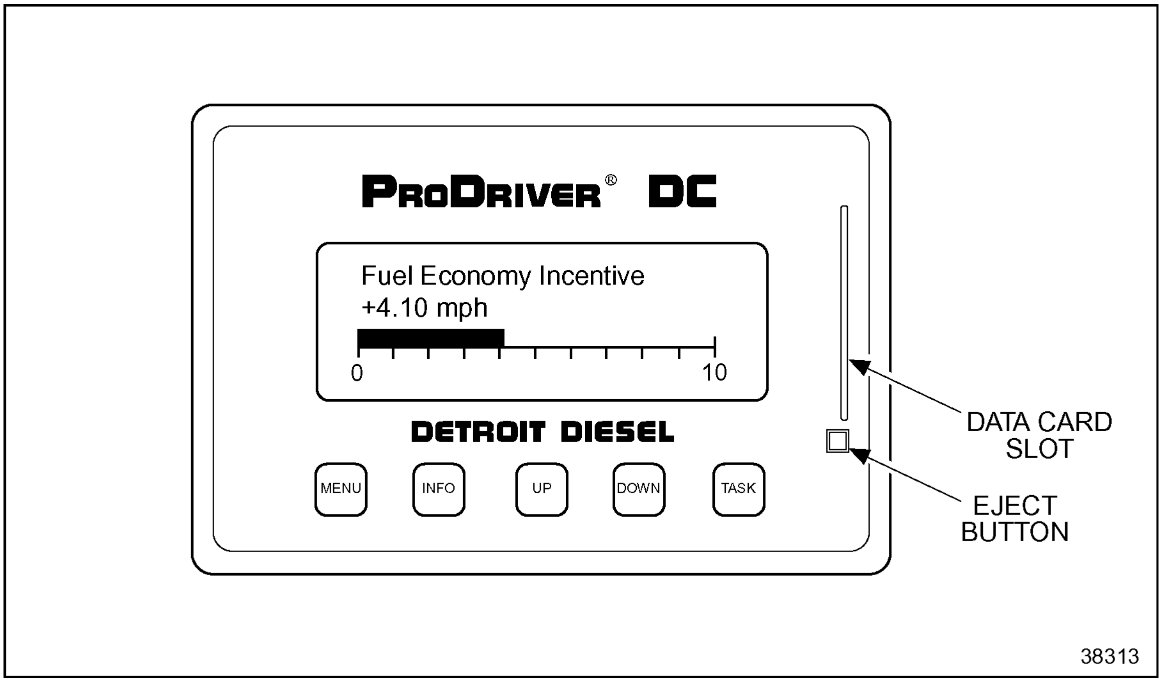


Figure 5-86 ProDriver DC

The Data Card provides a convenient way to transport data to and from the vehicle. The Data Card can hold up to two megabytes of data. It can also be formatted to perform various functions through the Detroit Diesel Data Summaries software. These functions are listed in Table 5-63.

Data Card	Functions
Driver Card	Assigned to a specific driver
	Capacity: 10 vehicles or 10 trips plus 2 months
Extraction Card	Extracts stored vehicle data
	Capacity: 100 extractions
Configuration Card	Loads new ProDriver DC user settings
	Multiple vehicles
	Vehicle ID and odometer not affected
Reprogramming Card	Upgrade ProDriver DC features, as new software becomes available

Table 5-63 Data Card Functions

Data Cards are the Smart Media product used in many digital cameras. The cards and card readers are readily available from local retail stores.

ProDriver configuration (user settings) can be viewed and changed with Detroit Diesel Data Summaries. Configuration options that can be changed at any time are: Display Intensity, Measurement Units, Language, and Alarm Status. Other setup parameters such as Vehicle Overspeed Limits can be changed, but only if the trip information in the ProDriver DC memory has first been extracted and cleared.

ProDriver DC has two access modes: Owner/Operator and Manager/Driver. The Owner/Operator mode does not require a password to change Setup. If the ProDriver access mode is set to Manager/Driver, a password is needed to enable changes to the ProDriver Setup menu.

Programming ProDriver DC with a Configuration Card is perhaps more convenient. When the card is inserted in ProDriver DC, the technician will be prompted through a few simple steps. Using the same Configuration Card on all ProDriver DC units in a fleet assures that each one has the same setup.

Trip summary data may be reviewed on the ProDriver DC screen or extracted to a PC for later analysis. Extraction options include:

- ☐ Direct connection to a PC running Detroit Diesel Data Summaries software through a translator box
- ☐ Automated direct connection with the Remote Data Interface
- ☐ Wireless communications such as the Highway Master cellular telephone service
- ☐ Extraction to a Driver Card or Extraction Card

ProDriver DC Installation

The ProDriver DC module should be dashboard mounted in a location that is easily seen so the driver's eyes do not have to leave the road for a long period of time. The ProDriver DC module has the same installation dimensions as the ProDriver module. ProDriver DC can be mounted as either a flush mount or a surface mount. See Figure 5-87.

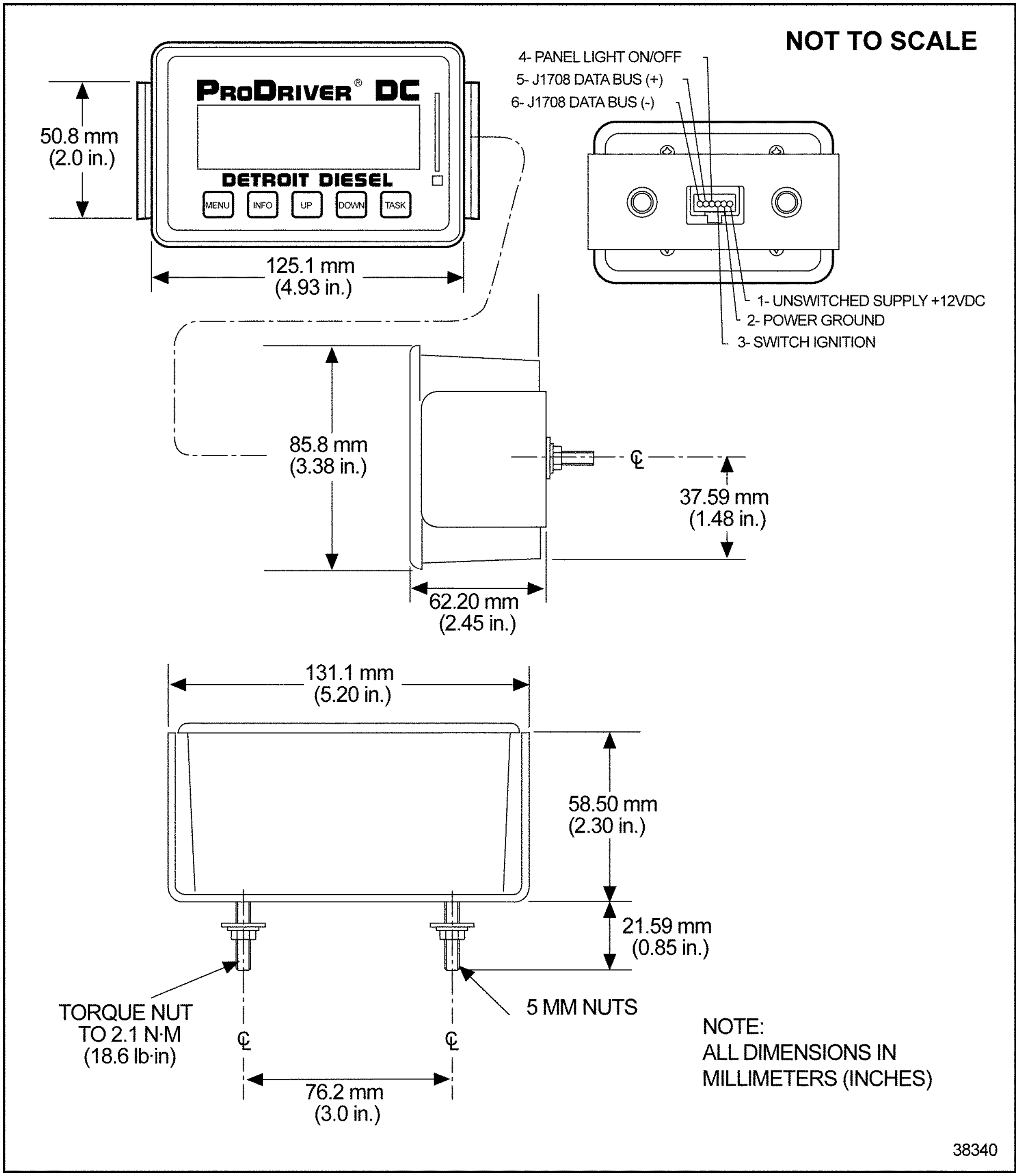


Figure 5-87 ProDriver DC Flush Mount

See Figure 5-88 for the mounting bracket for the flush mount ProDriver DC.

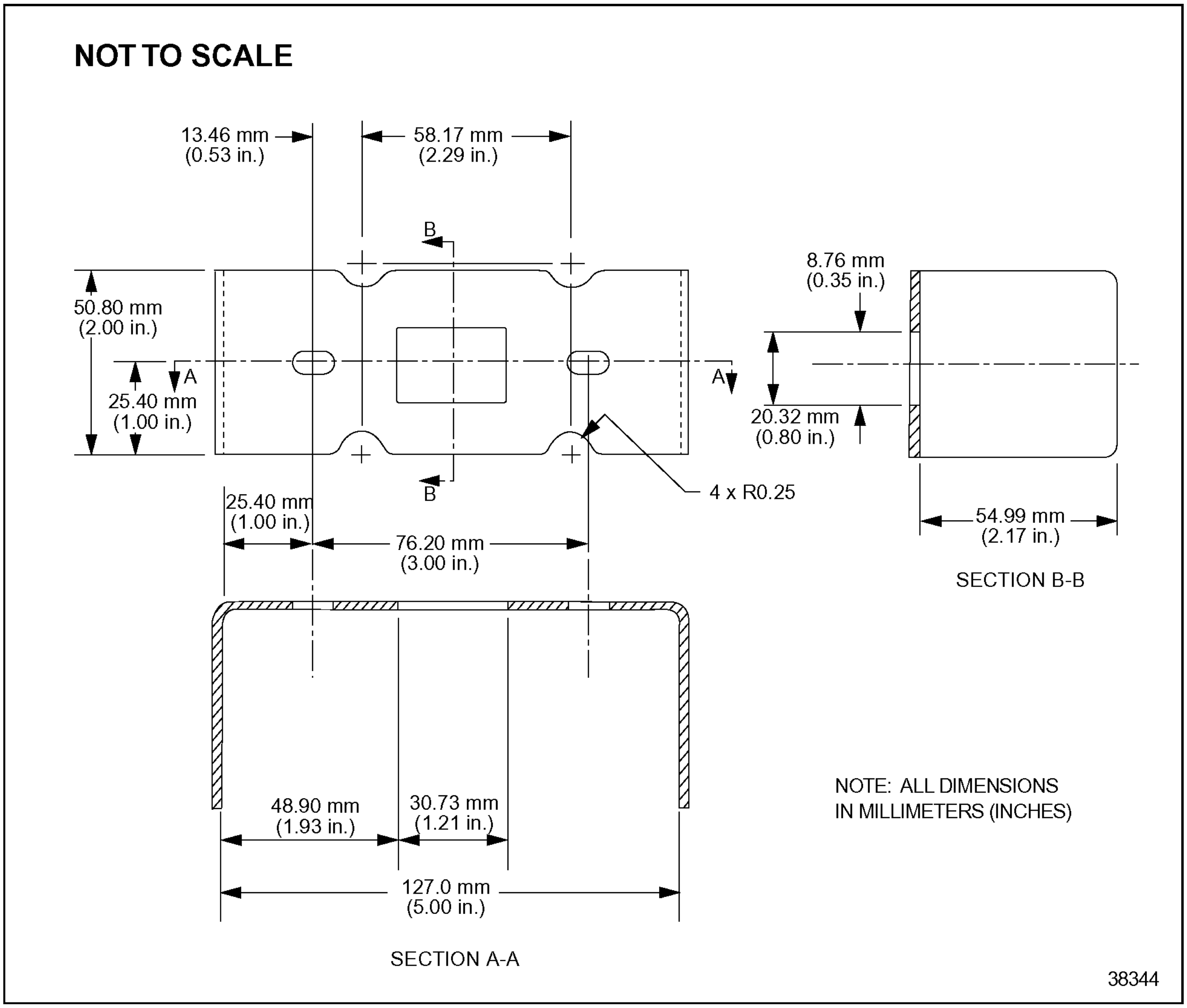


Figure 5-88 ProDriver DC Flush Mount Mounting Bracket

See Figure 5-89 for a cutout template of the flush mount display.

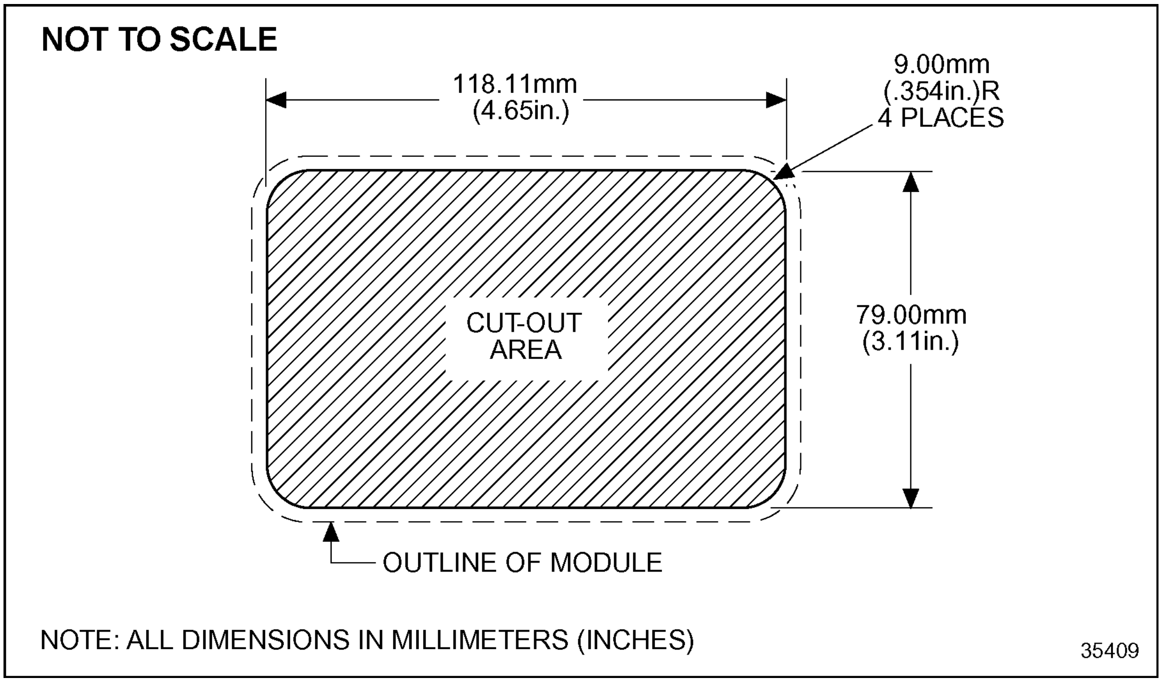


Figure 5-89 ProDriver DC Flush Mount Display Template

The surface mounted display for ProDriver DC is installed on top of the dash, the overhead or the face of the dash. See Figure 5-90.

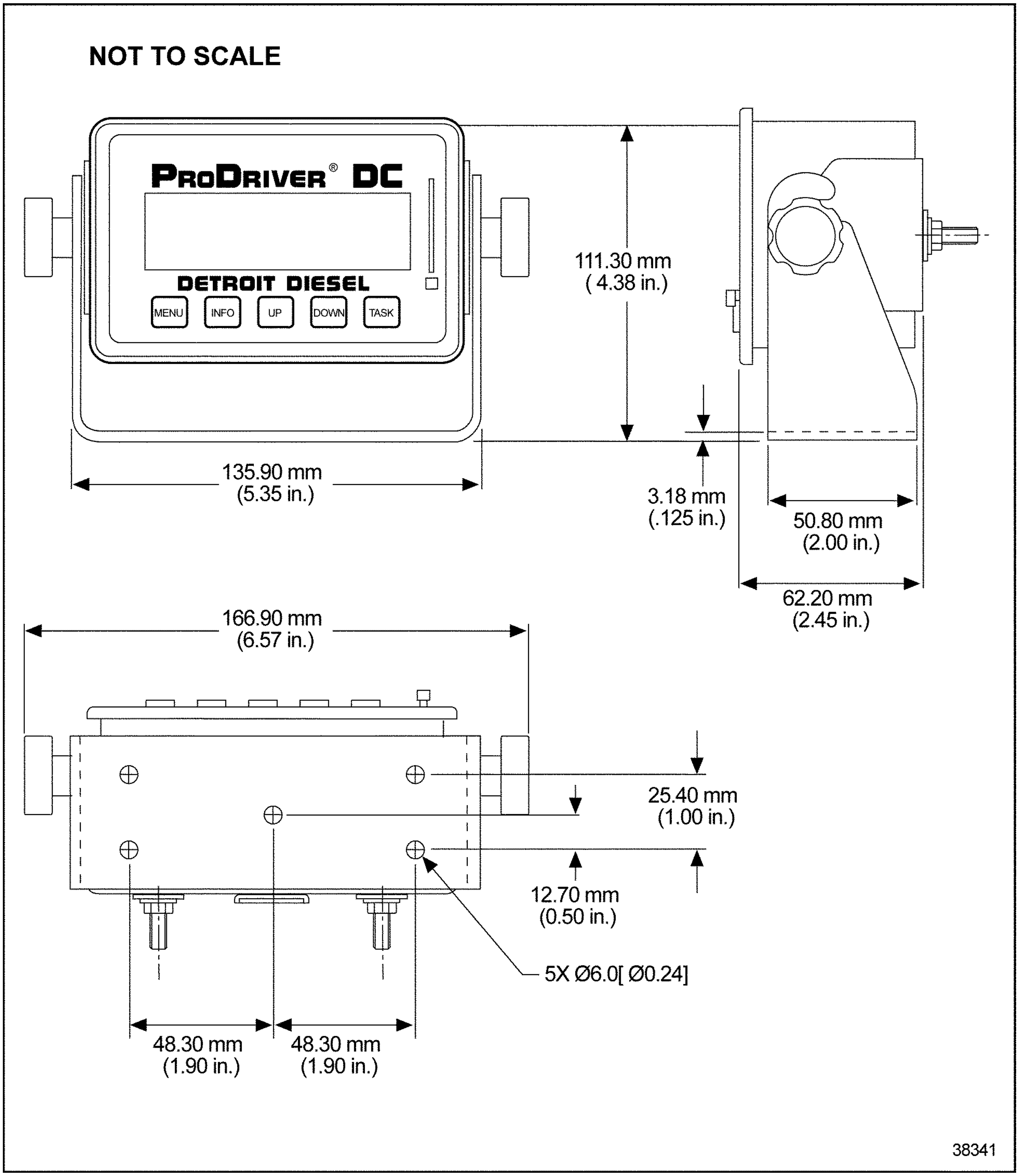


Figure 5-90 ProDriver DC Surface Mount

See Figure 5-91 for bracket dimensions and characteristics of the surface mount bracket.

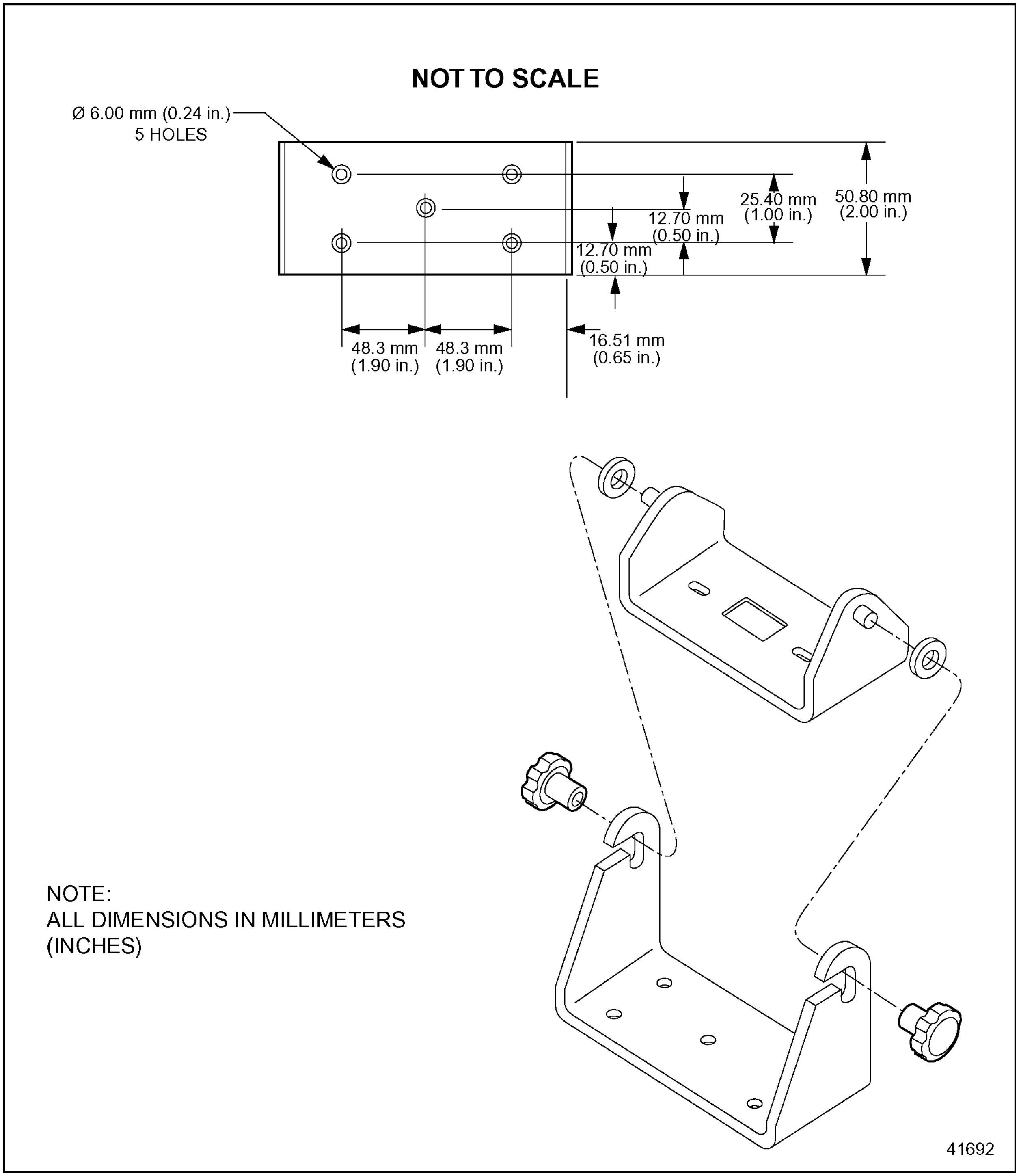
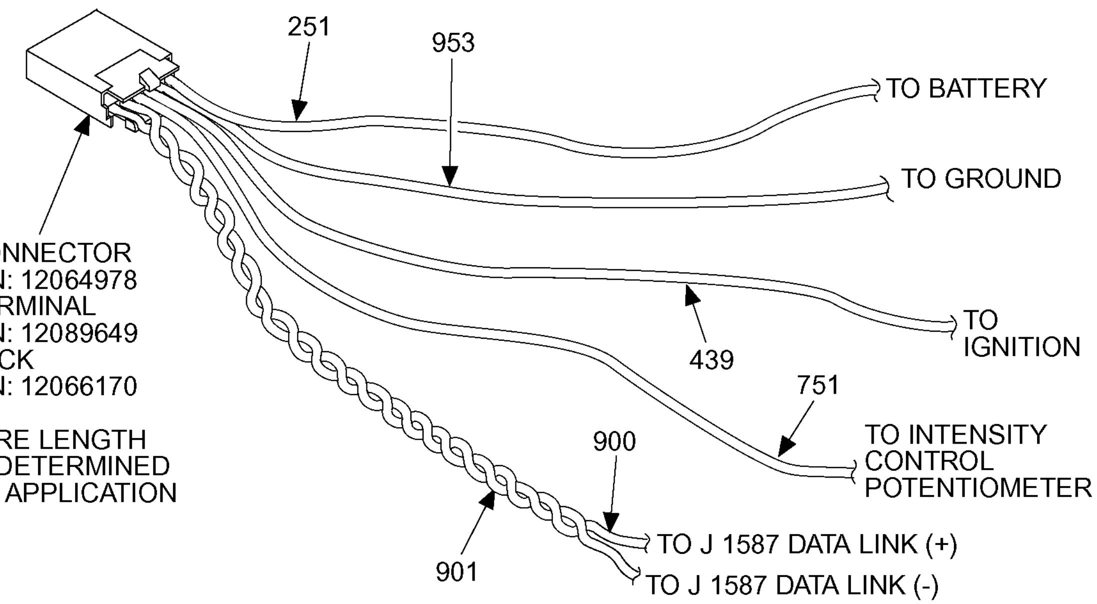


Figure 5-91 ProDriver DC Surface Mount Bracket

ProDriver DC has one harness for connection to the vehicle. The following paragraphs contain information that will be helpful in designing this harness.

The panel light on/off wire detects when the instrument panel lights are on. It is recommended that the 12 volt signal be taken from the high side of the intensity control potentiometer. This will ensure that the display intensity will change when the running lights are on as well as when the headlights are on.

See Figure 5-92 for the diagram to use when constructing a harness for ProDriver DC.



LABEL	WIRE NO.	PRODRIVER DC CONNECTOR CAVITY	WIRE COLOR
BATTERY (+12VDC)	251	1	RED
GROUND	953	2	BLK
IGNITION (+12VDC)	439	3	PNK
PANEL LIGHT	751	4	GRA
J 1587 DATA LINK (+)	900	5	DK GRN/YEL
J 1587 DATA LINK (-)	901	6	DK GRN

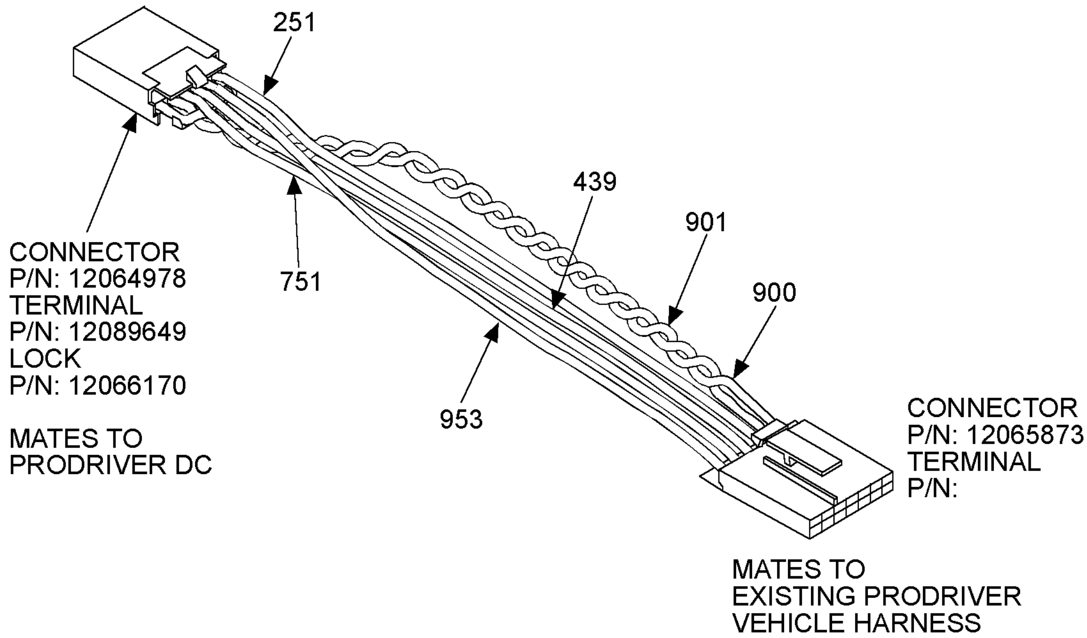
38334

Figure 5-92 ProDriver DC Vehicle Harness

NOTE:

ProDriver DC is 12V only. The ignition and battery wires must be connected to +12V only.

A jumper harness (P/N: 23524862) is available to install a ProDriver DC in place of a ProDriver (see Figure 5-93).



LABEL	WIRE NO.	WIRE COLOR	EXISTING PRODRIVER CONN. CAVITY	PRODRIVER DC CONNECTOR CAVITY
BATTERY	251	RED	4	1
GROUND	953	BLK	7	2
IGNITION	439	PNK	5	3
PANEL LIGHT	751	GRA	6	4
J 1587 DATA LINK (+)	900	DK GRN/YEL	2	5
J 1587 DATA LINK (-)	901	DK GRN	3	6

38355

Figure 5-93 ProDriver DC Jumper Harness

5.22.11 MANAGEMENT INFORMATION PRODUCTS KITS

Several kits are available to install the Management Information Products. The Management Information kits include the Data Logger, ProDriver (flush mount or surface mount), ProDriver DC (flush mount or surface mount), and the appropriate harnesses and hardware to install the system.

Management Information may be installed by the OEM or installed as aftermarket options.

The standard kits are listed in Table 5-64.

Management Information Flush Mount Kit, P/N: 23516620		**Management Information Surface Mount Kit, P/N: 23516619**	
Part Number	Part	Part Number	Part
23514077	Data Logger	23514077	Data Logger
23515650	Cable - Power Connections	23515650	Cable - Power Connections
23515651	Cable - Modem Connections	23515651	Cable - Modem Connections
23515448	ProDriver Flush Mounted	23515649	ProDriver Surface Mounted
23515655	Cable - Vehicle to ProDriver	23515655	Cable - Vehicle to ProDriver
12033769	2-Way 630 Metri-Pack Connector	23515893	Bracket Kit for Surface Mounted ProDriver
12033731	Fuse Holder Cover	12033769	2 Way 630 Metri-Pack Connector
12004003	3 Amp Fuse	12033731	Fuse Holder Cover
12020156	Fuse Terminals 16 Ga.	12004003	Fuse 3 Amp
05101020	Nylon Tie Strap	12020156	Fuse Terminals 16 Ga.
23515915	Audible External Warning Alarm	05101020	Nylon Tie Strap
23516459	Management Information Reference Card	23515915	Audible External Warning Alarm
23516460	Management Information User Manual	23516459	Management Information Reference Card
23516591	Download Connector Bracket	23516460	Management Information User Manual
23516976	Management Information Warranty Booklet	23516591	Download Connector Bracket
018SP365	Management Information Installation Instruction	23516976	Management Information Warranty Booklet
23519866	RDI Driver Card - 7SE0424	018SP365	Management Information Installation Instruction
		23519866	RDI Driver Card - 7SE0424

Table 5-64 Management Information Kits

The harnesses are listed in Table 5-65.

Part Number	**Description**
23515655	Vehicle to ProDriver Display Harness
23515651	Data Logger Modem Harness
23515650	Data Logger Power Harness

Table 5-65 Management Information Harnesses

ProDriver can also be installed separately. The available kits are listed in Table 5-66.

Surface Mount Kit P/N: 23515866		**Flush Mount Kit P/N: 23515867**	
Part Number	Part	Part Number	Part
23515649	ProDriver Display - Surface Mount	23515448	ProDriver Display - Flush Mount
23515893	Bracket kit for Surface Mount	23515655	Cable - Vehicle to ProDriver Display
23515655	Cable - Vehicle to ProDriver Display	12033769	Connector 2 way 630 Metri-Pack Fuse
12033769	Connector 2 way 630 Metri-Pack Fuse	12033731	Cover Fuse Holder
12033731	Cover Fuse Holder	12004003	3 AMP Fuse
12004003	3 AMP Fuse	12020156	Fuse Terminals
12020156	Fuse Terminals	05101020	Strap Nylon Tie
05101020	Strap Nylon Tie	23515915	Audible Alarm
23515915	Audible Alarm	23516025	ProDriver Reference Card
23516025	ProDriver Reference Card	23516026	ProDriver Operator's Manual
23516026	ProDriver Operator's Manual	23516976	Management Information Warranty Booklet
23516976	Management Information Warranty Booklet	018SP362	ProDriver Installation
018SP362	ProDriver Installation	23519866	Card RDI Driver 7SE0424
23519866	Card RDI Driver 7SE0424	--	--

Table 5-66 ProDriver Kits

Other available Management Information and ProDriver kits are listed in Table 5-67 and Table 5-68.

Part Number	**Description**
23515649	Pro Driver Display
23515893	Bracket kit for Surface Mount
23516025	ProDriver Reference Card
23516026	ProDriver Operating Manual
23516028	ProDriver Registration Card

Table 5-67 ProDriver Surface Mount Kit P/N: 23516789

Surface Mount Kit P/N: 23515698		**Flush Mount Kit P/N: 23515697**	
Part Number	**Part**	**Part Number**	**Part**
23515649	ProDriver Display - Surface Mount	23515448	ProDriver Display - Flush Mount
23514077	Data Logger	23514077	Data Logger

Table 5-68 Management Information System Mounting Kits

ProDriver DC Kits are listed in Table 5-69, Table 5-70, and Table 5-71.

Part Number	Description	Quantity
23525745	ProDriver DC Display Unit	1
23525872	ProDriver DC Flush Mount Bracket	1
23525874	ProDriver DC Wiring Harness	1
12033769	Connector 2–way 630 Metri-Pack Fuse Holder	1
12033731	Cover Fuse Holder	1
12020156	Fuse Terminals — 16 ga.	2
12004003	Fuse — 3 Amp.	1
05101020	Nylon Tie Strap	5
23525762	ProDriver DC Data Card	1
18SP528	ProDriver DC Installation Instructions	1
23529660	ProDriver DC User Manual (6SE703)	1
23529661	ProDriver DC Pocket Card (7SE447)	1

Table 5-69 ProDriver DC Flush Mount Kit P/N: 23525759

Part Number	Description	Quantity
23525745	ProDriver DC Display Unit	1
23525873	ProDriver DC Surface Mount Bracket	1
23525874	ProDriver DC Wiring Harness	1
12033769	Connector 2–way 630 Metri-Pack Fuse Holder	1
12033731	Cover Fuse Holder	1
12020156	Fuse Terminals — 16 ga.	2
12004003	Fuse — 3 Amp	1
05101020	Nylon Tie Strap	5
23525762	ProDriver DC Data Card	1
18SP528	ProDriver DC Installation Instructions	1
23529660	ProDriver DC User Manual (6SE703)	1
23529661	ProDriver DC Pocket Card (7SE447)	1

Table 5-70 ProDriver DC Surface Mount Kit P/N: 23525760

Part Number	Description
23525762	Data Card
23529276	ProDriver DC USB Data Card Reader
23529277	ProDriver DC PCMCIA Data Card Reader

Table 5-71 Other ProDriver DC Parts

The OEM ProDriver DC Kits are listed in Table 5-72 and Table 5-73.

Part Number	Description
23525745	ProDriver DC Display Unit
23525872	ProDriver DC Flush Mount Bracket
23524862	ProDriver DC Adapter Harness

Table 5-72 OEM ProDriver DC Flush Mount Kit P/N: 23525753

Part Number	Description
23525745	ProDriver DC Display Unit
23525873	ProDriver DC Surface Mount Bracket
23524862	ProDriver DC Adapter Harness

Table 5-73 OEM ProDriver DC Surface Mount Kit P/N: 23525754

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5.23 MARINE CONTROLS

The DDEC III Level II Bridge Control system combines the advantages of an advanced technological electronic fuel injection and control system with the ability to control up to six control stations and as many as four engines. Additional engines require additional control systems. For additional information, refer to *DDEC III Marine Level II Bridge Control Application and Installation* (18SA372).

The DDEC III system optimizes control of critical engine functions which affect fuel economy and provides the capability to protect the engine from serious damage resulting from conditions such as high engine temperatures or low oil pressure.

The Level II Bridge Control system supports up to six independent control stations located in separate areas in the vessel and allows interrupt-free transfer among them. A panel-mounted Electronic Display Module(s) (EDM) shows operational data including the status of the engines, transmissions and bridge control system.

The DDEC III Level I Bridge Control system is designed for use on vessels with only one control station and no more than two engines.

The DDEC III bridge controls and displays are available for Series 60, 71, 92, 149, 2000, and 4000 engines.

The DDEC III Level II Bridge Control system provides the following features:

- ☐ Seamless transfer of control from the active control station to any one of the additional control stations
- ☐ Control and synchronization of two to four engines
- ☐ Two levels of idle, low idle and user idle
- ☐ High engine speed shifting protection that allows forward motion to be stopped quickly without damaging the transmission
- ☐ Drag down prevention routine designed to prevent engine stall when changing gear direction
- ☐ Trolling gear control (optional)

5.23.1 OPERATION

The Engine Room Interface Module (ERIM), the master module in the DDEC III Level II Bridge Control system, can be considered the most important component of the system. The ERIM acts as an interface with the ECM and other subsystems and devices.

In this role the ERIM:

- ☐ Coordinates the transfer of control from one station to another
- ☐ Routes ECM outputs to each control station
- ☐ Permits control of the ECM inputs from any one station (one at a time)
- ☐ Arbitrates throttle and gear control transfer from one station to another

- ☐ Allows for engine synchronization
- ☐ Provides high (user) and low speed idle

In engine synchronization mode, both engines receive a common signal generated in the ERIM. A troll function is also available on this system.

The ECM used in DDEC engines is designed for a single control station. Many marine applications require control of multiple engines from more than one control station.

DDEC III Level II Bridge Control forms the interface between the engine speed commands from the vessel captain and the engine-mounted ECM. DDEC III Level II Bridge Control also interfaces between the captain's commands for gear direction and the shift mechanism in the transmission. These two control signals are coordinated by the control system to prevent shifts at high engine speeds that may damage internal gearbox components.

Control may be locked to any desired station once vessel control is transferred to it. See Figure 5-94 for a system block diagram of a throttle and gear control system for a two-engine marine application.

The system will also shift the marine gears. Throttle and shift commands from the captain are transmitted via control heads. The control heads located at each station are either single or dual lever designs. A single lever head combines control of both throttle and gear shifting in the same lever, while a dual lever head has separate throttle and gear shift levers.

A means for emergency backup of the bridge control system is provided. This backup scheme maintains control of engine speed and transmission gear direction in the event that the primary control system no longer functions correctly.

The DDEC III Level II Bridge Control system supports up to six independent control stations located in separate areas in the vessel and allows interrupt-free transfer among them. The Level II Bridge Control system is situated in two locations, the control station and the engine room.

Control Station

A control station is defined as any location on the vessel from which the propulsion system is controlled. One station is designated as the master station when there are multiple control stations. A typical control station includes:

- ☐ One Control Station Interface Module (CSIM)
- ☐ One Control Button Panel (CBP)
- ☐ One set of gear and throttle levers (port and starboard)
- ☐ One Electronic Display Module (EDM) for each engine
- ☐ One Emergency Backup Control Panel (EBCP) (master station only)
- ☐ Ignition switch (master station only)

Engine Room

The following components of the DDEC III Level II Bridge Control system are located in the engine room

- ☐ Engine Room Interface Module (ERIM) (required)
- ☐ Marine Interface Module (MIM) (required)
- ☐ Electronic Gear Interface Module (EGIM), Gear Actuators, Backup Gear Actuators and Troll Actuators
- ☐ Electronic Backup Power Module (EBPM)
- ☐ Local Control Panel (LCP)

For additional information, refer to *DDEC III Marine Level II Bridge Control Application and Installation* (18SA372).

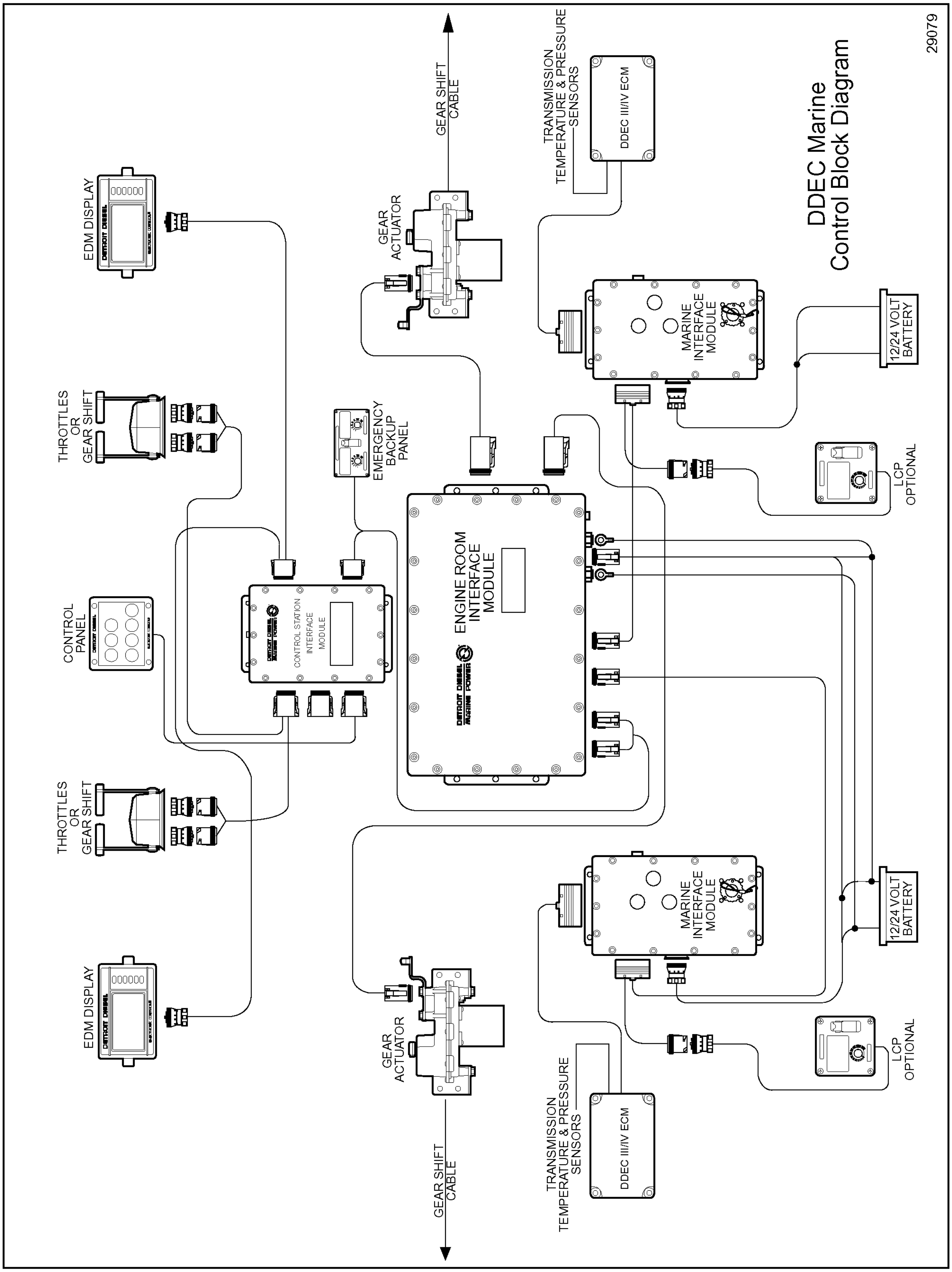

Figure 5-94 Two-Engine Marine Application

5.24 OPTIMIZED IDLE

Optimized Idle enhances the DDEC Idle Shutdown feature. Optimized Idle will automatically stop and restart the engine when required in order to keep the engine temperature above 60°F, the battery charged, and/or the vehicle interior at the desired temperature (using the optional Optimized Idle thermostat). Other benefits include an overall reduction in exhaust emissions and noise and improved starter and engine life (by starting a warm engine). The DDR, Detroit Diesel Diagnostic Link (DDDL), ProManager® software, and DDEC Reports provide access to the Optimized Idle fuel and idle time savings, and run time information.

5.24.1 OPERATION

The following conditions must be met in order to use the Optimized Idle function:

- ☐ The Ignition must be ON with the vehicle idling
- ☐ Hood, cab, and/or engine compartment doors closed
- ☐ Transmission in neutral and splitter in high range (if equipped)
- ☐ Park brake set
- ☐ Idle shutdown timer must be enabled
- ☐ Cruise master switch turned to ON position (if in the ON position, turn to OFF then to ON)

Once these conditions are met, remain idling and the Optimized Idle Active light will flash. This indicates that Optimized Idle will begin operation only after the idle shutdown timer is over. Optimized Idle allows the operation of all DDEC features such as PTO, throttle control, and VSG Cruise, while the active light is flashing.

The active light will stop flashing and stay on, after the shutdown timer has expired. The operator no longer can use other DDEC features, including the throttle, until the park brake is released, one of the safety conditions are broken, or the cruise switch is turned OFF. The engine operates in engine mode or thermostat mode. Once Optimized Idle becomes active, the engine will either shutdown if Optimized Idle parameters are satisfied or ramp to 1100 RPM.

If the engine does not start after the second attempt, or if the vehicle moves while Optimized Idle is active, the Check Engine Light will turn ON to indicate that Optimized Idle has been turned OFF (Active Light will turn OFF) due to the above condition. The ignition must be turned OFF and the engine restarted in order to use Optimized Idle.

The alarm will sound briefly prior to any engine start. After Optimized Idle starts the engine, the speed will be 1100 RPM.

Engine Mode

Optimized Idle will start and stop the engine to keep the following parameters within limits.

Battery Voltage - The engine will start when the battery voltage drops below 12.2 Volts for 12 Volt systems or 24.4 Volts for 24 Volt systems. A DDEC III (Release 9.0 or later) and DDEC IV engines (Release 22.01 or later) will run for a minimum of two hours when started due to low battery voltage.

Oil Temperature - The engine will start when the oil temperature drops below 60°F (15.55°C) and will run until the oil temperature reaches 104°F (40°C).

Thermostat Mode

The optional Optimized Idle thermostat must be turned ON. Engine mode parameters as well as the interior temperature are monitored in this mode. The thermostat informs the ECM when to start/stop the engine to keep the interior warm/cool based on the thermostat setting. It also monitors the outside temperature by way of the skin temperature sensor to determine if the ambient temperature is extreme enough that the engine should run continuously.

Any other accessories connected to the Vehicle Power Shutdown relay will turn ON for Thermostat Mode engine starts. The heater and A/C fans will remain OFF for Engine Mode starts.

If Optimized Idle starts the engine for the Engine Mode, and Thermostat Mode is then requested, the heater and A/C fan will turn ON approximately 30 seconds after the Thermostat Mode is requested.

For additional information, refer to the *Optimized Idle Installation and Troubleshooting* manual (7SA741).

Optimized Idle Start Up Sequence

The following occurs during to any Optimized Idle engine start:

1. Optimized Idle Active Light is ON. The ECM determines when the engine needs to start to charge the battery, warm the engine, or heat/cool the vehicle interior.
2. The alarm (mounted in the engine compartment) will sound briefly.
3. The starter will engage and the engine will start. If the engine speed does not reach a predetermined level within a few seconds, Optimized Idle will attempt a second engine start after 45 seconds. The alarm will sound again prior to the second engine start. If the engine still does not start after the second start attempt, the system will disarm for the rest of the ignition cycle. The CEL will flash and the ECM will go into low power mode after 20 minutes.
4. The engine will ramp up to 1100 RPM. If the engine was started in the Thermostat Mode, the heater or A/C fans will turn ON after approximately 30 seconds.

5.24.2 INSTALLATION

New installations must be approved by Detroit Diesel. See Figure 5-95 for the Optimized Idle overall system schematic. Refer to the *Optimized Idle Installation and Troubleshooting* manual (7SA741) for installation requirements.

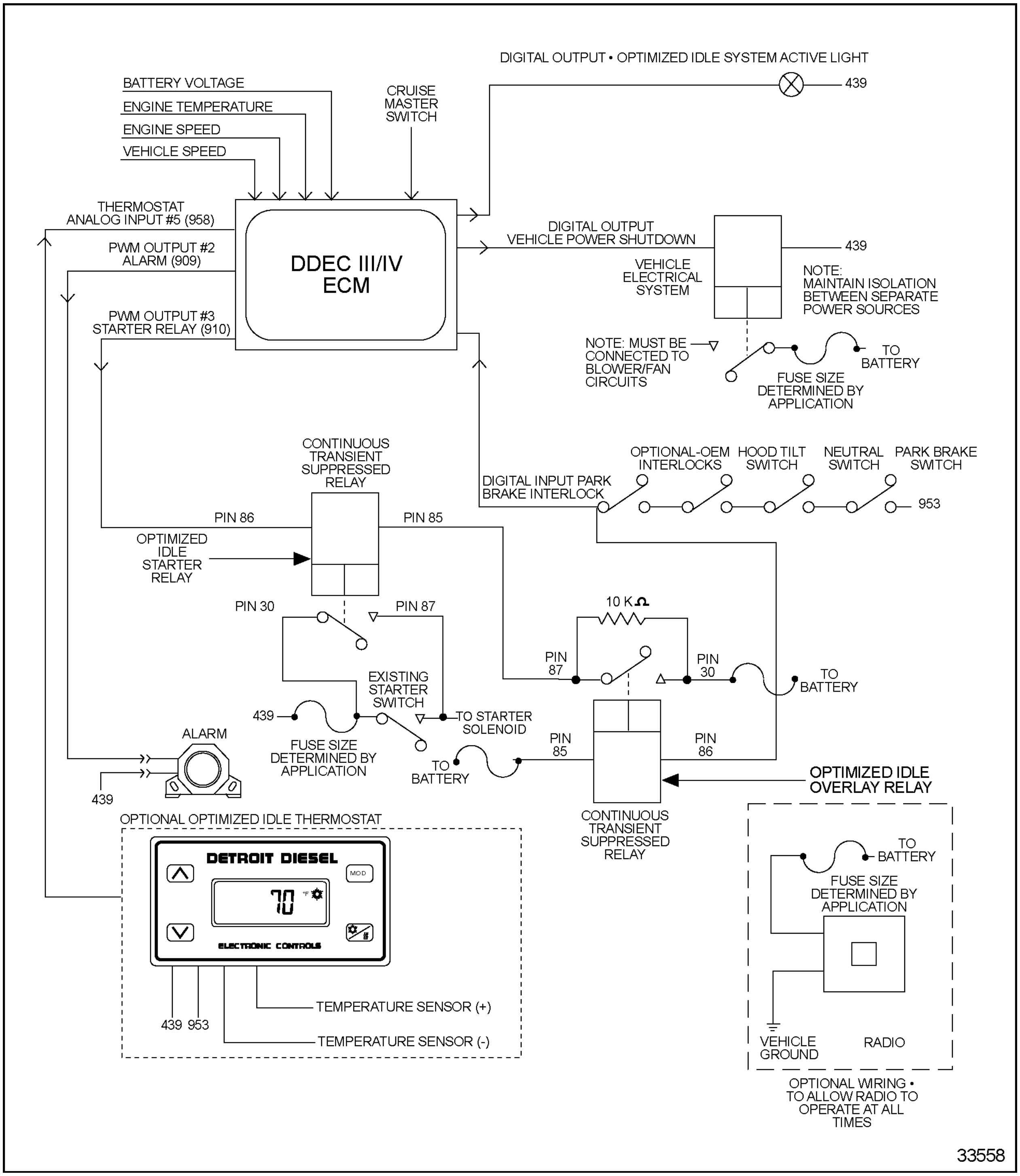

Figure 5-95 Optimized Idle System Overview

5.24.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Optimized Idle must be turned on by the factory via order entry or by Detroit Diesel Technical Service. Software group 6N5-3 must be specified.

The digital inputs and outputs listed in Table 5-74 can be programmed at order entry, VEPS or DRS.

Function Number	Type	Description
5	Digital Input	Park Brake / ISD
23	Digital Input	Cruise Enable
6	Digital Output	Vehicle Power Shutdown
26	Digital Output	Optimized Idle Active Light

Table 5-74 Optimized Idle Digital Inputs and Digital Outputs

The Idle Timer must be enabled by VEPS, DDR, DDDL or DRS. The recommended Idle Timer parameters are listed in Table 5-75.

Parameter	Description	Recommended Setting
IDLE SHUTDOWN TIMER ENABLE	Enables/Disables the Idle Shutdown Feature	YES (Required)
TIME (min)	The amount of engine idle time that is allowed before the idle shutdown feature stops fueling the engine	1-100 minutes (customer's choice)
OVERRIDE	Disables the Idle Shutdown timer Override feature.	NO
ENABLED ON VSG	Allows the Idle timer to shutdown the engine when operating on PTO	YES

Table 5-75 Idle Shutdown Timer Parameters

Optimized Idle installations should have the parameters listed in Table 5-76 set to Shutdown.

NOTICE:
DDC recommends that Shutdown be enabled for all Engine Protection parameters with Optimized Idle installations.

Parameter	Description	Setting
OIL TEMP	Indication of the type of engine protection based on high engine oil temp.	SHTDWN
COOLANT TMP	Indication of the type of engine protection based on high engine coolant temp.	SHTDWN
OIL PRS	Indication of the type of engine protection based on low engine oil pressure.	SHTDWN
COOLANT LVL	Indication of the type of engine protection based on low coolant level.	SHTDWN

Table 5-76 Engine Protection Parameters

5.24.4 DIAGNOSTICS

Refer to the *Optimized Idle Installation and Troubleshooting* manual (7SA741) for diagnostic and troubleshooting information.

5.24.5 INTERACTION WITH OTHER FEATURES

The Vehicle Power shutdown feature is used by Optimized Idle to turn off all accessory loads when the engine is shutdown. Optimized Idle will turn these loads on for Thermostat Mode starts.

Anti-Theft is a new feature that protects the vehicle from being driven by an unauthorized driver. When ProDriver DC is installed and Anti-Theft is enabled (Release 27.0 or later), the vehicle is protected during Optimized Idle operation.

No other DDEC features can be used when Optimized Idle is active.

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5.25 OPTIMUM LOAD SIGNAL

The optimum load signal provides feedback relative to current engine loading versus the optimum engine loading necessary to maximize engine performance and fuel economy. This feature is available with Software Release 21.0 or later.

5.25.1 OPERATION

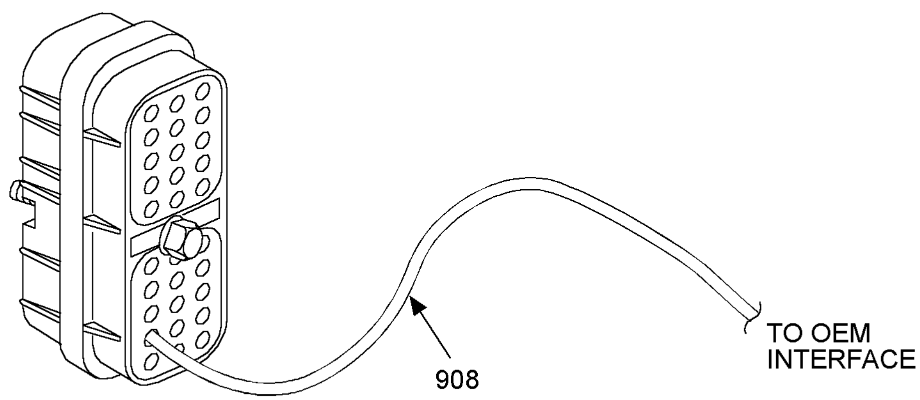
The feedback is in the form of a Pulse Width Modulated (PWM) output where a duty cycle of 50% indicates operation on the preferred load curve. The PWM output ranges from 5% to 95% where a 5% duty cycle indicates the maximum engine overload and 95% indicates the maximum engine underload. They duty cycle broadcast at various engine load points between the optimum curve and either the minimum or maximum load curves is determined by linear interpolation.

The ECM will broadcast a 50% duty cycle if the engine is in start mode, operating on the idle governor, or if the ignition is on and the engine is not running.

The PWM output signal may be converted into an analog voltage output through the use of DDC's Pulse to Voltage Module (P/N: 23522828). Refer to section 5.31 for additional information.

5.25.2 INSTALLATION

See Figure 5-96 for the installation of optimum load signal interface.



LABEL	WIRE NO.	VIH-TO-ECM CONNECTOR CAVITY	WIRE COLOR
PWM #1	908	J3	WHT

37710

Figure 5-96 Optimum Load Signal Interface

5.25.3 PROGRAMMING REQUIREMENT AND FLEXIBILITY

Configuring the transmission type to 32 sets the Optimum Load Signal. This configures PWM #1 output for the Optimum Load Signal. The transmission type can be set by order entry, VEPS or the DRS.

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5.26 OVERALL GOVERNOR GAIN

Overall Governor Gain is used to just to adjust the governor gain between the minimum and the maximum governor gain parameters. The Overall Governor Gain can be modified on generator set applications in the field to work with different inertia alternators.

The Overall Governor Gain can be displayed with Detroit Diesel Diagnostic Link (DDDL, release 3.1 or later) or the DDEC Reprogramming System (DRS).

5.26.1 PROGRAMMING REQUIREMENTS & FLEXIBILITY

The Overall Governor Gain can only be modified by the DRS as long as the feature has been configured in the 6N4C group. The DRS will display the minimum and maximum values for the Overall Governor Gain. This feature is available with Release 28.0 or later ECM software for generator set applications only. The description and range are listed in Table 5-77.

Parameter	Description	Range
Overall Governor Gain	The Overall Governor Gain can be changed between the minimum and maximum governor gain values.	The value is set by the Base Calibration and varies by engine series.

Table 5-77 Overall Governor Gain

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5.27 PASSMART

The PasSmart™ feature is available on selected on-highway DDEC engines equipped with a Vehicle Speed Sensor. This feature is available with DDEC IV ECM software (Release 28.00).

5.27.1 OPERATION

The PasSmart feature allows a fleet manager to enable a second Vehicle Limit Speed (VLS) above the normal VLS to assist while passing other vehicles on the highway. This second VLS is programmed for a limited duration during a given time period (interval). The passing speed interval starts when the feature is programmed. An interval of 8, 12, or 24 hours will always reset at midnight.

The driver activates PasSmart by double-pumping the EFPA. Starting at the full throttle position, the driver releases the throttle completely, returns the throttle to the full throttle position, releases it again and then returns to full throttle. If the driver completes this action within 5 seconds, PasSmart is activated.

After double-pumping the EFPA, the vehicle is given 20 seconds to accelerate to a speed above the normal VLS limit. If the vehicle speed does not exceed the normal VLS speed in 20 seconds, the driver must repeat the double-pump action. Once the normal VLS has been exceeded, a new higher VLS becomes the maximum vehicle speed limit. This limit is the normal VLS plus the Passing Speed Increment.

A passing speed duration timer starts when vehicle speed exceeds the normal VLS limit and continues to count until the vehicle speed drops back below the normal VLS speed. At the end of the passing event when the vehicle speed drops back below the normal VLS, PasSmart is automatically deactivated and the driver cannot exceed the normal VLS unless the Accelerator Pedal is double-pumped again.

PasSmart operates only with the foot pedal and not with the Cruise Control switches or hand throttle. However, activating PasSmart does not disturb or deactivate Cruise Control if it is on when the passing event begins. Once the driver has passed the other vehicles and PasSmart has deactivated, Cruise Control automatically takes over. To deactivate Cruise Control during the pass, the driver must turn the Cruise Control switch to off.

When the Passing Speed Duration time expires, the CEL will begin to flash one minute prior to ramping the VLS limit back down to the normal VLS limit. The rampdown event always takes 5 seconds regardless of the Passing Speed Increment programmed into the ECM. The rampdown alert can be distinguished from an engine fault warning in that the CEL flashes for the PasSmart alert and remains on constantly for an engine fault.

If intervals of 8, 12, or 24 hours are selected, the interval will always reset after the chosen interval and at midnight. This allows fleets to synchronize the reset with driver change periods. All other intervals reset from the time they are selected. For example, if you select 4 hours, then a reset will occur every 4 hours from the time of programming but not necessarily at midnight.

PasSmart still operates when there is an active (non-shutdown) system fault. In this situation the CEL goes from constant illumination to flashing one minute before the VLS limit ramps down. At the end of the passing event when PasSmart is deactivated, the CEL will return to constant illumination if the fault is still active.

If there is an active stop engine fault, the rampdown/shutdown activity overrides PasSmart. The additional passing speed is not available until the fault is cleared.

For example, if the normal fleet speed limit is 65 MPH, the fleet manager can increase the VLS an additional 5 MPH for up to 30 minutes each day with a reset interval of 8 hours. An example of these limits is listed in Table 5-78.

Parameter	Limit
Passing Speed Duration	30 minutes
Passing Speed Interval	8 hours
Passing Speed Increment	10 MPH

Table 5-78 PasSmart Limits

Each time the driver exceeds 65 MPH, the 30 minute clock counts down as long as the speed remains above 65 MPH. He or she can continue to enter and exit the PasSmart extra speed zone to pass vehicles until the entire 30 minutes of higher VLS is used up. The driver is warned by the CEL one minute before the time expires. The vehicle speed is then limited to 65 MPH until the 8 hour period expires and an additional 30 minutes of passing time is available.

5.27.2 INSTALLATION

An OEM supplied Vehicle Speed Sensor or output shaft speed over the SAE J1939 Data Link is required. Refer to section 3.14.25, "Vehicle Speed Sensor," for additional information.

5.27.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The PasSmart parameters are programmable at engine order entry or with DDDL (release 3.1 or later), WinVeps (Release 3.0 or later), Vehicle Electronic Programming System (VEPS), the DDEC Reprogramming System (DRS), or the DDR (Suite 7) as listed in Table 5-79.

Parameter	Description	Choice / Display
Passing Speed Duration	The duration of time per interval that is permitted at the higher speed. A value of zero will disable the feature.	0 to 255 minutes
Passing Speed Interval	The period of time when the ECM resets to begin a new period.	1 to 24 hours*
Passing Speed Increment	The additional vehicle speed permitted above the programmed vehicle speed limit. A value of zero will disable the feature.	0 to 20 MPH

* A value of 8, 12, or 24 will always reset the interval at midnight otherwise it resets every reset interval after the reprogramming was done.

Table 5-79 PasSmart Parameters

5.27.4 INTERACTION WITH OTHER FEATURES

PasSmart will increase the Vehicle Speed Limit.

A vehicle can be set up with both PasSmart and Fuel Economy Incentive, but the extra speed increments provided by the two features do not add together. For example, if Fuel Economy Incentive is set up to give 7 MPH of extra speed when the driver hits the maximum fuel economy target and the PasSmart increase is 5 MPH the resulting speed increase is 7 MPH, not 12 MPH.

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5.28 PASSWORDS

DDEC provides various levels of password protection such as Rating Password, Injector Password, Anti-Theft Password, and Customer Password. Parameter Group Lockout is needed for another level of password protection that affects groups of functions.

5.28.1 RATING PASSWORD

DDEC provides up to four preprogrammed horsepower ratings. The entry of a valid Rating Password and Customer Password are required in order to select a different rating. The rating password can be four alphanumeric characters consisting of the uppercase letters A-Z and the numerals 0-9. The default password is 0000. The Rating Password can be changed with VEPS, DRS, or DDDL. The Customer Password and the current Rating Password are required to change it.

5.28.2 INJECTOR PASSWORD

A valid Injector Password is required to update/change injector calibrations. The Injector Password can be four alphanumeric characters consisting of the uppercase letters A-Z and the numerals 0-9. The default password is 0000. The Injector Password can be changed with DDDL or DRS.

5.28.3 CUSTOMER PASSWORD

The entry of a valid password is required in order to reprogram any parameter(s). Current parameters may be read without entering a password. The password can be four alphanumeric characters consisting of the uppercase letters A-Z and the numerals 0-9.

A random Maximum Security Password can be set by VEPS or DRS for the Customer Password. When set, the factory backdoor password is required to make any changes. The factory backdoor password can be obtained from DDC Technical Service. The Customer Password can be changed with VEPS, DRS, or DDDL. The current Customer Password is required to change to another Customer Password. The default password is 0000.

Parameter Group Lockout

DDEC is capable of providing a second level of password protection for groups of functions. The entry of a valid Parameter Group Lockout Password and Customer Password are requirements before allowing changes to groups that are locked out. The lockout password can be four alphanumeric characters consisting of the uppercase letters A-Z and the numerals 0-9. The default password is 0000.

NOTE:
The parameters are not locked out until a four number non-zero lockout password has been defined.

The groups selected for additional password protection are listed in Table5-80 and Table 5-81 .

Feature with Lockout Enabled	Lockout Password Needed to Reprogram These Parameters	
Cruise Control	Enable Cruise Control	Tire Revs/Mile
	Minimum Cruise Control Speed	Axle Ratio
	Max Cruise Control Speed	Top Gear Ratio
	Enable Engine Brake on Cruise Control	VSS Teeth
	Engine Brake Increment	Max Speed with Fuel
	Enable Auto Resume	Max Speed without Fuel
	Enable Vehicle Speed Limiting	Cruise Switch VSG Enable
	Maximum Vehicle Limit Speed	Cruise Switch VSG Initial RPM
	Enable Vehicle Speed Sensor	Cruise Switch VSG Increment
	Sensor Type	Enable Adaptive Cruise Control
	VSS Signal	--
Idle Shutdown Timer	Enable Idle Shutdown	Idle Shutdown Duration
	Enable Idle Shutdown on VSG	Idle Shutdown Min Ambient Temperature
	Enable Idle Shutdown Override	Idle Shutdown Max Ambient Temperature
Engine Protection	Engine Protection on Oil Temperature High	Engine Protection on Intercooler Temperature High
	Engine Protection on Coolant Temperature High	Engine Protection on Crankcase Pressure High
	Engine Protection on Oil Pressure Low	Engine Protection on Auxiliary Shutdown #1
	Engine Protection on Coolant Level Low	Engine Protection on Auxiliary Shutdown #2
Air Compressor	Air Compressor Load Delta	Air Compressor Max #2 Pressure
	Air Compressor Unload Delta	Air Compressor Max #3 Pressure
	Air Compressor Min#1 Pressure	Air Compressor Pressure Increment
	Air Compressor Min#2 Pressure	Air Compressor Gain Proportional
	Air Compressor Min#3 Pressure	Air Compressor Gain Integral
	Air Compressor Max#1 Pressure	--
Progressive Shift	Enable Progressive Shift	Low Gear #2 RPM Limit
	Low Gear #1 Off Speed	Low Gear #2 Max Limit
	Low Gear #1 RPM Limit	High Gear On Speed
	Low Gear #1 Max Limit	High Gear RPM Limit
	Low Gear #2 Off Speed	--
ESS and Top2	ESS Late Change	ESS Skip Shift
	ESS Second Chance	Top2 Cruise Switch
	ESS Engine Brake Shift	--
Maintenance Alert	MAS CEL/SEL to flash for Levels	MAS CEL/SEL to flash for Filters

Table 5-80 Features and Parameters Selected for Additional Password Protection

Feature with Lockout Enabled	Lockout Password Needed to Reprogram These Parameters	
Engine/Vehicle	VIN	Fuel Economy Incentive MPH Delta
	A/C Fan Timer	Fuel Economy Incentive MPH to MPG
	Dynamic Brake Enabled	Fuel Economy Incentive Trip Mileage
	Fuel Economy Incentive MPG Threshold	--
Engine Droop	LSG Droop	VSG Droop
VSG	VSG Minimum RPM	VSG Maximum RPM
	Alternate Minimum VSG RPM	--

Table 5-81 Features and Parameters Selected for Additional Password Protection (continued)

5.28.4 PROGRAMMING REQUIREMENTS & FLEXIBILITY

VEPS, DRS, or DDDL can set the group lockouts listed in Table 5-82.

Parameter	Description	Choice
ENGINE/VEHICLE OPTIONS	Enables/Disables lockout for Engine/Vehicle parameters.	YES, NO
DROOP	Enables/Disables lockout for Droop parameters.	YES, NO
VSG	Enables/Disables lockout for VSG parameters.	YES, NO
CRUISE CONTROL	Enables/Disables lockout for Cruise Control parameters.	YES, NO
IDLE SHUTDOWN TIMER	Enables/Disables lockout for Idle Shutdown parameters.	YES, NO
ENGINE PROTECTION	Enables/Disables lockout for Engine Protection parameters.	YES, NO
AIR COMPRESSOR	Enables/Disables lockout for Air Compressor parameters.	YES, NO
PROGRESSIVE SHIFT	Enables/Disables lockout for Progressive Shift parameters.	YES, NO
ESS / TOP2	Enables/Disables lockout for ESS/Top2 parameters.	YES, NO
MAINTENANCE ALERT SYSTEM	Enables/Disables lockout for Maintenance Alert System parameters.	YES, NO

Table 5-82 Group Lockout Parameters

The Lockout Password can be changed with the VEPS, DRS, or DDDL. The Customer Password and the current Lockout Password are required to change it.

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5.29 PRESSURE SENSOR GOVERNOR

The Pressure Sensor Governor (PSG) is an optional DDEC feature designed primarily for fire truck applications. PSG is a unique governor system which electronically controls engine speeds based on one of two selected modes of operation. An optional panel display is available (refer to section 5.7, "Electronic Fire Commander").

5.29.1 PSG OPERATION

The Pressure Sensor Governor operates in one of two modes:

- Pressure Mode - monitors water pump discharge pressure while varying engine speed to maintain the set pump pressure
- RPM Mode - maintains a set engine speed regardless of engine load, similar to Variable Speed Governor (VSG) operation

Once PSG has been enabled, the mode is selected with the Pressure/RPM Mode Switch. PSG is enabled by grounding the digital input "PSG Enable" (function #24). The mode is selected by either providing battery ground (Pressure Mode) or an open circuit (RPM Mode) to the digital input "Pressure/RPM Mode" (function #8).

The engine will maintain the engine speed or pump pressure that is current when the mode switch is toggled between the RPM and Pressure modes.

The PSG Ready Light illuminates when PSG is waiting for an operating point. After the Increase or Decrease button has been pressed the PSG active output will be turned on illuminating the PSG Active Light.

See Figure 5-97 for a schematic of the PSG system.

RPM Mode

RPM Mode allows the governor to maintain the set speed within engine operating capabilities. RPM Mode is selected when the digital input "Pressure/RPM Mode" (Function #8) is an open circuit. If the pump is not engaged, RPM Mode can still be used to vary engine speed.

Pressure Mode

Pressure Mode allows the governor to monitor and maintain the fire pump discharge pressure. Pressure Mode is selected by providing battery ground via the digital input Pressure/RPM Mode (Function #8).

In Pressure Mode, the maximum allowable increase above the RPM at which the pressure setpoint was established is 400 RPM. This protects the fire fighter from a pressure surge which may result from a momentary loss of pressure if the maximum allowable increase in engine speed is not limited. Also, the maximum allowable increase in engine speed protects the pump from cavitation.

The Pressure Mode is maintained until one of the following situations occurs:

Situation 1 - The Pressure/RPM Mode switch is moved to the RPM Mode. The system reverts to RPM Mode and the same engine speed is maintained.

Situation 2 - The Pressure Sensor signal exceeds diagnostic limits. The system reverts to RPM Mode. The same engine speed will be maintained. The Check Engine Light (CEL) illuminates, and either Code 86 or 87 will be logged into the ECM memory.

Situation 3 - If the water pump discharge pressure falls below 40 psi and the engine RPM rises a minimum of 400 rpm above the current set point for more than five (5) seconds, the system also considers cavitation to have occurred and the following happens:

1. The engine will return to idle.
2. The current engine speed and discharge pressure set points will be cleared.
3. The CEL will illuminate.

5.29.2 SWITCHES - DECREASE AND INCREASE

The Increase and Decrease switches follow similar logic as the Cruise Control switches (Set/Coast On and Resume/Accel On). The Increase and Decrease switches use digital inputs.

Increase (Resume/Acceleration On)

Momentarily toggling and releasing the increase switch (grounding the Resume/Acceleration On digital input) at the initiation of PSG operation will set the Pressure or RPM operating point. The Pressure or RPM setting will increase by 4 psi (approximately 27.6 kPa) or 25 RPM per increment by momentarily contacting the increase switch as listed in Table 5-83.

Mode	Switch	Amount
RPM Mode	Increase/Decrease	+/- 25 rpm
Pressure Mode	Increase/Decrease	+/- 4 psi

Table 5-83 Increase and Decrease for RPM and Pressure Mode

Holding the switch in the increase position (grounding the Resume/Acceleration On digital input), will increase the pressure or engine speed. The pressure or engine speed will increase by 4 psi (approximately 27.6 kPa) or 25 RPM per increment at a rate of two increments per second. Releasing the switch sets PSG to the higher setting.

Decrease (Set/Coast On)

The pressure or engine speed is decreased by momentarily contacting the switch to the decrease position (grounding the Set/Coast On digital input). The Pressure/RPM setting will decrease by 4 psi (approximately 27.6 kPa) or 25 RPM per increment when the Decrease Switch is momentarily contacted as listed in Table 5-83.

Holding the switch in the decrease position (grounding the Set/Coast On digital input) will decrease the pressure or engine speed. The pressure or engine speed will decrease by 4 psi (approximately 27.6 kPa) or 25 RPM per increment at a rate of two increments per second. Releasing the switch sets the Pressure/RPM to the lower setting.

5.29.3 INSTALLATION

See Figure 5-97

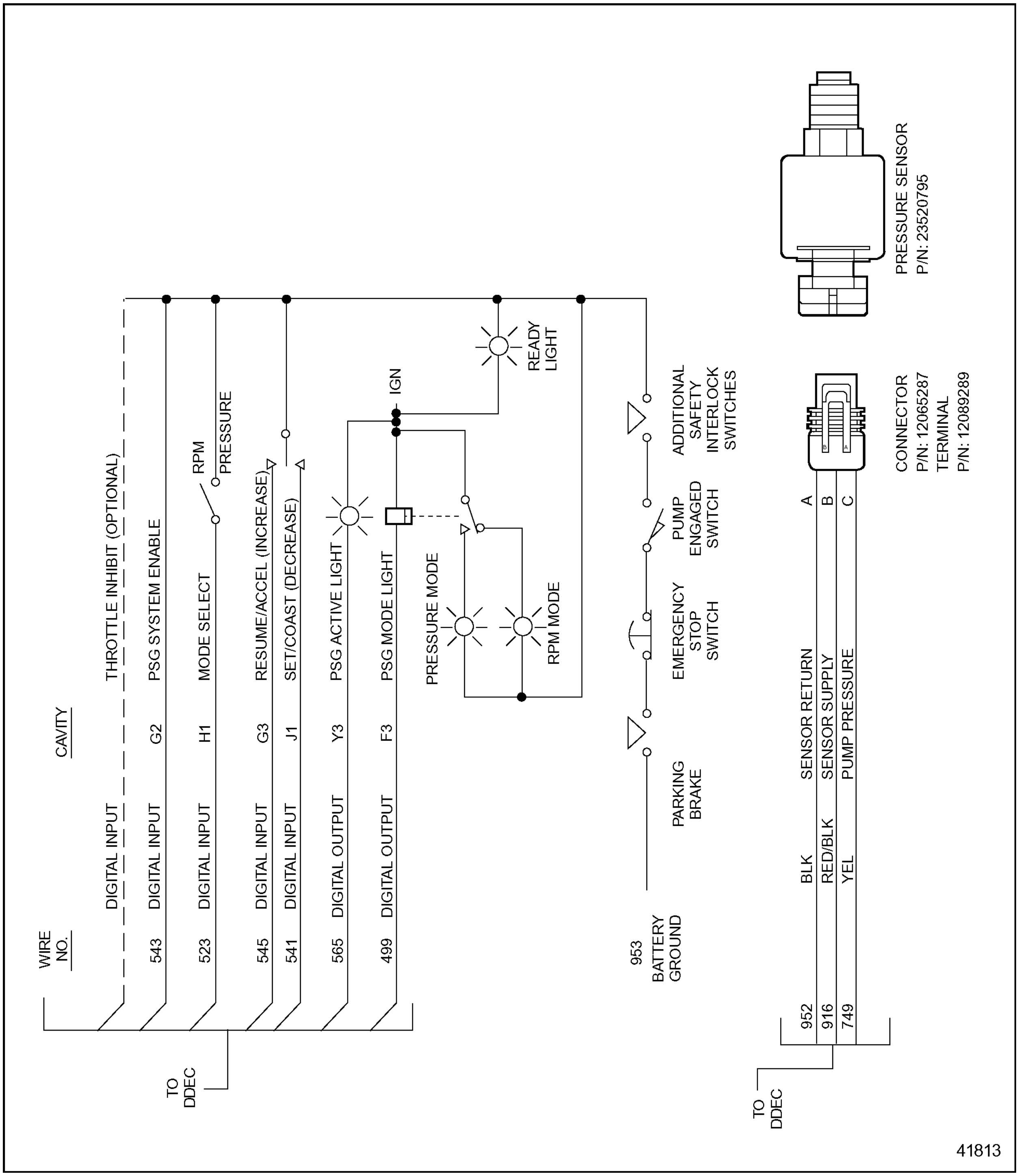

Figure 5-97 Pressure Sensor Governor System - Vehicle Interface Harness Connector

5.29.4 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

There are four digital inputs and two digital outputs required for PSG. The four digital inputs required for use with PSG are listed in Table 5-15.

Order Entry Function Number	Circuit Number*	VIH-to-ECM Connector Assignment*	DDR Description
8	523	H1	Pressure/RPM Mode
24	543	G2	PSG Enable
22	545	G3	Resume/Accel On (increase)
20	541	J1	Set/Coast On (decrease)

* DDC circuit numbers and port assignments shown are default settings but can differ from application to application.

Table 5-84 Required Digital Inputs for PSG

The digital outputs required for use with PSG are listed in Table 5-16.

Order Entry Function Number	Circuit Number*	Connector Assignment*	DDR Description
5	499	VIH-to-ECM Connector - Cavity F3	PSG Active
11	565	Pigtail off the Engine Sensor Harness - Cavity Y3	Cruise Active

* DDC circuit numbers and port assignments shown are default settings but can differ from application to application.

Table 5-85 Required Digital Outputs for PSG

The Pressure Sensor Governor is programmed with unique operational parameter defaults intended to cover a wide variety and range of pump applications. The PSG parameter defaults are listed in Table 5-86.

Parameter	Default	Range
Integral Gain	10.00 rpm/(psi-s)	0.000 - 39.845
Proportional Gain	0.75 rpm/s	0.00 - 512.00
Engine Speed Increment	25.00 rpm	0 - 250
Pump Pressure Increment	4.00 psi (27.6 kPa)	0 - 99
Cavitation Time Out	5.00 s	0 - 99

Table 5-86 PSG Parameters and Defaults

Customizing the parameter defaults can be accomplished at the time of engine order, by VEPS or DRS. Changes to the parameter defaults can not be made with DDDL/DDR.

5.29.5 INTERACTION WITH OTHER FEATURES

The EFPA (LSG) remains active while PSG is operating unless the digital input Throttle Inhibit (function #9) is configured and enabled by switching to battery ground.

PSG has priority in installations where both VSG and PSG are used. The VSG input is completely independent of PSG. When the PSG Enable digital input is grounded, the VSG system is disabled.

PSG uses logic similar to Cruise Control and requires many of the same digital inputs and outputs. Therefore, neither Cruise Control or the digital input Cruise Enable (function #23) may be specified in conjunction with PSG (refer to section 4.1.1 for more information on Cruise Control digital inputs). Refer to section 4.1.6 for more information on PSG digital inputs. Refer to section 5.7 for information on PSG interaction with Electronic Fire Commander.

Cruise Switch VSG can not be used if PSG is configured.

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5.30 PROGRESSIVE SHIFT

The Progressive Shift option offers a high range maximum vehicle speed limit to encourage the use of high (top) gear during cruise operation. Progressive Shift encourages the driver to upshift from a lower to a higher gear prior to reaching the engine's governed speed. The resulting lower engine speed in high range should result in improved fuel economy. Progressive shifting techniques should be practiced by every driver, but can be forced if fleet management considers it necessary. The benefits from progressive shifting are best realized during stop-and-go driving cycles.

The rate of acceleration will be limited below the programmed MPH to encourage up shifting.

As the driver accelerates beyond a specified MPH, the rate of engine acceleration is limited in higher RPM, to encourage (force) the operator to select the top gear.

- ☐ Progressive Shift should be used with 2100 RPM rated engines in fleet applications where the reduced driveability will not impede trip times or productivity.
- ☐ Progressive Shift is not compatible with most automatic transmission.

NOTICE:
Progressive Shift may be selected only when Spec Manager is run. Progressive Shift selection without Spec Manager could result in mismatched equipment, poor fuel economy, and poor performance. Your local Detroit Diesel Distributor will run the program.

5.30.1 OPERATION

The Progressive Shift option has two sets of low ranges and one set of high range parameters, which should be selected at the time of engine order, but also are programmable with the DDR, DDDL, or VEPS. Refer to section 5.30.6. The example shift pattern chart (see Figure 5-98) reflects default values when the Progressive Shift option is chosen and the low and high gear parameters are not modified.

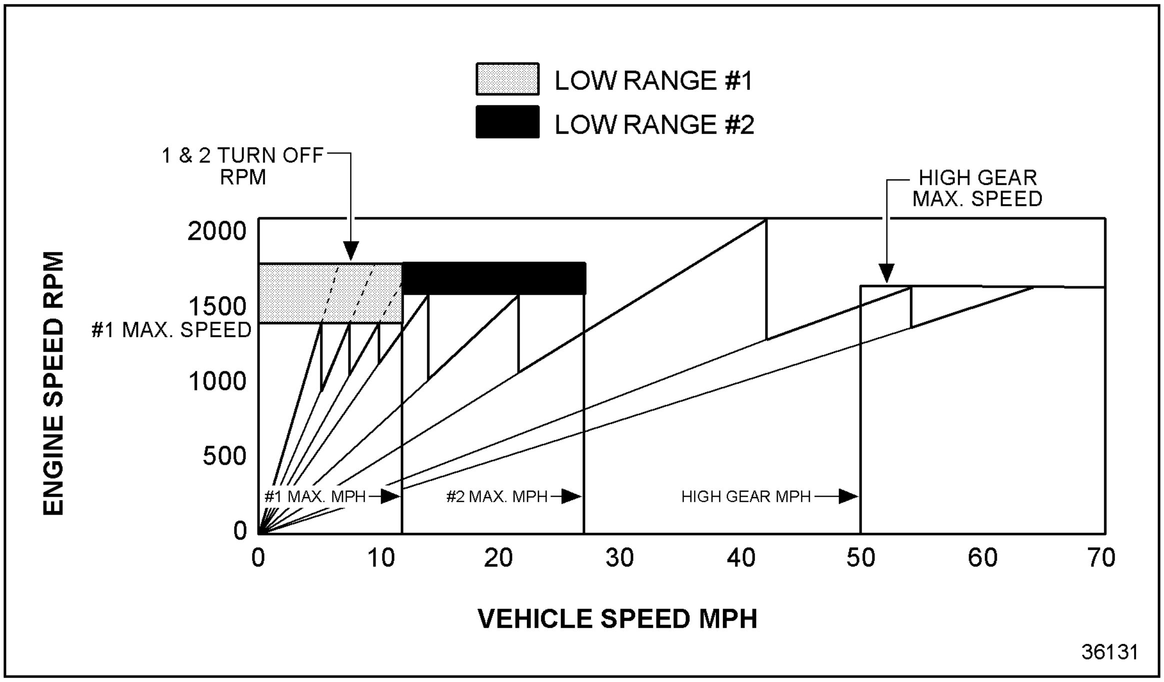


Figure 5-98 Progressive Shift Chart - Represents Default

An alternate use for the Progressive Shift option would be to encourage a driver (or force him/her) into top gear. Normally this condition exists when the gearing selected at the time of order allows a vehicle speed limit to be reached in a gear lower than top gear. See Figure 5-99.

5.30.2 LOW RANGE #1

The low range #1 area of operation is bound by a maximum vehicle speed, a maximum engine speed and a maximum turnoff speed. In the first illustration (see Figure 5-98) the default values are 12 MPH (approximately 19.3 kmh), 1400 RPM and 1800 RPM, respectively. During vehicle acceleration, when the vehicle speed is below selected maximum vehicle speed value attained, the maximum rate the engine can be accelerated is reduced to 33 RPM/s. During light load operation, the driver will feel this and be encouraged to up-shift to regain his rate of acceleration. If the engine continues to be operated above the low range #1 maximum speed, it may eventually reach the low range #1 turnoff speed. When the low range #1 turnoff speed is obtained, no additional increase in engine speed will be allowed. At this point, the transmission must be up-shifted if the vehicle is to continue accelerating.

5.30.3 LOW RANGE #2

The low range #2 area of operation is bounded by a maximum speed (MPH), a maximum engine speed and a maximum engine turnoff speed. In the first illustration (see Figure 5-98) the default values shown are 27 MPH (approximately 43.5 km/h), 1600 RPM and 1800 RPM, respectively. (The lower vehicle speed boundary is the low range #1 maximum speed value.) Different values can be selected at the time of the engine order or programmed with the DDR. The engine acceleration rate for low range #2 is 25 RPM/sec.

5.30.4 HIGH RANGE

Two high range parameters should be selected; a high range maximum vehicle speed (MPH) and a high range maximum engine speed (RPM). The default values shown in the first illustration (see Figure 5-98) are 50 MPH (approximately 80.5 km/h) and 1650 RPM, respectively. Once the high range maximum engine speed is attained, the engine will not be allowed to operate above the high range maximum engine speed. This is meant to encourage up-shifting to high gear in order to increase vehicle speed (see Figure 5-99 and Figure 5-99). Spec Manager should be used if the HIGH GEAR MPH is set such that it reduces the vehicle speed and the engine MPH; this limit will not work as desired.

NOTE:
The HIGH GEAR maximum engine speed could change the maximum vehicle speed limit if the high gear maximum engine speed (RPM) limits the vehicle speed limit. With Progressive Shift enabled, the high gear RPM limit overrides the rated speed of the engine rating.

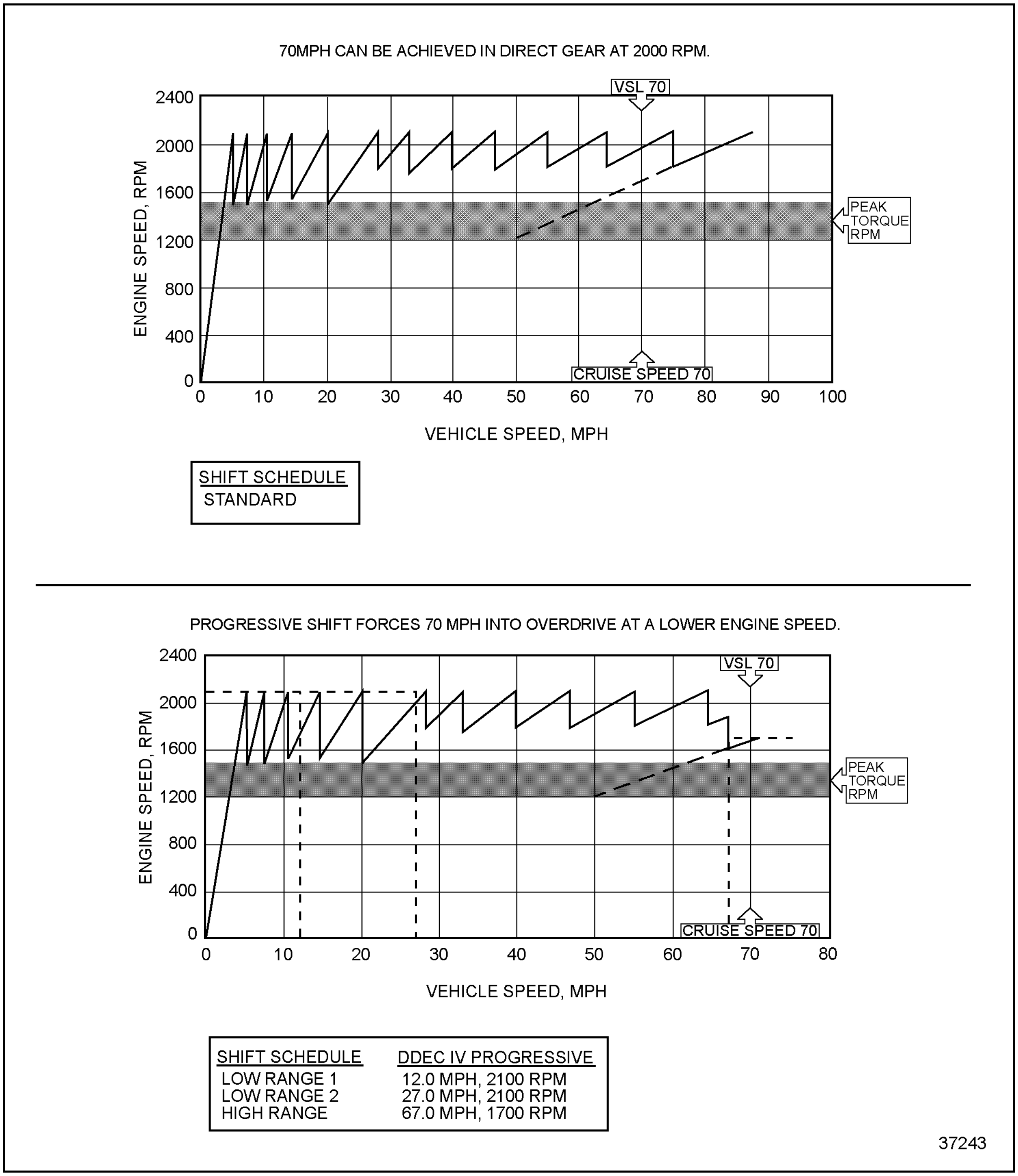


Figure 5-99 Progressive Shift Corrects Problem with High and Low Gears Modified

5.30.5 INSTALLATION INFORMATION

A Vehicle Speed Sensor (VSS) must be installed. It must be enabled, and all proper calculations entered into the ECM with DRS, DDDL, VEPS, or the DDR as listed in Table 5-87. Refer to section 3.14.25, "Vehicle Speed Sensor," for additional information.

Parameter	Choice
VSS ENABLED	Yes
VSS TYPE	Tail/Wheel
VSS TEETH	8 - 160
VSS SIGNAL	Magnetic/Switched
TIRES REVS/MI	Actual revolutions per mile
AXLE RATIO	Rear Axle ratio
TOP GEAR RATIO	Gear ratio in top gear.

Table 5-87 VSS Parameters

The Spec Manager program should be utilized to determine maximum vehicle speed for low range #1 and #2. If the maximum engine speed and maximum vehicle speed coincide, the Progressive Shift logic may not correctly compensate faster or slower on either side of the maximum vehicle speed. Spec Manager can alert the programmer to this dilemma and advise accordingly on maximum vehicle speed set points.

Example: If the maximum vehicle speed #1 was 12 MPH (approximately 19.5 kmh), the Progressive Shift logic may not determine if the maximum engine speed is 1400 or 1600 RPM. Spec Manager would advise moving the maximum vehicle speed #1 plus or minus 2 MPH (approximately 3.2 kmh) to eliminate any possible confusion.

5.30.6 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Enabling all areas required for Progressive Shift can be performed with the DDR, DDDL, VEPS, or at DRS.

The Progressive Shift option has two sets of low gear and one set of high gear parameters as listed in Table 5-88.

Parameter	Description	RANGE
ENABLED	Indicates the enabled/disabled status of the progressive shift feature.	YES, NO, N/A
LG#1 OFF SPD	Indicates the low gear #1 turn off speed.	0 to Low LG#2 OFF SPD
LG#1 RPM LMT	Indicates the low gear #1 RPM limit.	1000 to LG,#1 MAX LMT
LG#1 MAX LMT	Indicates the low gear #1 maximum RPM limit.	LG#1 RPM LMT to Rated Speed
LG#2 OFF SPD	Indicates the low gear #2 turn off speed.	LG#1 OFF SPD to HG ON SPD
LG#2 RPM LMT	Indicates the low gear #2 RPM limit.	1000 to LG#2 MAX LMT
LG#2 MAX LMT	Indicates the low gear #2 maximum RPM limit.	LG#2 RPM LMT to Rated Speed
HG ON SPD	Indicates the high gear turn on speed.	LG#2 OFF SPD to 127 MPH
HG RPM LMT	Indicates the high gear RPM limit.	1650 to Rated Engine Speed, N/A

Table 5-88 Progressive Shift Programming

5.30.7 INTERACTION WITH OTHER FEATURES

When Progressive Shift is enabled the ECM will treat "HG RPM LMT" as the rated speed of the engine. Vehicle maximum speed or maximum Cruise Control settings can not be set higher then engine speed will allow based on the VSS data entered.

5.31 PULSE TO VOLTAGE MODULE

The Pulse to Voltage Module (PVM) (see Figure 5-100) may be used for any application in which it is necessary to convert a PWM signal (50 Hz +/- 1 Hz) into a 0 to 10 volt analog voltage output.

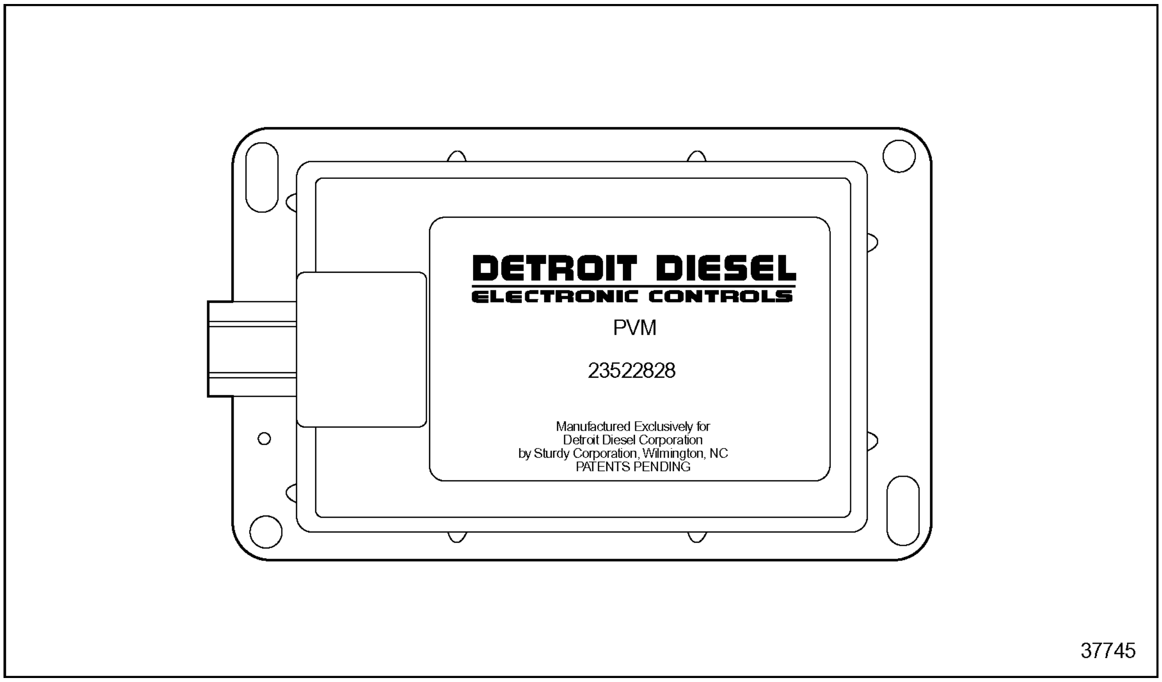


Figure 5-100 Pulse to Voltage Module

5.31.1 OPERATION

The PVM is currently used to convert the PWM signal produced by the DDEC III or IV ECM into a 0 - 10 volt analog voltage which is input into the GE Propulsion System Controller (PSC).

System Switched Power Input Requirements

The electrical input power shall be nominally a 15 volt fused switched DC supply directly from Battery or equivalent. For 12 volt systems, PVM power can be sourced from the DDEC ignition wire #439. Do not to exceed the current rating on the fuse in the ignition circuit.

Steady State Operating Voltage Ranges

The PVM is capable of normal operation in a voltage range from 11 to 20 volts DC. The system shall perform to the requirements stated herein when supplied with primary input power voltages measured across the Battery (+) and (-) terminals as follows (Ignition on state):

Note: Operation will be degraded if the system voltage drops below 11 volts.

Pulse Width Modulated Signal Input Requirements

The input signal that is to be converted to an analog voltage via the PVM must meet the requirements listed in Table 5-89.

Input Parameter	Input Requirement
Frequency Range	50 Hz +/- 1 Hz
Low State: (On) @ -1<Eout<2.0 V	I Sink < 500 mA
High State: (Off) Voltage determined by PVM	I Leakage < 1.0 mA

Table 5-89 PVM Input Signal Requirements

Ground Requirements

The PVM ground connection may be sourced from DDEC accessory ground wire #953 or a separate wire that goes to the battery negative post or equivalent ground bus bar.

PVM Analog Voltage Output

The PVM analog output voltage is proportional to the input duty cycle as listed in Table 5-90.

Input Duty Cycle %	Output Analog Voltage
<5	10.0
5	0.5
10	1.0
25	2.5
50	5.0
75	7.5
90	9.0
95	9.5
>95	10.0

Table 5-90 PVM Output Voltage Requirements

The PVM conforms to the table listed above with an accuracy of +/- 1% (+/- 0.1 volts) in the 10 to 90% PWM duty cycle range and +/- 2% (+/- 0.2 volts) in the 5 to 10% and 90 to 95% PWM duty cycle range.

5.31.2 INSTALLATION REQUIREMENTS

The PVM must be hard mounted in a cab environment, see Figure 5-101 for installation information.

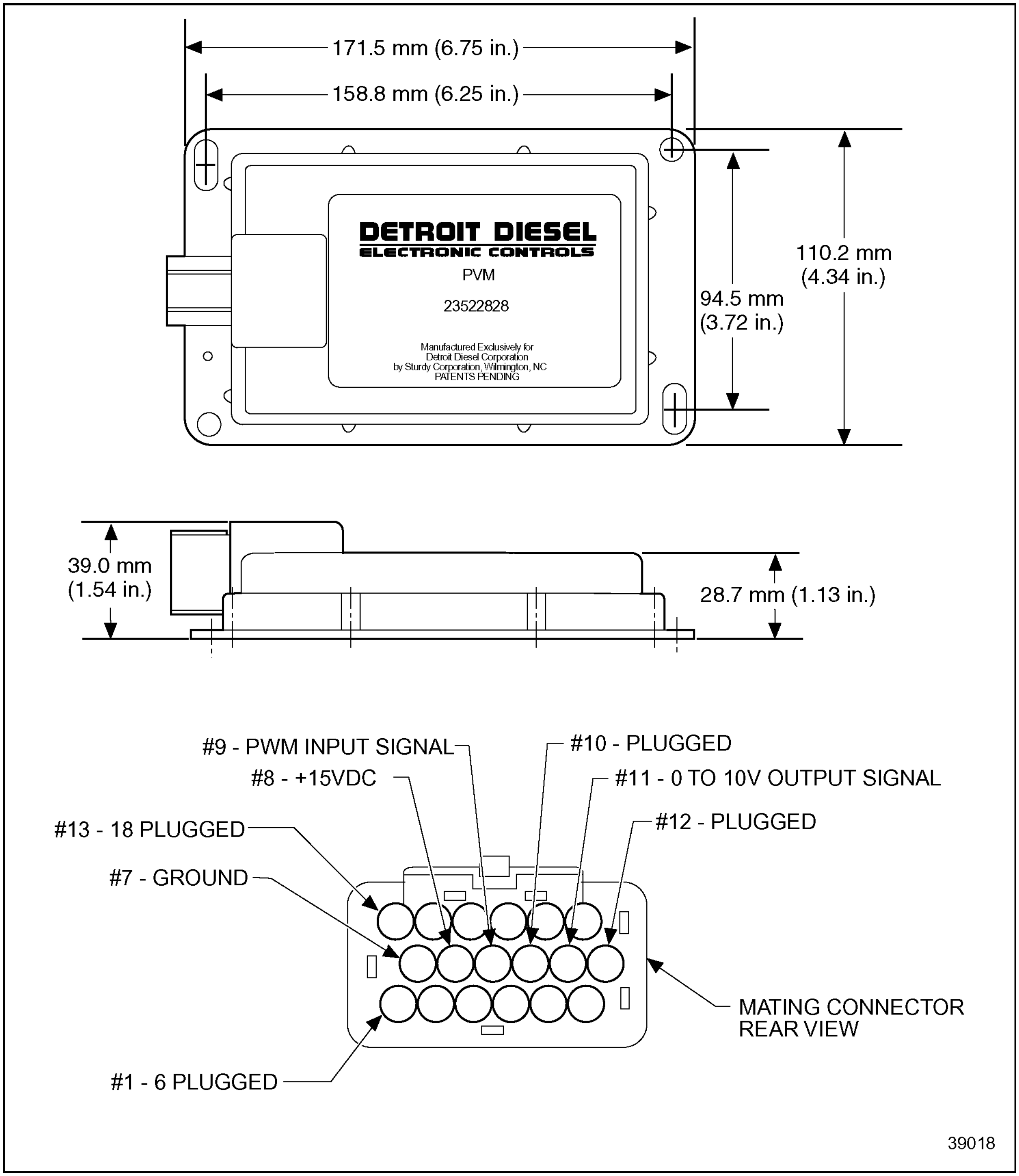


Figure 5-101 Pulse to Voltage Module Installation

Connector to PVM

The pin definition for the 18 pin Amp connector (P/N: 344106-1) is listed in Table 5-91.

Terminal Number	Signal
1 - 6	Plugged
7	GND
8	+15 VOLTS
9	PWM INPUT SIGNAL
10	Plugged
11	0 TO 10 VOLT OUTPUT
12 - 18	Plugged

Table 5-91 Connector To PVM

The PVM operating temperature range is -40°C to 85°C.

Connector part numbers are listed in Table 5-92.

Amp Part Number	DDC Part Number	Description
171662–1	23530076	Amp Terminal
344106–1	23530075	Amp Connector
172748–2	23530077	Plug
344103–01	23530078	Lock

Table 5-92 Connector Part Numbers

A kit containing all parts as listed in Table 5-93 is available.

Part Number	Quanity	Description
23522828	1	PVM
23530075	1	18–pin Connector
23530076	4	Terminal
23530077	14	Plug
23530078	1	Lock

Table 5-93 PVM Connector Kit, P/N: 23530079

5.32 TACHOMETER DRIVE

DDEC uses the TRS signals to compute engine speed (refer to section 3.14.13). The engine speed is transmitted over the 1708/1587 Data Link. Engine speed can be displayed by connecting a tachometer from VIH connector pin K-1. Circuit 505 provides the standardized output signals for the tachometer drive per ATA recommended practice RP123. See Figure 5-102.

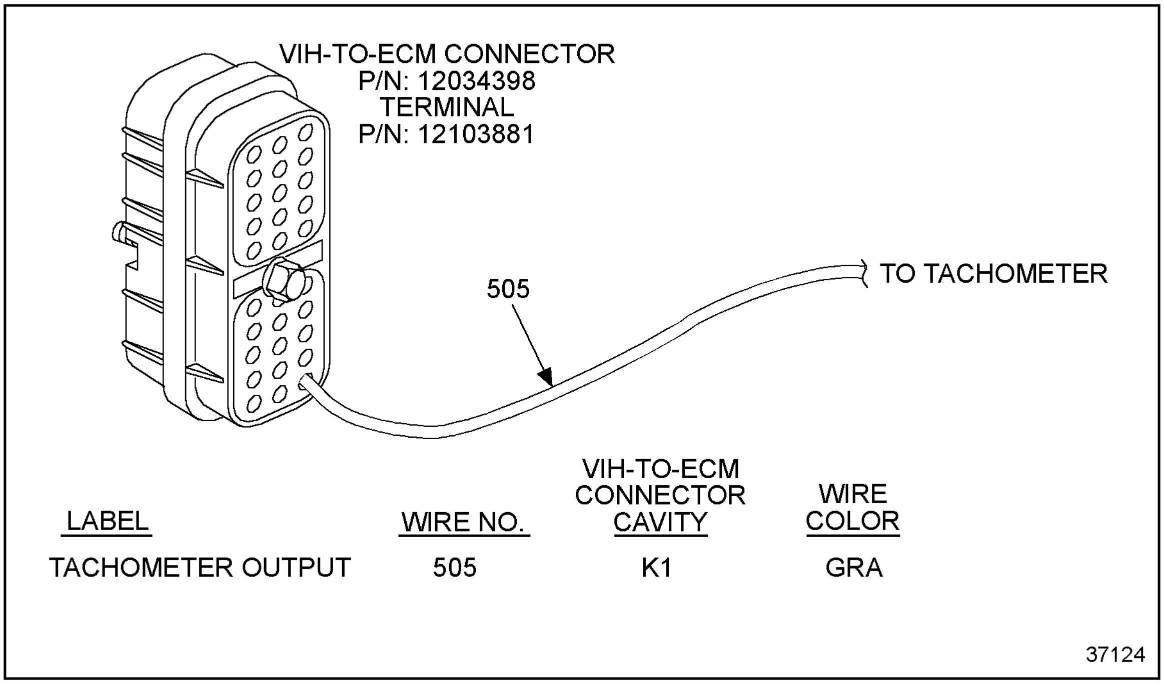


Figure 5-102 Tachometer Drive Installation

Signal output characteristics are listed in Table 5-94.

Signal	Signal Characteristics
PULSE RATE	12 Pulse/Rev (all engines)
DUTY CYCLE	50% ± 30%
SIGNAL LOW	0V<V<.5V when sinking less than 50mA out
SIGNAL HIGH	4.0<V<V Batt + sourcing less than 5mA out

Table 5-94 Tachometer Drive Signal Output Characteristics

See Figure 5-103 for the tachometer output signal.

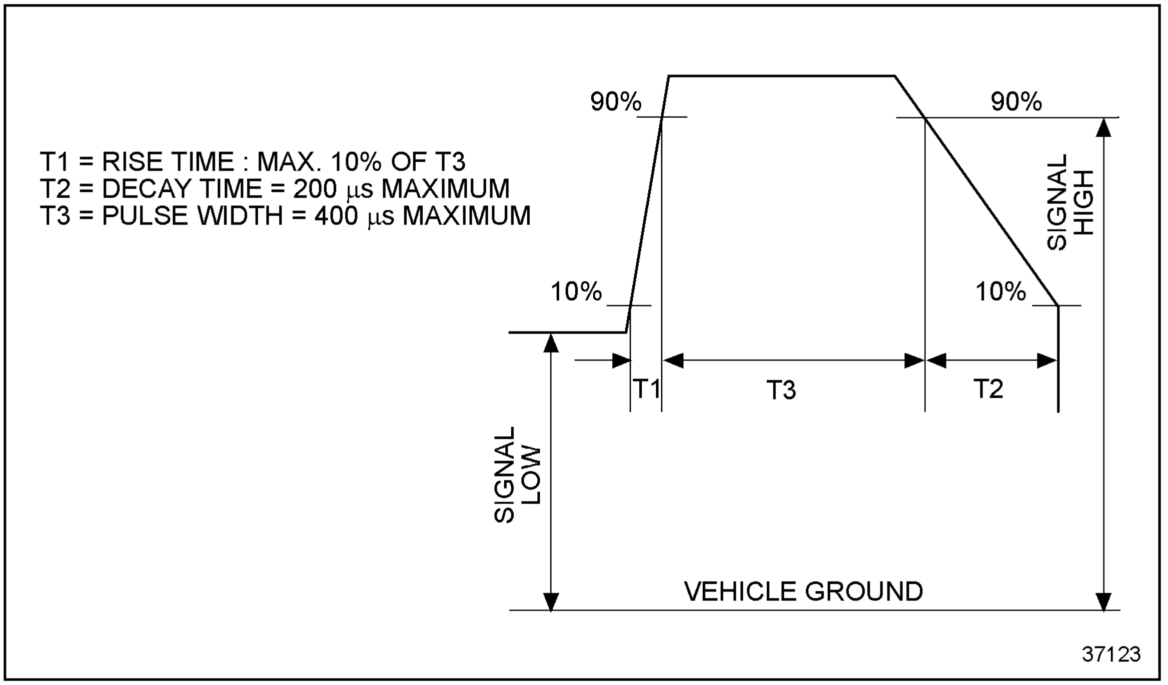


Figure 5-103 Tachometer Output Signal

5.33 THROTTLE CONTROL/GOVERNORS

There are two types of engine governors that are used with throttle controls. The engine governors are:

- ☐ The Limiting Speed Governor (LSG) for torque control, typical governor for on-highway (refer to section 5.33.1)
- ☐ The Variable Speed Governor (VSG) for speed control, typical governor for nonroad (refer to section 5.33.2)

5.33.1 LIMITING SPEED GOVERNOR - ON-HIGHWAY

In on-highway applications and some nonroad applications, LSG is the primary throttle source. The throttle input in a LSG sets percent load. The amount of fuel input to the engine is determined by the throttle position. As the load on the engine varies the resulting engine speed will vary between idle speed and rated speed.

The Hot Idle and Governor Droop are selected at the time of engine order. Both of these variables can be adjusted with DDDL/DDR. Hot idle is the engine idle RPM when the oil temperature is greater than 140°F and governor droop/overrun is the overrun beyond rated speed. The droop/overrun can be adjusted in the range from 0 to 300 RPM, depending on engine rating. VSG droop cannot exceed LSG droop. The idle can be adjusted in a range from 25 RPM below to 100 RPM above hot idle depending on engine rating.

If a wire is installed in circuit 510 (VSG Control) and is not terminated, the wire must be grounded to circuit 953 or sensor return circuit 952. Alternatively, if no wire exists, the cavity can be plugged, but there is a risk of water intrusion.

LSG Primary with VSG as a Secondary Control

VSG is available as a secondary control (LSG is primary) for specialized on-highway applications. For these applications, the LSG is programmed to override the VSG under certain conditions.

VSG is disabled during initial start-up, until the VSG throttle is moved to the idle range (less than 140 counts) and the LSG throttle is near idle (less than 4% throttle).

VSG may be disabled when a predetermined (set by ACS) LSG percent throttle is exceeded as listed in Table 5-95.

Application	% Throttle
On-highway Trucks	4%
Transit Bus	100%
Fire Truck	100%
Motor Coach	100%
Crane	4%

Table 5-95 Predetermined LSG % Throttle

VSG operation is disabled when the engine protection option has been selected and the SEL is illuminated because one of the engine parameters being monitored is out of limits.

See Figure 5-104 for an example of VSG or LSG only operation using switch selection.

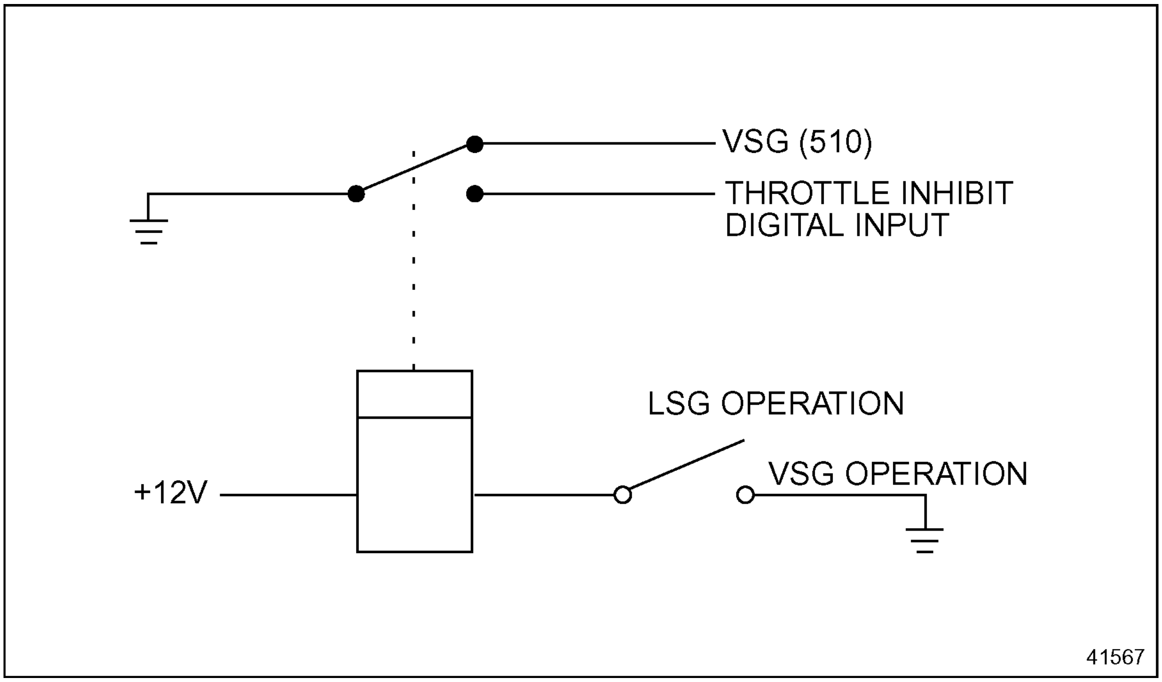


Figure 5-104 VSG or LSG Only Operation Using Switch Selection

VSG low side diagnostics must be disabled or a code will be logged. The proper 6N4C group must be specified at the time of engine order or by Detroit Diesel Technical Service. For additional information, contact your DDC Applications Engineer.

For another example of VSG or LSG only operation using two inputs see Figure 5-105.

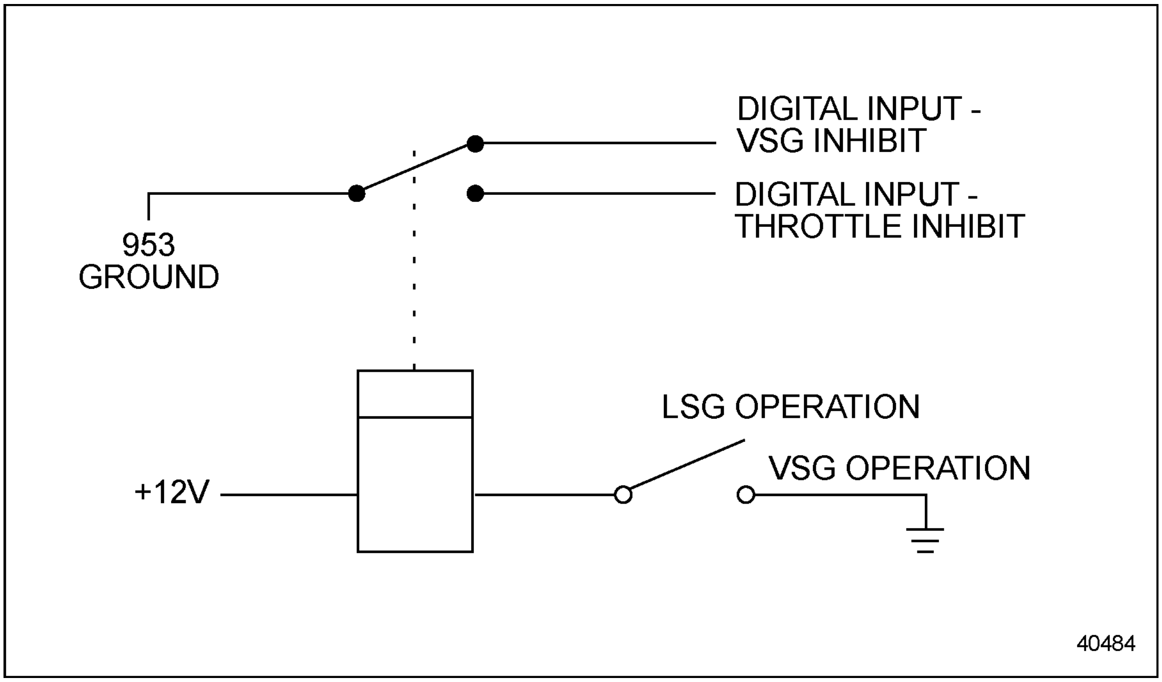


Figure 5-105 VSG or LSG Only Operation Using VSG Inhibit

Low-side diagnostics do not have to be disabled for this implementation. Grounding the VSG Inhibit digital input will reduce the engine speed to idle. When the ground is removed from the input, the throttle must be reset to zero before engine speed can be increased from idle.

LSG Control Options

The LSG control options are the following:

- ☐ Electronic Foot Pedal Assembly (EFPA)
- ☐ Dual Electronic Foot Pedal Assembly

LSG Electronic Foot Pedal Assembly

The EFPA sends an input signal which the LSG uses to calculate engine power proportional to the foot pedal position. This assembly is also referred to as the Throttle Position Sensor (TPS) assembly.

LSG Electronic Foot Pedal Assembly Installation

DDEC IV is compatible with an EFPA, which has an output voltage that meets SAE J1843 and has less than 5% of voltage supply closed throttle variability.

The EFPA is an OEM supplied part. Vendor sources that may be contacted for additional design and installation details are:

Williams Controls
14100 S.W. 72nd Avenue
Portland, Oregon 97223
(503) 684-8600

King Controls
5100 West 36th Street
St. Louis Park, Minnesota 55416
(612) 922-6889

Bendix Heavy Vehicle Systems
901 Cleveland
Elyria, Ohio 44036
1-800-AIR-BRAKE

The EFPA must be wired so at low engine speed a small resistance is seen between circuits 417 (signal) and 952 (reference ground). At high engine speed a larger resistance must be seen between circuits 417 and 952 (see Figure 5-106). A Volt/Ohm meter must be used to measure resistance to ensure correct installation.

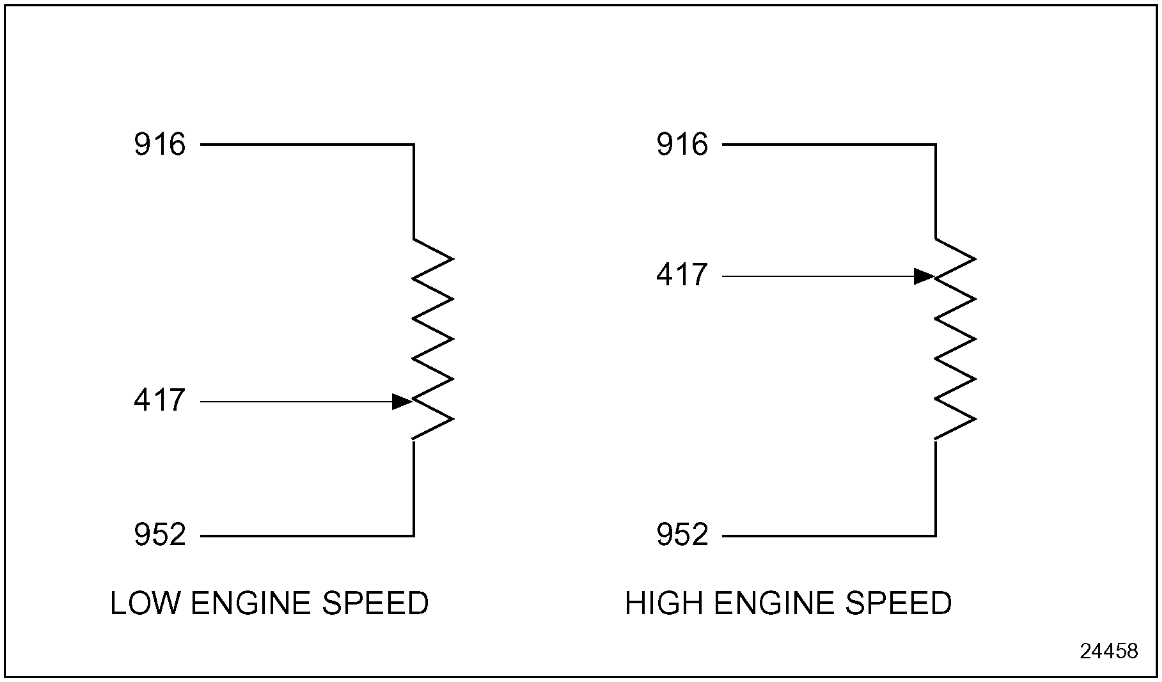


Figure 5-106 Electronic Foot Pedal Assembly Installation

The Idle Validation Switch is provided as an option and uses a digital input. Refer to section 4.1, "Digital Inputs," for additional information.

LSG Electronic Foot Pedal Assembly Diagnostics

An idle validation switch provides redundancy to assure that the engine will be at idle in the event of an EFPA in-range malfunction. The idle validation switch is connected to a digital input on the ECM. When the idle validation switch on the EFPA is switched to battery ground, the engine speed will be at idle.

LSG Dual Electronic Foot Pedal Assembly Throttle Controls

Some applications require LSG controls at two stations.

LSG Dual Throttle Control Installation

The dual EFPA schematic (see Figure 5-107) shows an EFPA at two locations with only one EFPA active at a time. The dual EFPA option requires one digital input. The digital input is switched to either battery ground or system voltage to indicate which EFPA is active.

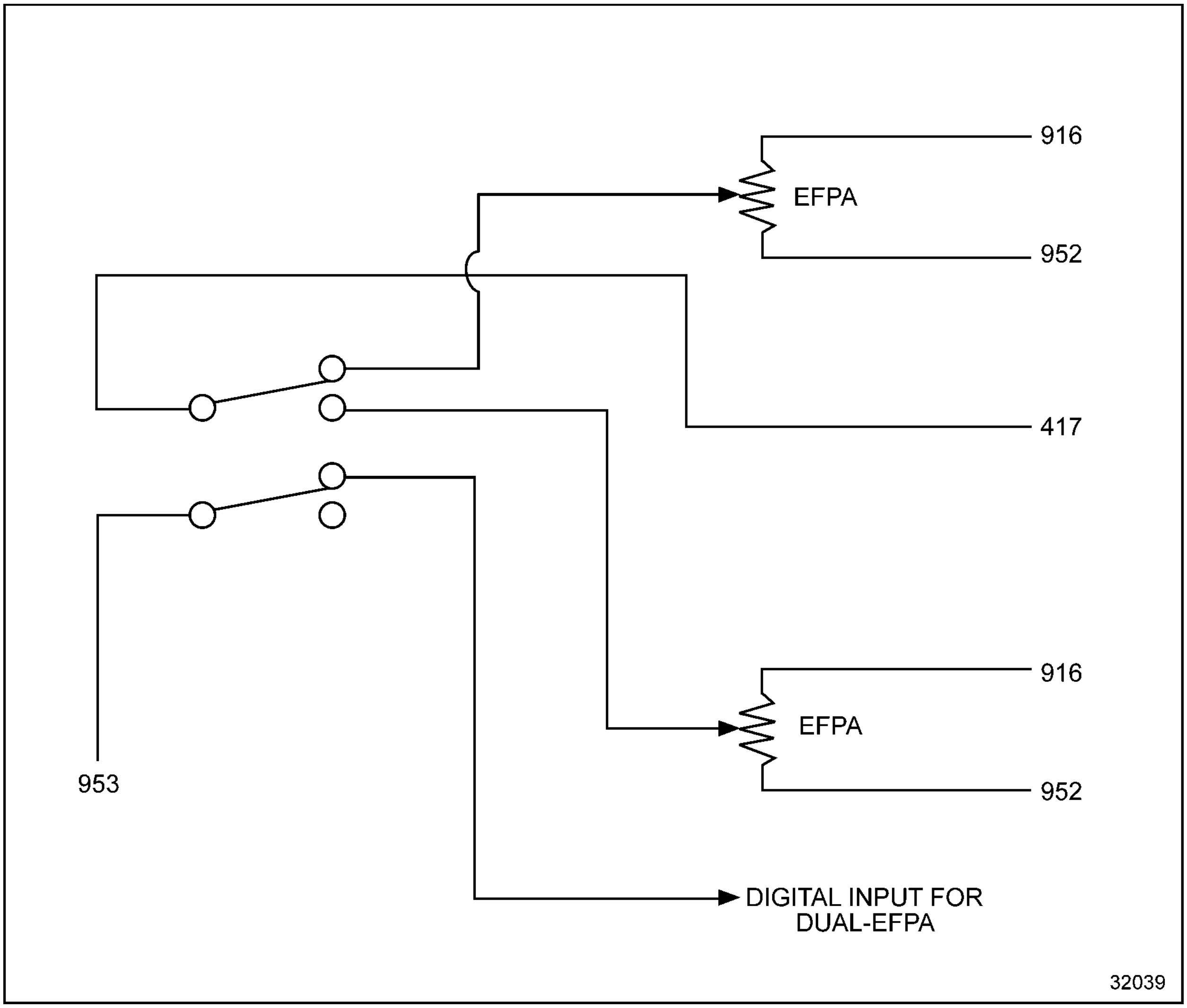


Figure 5-107 LSG Dual Electronic Foot Pedal Assembly Throttle

LSG Dual Throttle Control Programming Requirements and Flexibility

The digital input listed in Table 5-96 is required for LSG dual throttle control. This digital inputs may be ordered at the time of engine order, configured by VEPS or DRS.

Digital Input	Function Number
Dual EFPA	28

Table 5-96 LSG Dual Throttle Control Digital Input

Refer to section 4.1, "Digital Inputs" for additional information.

LSG Dual Throttle Control Diagnostics

System diagnostics will detect active sensor or associated wiring malfunction and return the engine to idle speed. System diagnostics will work with or without an Idle Validation Switch on the EFPA. An Idle Validation Switch provides redundancy to assure that the engine will be at idle in the event of an in-range malfunction. An Idle Validation Switch provides redundancy and swiftly returns the engine to idle.

5.33.2 VARIABLE SPEED GOVERNOR - NONROAD

The throttle input to a VSG controls engine speed between idle and rated speed. The engine speed is set by the throttle position. The VSG senses load and fuels the engine to maintain a set speed (within the capability of the engine). Upon start-up the engine will go to the speed selected by the VSG throttle position.

The Variable Speed Governor (VSG) throttle control options are:

- ☐ Cruise Switch VSG
- ☐ Hand Throttle
- ☐ EFPA
- ☐ Alternate Minimum VSG (Release 2.0 or later)
- ☐ Voltage Dividers
- ☐ Dual Throttle Controls
- ☐ Frequency Input

In on-highway applications and some nonroad applications, the LSG is the primary throttle source. In these applications, the following conditions must be met to operate on the VSG:

- ☐ On-highway truck applications disable VSG operation when the EFPA is pressed. In truck applications the EFPA must be released. Note that coach and motor home, and fire truck applications do not disable VSG operation when the EFPA is depressed as listed in Table 5-95.
- ☐ Once disabled, the VSG voltage must be reduced to < 0.68 volts before it can be reactivated.

- ☐ When fault code 12 (VSG voltage high) occurs, the VSG is disabled and the engine returns to idle. To regain VSG throttle control, the VSG throttle must be returned to the idle position (less than 140 counts).
- ☐ VSG will not operate when the vehicle speed exceeds a predetermined, application specific vehicle limit. Contact DDC Application Engineering for application specific details.

VSG Programming Requirements and Flexibility

The VSG parameters which can be selected at the time of engine order or programmed with a DDR, DDDL, VEPS or DRS are listed in Table 5-97.

Parameter	Description
VSG MIN SPD	The VSG minimum speed can be set between the hot idle speed and the rated engine speed (or VSG MAX SPD when selected). This causes the engine speed to jump from the hot idle speed to VSG idle speed when the VSG throttle position is first moved (above 140 counts, 205 counts - Series 4000).
VSG MAX SPD	The VSG maximum speed can be set between the hot idle (or VSG MIN SPD when selected) and the engine rated speed.
VSG ALT MIN SPD	The alternate minimum VSG (VSG ALT MIN SPD) option allows the customer to switch to a VSG idle speed greater than the VSG minimum speed (VSG MIN SPD). VSG ALT MIN SPD is active when its digital input is switched to battery ground. When VSG ALT MIN SPD is active and the throttle position is less than or equal to 140 counts (205 counts - Series 4000), the engine speed will jump from the VSG MIN SPD directly to the VSG ALT MIN SPD. After the throttle is moved above 140 counts (205 counts - Series 4000), the throttle will control the engine speed between VSG ALT MIN SPD and VSG MAX SPD (VSG maximum speed).
VSG DROOP	The VSG droop can be programmed between 0 and LSG droop but not greater than 300 RPM (125 RPM - Series 4000), depending on engine rating.

Table 5-97 VSG Options

NOTE:
Error code 22 (LSG Low) is disabled for most nonroad applications.

Cruise Switch VSG

The Cruise Control switches can be used to control the VSG set speed. This feature is referred to as Cruise Switch VSG.

NOTE:
This option is not recommended for fire truck pumping applications or crane applications and is not available for Pressure Sensor Governor systems.

The cruise switches are used to activate and control the Cruise Switch VSG option. The Cruise On/Off switch must be turned ON and the park brake must be engaged to enable this feature.

If Cruise Switch VSG is inactive and the Cruise Switch VSG conditions are met, pressing and releasing the Resume/Accel Switch will activate Cruise Switch VSG at the VSG initial speed. The VSG initial speed can be programmed with the DDR/DDDL, VEPS, DRS and cannot be greater than the VSG maximum speed. Pressing and releasing the Set/Coast Switch will activate Cruise Switch VSG at the current engine operating speed.

Once the VSG set speed is established, pressing and releasing the Resume/Accel Switch will increment the set speed by the amount defined by the VSG increment speed up to the VSG maximum speed. Pressing and holding the Resume/Accel Switch will initiate a speed increase, up to the VSG maximum speed. Releasing the Resume/Accel Switch will set the engine speed at the current operating speed.

Pressing and releasing the Set/Coast Switch will decrement the set speed by the amount defined by the VSG increment speed, down to the hot idle speed. Pressing and holding the Set/Coast Switch will initiate a speed decrease, down to the hot idle speed. Releasing the Set/Coast Switch will set the engine speed at the current operating speed.

NOTE:
VSG Min Speed is not recognized by Cruise Switch VSG.

Cruise Switch VSG Installation Requirements

The following must be installed for Cruise Switch VSG to operate:

- ☐ Vehicle Speed Sensor (VSS)
- ☐ Cruise Control Switches - digital inputs
- ☐ Park Brake Switch - digital input

Refer to section 4.1.1, Cruise Control and section 4.1, Digital Inputs.

Cruise Switch VSG Programming Requirements and Flexibility

The digital inputs listed in Table 5-98 are required for Cruise Switch VSG. These digital inputs may be configured at the time of engine order, configured by VEPS or DRS.

Digital Input	Function Number
Cruise Enabled Switch	23
Service Brake Switch	17
Clutch Switch (optional)	18
Set/Coast Switch	20
Resume/Accel Switch	22
Park Brake Switch	5

Table 5-98 Cruise Switch VSG Digital Inputs

Refer to section 4.1, "Digital Inputs," for additional information.

The DDR, DDDL, VEPS or DRS must enable a Vehicle Speed Sensor (VSS). Refer to section 3.14.25 for additional information on VSS.

The parameters listed in Table 5-99 can be set with at engine order entry DDDL/DDR, VEPS or DRS.

Parameter	Description	Choice / Display
VSG MAXIMUM RPM	Sets the maximum VSG RPM.	VSG MIN RPM to (Rated Engine RPM + LSG Droop)
CRUIZE SWITCH VSG	Enables or disables the cruise switch VSG set speed feature.	YES, NO
CRUIZE SWITCH VSG INITIAL SET SPEED	Sets the cruise switch VSG initial set speed.	VSG MIN RPM to VSG MAX RPM
VSG RPM INCREMENT	Sets the cruise switched VSG RPM increment.	1 to 255 RPM

Table 5-99 Cruise Switch VSG Programming

VSG Hand Throttle

A hand throttle (potentiometer) may be used to control engine speed on the VSG between the minimum VSG speed and maximum VSG speed. The total resistance must be between 1kW and 10 kW.

VSG Hand Throttle Installation

The hand throttle must be wired so at low engine speed a small resistance is seen between circuits 510 (signal) and 952 (reference ground). The low engine speed position is typically fully counter-clockwise. At high engine speed a larger resistance must be seen between circuits 510 (signal) and 952 (reference ground). See Figure 5-108.

NOTE:
A Volt/Ohm meter must be used to measure resistance to ensure correct installation.

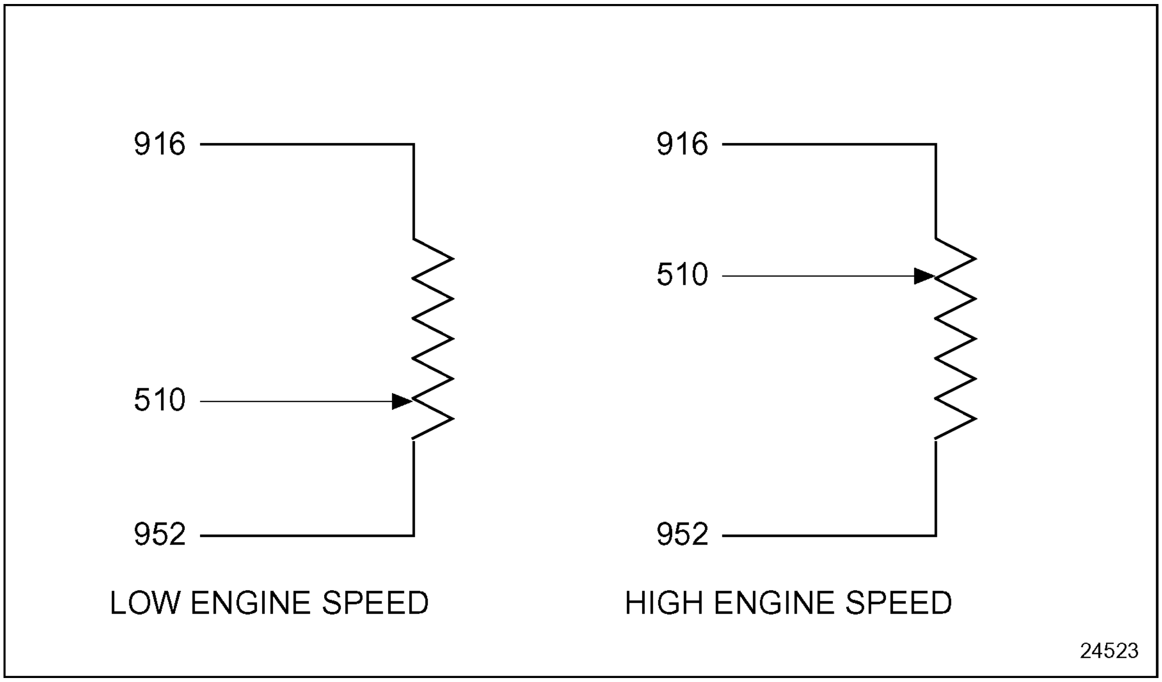


Figure 5-108 Hand Throttle Installation

VSG Hand Throttle Calibration

The hand throttle is calibrated with a DDR/DDDL as follows:

1. Display the VSG counts. The VSG counts will range from 0 to 1023.
2. In the low speed position, set the hand throttle between 100 and 130 counts.
3. In the high speed position, set the hand throttle between 920 and 950 counts.

The hand throttle is an OEM supplied part. Vendor sources that may be contacted for additional design and installation details are:

Morse Controls
21 Clinton Street
Hudson, Ohio 44236
(330) 653-7701
(330) 653-7799 - fax

VSG Electronic Foot Pedal Assembly

The EFPA can be used as an alternative to a hand throttle.

The EFPA provides an input signal to the ECM to control engine speed on the VSG, proportional to the foot pedal position. The idle validation switch is not applicable to the EFPA when used as an input to the VSG.

The Alternate Minimum VSG/Fast Idle digital input may also be used with the EFPA to provide an alternate engine operating speed range.

Alternate Minimum VSG (Fast Idle)

The Alternate Minimum VSG option allows a customer to switch to an alternate VSG operating range when its digital input is switched to battery ground and VSG is the active governor.

Example:

VSG Minimum Speed - 500 RPM

VSG Alternate Minimum Speed - 1000 RPM

VSG Maximum Speed - 1500 RPM

When the Alternate Minimum VSG/Fast Idle digital input is inactive, the engine speed will be controlled between 500 and 1500 RPM. When the Alternate Minimum VSG option is initiated, the engine speed will increase and be controlled between 1000 and 1500 RPM depending on the hand throttle position.

The Alternate Minimum VSG/Fast Idle digital input may be used to operate the engine at a higher engine idle speed.

This feature is available with Release 2.0 or later.

If the Alternate Minimum VSG becomes disabled when LSG is the primary governor or for any other reason, the operator must toggle the switch to re-enable fast idle unless the primary speed controller is VSG.

Alternate Minimum VSG Installation

Wire #510 must be wired to battery ground unless a hand throttle or voltage dividers are used in addition to Alternate Minimum VSG.

Alternate Minimum VSG Programming Flexibility

The digital input "Alternate Minimum VSG" (function #16) can be set by order entry, VEPS or DRS.

Refer to section 4.1, "Digital Inputs," for additional information.

The parameters listed in Table 5-100 can be set with DDDL/DDR, VEPS or DRS.

Parameter	Description	Choice / Display
ALT MIN VSG	Sets the Alternate Minimum VSG RPM.	VSG MIN RPM to VSG MAX RPM

Table 5-100 Alternate Minimum VSG Programming

VSG Voltage Dividers

Voltage dividers can be used with the VSG input to provide a means to select a predetermined engine speed. Voltage dividers can be used to provide a fast idle operation or other engine operations where a fixed engine speed is desired.

VSG Voltage Dividers Installation

The voltage divider consists of two precision resistors (+/- 1% tolerance, 1/4 watt minimum) in series between circuits 916 and 952 with a center tap connected to circuit 525. The values of the resistors determine engine speed. See Figure 5-109.

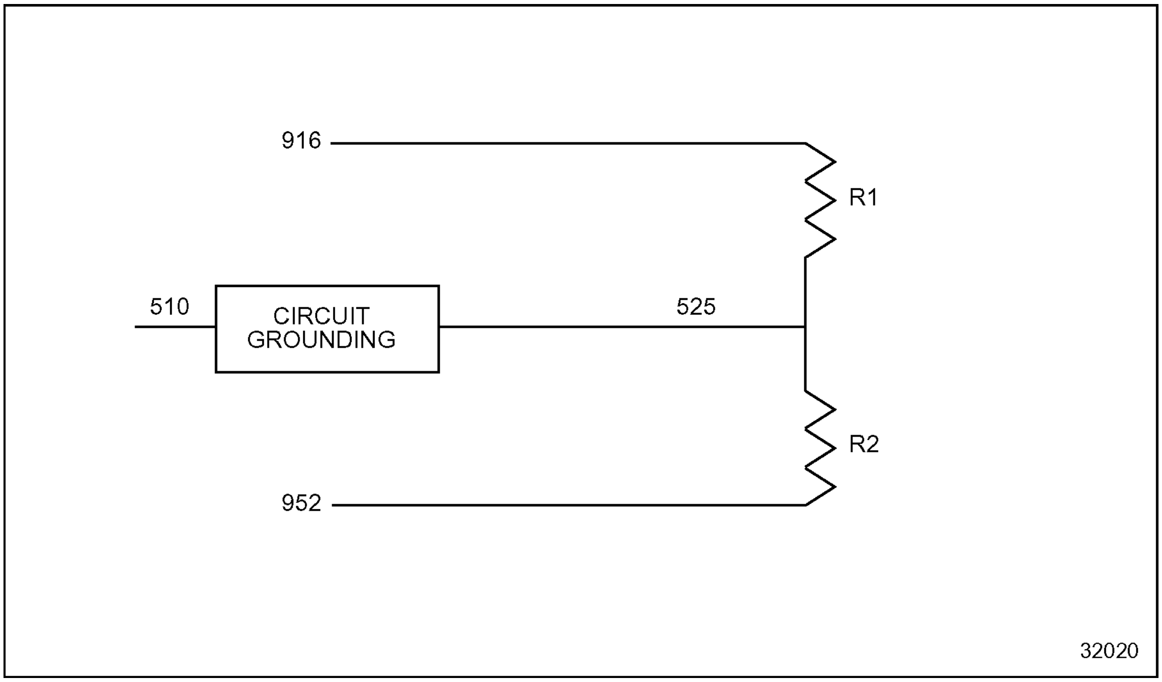


Figure 5-109 Voltage Divider

NOTE:
The voltage divider circuit must be placed inside a weatherproof container.

VSG Resistor Selection for Voltage Dividers

The selection of the resistors is accomplished by using the following calculations. These calculations determine the RPM/count, which is then used to determine the counts needed to reach the desired engine speed. The counts are a direct representation of voltage. See Figure 5-110.

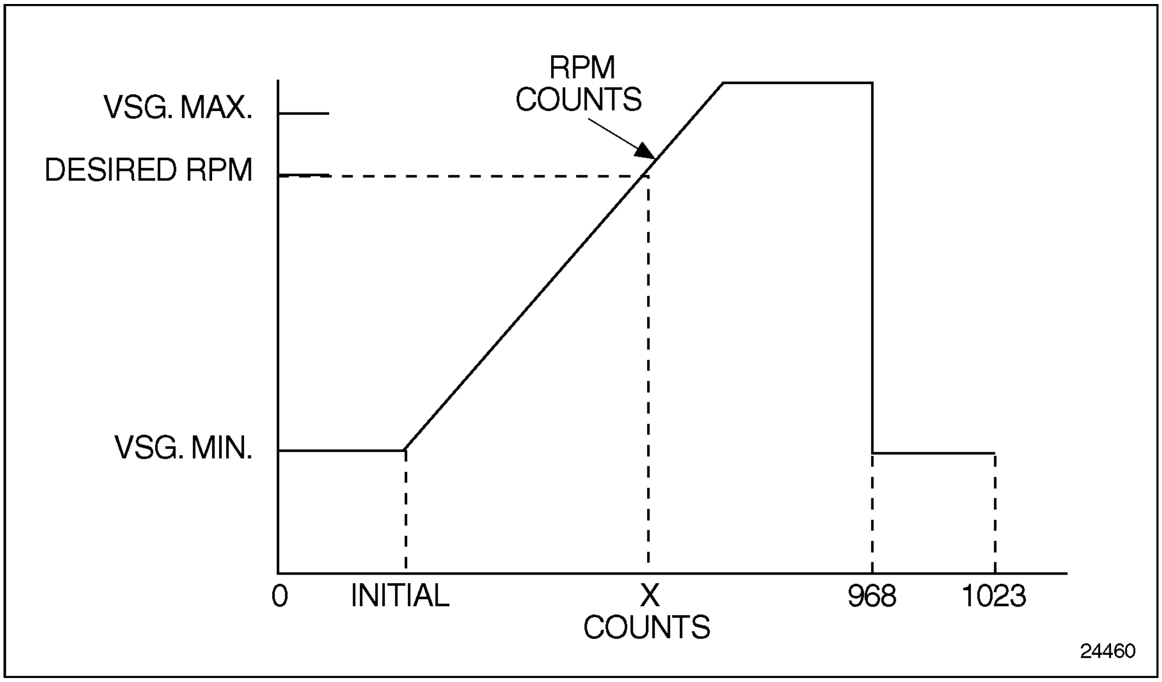


Figure 5-110 Throttle Count Profile

Use the following steps to calculate resistor values:

1. Determine a value for RPM/Count as follows:

$$\text{RPM / Count} = \frac{(\text{VSG Max. Speed} - \text{VSG Min. Speed})}{\text{Divisors}^{*}}$$

* Divisor = 775 (all applications not using VSG foot pedal)
Divisor = 512 (all applications using VSG foot pedals)

2. Solve for the counts at the desired engine speed, X:

$$X = \frac{\text{Desired Speed} - \text{VSG Min. Speed}}{\text{RPM / Count}} + \text{PTO Offset}^{\dagger}$$

† PTO Offset = 140 (all applications not using VSG foot pedal)
PTO Offset = 205 (all applications using VSG foot pedals)

PTO Offset = 205 (Series 4000 using G.E. Frequency Input)

3. Solve for the voltage divider resistance ratio, R:

$$R = \frac{X}{1024}$$

4. Choose a value for R1 and solve for a value of R2 as follows: $R = \frac{R2}{R1 + R2} \longrightarrow R2 = \frac{R1 \times R}{1 - R} \quad 1\ k\Omega \leq R1 + R2 \leq 10\ k\Omega$

The standard precision resistor values are listed in Table 5-101.

Standard Precision Resistor Values, Ω					
10.0	14.7	21.5	31.0	46.4	68.1
10.2	15.0	22.1	32.4	47.5	69.8
10.5	15.4	22.6	33.2	48.7	71.5
10.7	15.8	23.2	34.0	49.9	73.2
11.0	16.2	23.7	34.8	51.1	75.0
11.3	16.5	24.3	35.7	52.3	76.8
11.5	16.9	24.9	36.5	53.6	78.7
11.8	17.4	25.5	37.4	54.9	80.6
12.1	17.8	26.1	38.3	56.2	82.5
12.4	18.2	26.7	39.2	57.6	84.5
12.7	18.7	27.4	40.2	59.0	86.6
13.0	19.1	28.0	41.2	60.4	88.7
13.3	19.6	28.7	42.2	61.9	90.9
13.7	20.0	29.4	43.2	63.4	93.1
14.0	20.5	30.1	44.2	64.9	95.3
14.3	21.0	30.9	45.3	66.5	97.6

Standard precision resistors are available in the values listed and all multiples of 10 (i.e., 10.7W, 107W, 1.07kW, etc.)

Table 5-101 Precision Resistor Values (+/-1%; 1/4 Watt Minimum)

VSG Dual Throttle Controls

Some applications require VSG controls at multiple control stations. These include fire trucks, cranes, etc. Special circuits can be designed to handle these unique requirements.

A dual hand throttle implementation allows a hand throttle to be installed at two locations with one hand throttle active at any one time. Two digital inputs, Dual VSG and Dual VSG Complement, are used to transfer operation from one hand throttle to the other once station qualification is achieved.

DDEC monitors the switch inputs and maintains the engine speed when a station switch occurs until the newly selected station is qualified by reducing the station position to idle and then increasing it to the current engine speed position. After qualification, the engine speed is controlled by the new station. If qualification does not occur within 30 seconds, the engine speed will be ramped down from its current value to VSG minimum speed. If the new station becomes qualified, the rampdown process will be stopped and the new station will have control.

VSG Dual Throttle Controls Installation

See Figure 5-111 for a schematic of a dual hand throttle implementation (available with Release 2.0 or later). This allows a hand throttle to be installed at two locations with one hand throttle active at any one time.

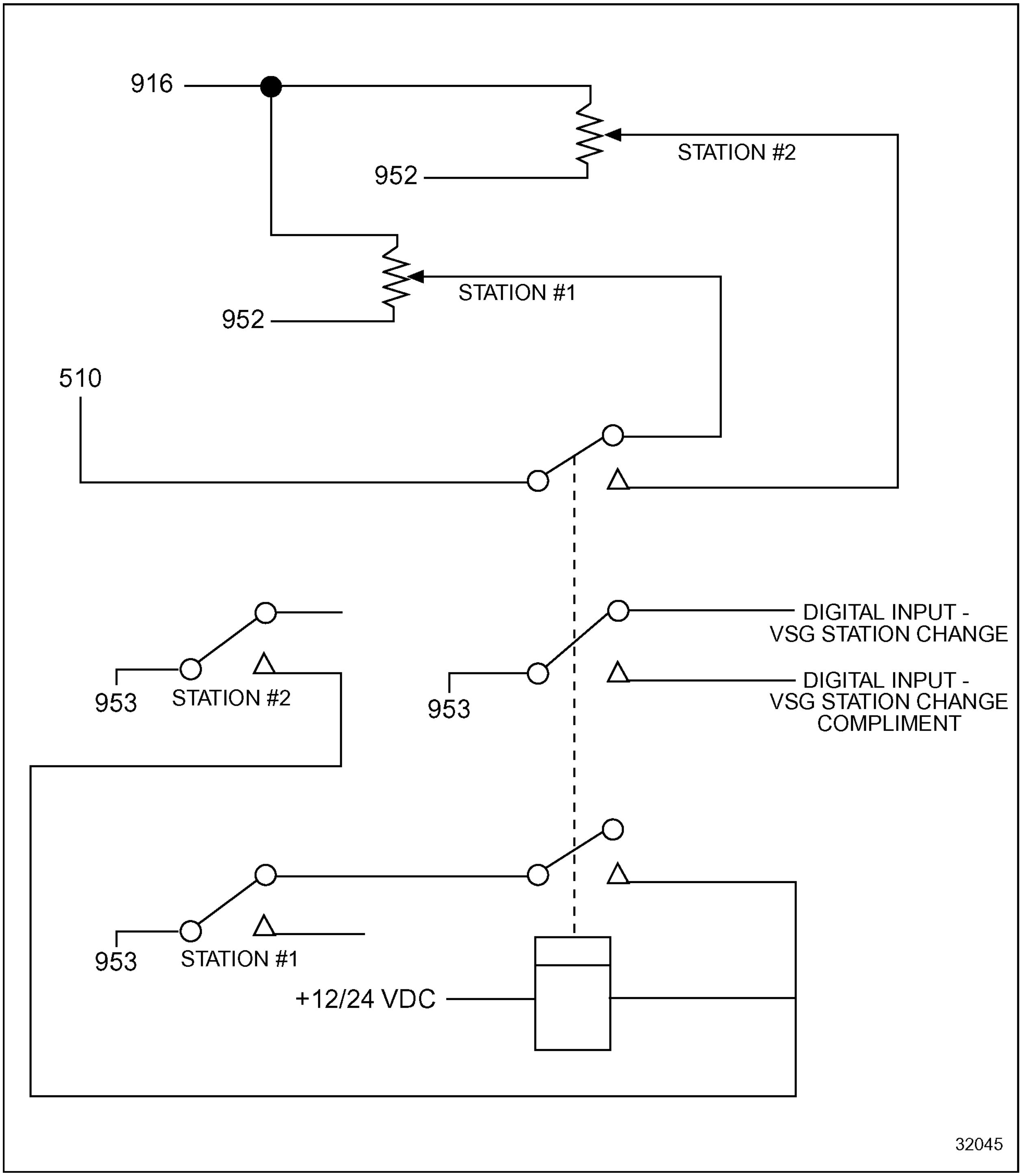


Figure 5-111 Dual Hand Throttle

Dual Throttle Controls Programming Requirements and Flexibility

The digital inputs listed in Table 5-102 can be set by order entry, VEPS or DRS.

Description	Function Number
VSG Station Change	33
VSG Station Change Complement	34

Table 5-102 Dual VSG Throttle Control Digital Inputs

Refer to section 4.1, Digital Inputs, for additional information.

VSG Dual Throttle Controls Diagnostics

If the two digital inputs (VSG Station Change and VSG Station Change Complement) are in the same state for two seconds, a fault (Flash code 11, PID 187 FMI 7) is logged. The engine will ramp to idle and neither station can control engine speed until the fault is inactive.

VSG Frequency Input

A frequency input can be used to control the VSG. This frequency is connected to the vehicle speed input or the Aux Timed Input. The VSS input offers better resolution than the Aux Timed Input. The Aux Timed Input must be used for frequency control when vehicle speed is required in the application.

VSG Frequency Input Installation

The digital input, External Engine Synchronization, must be grounded for frequency control. See Figure 5-112.

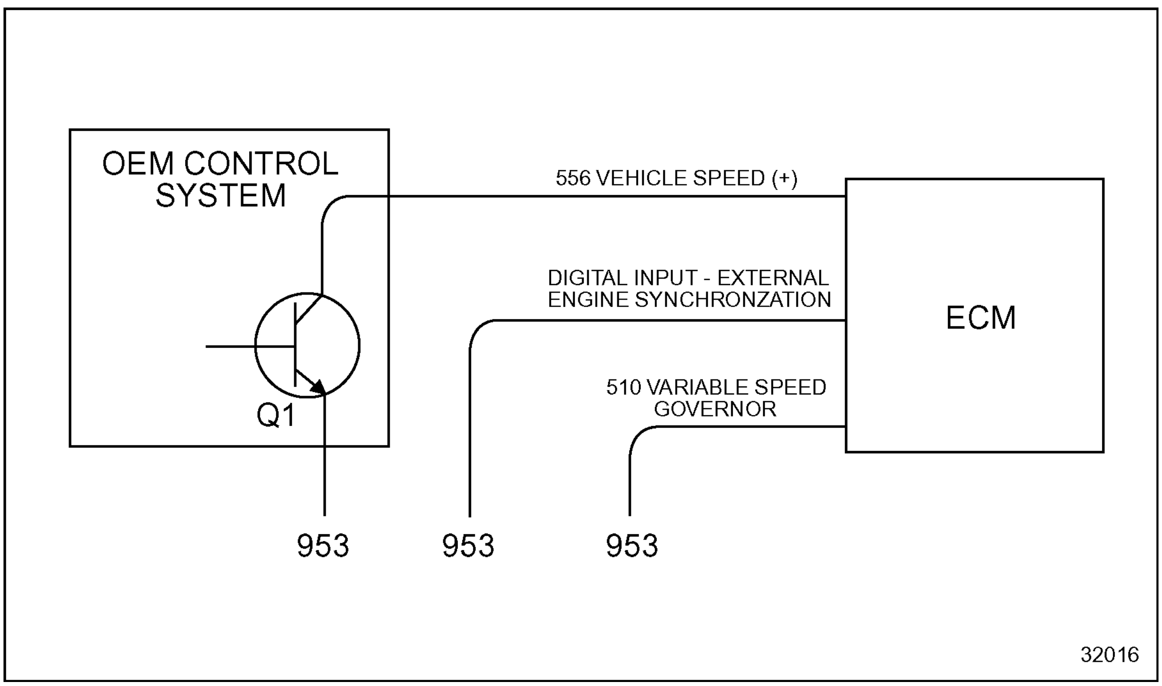


Figure 5-112 Frequency Input Diagram

The following specifications need to be followed when using the frequency input feature. These specifications apply when using the Aux Timed Input or the VSS in open collector mode. See Figure 5-113.

High State Input Voltage:	**V_{in}>4.0 Volts DC**
Low State Input Voltage:	V_{in}<0.4 Volts DC
Input Frequency:	80<freq <480 Hz
Q1 Off Impedance:	>10 kΩ
Q1 On Impedance:	<100 Ω
Resolution:	5 RPM/Hz

NOTE:
The VSS in open collector mode offers better resolution than Aux timed Input.

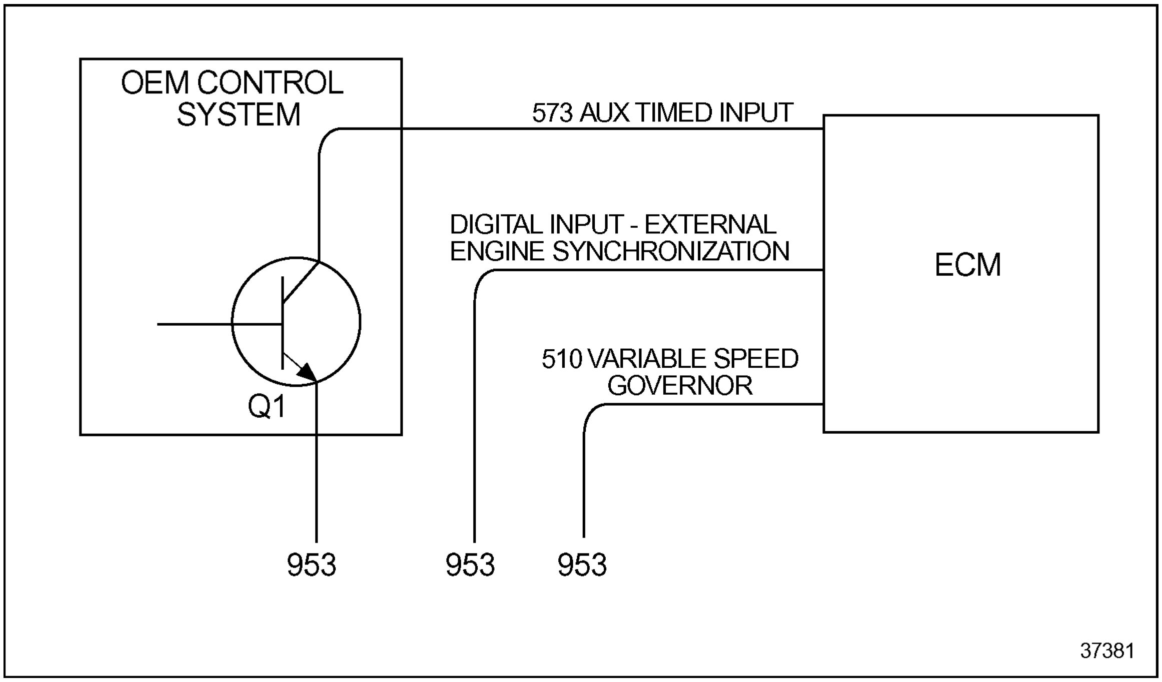


Figure 5-113 Frequency Input Diagram Using Aux Timed Input

VSG Frequency Input Programming Flexibility

The digital input "External Engine Synchronization" (function #10) must be configured by order entry, VEPS or the DRS.

This feature must be enabled by the appropriate application code.

5.34 TRANSMISSION INTERFACE

DDEC IV communicates to transmissions using the following:

- ☐ Pulse Width Modulated Signal (PWM 1)
- ☐ SAE J1587 Data Link
- ☐ SAE J1922 Powertrain Control Data Link
- ☐ SAE J1939 Powertrain Control Data Link
- ☐ Digital Inputs/Digital Outputs

5.34.1 PWM1 OPERATION

The PWM 1 port's output can be a 50 Hz modulated signal or a discrete on/off signal representing the powertrain demand with the corresponding duty cycle.

Powertrain demand is the ratio of operating torque over available torque at the current speed where operating torque:

- ☐ Includes torque generated by the driver (accelerator pedal)
- ☐ Includes torque generated by the Cruise Control Governor
- ☐ Includes torque reduction by the Vehicle Speed Governor
- ☐ Does not include torque generated by the Variable Speed Governor
- ☐ Does not include torque reduction due to emission control or engine protection
- ☐ Does not include torque generated by the Idle Governor
- ☐ Does not include torque reduction by the Rated Speed Governor

NOTE:
Percent load on the SAE J1587 link (PID 92) is current torque over the maximum torque at current engine speed; includes all internal torque reductions and governors.

Modulated Signal

The PWM signal duty cycle range can cover 0-100% or be limited to 5-95% (representing full range). PWM sample duty cycles can be seen in the next three illustrations. See Figure 5-114 for a 10% duty cycle.

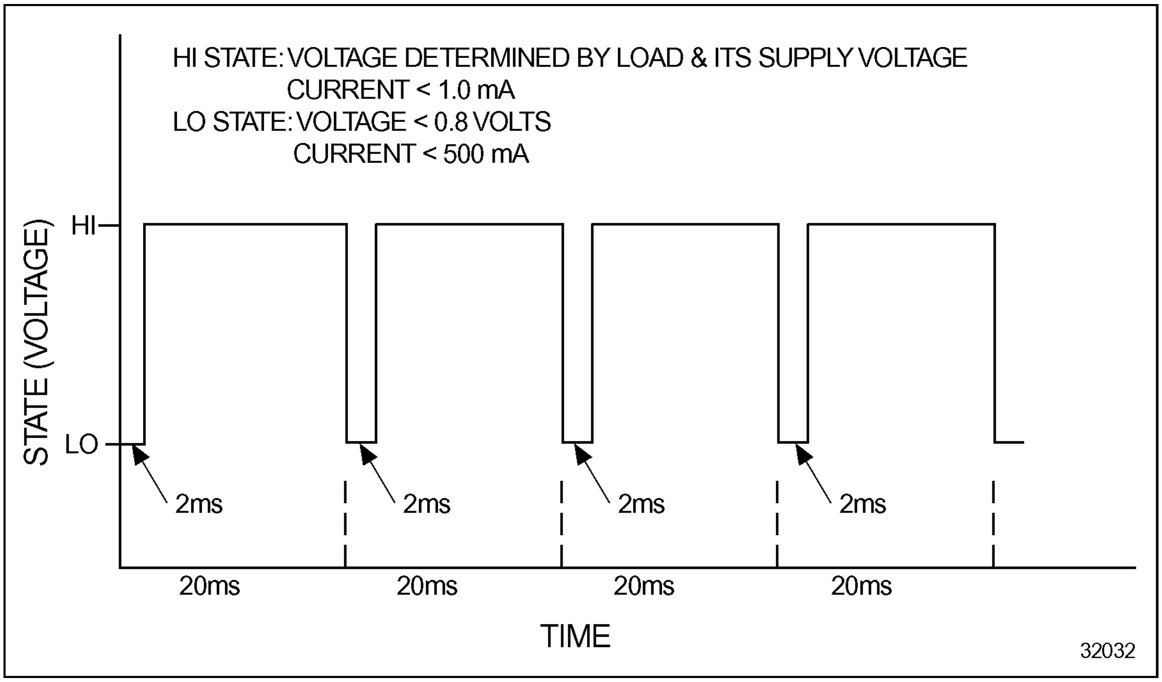


Figure 5-114 PWM Output - 10% Duty Cycle

See Figure 5-115 for a 50% duty cycle.

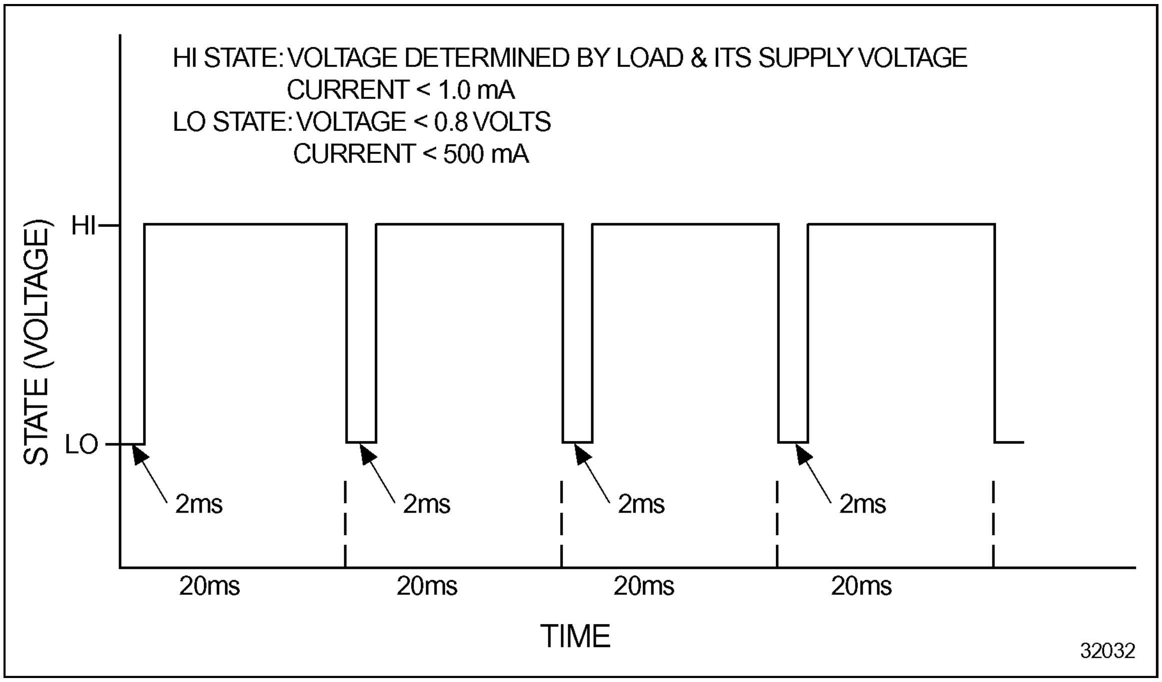


Figure 5-115 PWM Output - 50% Duty Cycle

See Figure 5-116 for a 90% duty cycle.

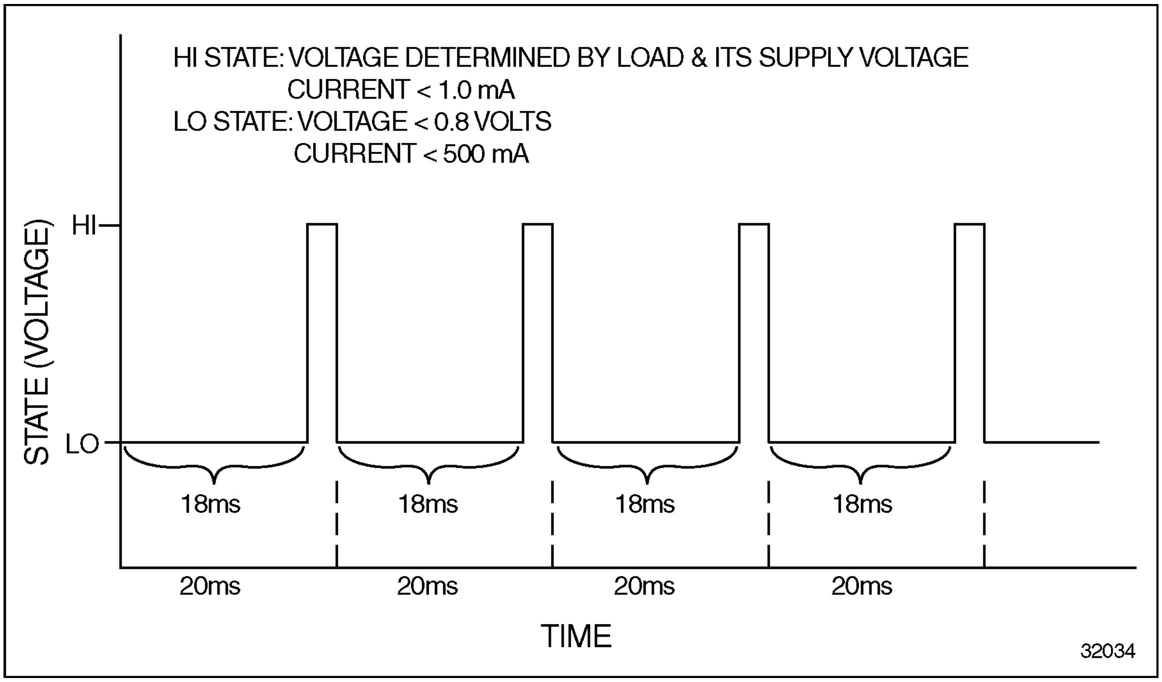


Figure 5-116 PWM Output - 90% Duty Cycle

Discrete On/Off signal

The PWM output can be used as a discrete on/off signal. The on trigger point and hysteresis are DDC calibrated parameters. The signal turns on (ground) once the powertrain demand reaches 80% and turns off (opens) once powertrain demand falls below 60%.

5.34.2 PWM1 INSTALLATION

The transmissions listed in Table 5-103 communicate with the ECM using PWM1.

Transmission	ECM Communication	Information Sent	Duty Cycle	PWM Signal Description
Allison Hydraulic (see Figure 5-123, page)	PWM 1	Powertrain Demand	0-100%	Discrete
Allison Transmission Electronic Controls (ATEC)	PWM 1	Powertrain Demand	0-100%	Modulated
GE Propulsion System Controller (see Figure 5-120, page)	PWM 1	Operation on Load Curve	5-95%	Modulated
VOITH (see Figure 5-122, page)	PWM 1 or SAE J1939	Powertrain Demand	5-95%	Modulated
ZF Transmissions AVS™ or Ecomat™ (see Figure 5-121, page)	PWM 1	Powertrain Demand	5-95%	Modulated

Table 5-103 Transmissions Communicating with PWM1

Allison Interface Modules

The Allison Throttle Interface Module (see Figure 5-117) translates the powertrain demand signal broadcast by the DDEC IV ECM into a signal which is recognized by the transmission.

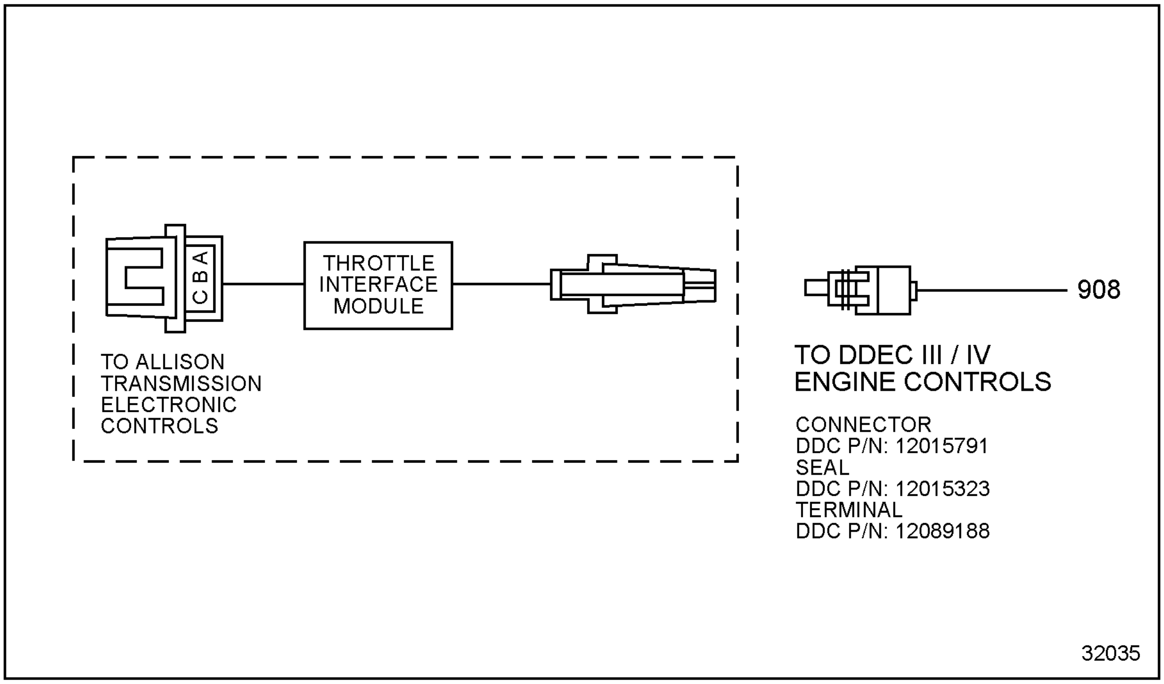


Figure 5-117 Throttle Interface Module, Allison Transmission

The Allison Maximum Feature Interface Module translates the powertrain demand signal broadcast by the DDEC IV ECM into a signal which is recognized by the transmission (see Figure 5-118).

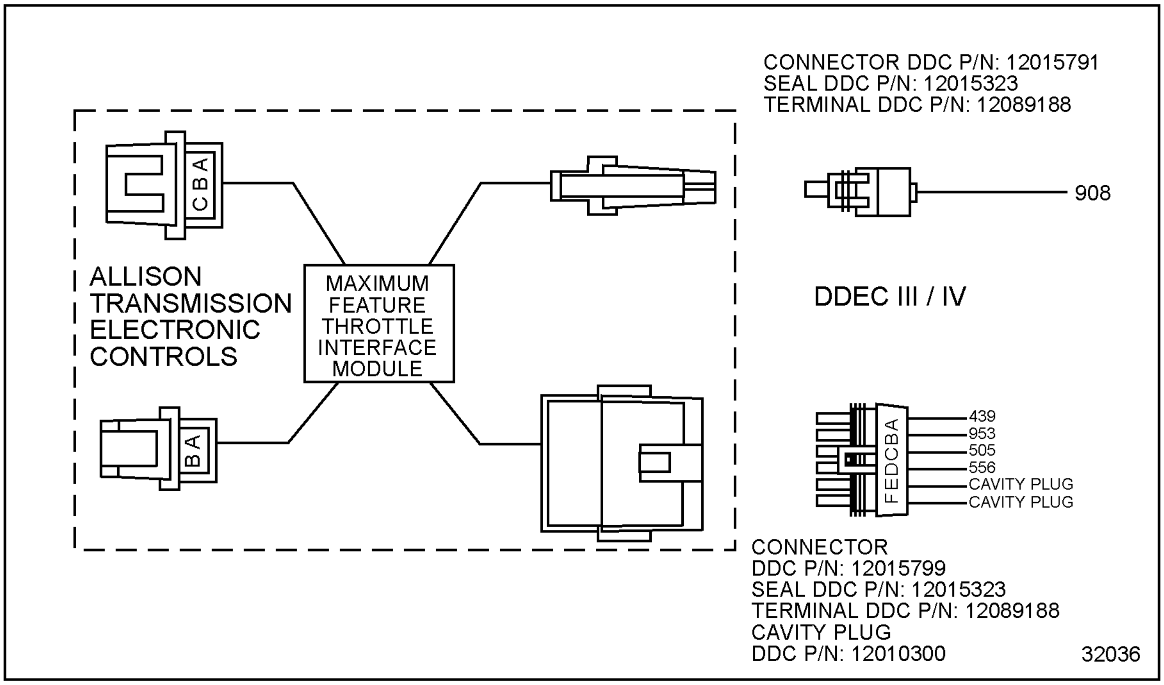
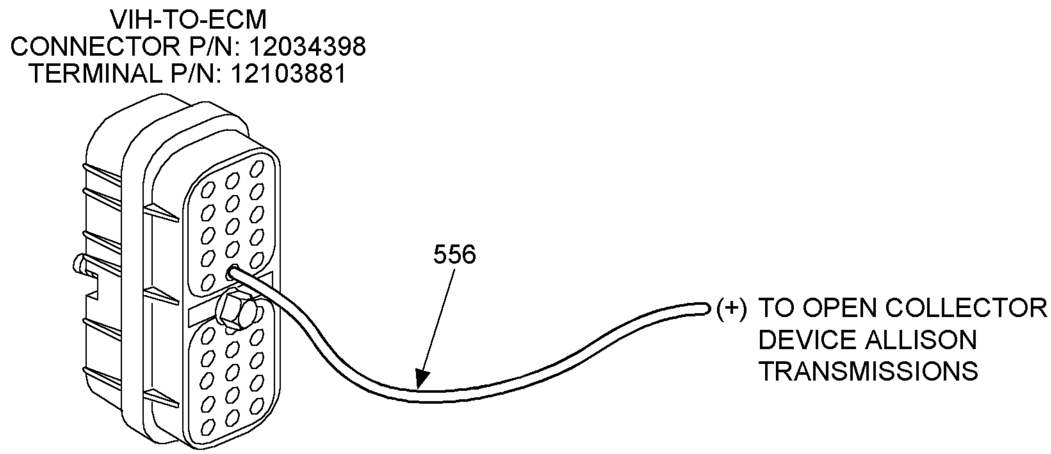


Figure 5-118 Maximum Feature Throttle Interface Module, Allison Transmission

The module communicates the transmission output speed signal back to DDEC for use in Cruise Control/vehicle speed limiting. It also incorporates an integral engine speed switch which is sent to Allison Electronic Control as an input signal for the logic preventing shifting into a range above preset engine speeds. All Allison Electronic Control transmissions require this module or the throttle interface module when connected to DDEC IV.

DDEC IV uses the open collector sensor type to integrate with the Allison Automatic Transmission to calculate vehicle speed (see Figure 5-119).

NOTE:
For Allison Transmission Electronic Controls refer to Allison Automatic Transmissions General Book #1, Page AS00-138, for world transmission refer to Allison Automatic Transmissions World Transmission WT Controls And General Information, Page Sa07-040.



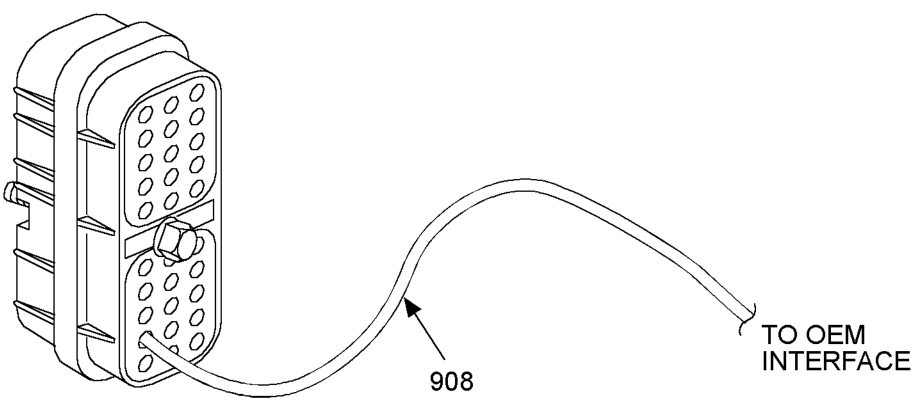
LABEL	WIRE NO.	VIH CONNECTOR CAVITY	WIRE COLOR	VSS CONNECTOR CAVITY
VEHICLE SPEED SENSOR (+)	556	E2	LT BLU/BLK	SIGNAL
VEHICLE SPEED SENSOR (-)	PLUGGED	–	–	–

32040

Figure 5-119 Allison Automatic Transmission Open Collector Speed Sensor

GE Propulsion System Controller

See Figure 5-120 for the PWM wiring for the GE Propulsion System.



LABEL	WIRE NO.	VIH-TO-ECM CONNECTOR CAVITY	WIRE COLOR
PWM #1	908	J3	WHT

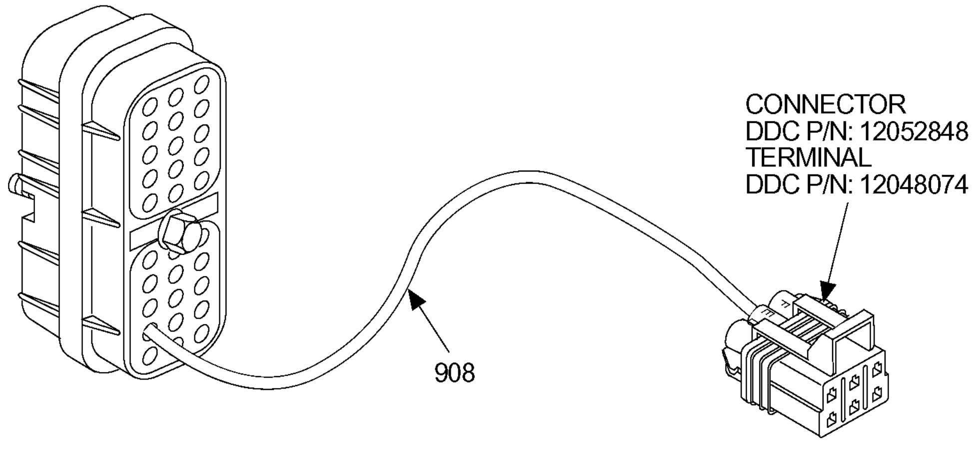
37710

Figure 5-120 DDEC IV to GE Propulsion System Controller

Refer to section 5.25, "Optimum Load Signal," for additional information.

ZF Ecomat and Voith Transmissions

See Figure 5-121 for installation of the ZF Ecomat transmission interface.

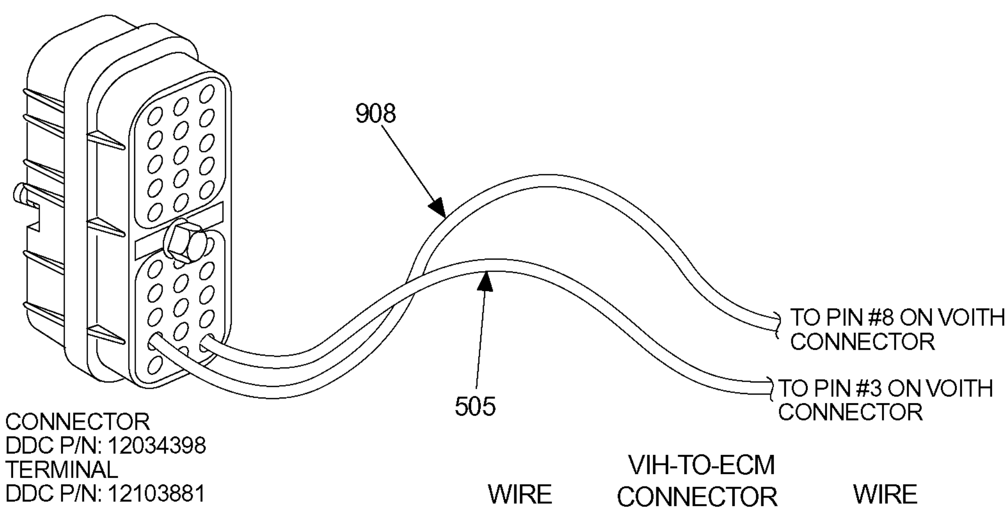


LABEL	WIRE NO.	VIH-TO-ECM CONNECTOR CAVITY	WIRE COLOR	ZF ECOMAT CONNECTOR
PWM #1	908	J3	WHT	E

37044

Figure 5-121 DDEC IV to ZF Ecomat Transmission

See Figure 5-122 for installation of the Voith transmission interface.



LABEL	WIRE NO.	VIH-TO-ECM CONNECTOR CAVITY	WIRE COLOR
PWM #1	908	J3	WHT
TACH DRIVE	505	K1	GRA

37045

Figure 5-122 DDEC IV to Voith Transmission

Allison Hydraulic Transmission

See Figure 5-123 for a schematic of the Allison Hydraulic Transmission and DDEC IV.

NOTE:
The exception to the following schematic is Allison HT750DR. Refer to "Allison Watch" #145 for DDECIV to HT750DR.

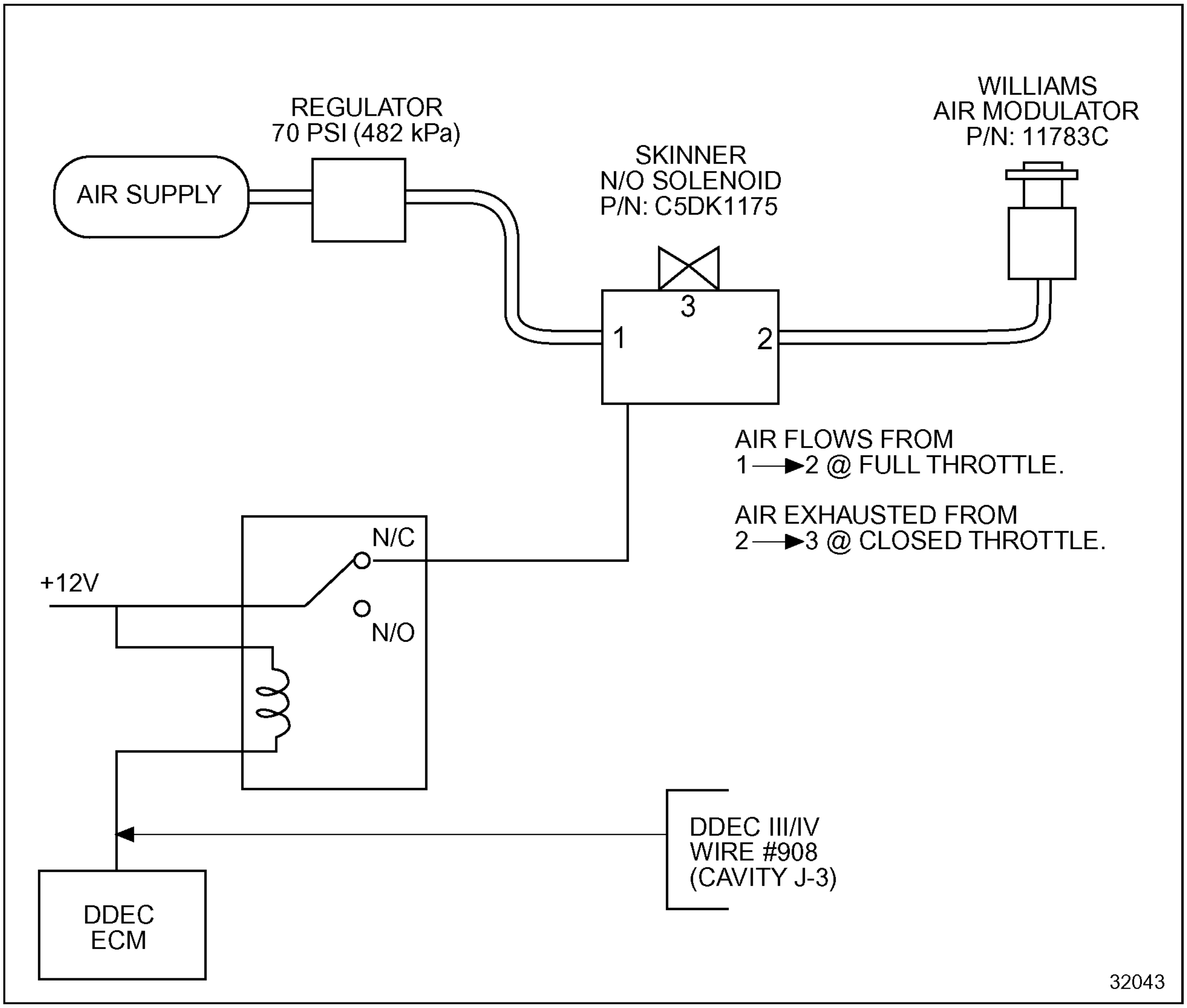


Figure 5-123 DDEC IV to Allison Hydraulic Transmission

Programming Requirements and Flexibility

The correct transmission type, listed in Table 5-104, must be programmed by VEPS or DRS.

Transmission	Transmission Type
Allison Hydraulic	1
Allison Transmission Electronic Controls (ATEC)	9
GE Propulsion System (AC)	32
Voith	3
Z-F Transmissions	4

Table 5-104 Transmission Types

DDEC uses the transmission output shaft speed to determine vehicle speed. Programming information is listed in Table 5-105.

Transmission	Sensor Type	DDEC IV Wire	Transmission Wire	DDEC IV Calibration
Allison Transmission Electronic Controls	Open Collector	556	205	Open Collector
Allison Hydraulic	External Magnetic	556 557	--	--
ZF Ecomat™	Open Collector	556	714	Open Collector or Magnetic
Voith	Magnetic	556 557	pin 5 Blue wire pin 6 Brown wire	Magnetic

Table 5-105 VSS Information for Various Transmissions

For additional information on Vehicle Speed Sensors, refer to section 3.13.2.12.

5.34.3 COMMUNICATION LINKS OPERATION

The serial communication links SAE J1587, SAE J1922, and SAE J1939 communicate control information from the engine to various vehicle systems such as transmissions. SAE J1587 defines the recommended format of messages and data being communicated between microprocessors used in heavy-duty vehicle applications. SAE J1922, and SAE J1939 transmit to the powertrain the messages assigned to both the engine and the transmission retarder.

5.34.4 COMMUNICATION LINKS INSTALLATION

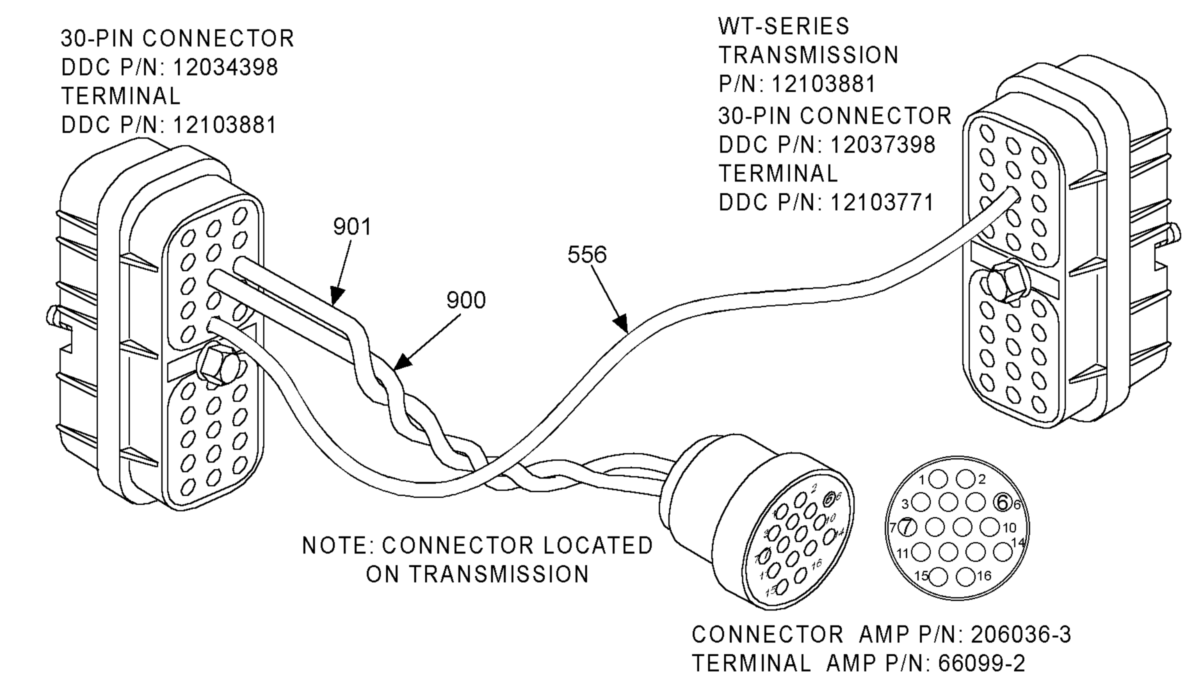
The transmissions listed in Table 5-106 communicate with the ECM using the data links.

Transmission	ECM Communication
Allison World Transmission (see Figure 5-124 on page)	SAE J1587
Allison WTEC III	SAE J1939 & SAE J1587
Eaton® CEEMAT™ (see Figure 5-126 on page)	SAE J1922
VOITH	PWM 1 or SAE J1939
SAE J1939 Transmissions	SAE J1939

Table 5-106 Transmissions Communicating with the Data Links

Allison World Transmission

The Allison World Transmission Series utilizes the SAE J1587 data link to obtain transmission control information. See Figure 5-124 for installation instructions.



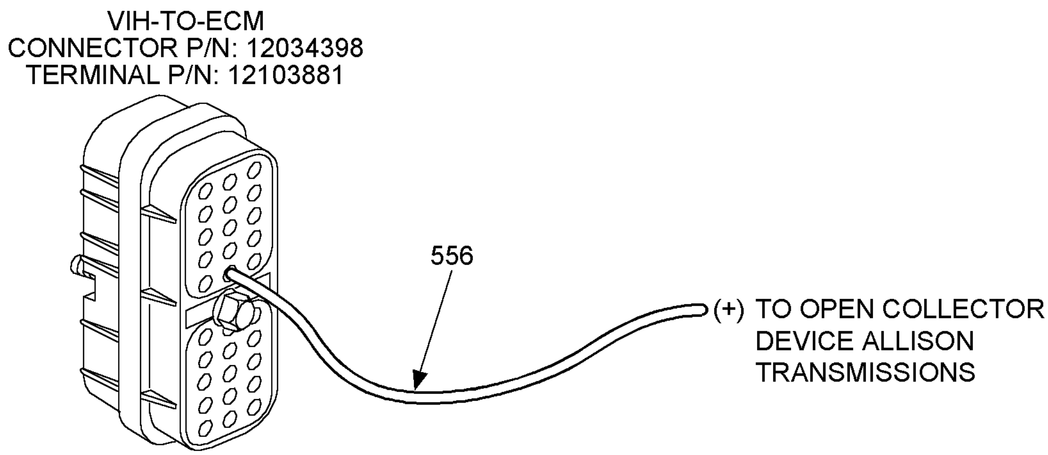
NOTE: WIRE PAIRS MUST BE TWISTED A MINIMUM OF 12 TURNS PER FOOT.

LABEL	WIRE NO.	DDEC CAVITY	WIRE COLOR	WT-SERIES CAVITY
J1587 DATA LINK (+)	900	C2	DK GRN/YEL	6 AMP CONNECTOR
J1587 DATA LINK (-)	901	C1	DK GREEN	7 AMP CONNECTOR
VEHICLE SPEED SENSOR (+)	556	E2	LT BLU/BLK	H2 PACKARD CONNECTOR

37567

Figure 5-124 DDEC IV to Allison WT-Series Transmission

DDEC IV uses the open collector sensor type to integrate with the Allison Automatic Transmission to calculate vehicle speed (see Figure 5-125).



LABEL	WIRE NO.	VIH CONNECTOR CAVITY	WIRE COLOR	VSS CONNECTOR CAVITY
VEHICLE SPEED SENSOR (+)	556	E2	LT BLU/BLK	SIGNAL
VEHICLE SPEED SENSOR (-)	PLUGGED	–	–	–

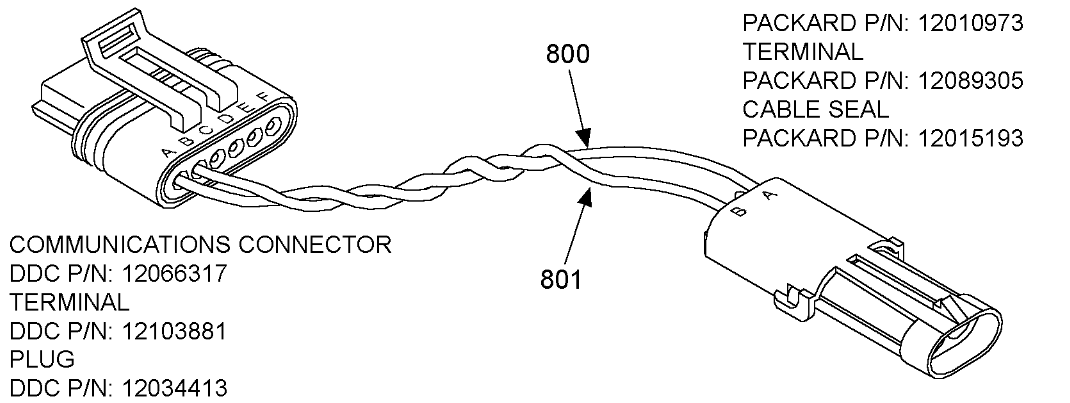
32040

Figure 5-125 Allison Automatic Transmission Open Collector Speed Sensor

NOTE:
For Allison Transmission Electronic Controls refer to Allison Automatic Transmissions General Book #1, Page AS00-138, for world transmission refer to Allison Automatic Transmissions World Transmission WT Controls And General Information, Page Sa07-040.

Eaton CEEMAT Transmission

The Eaton CEEMAT™ transmission utilizes the SAE J1922 powertrain control link to obtain transmission control information. See Figure 5-126.



LABEL	WIRE NO.	COMMUNICATION CONNECTOR CAVITY	WIRE COLOR	CEEMAT INTERFACE CONNECTOR CAVITY
J1922 DATA LINK (+)	800	A	TAN/WHT	A
J1922 DATA LINK (-)	801	B	TAN	B

37043

Figure 5-126 DDEC IV to CEEMAT Transmission

SAE J1939 Transmissions

The SAE J1939 powertrain control link is designed to communicate control information between the engine and the transmission. Refer to section 3.5, "Communication Harness," for additional information.

Programming Requirements and Flexibility

The correct transmission type, listed in Table 5-107, must be programmed by VEPS or DRS.

Transmission	Transmission Type
Allison World Transmission	12
Allison WTEC III	12 or 16
Eaton CEEMAT	14
Voith	16
SAE J1939 Transmissions	16

Table 5-107 Transmission Types

5.34.5 DIGITAL INPUT AND DIGITAL OUTPUT TRANSMISSIONS

The transmissions supported by DDEC IV that communicate using digital inputs and outputs are listed in Table 5-108.

Transmission	Transmission Models	ECM Communication
Eaton® Top2™	RTLO-xx610B-T2 (Release 4.01 or later) RTL-xx710B-T2 (Release 21.0 or later) RTLO-xx713A-T2 (Release 22.0 or later) RTLO-xx718B-T2 (Release 22.0 or later)	2 Digital Outputs
Meritor™ESS™	RS9 RSX9-A RSX9-B RSX9-R RS10 RSX10 RSX10-C	2 Digital Inputs 2 Digital Outputs

Table 5-108 Transmissions Communicating with Digital Inputs and Digital Outputs

5.34.6 EATON TOP2 OPERATION

The Top2system automatically shifts between the top two gears of the Eaton Top2 Transmission to optimize drivetrain for best fuel economy or performance. Shifting between the two highest gears in the transmission is done by the ECM and requires no driver interaction. The system works with engine brakes and Cruise Control during automatic shifts. The torque demand from throttle or Cruise Control is smoothly ramped down before the shift and ramped up after the shift allowing the driver to keep his foot on the throttle during shifts. Cruise Control is automatically resumed after the shift. When the transmission is shifted out of the two top gears, the driver has full manual control over the transmission. The engine will also detect skip shifts into the auto mode and still take control of the transmission's top two gears.

Installation

See Figure 5-127 to install Top2.

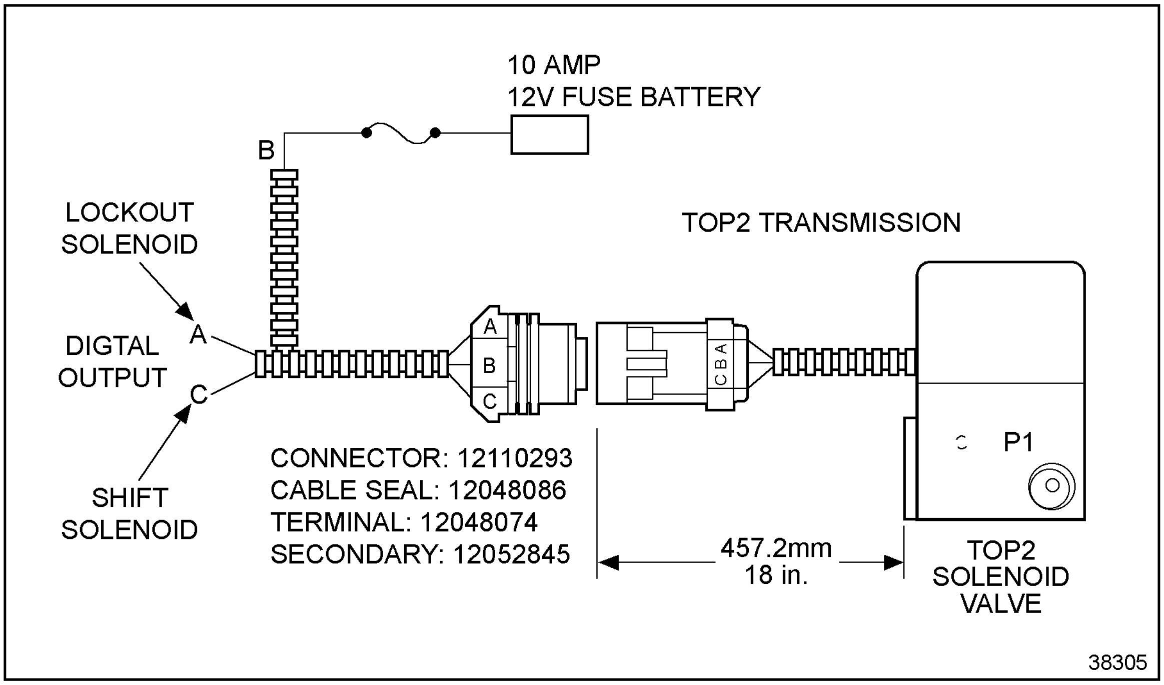


Figure 5-127 Top2 Transmission

Programming Requirements and Flexibility

The Top2 feature is enabled when the Top2 Shift Solenoid (function #30) and the Top2 Lockout Solenoid (function #31) digital outputs, listed in Table 5-109 are configured. The digital outputs must be configured by order entry, VEPS or DRS.

Description	Function Number
Top2 Shift Solenoid	30
Top2 Lockout Solenoid	31

Table 5-109 Digital Outputs Used by Top2

Once Top2 is enabled, the logic will default to support the Super 10 Overdrive Transmission RTLO-xx610B-T2 unless one of the transmissions listed in Table 5-110 is selected.

Transmission	Transmission Type
RTLO-XX610B-T2	27
RTL-XX710B-T2	28
RTLO-XX713A-T2	29
RTLO-XX718B-T2	30

Table 5-110 Top2 Transmission Types

DRS, the DDR, or VEPS (Release 26.0) allow you to enable/disable Top2 functionality as listed in Table 5-111.

On-screen	Definition	Choice
TOP2 CRUISE SW*	Enables or disables Top2 functionality.	ON, OFF

* This feature is available for Release 8.0 or higher of DDEC III, Release 21.0 or higher for DDEC IV.

Table 5-111 Top2 Reprogramming Choices

Diagnostics

If a fault is detected on either the shift solenoid or shift lockout digital output, the ECM will leave the transmission in manual mode until the fault is repaired. When there is a fault in any of the following sensors, the driver will be left with manual control of the transmission and the ECM will turn ON the check engine light.

- ☐ Vehicle Speed Sensor
- ☐ Synchronous Reference Sensor/Timing Reference Sensor (SRS/TRS) failure
- ☐ Lockout and shift solenoid failures

When there is a fault in any of the following features, the driver will be left with manual control of the transmission. The Check Engine Light (CEL) will be turned ON for these conditions.

- ☐ Failed splitter engagements
- ☐ Failed splitter disengagements
- ☐ Failed synchronizing attempts (possible in-gear)

5.34.7 MERITOR ENGINE SYNCHRO SHIFT OPERATION

ESS is a Meritor transmission feature that aids the driver. The ESS system automatically synchronizes the transmission by matching the engine RPM speed to the road speed of the vehicle which eliminates the need to use the clutch pedal for shifting gears.

ESS eliminates the need to use the clutch and accelerator pedal for sequential shifts as DDEC automatically sets engine speed to the proper synchronous RPM for the next gear. The system simplifies power downshifts where matching speeds require increasing engine RPM. The system automatically performs the necessary range shifts at the appropriate place in the shift pattern. The driver indicates his intentions to the controller via the intent switch, a four position switch mounted on the side of the shift knob. The clutch is used for starting and stopping.

To initiate ESS, the clutch remains engaged and the transmission is shifted into neutral. The operator must release torque on the drivetrain via the break torque "over-travel" on the four position switch or manually via the accelerator pedal. Cruise Control (if operating) will be suspended when the transmission is shifted into neutral.

The current gear is calculated by DDEC using the current engine RPM and the transmission output RPM from the Vehicle Speed Sensor (VSS). The ESS logic in the DDEC ECM calculates the next desired gear ratio based on the current sensed gear ratio and the shift intent switch. It then uses this ratio to command the engine to a speed synchronous with the next gear. Control of the engine returns to the Throttle Position Sensor (TPS) when the driver shifts back into gear, uses the clutch, or the ESS system times out.

The system allows traditional manual shifting without automatic engine speed control. When the ESS system switch is ON, the driver can make manual shifts by pressing the clutch during shifting. Switching between high and low range is controlled automatically by DDEC.

The ESS system can also be turned OFF entirely with the system switch. Manual shifting is done with the use of the clutch. The shift intent switch locked in the up position (ON) selects the high range gear box and in the low position (OFF) selects the low range gear box.

The Shift-n-Cruise™ option is an ESS shift knob with integrated cruise control switches. The PAUSE, SET, and RESUME buttons are located on the transmission shift knob.

There are four options that can be programmed using the DDDL/DDR, VEPS, or DRS. These are:

- ☐ Late Change
- ☐ Second Chance
- ☐ Eng Brake Shift
- ☐ Skip Shift

The parameters for these options are listed in Table 5-115 in the section "Programming Requirements and Flexibility" on page 5-251.

Installation

The ECM must be programmed with a software level of Rel. 5.03 or higher. For installation, see Figure 5-128.

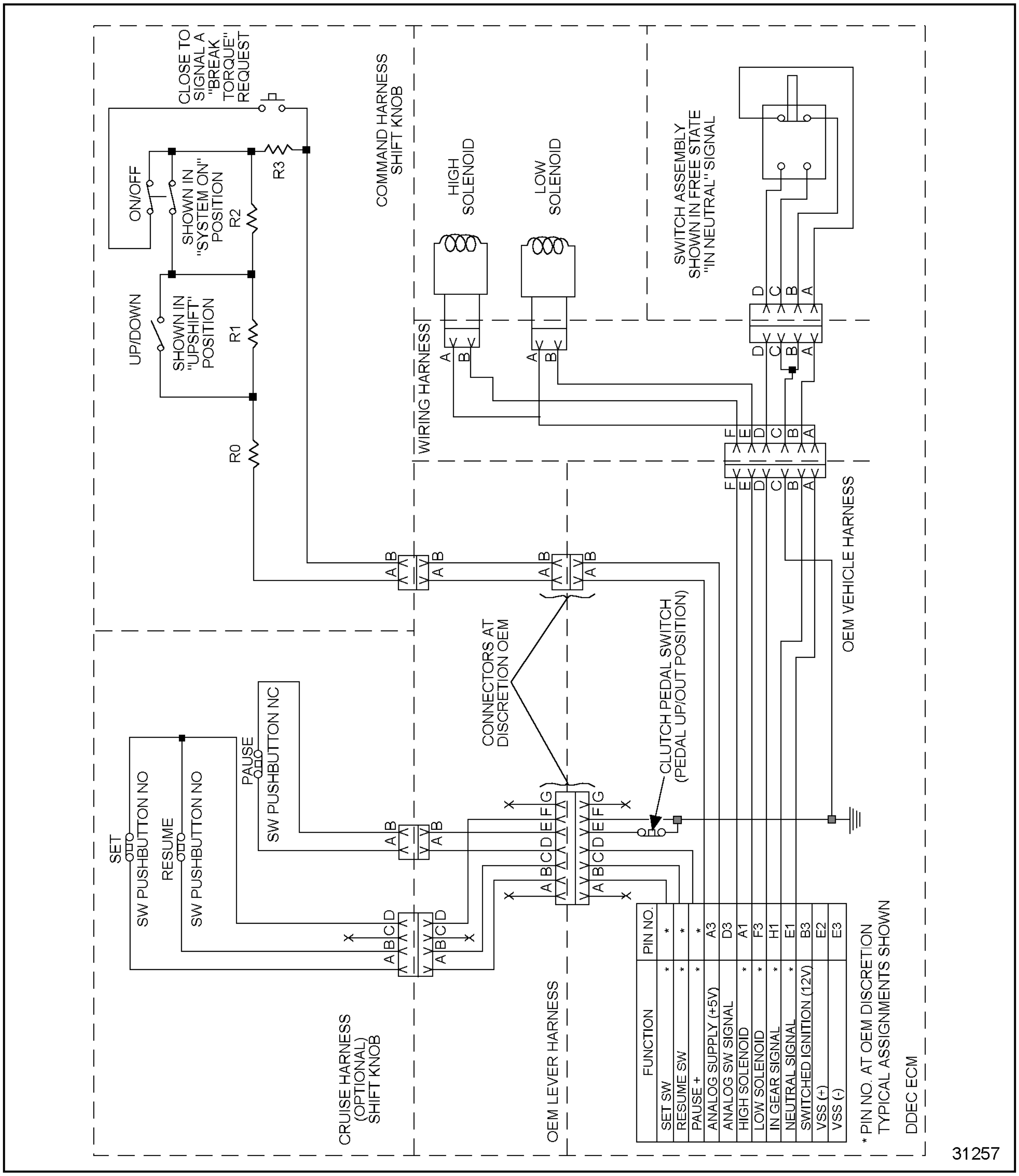


Figure 5-128 Engine Synchro Shift Schematic

Diagnostics

The faults that can occur in the system and the associated results are listed in Table 5-112.

Flash Code	SID	FMI	Description	Results
73	151	14	Stuck in gear detected	ESS is disabled. Manual shifting can be performed with the clutch. If the system switch is ON, DDEC will control the high/low range.
73	084	12	Vehicle Speed Sensor failure	ESS and automatic range control is disabled. Only manual range control is available providing the system switch is OFF. If the system switch is ON, then the last range is used.
73	227	4	Shift knob voltage below normal or shorted low	ESS is disabled. Manual shifting can be performed with the clutch. If the system switch is ON, DDEC will control the high/low range.
73	227	3	Shift know voltage below normal or shorted low	
73	227	2	Shift knob data erratic intermittent or incorrect	
73	226	11	Neutral/In Gear Switch fault	If both switches fail, ESS and automatic range control is disabled. The range will fail in the last selected position. If one switch fails, ESS operation will continue, but the system performance will be reduced.
62	*xxx	3	Low range solenoid-short to battery	ESS is disabled. Range control is lost towards the bad solenoid.
62	*xxx	4	Low range solenoid-open circuit	
62	*xxx	3	High range solenoid-short to battery	
62	*xxx	4	High range solenoid-open circuit	

* System Identifier (SID) dependent on output cavity item to which item is assigned.

Table 5-112 ESS Faults

For more diagnostic and troubleshooting information, refer to the *Engine Synchro Shift™ Troubleshooting* manual (6SE498).

Programming Requirements and Flexibility

The ECM must be programmed with software Release 5.03 or later. The correct transmission type, listed in Table 5-113, must be programmed with VEPS or DRS.

Transmission Type	Setting
RS9 (M-XXG9A-DXX)	17
RSX9-A (MO-XXG9A-DXX)	18
RSX9-B (MO-XXG9B-DXX)	19
RSX9-R	20
RS10 (M-XX-G10A-DXX)	21
RSX10 (MO-XX-G10A-DXX)	22
RSX10-C (MO-XX-G10C-DXX)	23

Table 5-113 ESS Transmission types

The digital outputs and digital inputs listed in Table 5-114 must be configured by order entry, VEPS or DRS.

Description	Type	Function Number
Low Range Solenoid	Digital Output	28
High Range Solenoid	Digital Output	29
Clutch Switch	Digital Input	18
In Neutral	Digital Input	38
In Gear	Digital Input	39

Table 5-114 Digital Inputs and Digital Outputs Used by ESS

DDDL/DDR, VEPS, or DRS can be used to change parameters in the ECM calibration. Parameters specific to ESS are listed in Table 5-115.

On-screen	Definition	Display/Choice
LATE CHANGE	Enables/disables Late Change feature.	YES, NO
SECOND CHANCE	Enables/disables Second Chance feature.	YES, NO
ENG BRAKE SHIFT	Enables/disables Eng Brake Shift feature.	YES, NO
SKIP SHIFT	Enables/disables Skip Shift feature.	YES, NO

Table 5-115 Programmable Parameters

Late Change - Late Change allows the driver, who has forgotten to change the shift direction intent switch, to correct the switch position while in neutral. The ECM will then recalculate the desired next gear and re-synchronize the engine speed to allow the driver to complete the shift into the newly revised gear. The default is YES.

Second Chance - When activated, Second Chance allows the ECM to calculate the best gear in which to shift and synchronizes the engine to that speed. The driver must find that selected gear. This feature can only be used while the system switch in ON, the clutch switch is ON, the vehicle has been shifted into NEUTRAL, there are no VSS faults, no shift knob fault, no neutral switch faults, no in gear switch faults, and the vehicle is at speed that will be conducive to shifting. If an ESS shift had been attempted, then the shift must have been aborted and/or timed out. The default is YES.

Eng Brake Shift - The engine brakes can be actuated during an ESS shift operation. The use of engine brakes allows the engine speed to drop to the synchronous speed quicker than it would be able to spool down on its own. Normally the throttle pedal must be released for engine brake operation to go active, but for ESS the driver is allowed to have his foot on the throttle and still get engine brake operation. The default is YES.

Skip Shift - The driver can skip any number of gears by pressing the break torque switch multiple times in the direction of the desired shift which signals the ECM. The number of times the switch is toggled equals the number of gears to skip. Skip shifting is only allowed while the vehicle is in neutral. The default is YES.

5.35 TRANSMISSION RETARDER

A hydraulic transmission retarder is a device used to slow an engine by applying a torsional resistance to the engine output shaft. This resistance is achieved by the flow of hydraulic fluid against a rotating wheel, within an enclosed cavity. Energy is absorbed by the fluid, and is transferred as heat to an auxiliary cooler.

5.35.1 OPERATION

A digital output is switched to battery ground whenever the throttle is in the 0% position and Cruise Control is inactive. This signal, in conjunction with a relay, may be used to control a transmission retarder. The retarder option must be specified at the time of engine order. This output will also be enabled if a SAE J1922 data link message is received requesting transmission retarder.

5.35.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The transmission retarder option must be specified at the time of engine order.

The digital output listed in Table 5-116 must be configured by order entry, VEPS, or DRS.

Function Number	Type	Description
9	Digital Output	Transmission Retarder

Table 5-116 Transmission Retarder Digital Outputs

5.35.3 INTERACTION WITH OTHER FEATURES

A deceleration light can be used to warn that the vehicle is slowing down. A digital output is switched to ground whenever the percent throttle is zero and Cruise Control is inactive. This output is typically used to drive a relay, which drives the deceleration lights. Refer to section 4.2 , "Digital Outputs," for additional information.

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5.36 VEHICLE SPEED LIMITING

The Vehicle Speed Limiting feature is available on all DDEC engines equipped with a Vehicle Speed Sensor.

5.36.1 OPERATION

Vehicle Speed Limiting discontinues engine fueling at any vehicle speed above the programmed limit. DDEC stops fueling when maximum vehicle speed is reached. The Fuel Economy Incentive option will increase the Vehicle Speed Limit (refer to section 5.15, "Fuel Economy Incentive").

5.36.2 INSTALLATION

An OEM supplied Vehicle Speed Sensor or output shaft speed over the SAE J1939 Data Link is required. Refer to section 3.14.25, "Vehicle Speed Sensor," for additional information.

5.36.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The Vehicle Speed Limit is programmable at engine order entry or with the DDR, DDDL, VEPS or DRS as listed in Table 5-117.

Parameter	Description	Choice / Display
VEHICLE SPEED LIMIT ENABLE	Enables or disables vehicle speed limiting feature.	YES, NO, N/A
MAX VEHICLE SPD	Sets the maximum vehicle speed in MPH.	20 MPH to (rated speed/VSS ratio)
MAX OVERSPEED LIMIT	Sets the vehicle speed above which a diagnostic code will be logged if the driver fuels the engine and exceeds this limit. Entering a zero (0) will disable this option.	0 to 127 MPH
MAX SPEED NO FUEL	Sets the vehicle speed above which a diagnostic code will be logged if the vehicle reaches this speed without fueling the engine. Entering a zero (0) will disable this option.	0 to 127 MPH

Table 5-117 Vehicle Speed Limiting Parameters

5.36.4 INTERACTION WITH OTHER FEATURES

The Cruise Control maximum set speed cannot exceed the Vehicle Speed Limit.

Fuel Economy Incentive will increase the Vehicle Speed Limit. When Vehicle Speed Limiting is enabled and a VSS code is logged, the engine speed in all gears will be limited for the duration of the ignition cycle to engine speed at the Vehicle Speed Limit in top gear.

A vehicle can be set up with both PasSmart and Fuel Economy Incentive, but the extra speed increments provided by the two features do not add together. For example, if Fuel Economy Incentive is set up to give 7 MPH of extra speed when the driver hits the maximum fuel economy target and the PasSmart increase is 5 MPH the resulting speed increase is 7 MPH, not 12 MPH.

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5.37 VEHICLE SPEED SENSOR ANTI-TAMPERING

VSS Anti-tampering can be used to detect fixed frequency oscillators or devices which track engine RPM and produce fewer pulses per revolution than a VSS wheel. These devices are used to trick the ECM into believing that vehicle speed is low.

A VSS fault will be logged if the sensor appears to be working improperly but the vehicle speed is not zero. The engine speed in all gears will be limited for the duration of the ignition cycle to the engine speed at the Vehicle Speed Limit in top gear.

NOTE:
Enabling VSS anti-tampering for use with SAE J1939, automatic, semi-automatic, or torque converter transmissions such as Meritor ESS or Eaton Top2 may cause false codes.

5.37.1 PROGRAMMING FLEXIBILITY

The DDR, DDDL, or the DRS can enable VSS anti-tampering. Vehicle Speed Limiting must also be enabled. The parameters are listed in Table 5-118.

Parameter	Description	Choice/Display
VSS Anti-tamper	Enables or Disables VSS Anti-tamper Feature	YES/NO
Vehicle Speed Limit Enable	Enables or Disables Vehicle Speed Limiting	YES/NO
Max Vehicle Speed	Sets the Max Vehicle Speed in MPH	20 MPH to (rated speed/VSS ratio)

Table 5-118 VSS Anti-tampering Parameters

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6 COMMUNICATION PROTOCOLS

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6.1 OVERVIEW

Key components of the DDEC IV system are the serial communication links SAE J1587, SAE J1922, and SAE J1939. Using these communication links allows DDEC IV to offer the following functionality:

- ☐ Transmitting sensor information from the ECM via the data link at regular intervals and/or upon request to obtain data and to monitor for failures
- ☐ Sharing information between stand-alone modules used in the system via the data link
- ☐ Sharing engine data with electronic dashboard displays and vehicle management information systems via the data link
- ☐ Transmitting and performing diagnostic procedures from external instrumentation such as the hand-held diagnostic data readers or DDDL via the data link
- ☐ Transmitting customer requested changes to the ECM from external instrumentation via the data link
- ☐ Transmitting to the powertrain the messages assigned to both the engine and the transmission retarder.

The following industry standard Society of Automotive Engineers (SAE) documents can be used as a reference:

- ☐ SAE J1587 MAR96 , *Electronic Data Interchange Between Microcomputer Systems In Heavy Duty Vehicle Applications*
- ☐ SAE J1708 OCT93, *Serial Data Communications Between Microcomputer Systems In Heavy Duty Vehicle Applications*
- ☐ SAE J1922, DEC89, *Powertrain Control Interface For Electronic Controls Used In Medium And Heavy Duty Diesel On-highway Vehicle Applications*
- ☐ SAE J1939, Recommended Practice for a Serial Control and Communication Vehicle Network
- ☐ SAE J1939/71, AUG97, Vehicle Application Layer

To obtain a copy of the above documents contact the Society of Automotive Engineers (SAE).

SAE International
400 Commonwealth Drive
Warrendale, PA 15096
Attention: Publications
Phone: (412) 776-4970

DDEC IV complies with the interface definition of the SAE J1708 OCT93.

DDEC IV complies with the standard diagnostic messages defined by SAE J1587 MAR96.

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6.2 SAE J1587

SAE RP J1587 defines the recommended format of messages and data being communicated between microprocessors used in heavy-duty vehicle applications. Circuits 900 (Data Link +) and 901 (Data Link -) as shown on the Vehicle Interface Harness schematic are used as the J1587 communication link. These circuits also exist in the DDEC six-pin diagnostic connector for use with the DDR.

NOTE:
The maximum length for the SAE J1587 Data Link is 40 m (130 ft).

6.2.1 MESSAGE FORMAT

A complete description of the DDEC IV parameters is provided within this section of the manual. DDEC IV transmits parametric data at SAE J1587 recommended rates in packed message form. The first byte or character of each message is the Message Identification character (MID). The MID identifies which microcomputer on the serial communication link originated the information. Each device in the system originating messages must have a unique MID. The assignment of MIDs should be based on those listed in SAE RP J1587. The primary MID for DDEC IV is 128. Engines with 12 and 16 cylinders use MID 128 and MID 175. Engines with 20 cylinders use MID 128, MID 175 and MID 183.

The ProDriver display uses MID 171. Off-board diagnostic tools like hand-held readers should be identified by MID 172. Off-board programming stations like Vehicle Engine Programming Station (VEPS) should be identified by MID 182. Messages using MIDs as recommended by SAE RP J1587 will be responded to by the ECM.

Subsystems also require identifiers. The subsystem identifier character (SID) is a single byte character used to identify field-repairable or replaceable subsystems for which failures can be detected or isolated. SIDs are used in conjunction with SAE standard diagnostic codes defined in J1587 within PID 194.

The identifiers used by DDEC are defined and listed in Table 6-1.

Identifier	Description
Failure Mode Identifier (FMI)	The FMI describes the type of failure detected in the subsystem and identified by the PID or SID.
Message Identification Character (MID)	The MID is the first byte or character of each message that identifies which microcomputer on DDEC 1587 serial communication link originated the information.
Parameter Identification Character (PID)	A PID is a single byte character used in DDEC 1587 messages to identify the data byte(s) that follow. PIDs identify the parameters transmitted.
Subsystem Identification Character (SID)	A SID is a single byte character used to identify field-repairable or replaceable subsystems for which failures can be detected or isolated.

Table 6-1 Identifiers Used by DDEC

6.2.2 1708/1587 MESSAGE PRIORITY

Each message sent by DDEC is assigned a priority on a scale of 1 to 8, in compliance with the message priority assignment specified in SAE RP J1708. The most critical message has a priority of one. The message assignments are listed in Table 6-2. All devices transmitting messages across DDEC's 1708/1587 Data Link must be prioritized and transmitted in this manner.

Priority	Description
1 and 2	Reserved for messages that require immediate access to the bus.
3 and 4	Reserved for messages that require prompt access to the bus in order to prevent severe mechanical damage.
5 and 6	Reserved for messages that directly affect the economical or efficient operation of the vehicle.
7 and 8	All other messages not fitting into the previous priority categories.

Table 6-2 Message Priority Assignments

SAE J1587 Parameters Available with DDEC IV

DDEC IV supports the J1587 parameter identifiers (PIDs) listed in Table 6-3 and Table 6-4.

NOTE:
Data is transmitted only if the source has been configured for the engine.

PID	Description	PID	Description
243	Device Identification	249	Total Engine Revolution
244	Trip Miles	250	Total Fuel Used
245	Total Miles	251	Clock Module
247	Total Engine Hours	252	Clock Module
248	Total VSG Hours	404	Turbo Compressor

Table 6-3 SAE J1587 PIDs Provided by DDEC IV

PID	Description	PID	Description
3	Extended Range Cylinder Head Temperature	109	Coolant Pressure
18	Extended Range Fuel Pressure	110	Coolant Temperature
19	Extended Range Oil Pressure	111	Coolant Level
20	Extended Range Coolant Pressure	113	Engine Governor Droop
44	Attention/Warning Indicator Lamps Status	121	Engine Retarder Status
48	Extended Range Barometric Pressure	122	Engine Retarder Percent
51	Throttle Position	153	Crankcase Pressure
52	Engine Intercooler Temperature	154	Auxiliary Input & Output Status #2
62	Retarder Inhibit Status	155	Auxiliary Input & Output Status #1
65	Service Brake Switch Status	162	Transmission Range Selected
68	Torque Limiting Factor	163	Transmission Range Attained
70	Parking Brake Switch Status	164	Injection Control Pressure
71	Idle Shutdown Timer Status	166	Rated Engine Power
72	Blower Bypass Valve Position/Blower Bypass Door Position	168	Battery Potential (Voltage)
73	Extended Range Auxiliary Water Pump Pressure	171	Ambient Air Temperature
74	Vehicle Speed Set Limit	172	Air Inlet Temperature
81	Exhaust Back Pressure	173	Exhaust Temperature
83	Vehicle Speed Limit Status	174	Fuel Temperature
84	Vehicle Speed	175	Engine Oil Temperature
85	Cruise Control Switch Status	182	Trip Fuel
86	Cruise Control Set Speed	183	Fuel Rate
87	Cruise Control High Limit	184	Instantaneous Fuel Economy, (mile/gal)
88	Cruise Control Low Limit	185	Average Fuel Economy, (mile/gal)
89	VSG Switch Status	187	188
91	Percent Throttle	188	Idle Engine Speed
92	Percent Engine Load	189	Rated Engine Speed
93	Output Torque	190	Engine Speed
94	Fuel Delivery Pressure	191	Transmission Output Shaft Speed
95	Fuel Filter Differential Pressure	192	Multi-sectioned Parameter
98	Engine Oil Level	194	Transmitter System Diagnostic Code and Occurrence Count Table
99	Oil Filter Differential Pressure	196	Diagnostic Data/Count Clear Response
100	Engine Oil Pressure	222	Anti-Theft
101	Crankcase Pressure	228	Speed Sensor Calibration
102	Turbo Boost Pressure	233	Unit Number
103	Turbo Speed	234	Software Identification
105	Intake Manifold Temperature	235	Total Idle Hours
106	Air Inlet Pressure	236	Total Idle Fuel Used
107	Air Filter Differential Pressure	237	Vehicle Identification Number (VIN)
108	Barometric Pressure	240	Last Customer Calibration Change Hours

Table 6-4 SAE J1587 PIDs Provided by DDEC IV (continued)

6.2.3 SAE J1587 PIDS REQUIRING DDEC ACTION

DDEC will respond to data requests per the J1587 PID requests shown in the next sections.

Data Request

The format for a data request is shown below.

PID	Data
0	a
	a - Parameter number of the requested parameter

Component Specific Request

The format for a component specific request is shown below.

PID	Data
128	a b
	a - Parameter number of the requested parameter
	b - MID of the component from which the parameter data is requested

NOTE:
DDEC responds with the appropriate data provided the MID in byte (b) matches the MID stored in calibration. The primary MID for DDEC III/IV is 128. Engines with 12 and 16 cylinders use MID 128 and MID 175. Engines with 20 or 24 cylinders use MID 128, MID 175 and MID 183.

Retarder Status Request

Electronic transmissions may indicate the status of the transmission output

retarder to DDEC by using the following message:

PID	Data	
47	a	
	a - Transmission output retarder status	
	Bits 2-1 Output retarder status	
	00 = off	10 = error
	01 = on	10 = error
	Bits 8-3 Reserved, Bits set to 1	
comments:	This parameter is supported in Release 4.00 or later.	

Transmitter Data Request / Clear Count

The format for a transmitter data request is shown below.

PID	Data
195	n a b c
	n - Number of parameter data characters = 3
	a - MID of the device to which the request is directed
	b - SID or PID of a standard diagnostic code
	c - Diagnostic code number

Bits: 1 - 4		Failure mode identifier (FMI) of a standard diagnostic code
Bit: 5		Byte (b) identifier
	1 -	Byte (b) is a Subsystem Identifier (SID)
	0 -	Byte (b) is a Parameter Identifier (PID)
Bit: 6		Type of diagnostic code
	1 -	Standard diagnostic code
	0 -	Reserved for expansion diagnostic codes
Bit: 7, 8	--	Request an ASCII descriptive message for the given diagnostic code.
	01 -	Request count be cleared for the given diagnostic code on the device with the given MID.
	10 -	Request counts be cleared for all diagnostic codes on the device with the given MID. The diagnostic code given in this transmission is ignored.
	11 -	Request additional diagnostic information for the given diagnostic code, the content of which is defined under PID 196.

NOTE:
DDEC responds with the appropriate data using PID 196.

source: ECM calculated; outputs represent intended state

J1587 Outputs - Single Byte Parameters

PID 18 - Extended Range Fuel Pressure

update rate:	1 time/s
resolution:	4 kPa/Bit (Uns/SI)
source:	Fuel Pressure Sensor
comments:	This PID is used to provide a wider range of pressure values than that provided with PID 94. This parameter is available with Release 24.00 software or later.

PID 19 - Extended Range Engine Oil Pressure

update rate:	1 time/s
resolution:	4 kPa/Bit (Uns/SI)
source:	Engine Oil Pressure Sensor
sensor range:	0 to 145 psi
comments:	This PID is used to provide a wider range of pressure values than that provided with PID 100. This parameter is available with Release 24.00 software or later.

PID 20 - Extended Range Coolant Pressure

update rate:	1 time/s
resolution:	2 kPa/Bit (Uns/SI)
source:	Coolant Pressure Sensor
comments:	This PID is used to provide a wider range of pressure values than that provided with PID 109. This parameter is available with Release 24.00 software or later.

PID 44 - Attention/Warning Indicator Lamps Status

update rate:	10 time/s or 1 time/s when changing	
format:		
	Bit: 1,2	Stop Engine Light Status
		00 - off
		01 - on
		10 - error
		11 - Not Available
	Bit: 3,4	Check Engine Light Status
		00 - off
		01 - on
		10 -
		11 - Not Available
	Bit: 5-8	Reserved, All Bits set to 1

PID 48 - Extended Range Barometric Pressure

update rate: 1 time/s
resolution: 0.6 kPa/Bit (Uns/SI)
source: Barometric Pressure Sensor or Turbo Boost Pressure Sensor

PID 51 - Throttle Position

update rate: 5 time/s
resolution: 0.4%/Bit (Uns/SI)
source: Throttle Position Sensor
comments: This parameter identifies the position of the value used to regulate the supply of a fluid, usually air or fuel/air mixture, to an engine - 0% represents no supply.

PID 52 - Engine Intercooler Temperature

update rate: 1 time/s
resolution: 1°F/Bit (Uns/SI)
source: Engine Intercooler Temperature Sensor

PID 62 - Retarder Inhibit Status

update rate:	On request	
format:		
	Bits: 1, 2	Retarder Inhibit Status 00 - Off (not Inhibited) 01 - On (Inhibited)
	Bits: 3-8	Uncommitted, all Bits set to 1
source:	Digital output for Engine Brake Enable	
comments:	Used with the Engine Brake outputs.	

PID 65 - Service Brake Status

update rate:	1 time/s	
format:		
	Bits: 1, 2	Service Brake Status 00 - off 01 - on
	Bits: 3-8	Uncommitted, all Bits set to 1 Bits 3-8 = 1
source:	Service Brake Switch	

PID 68 - Torque Limiting Factor

update rate:	1 time/s
resolution:	0.5%/Bit (Uns/SI)
source:	ECM calculated.
comments:	This parameter indicates the amount of engine protection torque reduction that is in effect.

PID 70 - Parking Brake Switch Status

update rate:	1 time/s	
format:		
	Bits: 8	Parking Brake Switch Status 0 - off 1 - on
	Bits: 1-7	Uncommitted, all Bits set to 0
source:	Parking Brake Switch	

PID 71 - Idle Shutdown Timer Status
update rate: 1 time/s
format:

Bit: 1	Idle Shutdown Override ("Driver Alert") 1 - Active
Bit: 2	Engine Has Shutdown by Idle Timer to 1 - Yes
Bit: 3	Idle Timer Shutdown Override 1 - Active (Idle Shutdown has been overridden)
Bit: 4	Idle shutdown timer function 1 - Enabled in calibration 0 - Disabled in calibration
Bit: 8	Idle Shutdown Timer Status 1 - Active
Bits: 5-7	All Bits set to 0

source: ECM calculated

PID 72 - Blower Bypass Valve Position
update rate: 2 times/s
resolution: 0.4%/Bit (Uns/SI)
source: Blower Bypass Valve Position sensor
comments: Electronically controlled blower bypass valves are used on Methanol engines.

PID 73 - Auxiliary Water Pump Pressure
update rate: 1 time/s
resolution: 2 psi/Bit (Uns/SI)
source: Water Pump Pressure Sensor
comments: The auxiliary Water Pump Pressure system is used on fire trucks with DDEC pressure control. The transmitted value is gage pressure.

PID 74 - Vehicle Speed Set Limit (Road Speed Limiting)
update rate: On request only
resolution: 0.5 mph/Bit (Uns/SI)
source: Calibration value (customer defined)
comments: Vehicle Speed Limiting is a customer option.

PID 81 — Exhaust Back Pressure
update rate: 0.1 times/sec.
resolution: 0.169 kPa/Bit

PID 83 - Vehicle Speed Limit Status

update rate:	1 time/s	
format:		
	Bit: 8	Vehicle Speed Status 1 - Active
	Bits: 1-7	All Bits set to 0
source:	ECM calculated	
comments:	Vehicle Speed Limiting is a customer option.	

PID 84 - Vehicle Speed

update rate:	10 times/s
resolution:	0.5 mph/Bit (Uns/SI)
source:	Vehicle Speed Sensor input
comments:	Transmitted only if the Vehicle Speed Sensor is configured.

PID 85 - Cruise Control Switch Status

update rate: 10 times/s

format:

		On/Off Switch
	Bit: 1	1-On
		0-Off
		Set Switch
	Bit: 2	1-Off
		0-On
		Coast Switch
	Bit: 3	1-Off
		0-On
		Resume Switch
	Bit: 4	1-Off
		0-On
		Accel Switch
	Bit: 5	1-Off
		0-On
		Brake Switch
	Bit: 6	1-Off
		0-On
		Clutch Switch
	Bit: 7	1-Off
		0-On
		Cruise Active
	Bit: 8	1-On
		0-Off

source: Cruise Control switch inputs

comments: Cruise Control status (Bit 8) is not cleared if Cruise Control is active but being overridden by the throttle.

PID 86 - Cruise Control Set Speed

update rate: 0.1 times/s, 5 times/s when the set speed is changing

resolution: 0.5 mph/Bit (Uns/SI)

source: Cruise Control switch inputs

comments: Transmitted if Vehicle Speed Cruise control is enabled.

PID 87 - Cruise Control High Set Limit

update rate: On request only

resolution: 0.5 mph/Bit (Uns/SI)

source: Calibration value (customer define)

comments: Transmitted if Vehicle Speed Cruise control is enabled.

PID 88 - Cruise Control Low Set Limit

update rate:	On request only
resolution:	0.5 mph/Bit (Uns/SI)
source:	Calibration value
comments:	Transmitted if Vehicle Speed Cruise control is enabled.

PID 89 - VSG Switch Status

update rate: 1 time/s

format:

Bit: 1	On/off switch 0-Off 1-On
Bit: 2	Set switch 0-Off 1-On
Bit: 3	Coast switch 0-Off 1-On
Bit: 4	Resume switch 0-Off 1-On
Bit: 5	Accel switch 0-Off 1-On
Bit: 6	Brake 0-Off 1-On
Bit: 7	Clutch 0-Off 1-On
Bit: 8	VSG 0-Off 1-On

source: VSG switch inputs/ECM calculated

comments: Transmitted when either the Pressure Sensor Governor, Cruise-Switch VSG or analog VSG is configured.

PID 91 - Percent Throttle

update rate:	10 times/s
resolution:	0.4%/Bit (Uns/SI)
source:	Throttle Sensor input

PID 92 - Percent Engine Load
update rate: 10 times/s
resolution: 0.5%/Bit (Uns/SI)
source: ECM calculated
comments: Percent engine load is the ratio of actual torque and the minimum of the requested torque and digital torque limit.

PID 93 - Output Torque
update rate: 1 time/s
resolution: 20 ft-lb/Bit (S/SI)
source: ECM calculated

PID 94 - Fuel Delivery Pressure
update rate: 1 time/s
resolution: 0.5 psi/Bit (Uns/SI)
source: Fuel Pressure Sensor

PID 95 - Fuel Filter Differential Pressure
update rate: 0.1 time/s
resolution: 0.25 psi/Bit (Uns/SI)
source: Fuel Filter Differential Pressure Sensor
comments: This parameter is available with Release 24.00 software or later.

PID 98 - Engine Oil Level
update rate: 0.1 time/s
resolution: 0.5%/Bit (Uns/SI)
source: Oil Level Sensor

PID 99 - Oil Filter Differential Pressure
update rate: 0.1 time/s
resolution: 0.0625 psi/Bit (Uns/SI)
source: Oil Filter Differential Pressure Sensor
comments: This parameter is available with Release 24.00 software or later.

PID 100 - Engine Oil Pressure
update rate: 1 time/s
resolution: 0.5 psi/Bit (Uns/SI)
source: Oil pressure sensor
sensor range: 0 to 65 psi

PID 101 - Crankcase Pressure
update rate: 1 time/s
resolution: 0.125 psi/Bit (Uns/SI)
source: Crankcase pressure sensor
comments: Some engine applications use a discrete switch in place of a full range sensor. In these applications, the crankcase pressure data transmitted on the J1587 data link is not a true representation of crankcase pressure.

PID 102 - Turbo Boost Pressure (Gage)
update rate: 2 times/s
resolution: 0.125 psig/Bit (Uns/SI)
source: Turbo Boost Pressure Sensor

PID 103 - Turbo Speed
update rate: 1 time/s
resolution: 500 rpm/Bit (Uns/SI)
source: Turbo Speed Sensor

PID 105 - Intake Manifold Temperature
update rate: 1 time/s
resolution: 1°F/Bit (Uns/SI)
source: Intake Manifold Temperature Sensor

PID 106 - Air Inlet Pressure
update rate: 1 time/s
resolution: 0.25 psi/Bit (Uns/SI)
source: Air Inlet Pressure Sensor or Boost Pressure Sensor (Series 2000 and Series 4000 only before Release 21.0, Series 50 and Series 60 beginning with Release 21.0)

PID 107 - Air Filter Differential Pressure
update rate: 0.1 time/s
resolution: 0.2 in.H_2O/Bit (Uns/SI)
source: Air Filter Differential Pressure Sensor
comments: This parameter is available with Release 24.00 software or later.

PID 108 - Barometric Pressure
update rate: 1 time/s
resolution: 0.0625 psi/Bit (Uns/SI)
source: Barometric Pressure Sensor or ECM calculated

PID 109 - Coolant Pressure

update rate:	1 time/s
resolution:	0.125 psi/Bit (Uns/SI)
source:	Coolant Pressure Sensor

PID 110 - Coolant Temperature

update rate:	1 time/s
resolution:	1°F/Bit (Uns/SI)
source:	Coolant Temperature Sensor
sensor range:	0 to 300 F

PID 111 - Coolant Level

update rate:	10 times/s
resolution:	0.5%/Bit (Uns/SI) (or full = 100%, low = 0%)
source:	Coolant Level Sensor
comments:	If the Add Coolant Level Sensor (ACLS) is installed with the Engine Protection Coolant Level Sensor (CLS), the coolant level will be:

100%	When both sensors are in coolant
50%	When the ACLS is out of the coolant
0%	When both sensors are out of the coolant

If only the CLS is configured:

100%	Full
0%	Low

PID 113 - Engine Governor Droop

update rate:	On request only
resolution:	2 rpm/Bit (Uns/SI)
source:	Calibration value

PID 121 - Engine Retarder Status

update rate: 1 time/s (5 times/s when changing)

format:

Bit: 1	1 - 2 cylinders active
Bit: 2	1 - 3 cylinders active
Bit: 3	1 - 4 cylinders active
Bit: 4	1 - 6 cylinders active
Bit: 5	1 - 8 cylinders active
Bit: 8	1 - Retarder active

comments: Transmitted only if engine brakes are configured.

PID 122 - Engine Retarder Percent

update rate:	1 time/s
resolution:	0.5%Bit (Uns/SI)
source:	ECM calculated
comments:	This parameter is available with Release 5.00 or later

Double Byte Parameters

PID 153 - Crankcase Pressure

update rate:	1 time/s
resolution:	0.0078125 kPa/Bit (S/I)
comments:	Some engine applications use a discrete switch in place of a full range sensor. In these applications, the crankcase pressure data transmitted on the J1587 data link is not a true representation of crankcase pressure. This PID is used to provide crankcase pressure with better resolution then that provided with PID 101. This parameter is available with Release 3.00 software or later.

PID 154 - Auxiliary Input and Output status #2

update rate: On request

format:

PID Data

154 a b

a - Auxiliary Input Status

Bit: 1, 2 Torque/RPM Limiting Switch
00 - Off
01 - On
10 - Error Condition
11 - Not Available

Bit: 4-3 Stop Engine Override Switch
00 - Off
01 - On
10 - Error Condition
11 - Not Available

Bit: 5, 6 A/C Disengaged
00 - Off
01 - On
10 - Error Condition
11 - Not Available

Bit: 8-7 Reserved

b - Auxiliary Output Status

Bit: 1, 2 Fan Control #2
00 - Off
01 - On
10 - Error Condition
11 - Not Available

Bit: 3, 4 Reserved

Bit: 5, 6 Reserved

Bit: 7, 8 Reserved

source: ECM calculated; outputs represent intended state

PID 155 - Auxiliary Input and Output status #1

update rate: On request

format:

PID	Data			
154	a b			
	a -	Auxiliary Input Status		
		Bit:1, 2	Jake Brake Low Switch	
			00 - Off	
			01 - On	
			10 - Error Condition	
			11 - Not Available	
		Bit: 3, 4	Jake Brake Medium Switch	
			00 - Off	
			01 - On	
			10 - Error Condition	
			11 - Not Available	
		Bit: 5, 6	Idle Validation Switch	
			00 - Off	
			01 - On	
			10 - Error Condition	
			11 - Not Available	
		Bit: 7, 8	Throttle Inhibit Switch	
			00 - Off	
			01 - On	
			10 - Error Condition	
			11 - Not Available	
	b -	Auxiliary Output Status		
		Bit: 1, 2	Vehicle Power Shutdown	
			00 - Off	
			01 - On	
			10 - Error Condition	
			11 - Not Available	
		Bit: 3, 4	Starter Lockout	
			00 - Off	
			01 - On	
			10 - Error Condition	
			11 - Not Available	
		Bit: 5, 6	Coolant Level Low Light	
			00 - Off	
			01 - On	
			10 - Error Condition	
			11 - Not Available	

Bit: 7, 8 Fan Control #1
00 - Off
01 - On
10 - Error Condition
11 - Not Available

source: ECM calculated; outputs represent intended state

PID 162 - Transmission Range Selected

update rate: 2 times/s

format: aa - Transmission Range Selected (ASCII)

comments: Transmitted only when the transmission type is a Meritor ESS (17-22). Characters sent will be 0, L, 1, 2, ..., 15. If only one character is required, the second character will be used and the first character will be a space. Whenever a target gear is not selected a "0" will be transmitted.

PID 163 - Transmission Range Attained

update rate: 2 times/s

format: aa - Transmission Range Attained (ASCII)

comments: Transmitted only when the transmission type is a Meritor ESS (17-22). Characters sent will be 0, L, 1, 2, ..., 15. If only one character is required, the second character will be used and the first character will be a space. Whenever a target gear is not selected a "0" will be transmitted.

PID 164 - Injection Control Pressure

update rate: 1 time/s

resolution: 1/256 MPa (Uns/I)

source: Injection Pressure Sensor

PID 166 - Engine Horsepower Rating

update rate: On request only

resolution: 1 bhp/Bit (Uns/I)

source: Calibration value

PID 168 - Battery Voltage

update rate: 1 time/s

resolution: 0.05 volts/Bit (Uns/I)

source: Battery voltage measured at input to ECM

comments: The ECM input battery voltage does fluctuate as injectors fire and will require filtering if used for display purposes.

PID 171 - Ambient Air Temperature
update rate: 1 time/s
resolution: 0.25°F/Bit (S/I)
source: ECM estimated
comments: This parameter is available with Release 2.00 software or later.

PID 172 - Air Inlet Temperature
update rate: 1 time/s
resolution: 0.25°F/Bit (S/I)
source: Air Temperature Sensor
sensor range: -40 to 175°F
comments: Location of air temperature sensor depends on engine series.

PID 173 — Exhaust Temperature
update rate: 1 time/sec
resolution: 0.25°F/Bit (S/I)

PID 174 - Fuel Temperature
update rate: 1 time/s
resolution: 0.25°F/Bit (S/I)
source: Fuel Temperature Sensor
sensor range: -40 to 175°F
comments: Location of air temperature sensor depends on engine series.

PID 175 - Engine Oil Temperature
update rate: 1 time/s
resolution: 0.25°F/Bit (S/I)
source: Oil temperature sensor
sensor range: -40 to 300°F
comments: Location of air temperature sensor depends on engine series.

PID 182 - Trip Fuel
update rate: 0.1 times/s
resolution: 0.125 gal/Bit (Uns/I)
source: ECM calculated

PID 183 - Fuel Rate
update rate: 5 times/s
resolution: 1/64 gal/hour/Bit (Uns/I)
source: ECM calculated

PID 184 - Instantaneous Fuel Economy (MPG)
update rate: 5 times/s
resolution: 1/256 mpg/Bit (Uns/I)
source: ECM calculated
comments: Transmitted only if the Vehicle Speed Sensor is configured.

PID 185 - Average Fuel Economy (MPG)
update rate: 0.1 times/s
resolution: 1/256 mpg/Bit (Uns/I)
source: ECM calculated
comments: Trip information from DDEC requires that the Vehicle Speed Sensor is enabled.

PID 187 - VSG Set Speed
update rate: 0.1 times/s, 5 times per s when the set speed is changing
resolution: 0.25 rpm/Bit (Uns/I)
source: VSG switch input
comments: Used to indicate the current set speed from:

- ☐ Analog VSG
- ☐ Cruise Switch VSG
- ☐ Engine Speed Cruise Control
- ☐ Pressure Governor Mode - RPM or pressure
- ☐ Engine Sync. Mode (marine applications)

PID 188 - Idle Set Speed
update rate: On request only
resolution: 0.25 rpm/Bit (Uns/I)
source: Calibration value

PID 189 - Rated Engine Speed
update rate: On request only
resolution: 0.25 rpm/Bit (Uns/I)
source: Calibration value

PID 190 - Engine Speed
update rate: 10 times/s
resolution: 0.25 rpm/Bit (Uns/I)
source: ECM calculated

PID 191 - Transmission Output Shaft Speed
update rate: 10 times/s
resolution: 0.25 rpm/Bit (Uns/I)
source: Transmitted when configured for Meritor ESS transmissions only.

PID 404 - Turbo Compressor Temperature Out
update rate: 1 times/s
resolution: 0.25°F/Bit (S/I)

Variable Length Parameters

PID 192 - Multi-Section Parameter
update rate: Used to transmit messages that are greater than 21 bytes in length.
format:

PID	Data	
192	n a b c/d c c c c c	
	n -	Byte count of data that follows this character. This excludes characters MID, PID 192 and n but it includes a, b, c, or d type character.
	a -	PID specifying the parameter that has been sectioned.
	b -	The last section number (total number of sections minus ONE) and the current section number. The upper nibble contains the current section number (1 to 15). The lower nibble contains the current section number and is limited to the range 0 to 15. Section numbers are assigned in ascending order.
	c -	Data portion of the sectioned parameter. May be 1 to 14 characters in the first packet. May be 1 to 15 characters in the middle and ending packets.
	d -	Byte count of the total data portion. This character is sent only in the first packet. The values are limited to 239 or less but must be greater than 17.

comment: PID 192 is used to section any DDEC message that exceeds 21 bytes while the engine is running, in particular PID 194, PID 196, and PID 243. If the engine is stopped, DDEC may transmit messages up to 40 bytes in length.

PID 194 - Transmitter System Diagnostic Code / Occurrence Count Table

update rate: On Request only

format:

PID Data

194 n a b c a b c a b c a b c a b c...

n - Byte count of data that follows this character. This excludes characters MID, PID 194 and n but includes a, b, c type characters.

a - SID or PID of a standard diagnostic code.

b - Diagnostic code character

Bits: 1-4 FMI of a standard diagnostic code

Bit: 5 Byte (a) Identifier
- 1 - Byte (a) is a SID
- 0 - Byte (a) is a PID

Bit: 6 Type of Diagnostic Code
- 1 - standard diagnostic code
- 0 - expansion diagnostic codes (PID/SID from page 2)

Bit: 7 Current Status of Fault
- 1 - fault is inactive
- 0 - fault is active

Bit: 8 Occurrence count
- 1 - count is included
- 0 - count is not included

c - Occurrence count for the diagnostic code defined by the preceding 2 characters. The maximum occurrence count is 255. Bit 8 of byte (b) of the diagnostic code is used to determine if it is included.

source: ECM calculated

comment: comments: Diagnostic codes are transmitted periodically while active. When the active code becomes inactive, the code is transmitted once to indicate that the fault became inactive. Inactive diagnostic codes are available by request of PID 194. If more than 6 codes are active at any point, PID 194 is sectioned as described in PID 192.

PID 196 - Diagnostic Data/count clear response

update rate: On Request only

format:

PID	Data
196	n a b c c c c c

n - Byte count of data that follows this character. This excludes characters MID, PID 194 and n but includes a, b, and c type characters.

a - SID or PID of a standard diagnostic code

b - Diagnostic Code Character

- Bits 1-4 - FMI of a standard diagnostic code
- Bit 5 - Byte (a) identifier
  - 1 - Byte (a) is a SID
  - 0 - Byte (a) is a PID
- Bit 6 - Type of diagnostic code
  - 1 - standard diagnostic code
  - 0 - expansion diagnostic codes (PID/SID from page 2)
- Bit 7-8 - Action
  - \- Message is an ASCII descriptive message for the given diagnostic code.
  - 01 - The count has been cleared for the given diagnostic code.
  - 10 - All clearable diagnostic counts have been cleared for this device.
  - \- Message is additional diagnostic information for the given diagnostic code, as defined below.

c = Additional information (if applicable)

- c1-c5 - ATA/VMRS (DTDSC)
- c6, c7 - Engine hours the code was first logged (LSB first)
  format: 1 h/Bit.
  range - 0-65535 hours.
- c8, c9 - Calendar date (Month, Day) the code was first logged, if available.
- c10, c11 - Clock time the code was first logged (hours, minutes), if available.
- c12, c13 - Engine hours the code last became active (LSB first).
- c14, c15 - Calendar date (Month, Day) the code last became active, if available.
- c16, c17 - Clock time the code last became active (hours, minutes), if available.

PID 196 - Diagnostic Data/count clear response

update rate: On Request only

format:

PID	Data	
	c18, c19 -	Number of ss the code has been active (LSB first). format: ss = 1 s/Bit range = 0-65535 (18.2 hours) Value remains at 65535 ss once it has been reached.
	c20 -	Number of Stop Engine Override Switch restarts while the code was active. The value remains at 255 once it has been reached.
	c21+ =	Optional associated parameter value (scaled as defined in J1587) For temperatures, pressures, and voltages with FMI 0 - Highest value achieved For temperatures, pressures, and voltages with FMI 1 - Lowest value achieved For engine speed with FMI 0 - Highest speed achieved For vehicle speed with FMI 0 or 11 - Highest speed achieved
	Last byte =	checksum

source: ECM calculated

comment: The date and time that the code last became inactive (bytes c14-c17) will be transmitted as zero if the code is currently active. This data may be sectioned using PID 192.

PID 228- Speed Sensor Calibration

update rate: On Request only

format:

PID	Data
228	n a a a a
	n = number of bytes: 4
	a = Speed Sensor Calibration 1 pulse/mi (Uns/LI)

source: Calculated from calibration values

comment: This parameter is available with Release 5.00 or later

PID 233- Unit Number (Power Unit)
update rate: On Request only
format:

PID	Data
231	n a a a . . .
	n = number of bytes: 10
	a = unit number in alphanumeric ASCII characters

comment: This parameter is available with Release 20.00 software or later

PID 234- Software Identification
update rate: On Request only
format:

PID	Data
234	n a a b c c
	n = number of bytes: 5
	a = Major software release level in ASCII
	b = ASCII "."
	b = Minor software release level in ASCII

Example: "01.05" is interpreted as Major release 1, Minor release 5
source: ECM calculated
comment: This parameter is available with Release 3.00 software or later

PID 235- Total Idle Hours
update rate: On Request only
format:

PID	Data
235	n a a a a
	n = number of bytes: 4
	a = Total idle hours; scaled 0.05 hours/Bit (Uns/LI)

source: ECM calculated
comment: Accumulates time while the engine is operating at idle.

PID 236- Total Idle Fuel Used
update rate: On Request only
format:

PID	Data
236	n a a a a
	n = number of bytes: 4
	a = Idle fuel used; scaled 1/8 hours/Bit (Uns/LI)

source: ECM calculated
comment: Accumulates while the engine is operating at idle.

PID 237- Vehicle Identification Number (VIN)
update rate: On Request only
format:

PID	Data
237	n a a a ...
	n = number of bytes: up to 17
	a = VIN in ASCII characters

source: Calibration value

PID 240- Last Customer Calibration Change Hours
update rate: On Request only
format:

PID	Data
240	n a a a a
	n = number of bytes: 4
	a = Last customer calibration change hours; scaled 0.05 h/Bit (Uns/LI)

source: ECM calculated
comment: Used to identify the last customer reprogramming occurrence, stored in engine hours.

PID 243- Device Identification
update rate: On Request only
format:

PID Data
243 n a b b b b b c d d d d d d d d e f f f f f f f f f f

n = number of bytes
a = component ID = MID
b = ATA/VMRS manufacturer ID (5 bytes)
c = delimiter: ASCII ‘*'
d = engine model number (8 bytes)

e = delimiter: ASCII ‘*'

f = engine serial number (10 bytes)

source: Calibration value
comment: This parameter may be sectioned using PID 192.

PID 244- Trip Miles
update rate: 0.1 times/s
format:

PID Data
244 n a a a a

n = number of bytes: 4
a = trip miles 0.1 mile/Bit (Uns/LI)

source: ECM calculated
comment: Transmitted only if the vehicle speed sensor is configured.

PID 245- Total Miles
update rate: 0.1 times/s
format:

PID Data
245 n a a a a

n = number of bytes: 4
a = trip miles, 0.1 mile/Bit (Uns/LI)

source: ECM calculated
comment: Transmitted only if the vehicle speed sensor is configured.

PID 247- Total Engine Hours
update rate: On request only
format:

PID Data
247 n a a a a
n = number of bytes: 4
a = total engine hours 0.05 hour/Bit (Uns/LI)

source: ECM calculated
comment: Used to identify the total hours that the engine is operating. Time accumulated while the engine speed is above 60 rpm.

PID 248- Total VSG Hours
update rate: On request only
format:

PID Data
248 n a a a a
n = number of bytes: 4
b = total VSG hours 0.05 hour/Bit (Uns/LI)

source: ECM calculated
comment: Used to identify total engine hours the engine is operating in the following modes:
-Hand throttle VSG
-High idle using cruise switches
-Pressure governor mode: either RPM or pressure

PID 249- Total Engine Revolutions
update rate: On request only
format:

PID Data
249 n a a a a
n = number of bytes: 4
a = total engine revolutions 1000 revolutions/Bit (Uns/SI)

comment: This parameter is available with Release 20.00 software or later

PID 250- Total Fuel Used
update rate: On request only
format:
PID Data
250 n a a a a
n = number of bytes: 4
a = total fuel used 0.125 gal/Bit (Uns/LI)
source: ECM calculated

PID 251- Clock
update rate: On request only
format:
PID Data
251 n a b c
n = number of bytes: 3
a = Seconds 0.25 sec/Bit, range 0 to 59.75 seconds
b = Minutes 1.0 min/Bit, range 0 to 59 minutes
c = Hours 1.00 hour/Bit, range 0 to 23 hours
comment: Transmitted if clock data is considered valid. The time is broadcast in Greenwich Mean Time. This parameter is available with Release 20.00 software or later.

PID 252- Date
update rate: On request only
format:
PID Data
252 n a b c
n = number of bytes: 3
a = Day 0.25 day/Bit, range 1 to 31.75 days
b = Month 1.0 month/Bit, range 1 to 12 months
c = Year - 1985 1.00 year/Bit, range 0 to 99
comment: Day of the month is scaled such that 0 is a null value, values 1, 2, 3, and 4 are the first day of the month, 5, 6, 7, 8, are the second day of the month, etc. Transmitted if clock data is considered valid. This parameter is available with Release 20.00 software or later.

6.3 SAE J1922

Circuits800 (Data Link +) and 801 (Data Link-) as shown on the communications harness schematic are used as the J1922 communication link.

6.3.1 MESSAGE FORMAT

A complete description of the DDEC III/IV parameters is provided within this section of the manual. DDEC III/IV transmits parametric data at SAE J1922 recommended rates in packed message form. The first byte or character of each J1922 message is the Message Identification Character (MID). The MID is used to identify the source of a data transmission and identify the type of data being transmitted.

6.3.2 SAE J1922 PARAMETERS AVAILABLE WITH DDEC III/IV

DDEC III/IV supports the J1922 message identifiers (MIDs) listed in Table 6-5.

MID	Description
69	Engine to powertrain message
70	Engine to powertrain initialization message
74	Transmission to powertrain message
76	Transmission to powertrain initialization request message
79	ABS/traction control to powertrain message
81	ABS/traction control to powertrain initialization request message
83	Retarder to powertrain message
84	Retarder to powertrain initialization message

Table 6-5 SAE J1922 MIDs Supported by DDEC

6.3.3 SAE J1922 MIDS

The following sections identify the MIDs supported by DDEC.

Engine to Powertrain

Byte 1	069	MID - Engine to powertrain
Byte 2	---	Percent torque value scaled 1% of peak torque/Bit - S/SI
Byte 3	---	Accelerator pedal position scaled 0.392%/Bit (100/255%/Bit) - Uns/SI
Byte 4	---	Control/status byte
	Bit 1	Cruise control status
		1: cruise control active
		0: cruise control inactive
	Bit 2	VSG control status
		1: VSG active
		0: VSG inactive
	Bit 3	Road speed limit status
		1: road speed limit active
		0: road speed limit inactive
	Bit 4	Retarder control status
		1: engine retarder enabled
		0: engine retarder not enabled
	Bit 5	AP kickdown switch
		1: in kickdown position
		0: not in kickdown position
	Bit 6	AP low idle switch
		1: in low idle position
		0: not in low idle position
	Bit 7	Engine parameter change
	Bit 8	Reserved
		1: parameters have changed
		0: current parameters valid
Byte 5	---	Engine's desired RPM scaled 16 rpm/Bit - Uns/SI
Byte 6	---	Desired RPM asymmetry adjustment scaled as a ratio - Uns/SI
Byte 7	---	Checksum

If either the transmission messages or the ABS messages are enabled, DDEC shall transmit this message 20 times per second.

Engine Initialization Response

Byte 1	070	MID - Engine initialization response
Byte 2,3	---	Engine speed at idle (warm condition) scaled 0.0625 rpm/Bit - Uns/I
Byte 4	---	Percent of peak torque at idle scaled 1% of peak torque/Bit - S/SI
Byte 5,6	---	Rated engine speed scaled 0.0625 rpm/Bit - Uns/I
Byte 7	---	Percent of peak torque at rated engine speed scaled 1% of peak torque/Bit - S/SI
Byte 8,9	---	Engine speed at point 3 scaled 0.0625 rpm/Bit - Uns/I
Byte 10	---	Percent of peak torque at point 3 scaled 1% of peak torque/Bit - S/SI
Byte 11,12	---	Engine speed at point 4 scaled 0.0625 rpm/Bit - Uns/I
Byte 13	---	Percent of peak torque at point 4 scaled 1% of peak torque/Bit - S/SI
Byte 14,15	---	Engine speed at point 5 scaled 0.0625 rpm/Bit - Uns/I
Byte 16	---	Percent of peak torque at point 5 scaled 1% of peak torque/Bit - S/SI
Byte 17,18	---	Engine speed at peak torque scaled 0.0625 rpm/Bit - Uns/I
Byte 19	---	Peak torque of engine scaled 10 lb·ft/Bit - Uns/SI
Byte 20,21	---	Engine speed at high idle scaled 0.0625 rpm/Bit - Uns/I
Byte 22	---	Maximum engine override speed scaled 16 rpm/Bit - Uns/SI
Byte 23	---	Checksum

DDEC transmits this message in response to the initialization request messages defined in "Transmission Initialization Request" and "ABS/Traction Control Initialization Request."

Transmission to Powertrain Message

Byte 1	074	MID - transmission to powertrain
Byte 2	---	Control/status byte
	Bit 1,2	Override control mode
		00: override disabled
		01: engine speed control
		10: engine torque control
		11: engine speed/torque limit
	Bit 3	Retarder enable
		1: enable retarder
		0: disable retarder
	Bit 4	Momentary high idle enable
		1: override enabled
		0: override disabled
	Bit 5	Driveline engaged (ignored by DDEC)
		1: driveline engaged
		0: driveline disengaged
	Bit 6	Transmission retarder status (ignored by DDEC)
		1: retarder active
		0: retarder inactive
	Bit 7,8	Reserved
Byte 3	---	When mode is as follows
		00: Not broadcast
		01: Desired engine speed (LSB)
		scaled 0.0625 rpm/Bit - Uns/I
		10: Not broadcast
		11: Engine speed upper limit
		scaled 16 rpm /Bit - Uns/SI
Byte 4	---	When mode
		00: Not broadcast
		01: Desired engine speed (MSB) - scaled 0.0625 rpm/Bit - Uns/I
		10: Desired torque value scaled 1% of peak torque/Bit - S/SI
		11: Percent torque upper limit scaled 1% of peak torque/Bit - S/SI
Byte 5	---	Output shaft speed scaled 16 rpm/Bit - Uns/SI
Byte 6	---	Checksum

The desired speed request requires a zero droop operation, regardless of the droop calibrated for either the rated speed governor or the VSG governor. While the transmission is requesting an override control mode other than override disabled (00), the messages are expected to be repeated on a continuous basis. DDEC will maintain the most recent requested control mode until a request to disable override (00) is received or a time-out period has elapsed without any request from the transmission, at which point DDEC will revert to its normal (override disabled) state.

Requests to disable the retarder (Bit 3 of byte 2) and override momentary high idle (Bit 4 of byte 2) follow the same strategy. DDEC will maintain the most recent requested state until a new request is received or a time-out period has elapsed without any request from the transmission. The default state for the retarder is enabled and for override momentary high idle is disabled.

NOTE:
This message has a variable length.

Transmission Initialization Request

Byte 1	076	MID - transmission initialization request
Byte 2		Status/enable byte
	Bit 1	1 = request engine initialization message
	Bit 2	1 = request trans. initialization message (ignored by DDEC)
	Bit 3	1 = request ABS initialization message (ignored by DDEC)
	Bit 4	1 = request retarder initialization message
	Bit 5-7	Reserved
	Bit 8	1 = progressive shift disable
Byte 3	---	Checksum

If enabled, DDEC responds to this request with the initialization messages defined in "Engine Initialization Response" and "Retarder Initialization Response" as appropriate. Once a progressive shift indication (allow or disallow) is transmitted, this state is maintained until a subsequent request from the transmission changes the state or a new ignition cycle begins.

ABS/Traction Control To Powertrain

Byte 1	079	MID - ABS/Traction control to powertrain
Byte 2	---	Control/status byte
	Bit 1,2	Override control mode
		00: override disabled
		01: engine speed control
		10: engine torque control
		11: engine torque limit
	Bit 3	Retarder or engine control select
		1: retarder control
		0: engine fueling control
	Bit 4	Gear shift disable (ignored by DDEC)
		1: Inhibit gear shifts
		0: allow shifts
	Bit 5	Retarder disable
		1: disable retarders
		0: enable retarders
	Bit 6	Torque converter lock up disable (ignored by DDEC)
		1: disable lock up clutch
		0: enable lock up clutch
	Bit 7	Request to neutral (ignored by DDEC)
		1: request de-clutch to neutral
		0: allow normal operation
	Bit 8	Reserved
Byte 3	---	When mode is as follows:
		00: Not broadcast
		01: Desired engine speed value scaled 16 rpm/Bit - Uns/SI
		10: Desired % peak torque value scaled 1% of peak torque/Bit - S/SI
		11: Percent torque upper limit scaled 1% of peak torque/Bit - S/SI
Byte 4	---	Checksum

While the traction control system is requesting a override control mode other than override disabled (00), the messages are expected to be repeated on a continuous basis. DDEC will maintain the most recent requested engine control mode and/or retarder control mode until a request to disable override (00) is received or a time-out period has elapsed without any request from the traction control system, at which point DDEC will revert to its normal (override disabled) state.

Requests to disable the retarder (Bit 5 of byte 2) follow the same strategy. DDEC will maintain the most recent requested state until a new request is received or a time-out period has elapsed without any request from the traction control system. The default state for the retarder is enabled. The retarder request is honored independent of the particular control select (Bit 3 of byte 2) in effect.

NOTE:
The retarder disable request applies to all retarder types; external engine retarder, DDEC controlled engine retarder, and transmission retarder.

DDEC will ignore requests from the ABS system when the transmission type is a Meritor ESS and the transmission is performing a shift.

DDEC will honor requests for both retarder control (Bit 3 of byte 2 = 1) and engine control (Bit 3 of byte 2 = 0). For retarder control, the percent of peak torque request will be translated into engine brake low, medium and high as follows:

0%	no braking or disable retarder
1% to 33%:	low braking
34% to 66%:	medium braking
67% to 100%:	high braking

Low, medium and high braking modes only apply when DDEC controls the engine brake directly. A request of 0% torque may apply to either direct engine brake control by DDEC or indirect engine brake control.

NOTE:
This message has a variable length.

ABS/Traction Control Initialization Request

Byte 1	**081**	**MID - ABS/Traction control initialization request**
Byte 2	---	Status/enable byte
	Bit 1	1 = request engine initialization message
	Bit 2	1 = request transmission initialization message (ignored by DDEC)
	Bit 3	1 = request ABS initialization message (ignored by DDEC)
	Bit 4	1 = request retarder initialization message
	Bit 5-8	Reserved
Byte 3	---	Checksum

If enabled, DDEC responds to this request with the initialization messages defined in "Engine Initialization Response" and "Retarder Initialization Response" as appropriate.

Retarder to Powertrain

Byte 1	083	MID - Retarder to powertrain
Byte 2	---	Retarder status byte
	Bit 1	Retarder active/inactive
		1: retarder active
		0: retarder inactive
	Bit 2	Retarder operational status
		1: retarder selected
		0: not selected
	Bit 3,4	For future use
	Bit 5-8	Retarding level status
		0000: Off
		0101: Active in low (33%)
		1010: Active in medium (66%)
		1111: Active in high (100%)
Byte 3	---	Checksum

If either the transmission messages or the ABS/ASR messages are enabled and digital outputs are configured for DDEC controlled engine brake operation, DDEC shall transmit this message 10 times per second.

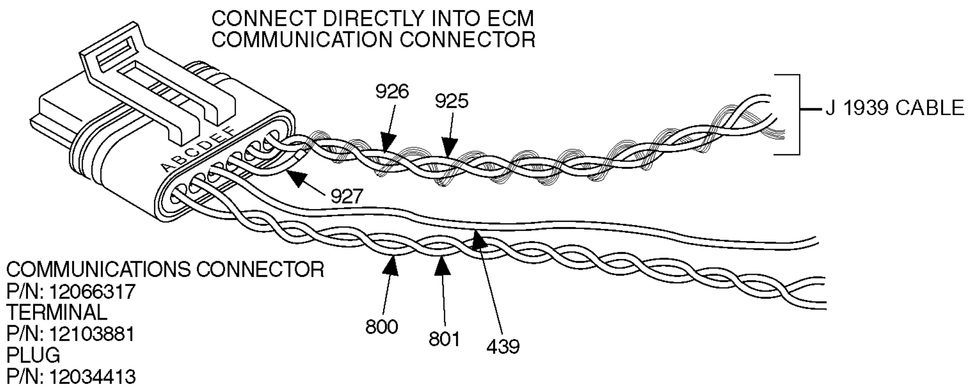
Retarder Initialization Response

Byte 1	084	MID - Retarder initialization response
Byte 2	---	Type of retarder
	Bit 1	Reserved - sent as 0
	Bit 2	1 = Engine compression release
	Bit 3-7	Not applicable for DDEC - sent as 0
	Bit 8	Reserved - sent as 0
Byte 3	---	Peak torque of retarder (10 lb·ft/Bit) - Uns/SI
Byte 4	---	Checksum

If either the transmission messages or the ABS/ASR messages are enabled and digital outputs are configured for DDEC controlled engine brake operation, DDEC transmits this message in response to the initialization request messages defined in "Transmission Initialization Request" and "ABS/Traction Control Initialization Request."

6.4 SAE J1939

Circuits 925 (CAN_H/J1939 [+]), 926 (CAN_L/J1939 [-]) and 927 (CAN_SHLD/J1939 Shield) as shown on the communications harness schematic are used as the J1939 communication link. See Figure 6-1.



LABEL	WIRE NO.	COMMUNICATION CONNECTOR CAVITY	WIRE COLOR
CAN_H/J 1939 (+) CONTROL DATA LINK	925	F	DK BLU
CAN_L/J 1939 (-) CONTROL DATA LINK	926	E	DK BLU/WHT
CAN_SHLD/J 1939 SHIELD	927	D	WHT/BLU
IGNITION	439	C	PNK
J 1922 (-) DATA LINK	801	B	TAN

NOTE: CIRCUIT 927 MUST USE A SHORT LENGTH (APPROX.) 6 in. OF STANDARD GAUGE GXL IN CAVITY D OF THE CONNECTOR, SPLICED TO THE NON-INSULATED SHIELD WIRE OF THE J 1939 COMMUNICATIONS CABLE. THE SPLICE MUST BE WRAPPED OR COVERED WITH A MATERIAL SUITABLE TO PREVENT DAMAGE TO THE OTHER WIRES. THE ENTIRE ASSEMBLY MUST BE COVERED WITH A GLUE LINED HEAT SHRINK.

NOTE: THE IGNITION WIRE IS OPTIONAL IF THE OEM HAS INSTALLED IGNITION ON THE 30-PIN VEHICLE INTERFACE HARNESS.

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Figure 6-1 Communication Harness

6.4.1 MESSAGE FORMAT

The message format uses the parameter group number as the label for a group of parameters. Each of the parameters within the group can be expressed in ASCII, as scaled data, or as function states consisting of one or more Bits. Alphanumeric data will be transmitted with the most significant byte first. Other parameters consisting of two or more data bytes shall be transmitted least significant byte first. The type of data is also identified for each parameter.

The following sections identify the parameters that are supported by DDEC, parameter group number response definitions (refer to section 6.4.2) and parameter group number command definitions (refer to section 6.4.3).

6.4.2 SAE J1939/71 APPLICATION LAYER

The Application Layer Parameter Group Number (PGN) response definitions are described in the following sections.

Electronic Engine Controller #1 – EEC1

Transmission Rate:		engine speed dependent
Data Length:		8 bytes
Data Page:		0
PDU format:		240
PDU specific:		4
Default priority:		3
PGN:		61,444 (0x00F004)
Byte : 1	Status_EEC1	
	Bits: 8-5	Not Defined
	Bits: 4-1	Engine / Retarder Torque Mode
		0000: Low Idle Governor/No Request (Default Mode)
		0001: Accelerator Pedal/Operator Selection
		0010: Cruise Control
		0011: PTO Governor
		0100: Road Speed Governor
		0101: ASR Control
		0110: Transmission Control
		0111: ABS Control
		1000: Torque Limiting
		1001: High Speed Governor
		1010: Braking System
		1011: Remote Accelerator - N/A
		1100: Not Defined
		1101: Not Defined
		1110: Other
		1111: Not Available
Byte: 2	Drivers Demand Engine - Pct Torque	
	Resolution:	1% / Bit, -125% offset
Byte: 3	Actual Engine - Percent Torque	
	Resolution:	1% / Bit, -125% offset
Bytes: 4,5	Engine Speed	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Bytes: 6-8	Not Defined	

Electronic Engine Controller #2 – EEC2

Transmission Rate :		50 ms
Data Length:		8 bytes
Data Page:		0
PDU format:		240
PDU specific:		3
Default priority:		3
PGN:		61,443 (0x00F003)
Byte: 1	Status_EEC2	
	Bits: 8-5	Not Defined (Transmitted as 1111)
	Bits: 4-3	AP Kickdown Switch
		00: Kickdown Passive
		01: Kickdown Active
		11: Not Configured
	Bits: 2,1	AP Low Idle Switch
		00: Not In Low Idle Condition
		01: In Low Idle Condition
		11: Not Configured
Byte: 2	Accelerator Pedal Position (TPS)	
	Resolution:	0.4% / Bit, 0% offset
Byte: 3	Percent Load At Current Speed	
	Resolution:	1% / Bit, 0% offset
Bytes: 4-8	Not Defined	

Idle Operation

Transmission Rate :		On Request
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		220
Default priority:		8
PGN:		65,244 (0x00FEDC)
Bytes: 1-4	Total Idle Fuel Used	
	Resolution:	0.5 L / Bit, 0 L offset
Bytes: 5-8	Total Idle Hours	
	Resolution:	0.05 hr / Bit, 0 hr offset

Turbocharger

Transmission Rate :		1 sec
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		221
Default priority:		6
PGN:		65, 245 (0x00FEDD)
Byte: 1	Turbo Oil Pressure - N/A	
Bytes: 2,3	Turbo Speed	
	Resolution:	4 rpm / Bit, 0 rpm offset
Bytes: 4-8	Not Defined	

Electronic Engine Controller #3 – EEC3

Transmission Rate :		250 ms
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		223
Default priority:		6
PGN:		65,247 (0x00FEDF)
Byte: 1	Nominal Friction - Percent Torque	
	Resolution:	1% / Bit, -125% offset
Bytes: 2,3	Engine's Desired Operating Speed	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte 4:	Engine's Desired Operating Speed Asymmetry Adjustment ratio 0 to 250	
Bytes: 5-8	Not Defined	

Vehicle Distance

Transmission Rate :		On Request
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		224
Default priority:		6
PGN:		65,248 (0x00FEE0)
Bytes: 1-4	Trip Distance	
	Resolution:	0.125 km / Bit, 0 km offset
Bytes: 5-8	Total Vehicle Distance	
	Resolution:	0.125 km / Bit, 0 km offset

Idle Shutdown

Transmission Rate :		1 sec	
Data Length:		8 bytes	
Data Page:		0	
PDU format:		254	
PDU specific:		228	
Default priority:		6	
PGN:		65,252 (0x00FEE4)	
Byte: 1	Idle shutdown_1		
	Bits: 8,7	Idle Shutdown Timer State	
		00:	Inactive
		01:	Active
	Bits: 6,5	Idle Shutdown Timer Override	
		00:	Inactive
		01:	Active
	Bits: 4,3	Driver Alert Mode	
		00:	Inactive
		01:	Active
	Bits: 2,1	Engine Has Shutdown by Idle Shutdown	
		00:	Engine has not shutdown by idle shutdown
		01:	Engine has shutdown by idle shutdown
Byte: 2	Idle shutdown_2		
	Bits: 8,7	Idle Shutdown Timer Function.	
		00:	Disabled in Calibration
		01:	Enabled in Calibration
	Bits: 6-1	Not Defined	
	Byte: 3	Refrigerant_press_1 - N/A	
	Byte: 4	Lamp_commands - N/A	

Transmission Rate :		1 sec
	Byte: 5	Engine shutdown_1
	Bits: 8,7	Engine Protection Shutdown Timer State
		00:Timer not Active
		01:Timer Active
	Bits: 6,5	Engine Protection Shutdown Override
		00:Override Off
		01:Override On
	Bits: 4,3	Engine Shutdown Approaching - N/A
	Bits: 2,1	Engine Has Shutdown By Engine Protection System
		00:Not Shutdown
		01:Has Shutdown
	Byte: 6	Engine shutdown_2
	Bits: 8,7	Engine Protection System Configured
		00:Not Enabled In Calibration
		01:Enabled In Calibration
	Bits: 6-1	Not Defined
Bytes: 7-8	Not Defined	

Engine Hours, Revolutions

Transmission Rate :		On Request
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		229
Default priority:		6
PGN:		PGN:65,253 (0x00FEE5)
Bytes: 1-4	Total Engine Hours	
	Resolution:	0.05 h / Bit, 0 h offset
Bytes: 5-8	Total Engine Revolutions	
	Resolution:	1000 revs / Bit, 0 revs offset

Time/Date

Transmission Rate :		On Request
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		230
Default priority:		6
PGN:		65,254 (0x00FEE6)
Byte: 1	Seconds	
	Resolution:	0.25 sec / Bit, 0 sec offset
Byte: 2	Minutes	
	Resolution:	1 min / Bit, 0 min offset
Byte: 3	Hours	
	Resolution:	1 hour / Bit, 0 h offset
Byte: 4	Month	
	Resolution:	1 month / Bit, 0 month offset
Byte: 5	Day	
	Resolution:	0.25 day / Bit, 0 day offset
Byte: 6	Year	
	Resolution:	1 year / Bit, 1985 year offset
Bytes: 7,8	Not Defined	

Vehicle Hours

Transmission Rate :		On Request
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		231
Default priority:		6
PGN:		65,255 (0x00FEE7)
Bytes: 1-4	Total Vehicle Hours -N/A	
Bytes: 5-8	Total Power Takeoff Hours	
	Resolution:	0.05 h / Bit, 0 h offset

Fuel Consumption

Transmission Rate :		On Request
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		233
Default priority:		6
PGN:		65,257 (0x00FEE9)
Byte: 1-4	Trip Fuel	
	Resolution:	0.5 L / Bit, 0 L offset
Bytes: 5-8	Total Fuel Used	
	Resolution:	0.5 L / Bit, 0 L offset

Cruise Control / Vehicle Speed Setup

Transmission Rate :		On Request
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		237
Default priority:		6
PGN:		65,261 (0x00FEED)
Byte: 1	Maximum Vehicle Speed Limit	
	Resolution:	1 km/h / Bit, 0 km/h offset
Byte: 2	Cruise Control High Set Limit Speed.	
	Resolution:	1 km/h / Bit, 0 km/h offset
Byte: 3	Cruise Control Low Set Limit Speed	
	Resolution:	1 km/h / Bit, 0 km/h offset
Bytes: 4-8	Not Defined	

Engine Temperature

Transmission Rate :	1 sec
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	238
Default priority:	6
PGN:	65,262 (0x00FEEE)

Byte: 1	Engine Coolant Temperature	
	Resolution:	1°C / Bit, -40°C offset
Byte: 2	Fuel Temperature	
	Resolution:	1°C / Bit, -40°C offset
Bytes: 3,4	Engine Oil Temperature	
	Resolution:	0.03125°C / Bit, -273°C offset
Bytes: 5,6	Turbo Oil Temperature -N/A	
Byte: 7	Engine Intercooler Temperature	
	Resolution:	1°C / Bit, -40°C offset
Byte 8:	Not Defined	

Engine Fluid Level/Pressure

Transmission Rate :		0.5 sec
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		239
Default priority:		6
PGN:		65,263 (0x00FEEF)
Byte: 1	Fuel Delivery Pressure	
	Resolution:	4 kPa / Bit, 0 kPa offset
Byte: 2	Not Defined	
Byte: 3	Engine Oil Level	
	Resolution:	0.4% / Bit, 0% offset
Byte: 4	Engine Oil Pressure	
	Resolution:	4 kPa / Bit, 0 kPa offset
Byte: 5,6	Crankcase Pressure	
	Resolution:	0.0078125 kPa / Bit (1/128 kPa / Bit), -250 kPa offset
Byte: 7	Coolant Pressure	
	Resolution:	2 kPa / Bit, 0 kPa offset
Byte: 8	Coolant Level	
	Resolution:	0.4% / Bit, 0% offset

Power Takeoff Information

Transmission Rate :		100 ms	
Data Length:		8 bytes	
Data Page:		0	
PDU format:		254	
PDU specific:		240	
Default priority:		6	
PGN:		65,264 (0x00FEF0)	
Byte: 1	Power Takeoff Oil Temperature - N/A		
Byte: 2,3	Power Takeoff Speed - N/A		
Byte: 4,5	Power Takeoff Set Speed		
	Resolution:	0.125 rpm / Bit, 0 rpm offset	
Byte: 6	Measured_PTO_1		
	Bits: 8,7	Not Defined	
	Bits: 6,5	Remote PTO Variable Speed Control Switch - N/A	
	Bits: 4,3	Remote PTO Preprogrammed Speed Control Switch	
		00:	Switch Off
		01:	Switch On
		11:	Not Configured
	Bits: 2,1	PTO Enable Switch	
		00:	Switch Off
		01:	Switch On
		11:	Not Configured
Byte: 7	Measured_PTO_2		
	Bits: 8,7	PTO Accelerate Switch	
		00:	Switch Off
		01:	Switch On
		11:	Not Configured
	Bits: 6,5	PTO Resume Switch	
		00:	Switch Off
		01:	Switch On
		11:	Not Configured
	Bits: 4,3	PTO Coast/Decelerate Switch	
		00:	Switch Off
		01:	Switch On
		11:	Not Configured
	Bits: 2,1	PTO Set Switch	
		00:	Switch Off
		01:	Switch On
		11:	Not Configured
Byte: 8	Not Defined		

Cruise Control / Vehicle Speed

Transmission Rate :		100 ms
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		241
Default priority:		6
PGN:		65,265 (0x00FEF1)
Byte: 1	Measured_SW1	
	Bits: 8-5	Not Defined
	Bits: 4,3	Parking Brake Switch
		00: Park Brake Not Set
		01: Park Brake Set
		11: Not Configured
	Bits: 2,1	Two Speed Axle Switch - N/A.
Byte: 2,3	Wheel Based Vehicle Speed	
	Resolution:	1/256 km/h / Bit, 0 km/h offset (1/412 mph / Bit, 0 mph offset)
Byte: 4	Measured_CC_SW1	
	Bits: 8,7	Clutch Switch
		00: Clutch Pedal Released
		01: Clutch Pedal Depressed
		11: Not Configured
	Bits: 6,5	Brake Switch
		00: Brake Pedal Released
		01: Brake Pedal Depressed
		11: Not Configured
	Bits: 4,3	Cruise Control Enable Switch
		00: Cruise Control Disabled
		01: Cruise Control Enabled
		11: Not Configured
	Bits: 2,1	Cruise Control Active
		00: Cruise Control Off
		01: Cruise Control On
		11: Not Configured
Byte: 5	Measured _CC_SW2	
	Bits: 8,7	Cruise Control Accelerate Switch
		00: Accelerate Switch Off
		01: Accelerate Switch On
		11: Not Configured
	Bits: 6,5	Cruise Control Resume Switch
		00: Resume Switch Off

		01: Resume Switch On
		11: Not Configured
	Bits: 4,3	Cruise Control Coast Switch
		00: Coast Switch Off
		01: Coast Switch On
		11: Not Configured
	Bits: 2,1	Cruise Control Set Switch
		00: Set Switch Off
		01: Set Switch On
		11: Not Configured
	Byte: 6	Cruise Control Set Speed
	Resolution:	1 km/h / Bit, 0 km/h offset
Byte: 7	State_CC	
	Bits: 8–6	Cruise Control State
		000: Off/Disabled
		001: Hold
		010: Accelerate
		011: Decelerate/Coast
		100: Resume
		101: Set
		110: Accelerator Override
		111: Not Available
	Bits: 5-1	PTO State - N/A
Byte: 8	Measured_idle_SW1	
	Bits: 8,7	Not Defined
	Bits: 6,5	Engine Test Mode Switch - N/A
	Bits: 4,3	Idle Decrement Switch - N/A
	Bits: 2,1	Idle Increment Switch - N/A

Fuel Economy

Transmission Rate :		100 ms
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		242
Default priority:		6
PGN:		65,266 (0x00FEF2)
Bytes: 1,2	Fuel Rate	
	Resolution:	0.05 L/h / Bit, 0 L/h offset
	Data Range:	0 to 3212.75 L/h
Bytes: 3,4	Instantaneous Fuel Economy	
	Resolution:	1/512 km/L / Bit, 0 km/L offset
	Data Range:	0 to 125.5 km/L
Bytes: 5,6	Average Fuel Economy	
	Resolution:	1/512 km/L / Bit, 0 km/L offset
	Data Range:	0 to 125.5 km/L
Bytes: 7,8	Not Defined	

Ambient Conditions

Transmission Rate :		1 sec
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		245
Default priority:		6
PGN:		65,269 (0x00FEF5)
Byte: 1	Barometric Pressure	
	Resolution:	0.5 kPa / Bit, 0 kPa offset
Byte: 2	Cab Interior Temperature - N/A	
Bytes: 4,5	Ambient Air Temperature	
	Resolution:	0.03125°C / Bit, -273°C offset
Byte: 6	Air Inlet Temperature	
	Resolution:	1°C / Bit, -40°C offset
Bytes: 7,8	Road Surface Temperature - N/A	

Inlet / Exhaust Conditions

Transmission Rate :		0.5 sec
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		246
Default priority:		6
PGN:		65,270 (0x00FEF6)
Byte: 1	Particulate Trap Inlet Pressure - N/A	
Byte 2:	Boost Pressure	
	Resolution:	2 kPa / Bit, 0 kPa offset
Byte 3:	Intake Manifold Temperature	
	Resolution:	1°C / Bit, -40°C offset
Byte 4:	Air Inlet Pressure	
	Resolution:	2 kPa / Bit, 0 kPa offset
Byte 5:	Air Filter Differential Pressure	
	Resolution:	0.05 kPa / Bit, 0 kPa offset
Bytes: 6,7	Exhaust Gas Temperature	
	Resolution:	0.03125°C / Bit, -273°C offset
Byte: 8	Coolant Filter Differential Pressure - N/A	

Exhaust Port Temperature #1

Transmission rate:	1 sec
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific	163
Default Priority:	7
PGN:	65,185 (Ox00FEA3)

Byte: 1, 2	Exhaust Gas Port 1 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 3, 4	Exhaust Gas Port 2 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 5, 6	Exhaust Gas Port 3 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 7, 8	Exhaust Gas Port 4 Temperature Resolution: 0.03125°C/bit, —273°C offset

Exhaust Port Temperature #2

Transmission Rate:	1 sec
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	162
Default Priority:	7
PGN:	65, 186 (Ox00FEA2)

Bytes: 1, 2	Exhaust Gas Port 5 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 3, 4	Exhaust Gas Port 6 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 5, 6	Exhaust Gas Port 7 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 7, 8	Exhaust Gas Port 8 Temperature Resolution: 0.03125°C/bit, —273°C offset

Exhaust Port Temperature #3

Transmission Rate:	1 sec
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	162
Default Priority:	7
PGN:	65, 186 (Ox00FEA1)

Byte: 1, 2	Exhaust Gas Port 9 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 3, 4	Exhaust Gas Port 10 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 5,6	Exhaust Gas Port 11 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 7, 8	Exhaust Gas Port 12 Temperature Resolution: 0.03125°C/bit, —273°C offset

Exhaust Port Temperature #4

Transmission Rate:	1 sec
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	160
Default Priority:	7
PGN:	65, 184 (Ox00FEA0)

Byte: 1, 2	Exhaust Gas Port 13 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 3, 4	Exhaust Gas Port 14 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 5, 6	Exhaust Gas Port 15 Temperature Resolution: 0.03125°C/bit, —273°C offset
Byte: 7, 8	Exhaust Gas Port 16 Temperature Resolution: 0.03125°C/bit, —273°C offset

Vehicle Electrical Power

Transmission Rate :		1 sec
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		247
Default priority:		6
PGN:		65,271 (0x00FEF7)
Byte: 1	Net Battery Current - N/A	
Byte: 2	Alternator Current - N/A	
Bytes: 3,4	Alternator Potential (voltage) - N/A	
Bytes: 5,6	Electrical Potential (voltage)	
	Resolution:	0.05 V / Bit, 0 V offset
Bytes: 7,8	Battery Potential (Voltage), Switched - N/A	

Alternate Fuel #1

Transmission Rate :		500 ms
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		253
Default priority:		6
PGN:		65,277 (0x00FEFD)
Byte: 1	Blower Bypass Valve Position	
	Resolution:	0.4% / Bit, 0% offset
Bytes: 2,3	Gas Supply Pressure - N/A	
Bytes: 4-8	Not Defined	

Auxiliary Water Pump Pressure

Transmission Rate :		1 sec
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		254
Default priority:		6
PGN:		65,278 (0x00FEFE)
Byte: 1	Auxiliary Pump Pressure	
	Resolution:	16 kPa / Bit, 0 kPa offset
Byte: 2-8	Not Defined	

Engine Fluid Level/Pressure #2

Transmission Rate :		0.5 sec
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		219
Default priority:		6
PGN:		65,243 (0x00FEDB)
Bytes: 1,2	Injection Control Pressure - N/A	
Bytes: 3,4	Injector Metering Rail Pressure	
	Resolution:	1/256 MPa / Bit, 0 MPa offset
Bytes: 5-8	Not Defined	

High Resolution Vehicle Distance

Transmission Rate :		1 sec
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		193
Default priority:		6
PGN:		65,217 (0x00FEC1)
Bytes: 1-4	High Resolution Total Vehicle Distance	
	Resolution:	5 m / Bit, 0 m offset (16.4 ft/Bit, 0 ft offset)
Bytes: 5-8	High Resolution Trip Distance	
	Resolution:	5 m / Bit, 0 m offset (16.4 ft/Bit, 0 ft offset)

Electronic Engine Controller #4 : EEC4

Transmission Rate :		On Request
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		190
Default priority:		7
PGN:		65,214 (0x00FEBE)
Bytes: 1,2	Rated Engine Power	
	Resolution:	0.5 kW / Bit, 0 kW offset (0.67 hp / Bit, 0 hp offset)
Bytes: 3,4	Rated Engine Speed	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Bytes: 5-8	Not Defined	

Fan Drive

Transmission Rate :		1 sec	
Data Length:		8 bytes	
Data Page:		0	
PDU format:		254	
PDU specific:		189	
Default priority:		6	
PGN:		65,213 (0x00FEBD)	
Byte: 1	Estimated Percent Fan Speed		
	Resolution:	0.4% / Bit, 0% offset	
Byte: 2	State_Fan_Drive		
	Bits: 8-5	Not Defined	
	Bits: 4-1	Fan Drive State	
		0000:	Fan Off
		0001:	Engine System - General
		0010:	Excessive Engine Air Temperature
		0011:	Excessive Engine Oil Temperature
		0100:	Excessive Engine Coolant Temperature
		0101-1000:	Not Defined
		1001:	Manual Control
		1010:	Transmission Retarder
		1011:	A/C System
		1100:	Timer
		1101:	Engine Brake
		1110:	Other
		1111:	Not Available
Bytes: 3-8	Not Defined		

Electronic Retarder Controller #1 - ERC1

Transmission Rate :		100 ms	
Data Length:		8 bytes	
Data Page:		0	
PDU format:		240	
PDU specific:		0	
Default priority:		6	
PGN:		61,440 (0x00F000)	
Byte : 1	Status_ERC1		
	Bits: 8,7	Retarder Enable - Shift Assist Switch - N/A	
	Bits: 6,5	Retarder Enable - Brake Assist Switch - N/A	
	Bits: 4-1	Engine/Retarder Torque Mode	
		0000:	No Request (Default Mode)
		0001:	Accelerator Pedal/Operator Selection
		0010:	Cruise Control
		0011:	PTO Governor
		0100:	Road Speed Governor - N/A
		0101:	ASR Control
		0110:	Transmission Control
		0111:	ABS Control
		1000:	Torque Limiting - N/A
		1001:	High Speed Governor - N/A
		1010:	Braking System
		1011:	Remote Accelerator - N/A
		1100:	Not Defined
		1101:	Not Defined
		1110:	Other
		1111:	Not Available
Byte: 2	Actual Retarder - Percent Torque		
	Resolution:	1% / Bit, -125% offset	
Byte: 3	Intended Retarder Percent Torque - N/A		
Byte: 4	Coolant Load Increase - N/A		
Bytes: 5-8	Not Defined		

Software Identification

Transmission Rate :	On Request
Data Length:	31 bytes
Data Page:	0
PDU format:	254
PDU specific:	218
Default priority:	6
PGN:	65,242 (0x00FEDA)

Byte: 1	Number of Software Identification Fields - 7
Byte: 2	1st digit of Cal Major Version - ASCII
Byte: 3	2nd digit of Cal Major Version - ASCII
Byte: 4	3rd digit of Cal Major Version - ASCII
Byte: 5	* - Delimiter
Byte: 6	1st digit of Cal Minor Version - ASCII
Byte: 7	2nd digit of Cal Minor Version - ASCII
Byte: 8	3rd digit of Cal Minor Version - ASCII
Byte: 9	* - Delimiter
Byte: 10	1st Digit of Cal Edit Version - ASCII
Byte: 11	2nd Digit of Cal Edit Version - ASCII
Byte: 12	3rd Digit of Cal Edit Version - ASCII
Byte: 13	* - Delimiter
Byte: 14	1st Digit of Edit Build Version - ASCII
Byte: 15	2nd Digit of Edit Build Version - ASCII
Byte: 16	3rd Digit of Edit Build Version - ASCII
Byte: 17	* - Delimiter
Byte: 18	Software Release Type - ASCII X - Experimental T - Pre-production R - Production
Byte: 19	* - Delimiter
Byte: 20	DDEC Hardware Version - ASCII 3 – DDEC III, 4 – DDEC IV, 5 – DDEC V
Byte 21:	* - Delimiter
Bytes: 22-29	ECM Serial Number - ASCII
Byte: 30	* - Delimiter

Component Identification

Transmission Rate :	On Request
Data Length:	37 bytes
Data Page:	0
PDU format:	254
PDU specific:	235
Default priority:	6
PGN:	65,259 (0x00FEEB)

Bytes:	1-5	DTDSC - ASCII
Byte:	6	* - Delimiter
Byte:	7-14	Engine Model Number - ASCII
Byte:	15	* - Delimiter
Byte:	16-25	Engine Serial Number - ASCII
Byte:	26	* - Delimiter
Byte:	27-36	Unit Number (VIN) - ASCII
Byte:	37	* - Delimiter

Retarder Configuration

Transmission Rate :		On Request
Data Length:		19 bytes
Data Page:		0
PDU format:		254
PDU specific:		225
Default priority:		6
PGN:		65,249 (0x00FEE1)
Byte: 1	Type And Location	
	Bits: 8-5	Retarder Location
		0000: Primary Engine Retarder For Compression Brakes
		0001: Primary Engine Retarder For Exhaust Brakes
	Bits: 4-1	Retarder Type
		0011: Compression Release (Engine Retarder)
		0100: Exhaust
Byte: 2	Retarder Control Method	
	255 - when not configured	
	0 - DVB	
	1 - Konstantdrossel	
	2 - Low/High Compression	
	3 - Low/Med/High Compression	
Bytes: 3, 4	Retarder Speed At Idle, Point 1- N/A	
Byte: 5	Percent Torque At Idle, Point 1 - N/A	
Bytes: 6, 7	Maximum Retarder Speed, Point 2 - N/A	
Byte: 8	Percent Torque At Maximum Speed, Point 2 - N/A	
Bytes: 9, 10	Retarder Speed At Point 3 - N/A	
Byte: 11	Percent Torque At Point 3 - N/A	
Bytes: 12, 13	Retarder Speed At Point 4 - N/A	
Byte: 14	Percent Torque At Point 4 - N/A	
Bytes: 15,16	Retarder Speed At Peak Torque, Point 5 - N/A	
Bytes: 17,18	Reference Retarder Torque - N/A	
Bytes: 19	Percent Torque At Peak Torque, Point 5 - N/A	

Engine Configuration

Transmission Rate :	on change of torque/speed points of more than 10% since last transmission, or every 5 s
Data Length:	28 bytes
Data Page:	0
PDU format:	254
PDU specific:	227

Default priority:		6
PGN:		65,251 (0x00FEE3)
Bytes: 1,2	Engine Speed At Idle, Point 1	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte: 3	Percent Torque At Idle, Point 1	
	Resolution:	1% / Bit, -125% offset
Bytes: 4, 5	Engine Speed At Point 2	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte: 6	Percent Torque At Point 2	
	Resolution:	1% / Bit, -125% offset
Bytes: 7,8	Engine Speed At Point 3	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte: 9	Percent Torque At Point 3	
	Resolution:	1% / Bit, -125% offset
Bytes: 10, 11	Engine Speed At Point 4	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte: 12	Percent Torque At Point 4	
	Resolution:	1% / Bit, -125% offset
Bytes: 13, 14	Engine Speed At Point 5	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte: 15	Percent Torque At Point 5	
	Resolution:	1% / Bit, -125% offset
Bytes: 16, 17	Engine Speed At High Idle, Point 6	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Bytes: 18, 19	(KP) Of Endspeed Governor - N/A	
Bytes: 20, 21	Reference Engine Torque	
	Resolution:	1 Nm / Bit, 0 Nm offset
Byte: 22, 23	Maximum Momentary Engine Override Speed, Point 7	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte: 24	Maximum Momentary Engine Override Time Limit	
	Resolution:	0.1 s / Bit, 0 s offset
Byte: 25	Requested Speed Control Range Lower Limit - 300 RPM	
	Resolution:	10 rpm / Bit, 0 rpm offset
Byte: 26	Requested Speed Control Range Upper Limit	
	Resolution:	10 rpm / Bit, 0 rpm offset
Byte: 27	Requested Torque Control Range Lower Limit	
	Resolution:	1% / Bit, -125% offset
Byte: 28	Requested Torque Control Range Upper Limit	
	Resolution:	1 % / Bit, -125% offset

Adaptive Cruise Control

Transmission rate :		100 ms
Data length:		8 bytes
		0
PDU format:		254
PDU specific:		111
PGN:		0x00FE6F
Byte : 1	Speed of Forward Vehicle - N/A	
Byte : 2	Distance to Forward Vehicle - N/A	
Byte : 3	Adaptive Cruise Control Set Speed - N/A	
Byte : 4	ACC Status 1	
	Bits: 8,7	Not Defined
	Bits: 6-4	Adaptive Cruise Control Set Distance Mode - N/A
	Bits: 3-1	Adaptive Cruise Control State
		110: Error
		111: Not Available
Byte : 5	Road Curvature - N/A	
Byte : 6-8	Not Defined	
Note:	This message is received only from an ACC device. It is not transmitted by the ECM.	

Torque Speed Control - TSC1

Transmission Rate :		10 ms
Data Length:		8 bytes
Data Page:		0
PDU format:		0
PDU specific:		Destination Address
Default priority:		3
PGN:		0 (0x000000)
Byte : 1	Control Bits	
	Bits: 8,7	Not Defined
	Bits: 6,5	Override Control Mode Priority
		00: Highest
		01: High
		10: Medium
		11: Low
	Bits: 4,3	Requested Speed Control Conditions - N/A
	Bits: 2,1	Override Control Modes
		00: Override Disabled
		01: Speed Control
		10: Torque Control
		11: Speed/Torque Limit
Byte: 2,3	Requested Speed / Speed Limit	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte: 4	Requested Torque / Torque Limit	
	Resolution:	1% / Bit, -125% offset
		0-125% for engine torque requests
		-125-0% for retarder torque requests
Bytes: 5-8	Not Defined	

Electronic Transmission Controller #1 – ETC1

Transmission Rate :		10 ms
Data Length:		8 bytes
Data Page:		0
PDU format:		240
PDU specific:		2
Default priority:		3
PGN:		61,442 (0x00F002)
Byte : 1	Status_ETC1	
	Bits: 8,7	Not Defined
	Bits: 6,5	Shift in Progress
		00: shift is not in process
		01: shift in process
		11: N/A
	Bits: 4,3	Torque Converter Lockup Engaged - N/A
	Bits: 2,1	Driveline Engaged
		00: Driveline Disengaged
		01: Driveline Engaged
		11: N/A
Byte: 2,3	Output Shaft Speed	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte: 4	Percent Clutch Slip - N/A	
Byte: 5	Command_ETC1	
	Bits: 8-5	Not Defined
	Bits: 4-3	Progressive Shift Disabled
		00: Progressive Shift Is Not Disabled
		01: Progressive Shift Is Disabled
		11: N/A
	Bits: 2,1	Momentary Engine Overspeed Enable
		00: Momentary Engine Overspeed Is Disabled
		01: Momentary Engine Overspeed Is Enabled
		11: N/A
Bytes: 6,7	Input Shaft Speed - N/A	
Byte: 8	Not Defined	

6.4.3 SAE J1939/21 DATA LINK LAYER

The Data Link Layer Parameter Group Number (PGN) response definitions are described in the following sections.

Acknowledge / Negative Acknowledge

Transmission Rate :	As Needed
Data Length:	8 bytes
Data Page:	0
PDU format:	232
PDU specific:	Destination Address
Default priority:	6
PGN:	0x00E800

Byte : 1 Control Byte

- 0: Positive Acknowledgment (ACK)
- 1: Negative Acknowledgment (NACK)
- 2: Access Denied (PGN supported but access denied)

Byte: 2 Group Function Value (if applicable)- N/A

Bytes: 3-5 Not Defined

Bytes: 6 Least Significant Byte of PGN of Requested Information

Byte: 7 Middle Byte of PGN of Requested Information

Byte: 8 Most Significant Byte of PGN of Requested Information

Requests

Transmission Rate :		As Needed
Data Length:		3 bytes
Data Page:		0
PDU format:		234
PDU specific:		Destination Address
Default priority:		6
PGN:		59,904 (0x00EA00)
Byte : 1	Least Significant Byte of PGN	
Byte: 2	Byte 2 of PGN	
Byte: 3	Most Significant Byte of PGN	

NOTE:
It is recommended that requests occur no more than 2 or 3 times per second.

NOTE:
For any unsupported PGN that are destination specific DDEC will transmit a NACK. DDEC will not transmit a NACK to a global request.

Transport Protocol Broadcast Announce (TP.CM_BAM)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format:	236
PDU Specific:	255
Default Priority:	7

Byte: 1	Control Byte — set to 32 for CM_BAM
Byte: 2, 3	Total Message Size, number of bytes
Byte: 4	Total number of packets
Byte: 5	Not Defined
Byte: 6–8	PGN of packeted message

Transport Protocol Data (TP.DT)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format	235
PDU Specific:	255
Default Priority:	7

Byte: 1	Sequence Number
Byte 2–8	Packetized Data (7 bytes)

NOTE:
The last packet of a multi-packet parameter group may require less than eight data bytes. The extra bytes will be filled with 255.

NOTE:
The data packets are spaced between 50 and 200 ms.

Transport Protocol Request to Send (TP.CM_RTS)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format:	236
PDU Specific:	Destination Address
Default Priority:	7

Byte: 1	Control Byte 16 — Designation Specific Request_To_Send (RTS)
Bytes: 2, 3	Total Message Size, number of bytes
Byte: 4	Total Number of Packets, zero not allowed
Byte: 5	Not Defined
Bytes: 6–8	Parameter group Number (PGN)

NOTE:
The ECM does not support incoming multi-placket messages and will ignore TP.CM_RTS messages.

Transport Protocol Connection Abort (TP.ConnAbort)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format:	236
PDU Specific:	Destination Address
Default Priority:	7

Byte: 1	Control Byte	
		255 — Connection Abort
Byte: 2–5	Not Defined	
Bytes: 6–8	Parameter Group Number (PGN)	

NOTE:
This message is sent if any of the time outs occurs or an invalid packet request occurs.

Transport Protocol End of Message (TP.EndofMsgACK)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format:	236
PDU Specific:	Destination Address
Default Priority:	7

Byte: 1	Control Byte	
		19–End_of_Message Acknowledge
Bytes: 2, 3	Total Message Size, number of bytes	
Byte: 4	Total Number of Packets, zero not allowed	
Byte 5:	Not Defined	
Bytes: 6–8	Parameter Group Number (PGN)	

Transport Protocol Clear to Send (TP.CM_CTS)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format:	236
PDU Specific:	Destination Address
Default Priority:	7

Byte: 1	Control Byte 17 — Destination Specific Clear_to_Send (CTS)
Byte: 2	Number of packets that can be sent
Byte: 3	Next packet number to be sent
Bytes: 4-5	Not Defined
Bytes: 6-8	Parameter Group Number (PGN)

TP.DT

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format	235
PDU Specific:	Destination Address
Default Priority:	7

Byte: 1	Sequence Number
Bytes: 2–8	Packetized Data (7 Bytes)

NOTE:
The last packet of a multi-packet parameter group may require less than eighty data bytes. The extra bytes will be filled with 255.

The data packets will be spaced no more than 200 ms.

6.4.4 SAE J1939/73 DIAGNOSTIC LAYER

The Diagnostic Layer Parameter Group Number (PGN) response definitions are described in the following section.

Stop Start Broadcast

Transmission Rate :		As Needed
Data Length:		8 bytes
Data Page:		0
PDU format:		223
PDU specific:		Destination Address
Default priority:		3
PGN:		57,008 (0x00DF00)
Byte : 1	SAE Primary Links	
	Bits: 8,7	Current Data Link
		00: Stop Broadcast
		01: Start Broadcast
		11: Don't Care
	Bits: 6,5	J1587 *
		00: Stop Broadcast
		01: Start Broadcast
		11: Don't Care
	Bits: 4,3	J1922 †
		00: Stop Broadcast
		01: Start Broadcast
		11: Don't Care
	Bits: 2,1	J1939 Network #1, Primary Vehicle Network ‡
		00: Stop Broadcast
		01: Start Broadcast
		11: Don't Care
Byte: 2	Other Networks #1	
	Bits: 8,7	J1939 Network #2 - N/A
	Bits: 6,5	ISO 9141 - N/A
	Bits: 4,3	J1850 - N/A
	Bits: 2,1	Other, Manufacture Specified Port - N/A
Byte: 3	Other Networks #2	
	Bits: 8,7	J1939 Network #3 - N/A
	Bits: 6-1	Not Defined
Bytes: 4	Control Flags	
	Bits: 8-5	Hold Signal
		0000: All Devices

0001: Devices whose broadcast state has been modified

0010-1110: Not Defined

1111: N/A

Bytes: 5-8 Not Defined

* Only the broadcast data for the J1587 data link will be shutdown. The ECM will still respond to requests for data.

† Only the broadcast data for the J1922 data link will be shutdown. The ECM will still respond to commands from other devices.

‡ Only the broadcast data for the J1939 data link will be shutdown. The ECM will still respond to requests for data.

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7 TOOLS

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7.1 DIAGNOSTIC REQUEST SWITCH

The Diagnostic Request Switch is used to activate the CEL/SEL lights to flash codes. Active codes are flashed on the SEL and inactive codes are flashed on the CEL (see see Figure 5-6). Inactive codes are flashed in numerical order, active codes are flashed in the order received, most recent to least recent. The Diagnostic Request Switch can be used as the SEO switch also. The codesare flashed out of the ECM connected to the switch.

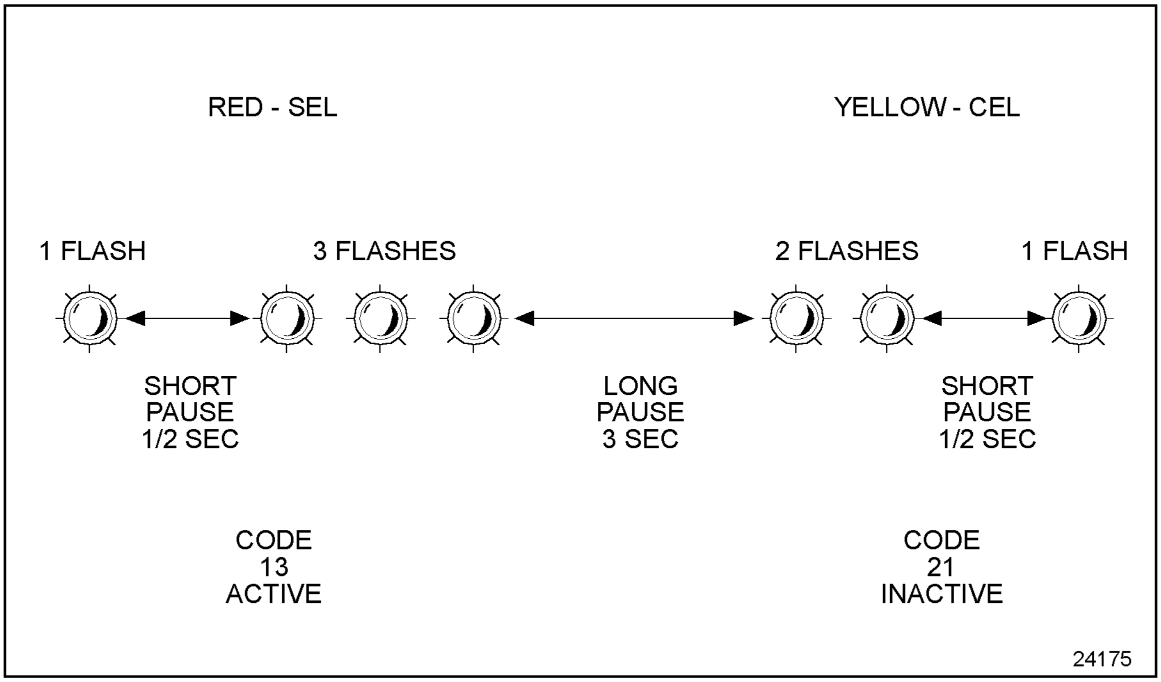

Figure 7-1 Flash Codes

NOTE:
For multi-ECM installations, the Diagnostic Request Switch and SEO are combined on the master ECM. All receiver ECMs have a separate Diagnostic Request Switch.

The Diagnostic Request Switch is used to flash codes in the following circumstances:

- ☐ The engine is not running and ignition is on
- ☐ The engine is idling and not in an "engine protection" condition

In both circumstances activating and holding the Diagnostic Request Switch will flash out the diagnostic codes. For additional information, refer to section 5.5, "Diagnostics."

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7.2 VEHICLE ELECTRONIC PROGRAMMING SYSTEM

The purpose of the DDEC Vehicle Electronics Programming System (VEPS) is to give OEMs the ability to configure many ECM parameters. This allows DDEC features to be tailored to the specific customer requirements when the vehicle is assembled. Some of the features which may be configured by VEPS are the transmission type, cruise control, vehicle speed limit, idle shutdown, rating switches, digital inputs, and digital outputs. VEPS requires the Windows 95 operating system.

7.2.1 SOFTWARE

The VEPS PC software package consists of the several files which are extracted when the software installation program is executed. A System Users Manual which defines the available parameters is included with the software package at the time of purchase.

The PC interface utilizes a communications driver which is defined in the TMC Recommended Practice RP1210A. The RP1210A software is used to translate the datalink signal of the ECM to the format required by Windows programs. The RP1210A communications driver is included as part of the VEPS software package.

7.2.2 HARDWARE

The hardware portion of the VEPS programming package includes the interface module and cables. The components that are included in the package are listed in Table 7-1.

Part Description	Part Number
100 Foot Cable	23512893
SAE J1708 6-Pin Dash Connector	23515957
J1708/RS-232 Translator Box	23512415
6 foot Cable	23515869

Table 7-1 VEPS Hardware

A cable kit, listed in Table 7-2, is also available.

Part Description	Part Number
Cable Kit (includes the 100 foot cable and the 6-pin dash connector)	23512980

Table 7-2 VEPS Cable Kit

A translator and cable kit, listed in Table 7-3, is also available.

Part Description	Part Number
Translator Kit (includes the J1708/RS-232 translator box, 100 foot cable and the 6-pin dash connector)	23512895

Table 7-3 VEPS Translator and Cable Kit

The VEPS software kit, listed in Table 7-4, is available.

Part Description	Part Number
Software Kit (includes the RP1202 Software and the VEPS Software)	Contact DDC Application Engineering

Table 7-4 VEPS Software Kit

7.2.3 OPTIONAL PARTS KITS

DDC offers vehicle repower kits to aid in the installation of DDEC III/IV.

NOTE:
This is a repower kit for DDEC II to DDEC III only. There are no repower kits for

NOTE:
DDEC IV.

The kits listed in Table 7-5and Table 7-6 include all of the necessary wiring for the installation of the DDEC III/IV engine and the following parts:

Part Description	Part Number
Terminal Kit	23515326
Vehicle Harness - 30 foot	23515152
Power Harness - 22 foot	23515151
Light and Switch Kit	23501634

Table 7-5 DDEC Repower Kit - DDC P/N: 23515327

Part Description	Part Number
Terminal Kit	23515326
Vehicle Harness - 70 foot	23515153
Power Harness - 22 foot	23515151
Light and Switch Kit	23501634

Table 7-6 DDEC Repower Kit - DDC P/N: 23515328

The harnesses come with ECM connectors on one end and no connections on the other end. These harnesses are intended to be cut to length by the OEM. The harnesses come with all the connections in the ECM connector. Wires can be removed if not used in a specific application.

7.3 DIAGNOSTIC DATA READER

The hand-held DDR plugs into the Diagnostic Data Link Connector located in the Vehicle Interface Harness (refer to section 3.10.7). This connection allows the DDR to receive data from the ECM. The DDR is used to display:

- ☐ Engine Description via the ENGINE DATA LIST menu
- ☐ Codes via the DIAGNOSTIC CODES menu
- ☐ View/reprogram certain operating parameters

A printout of the information displayed on the DDR can be obtained by attaching a printer.

7.3.1 REQUIREMENTS

The components required to receive data from the DDEC system can be seen in the next illustration (see Figure 7-2). The components and part numbers are listed in Table 7-7.

Component	Part Number
Pro-Link Main Unit	J 38500-1A
Multi Protocol Cartridge (MPC)	J 38500-1500C
Detroit Diesel Application Suite PC Card, DDEC III/IV	J 38500-2300D
6 pin Deutsch Adapter	J 38500-60A
6 pin to 9 pin Deutsch Adapter	J 38500-96A
Pro-Link Reprogramming Cable	J 38500-925
Pro-Link Portable Printer	J 38480-A

Table 7-7 Diagnostic Data Reader Components and Part Numbers

NOTE:
Printers used in Europe must use a European power supply as listed in Table 7-8. Do not substitute an AC adapter for the European power supply.

Component	Part Number
Printer (U.S.A.)	J 38480-A
Printer with European Power Supply	J 38699
European Power Supply only	J 38480-220

Table 7-8 DDR Printers and Power Supply

CAUTION:

To avoid injury from loss of vehicle/vessel control, the operator of a DDEC equipped engine must not attempt to use or read the Diagnostic Data Reader when the vehicle/vessel is moving.

The DDR must be used by personnel other than the vehicle operator. The vehicle operator must maintain control of the vehicle while an assistant performs the diagnostic evaluations.

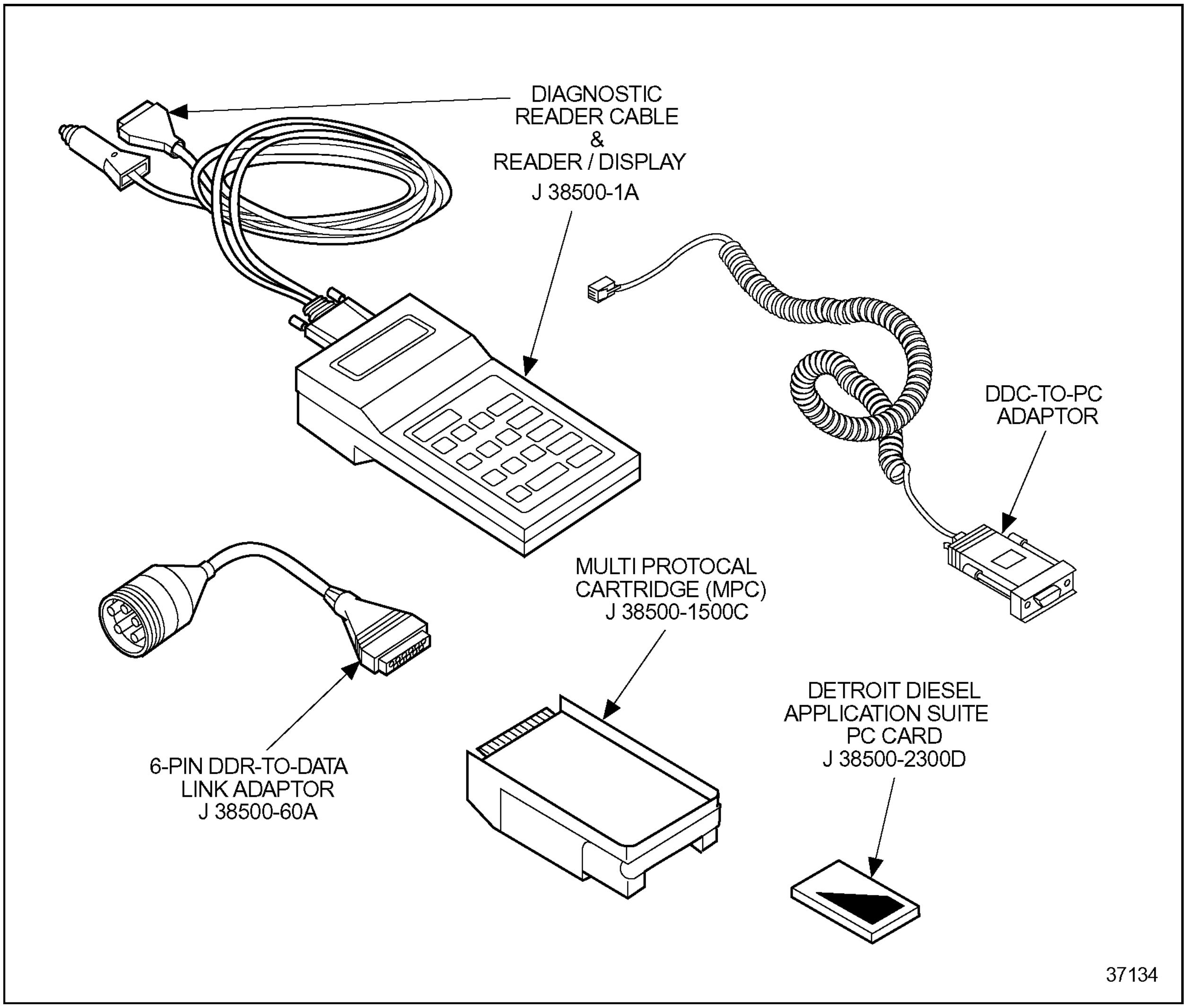


Figure 7-2 Diagnostic Data Reader Kit Plus DDEC Cartridge and PCMCIA Card

The DDR can be purchased from:

Kent-Moore
28635 Mound Road
Warren, MI 48092
Phone: 1-800-328-6657

See Figure 7-3 for a DDR menu options map.

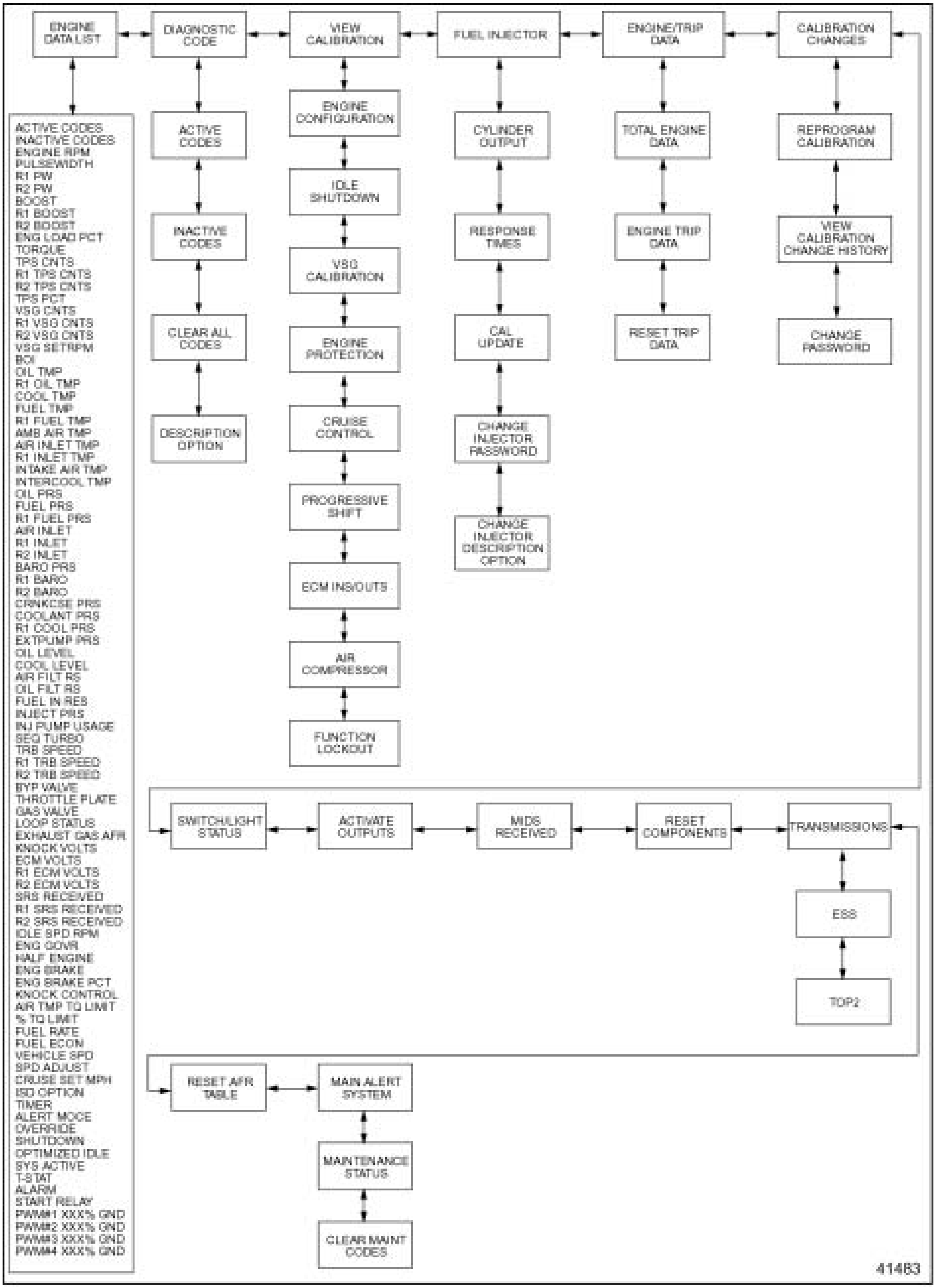


Figure 7-3 DDR Menu Options (Release 24.0 Software)

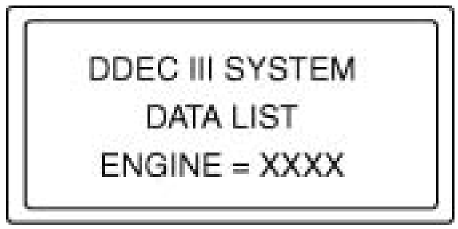
7.3.2 ENGINE DATA LIST

The DDR can be used to view operational data and parameter settings, via the Engine Data List feature.

View operational data as follows:

1. Turn the ignition ON.
2. Press 

until ENGINE DATA LIST is shown on the screen.



3. Scroll through the data list by pressing  and  until the desired parameter is shown on the screen.

7.3.3 DIAGNOSTIC CODES

The DDR can be used to view active and inactive codes.

Active Codes

View the (active) codes as follows:

1. Press FUNC until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press ENTER .
3. Press ↓ until DIAGNOSTIC CODES is shown on the screen.

4. Then press ENTER.
5. Press ↓ until ACTIVE CODES is shown on the screen.

6. Then press ENTER to view the first active code.
7. Press ↓ and ↑ to scroll through the active codes.

NOTE:
Refer to Appendix A for a list of all DDEC codes and code descriptions.

Inactive Codes

View the inactive codes as follows:

1. Press FUNC until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press ENTER.
3. Press ↓ until DIAGNOSTIC CODES is shown on the screen.

4. Then press ENTER.
5. Press ↓ until INACTIVE CODES is shown on the screen.

6. Then press ENTER to view the first inactive code.
7. Press ↑ and ↓ to scroll through the inactive codes.

NOTE:
Refer to Appendix A for a list of all DDEC codes and code descriptions.

Clearing Codes With A DDR

The diagnostic codes stored in the ECM's memory can be cleared with a DDR, via the DIAGNOSTIC CODES menu. To clear the codes perform the following:

1. Press 

until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press 

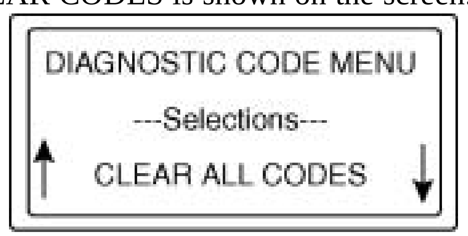
.

3. Press 
until DIAGNOSTIC CODES is shown on the screen.

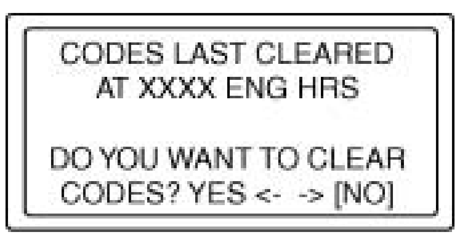
4. Then press 

.

5. Press 
until CLEAR CODES is shown on the screen.



6. Then press 



7. Use 
to select YES to clear the codes.

7.3.4 VIEW CALIBRATION

Perform the following steps to view the calibration data stored within the ECM:

1. Press  until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press  .
3. Press  until VIEW CALIBRATION is shown on the screen.

4. Then Press  .
5. Use  and  to scroll through the VIEW CALIBRATION menu to view the data.

The following information can be viewed with the DDR under the VIEW CALIBRATION menu:

- ☐ Engine Configuration
- ☐ Idle Shutdown
- ☐ VSG Configuration
- ☐ Engine Protection
- ☐ Cruise Control
- ☐ Progressive Shift
- ☐ ECM Input and Output
- ☐ Air Compressor
- ☐ Function Lockout

Engine Configuration

See Figure 7-4 for an Engine Configuration menu options map.

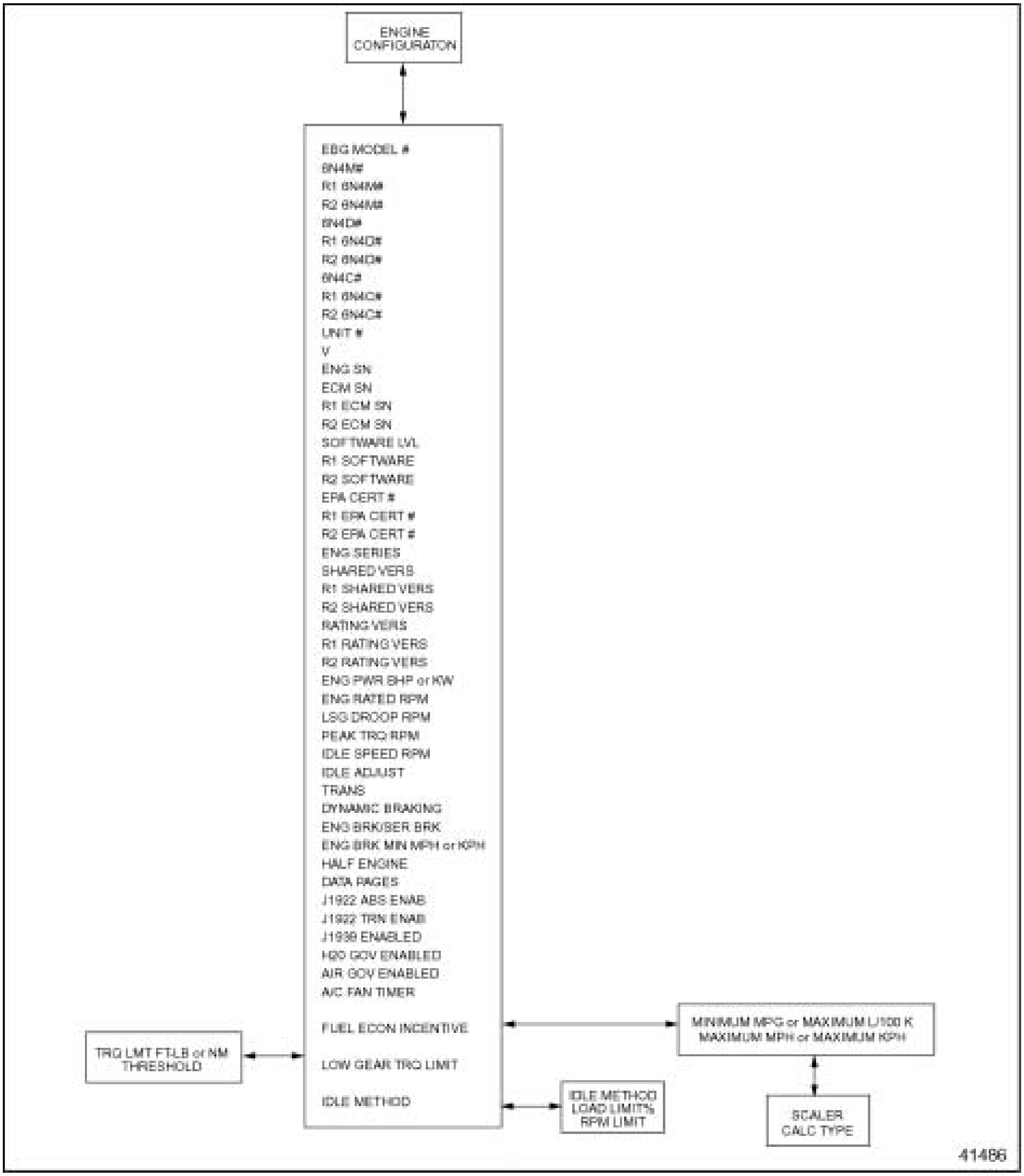


Figure 7-4 Engine Configuration Menu

7.3.5 FUEL INJECTOR

Perform the following steps to view the Fuel Injection information stored within the ECM:

1. Press FUNC until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press ENTER.
3. Press ↓ until FUEL INJECTOR INFO is shown on the screen.

4. Then Press ENTER.
5. Use the ↑ and ↓ to scroll through the FUEL INJECTOR INFO menu to view the required data or perform a function.

The following information can be viewed/modified with the DDR under the FUEL INJECTOR INFO menu:

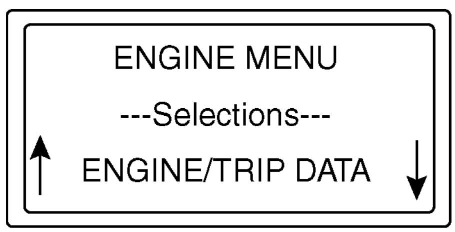
- ☐ Cylinder Cutout
- ☐ Response Times
- ☐ Cal Update
- ☐ Change Injector Password
- ☐ Change Injector Description Option (Series 2000 and Series 4000 only)

7.3.6 ENGINE/TRIP DATA

Perform the following steps to view the Engine/Trip data stored within the ECM:

1. Press FUNC until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press ENTER.
3. Press  until ENGINE/TRIP DATA is shown on the screen.



4. Then Press ENTER.
5. Use the  and  to scroll through the ENGINE/TRIP DATA menu.

The following information can be viewed with the DDR under the ENGINE/TRIP DATA menu:

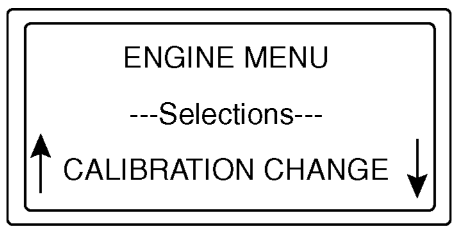
- ☐ TOTAL ENGINE DATA
- ☐ ENGINE TRIP DATA
- ☐ RESET TRIP DATA

7.3.7 CALIBRATION CHANGES

Perform the following steps to change calibration values stored within the ECM:

1. Press FUNC until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press ENTER.
3. Press ↓ until CALIBRATION CHANGE is shown on the screen.



4. Then press ENTER.
5. Use ↑ and ↓ to scroll through the CALIBRATION CHANGE menu.

The following menus are available under CALIBRATION CHANGE:

- ☐ Reprogram Calibration
- ☐ View Calibration Change History
- ☐ Change Password

Reprogram Calibration

This selection offers a list of ECM calibrations that can be modified. See Figure 7-5.

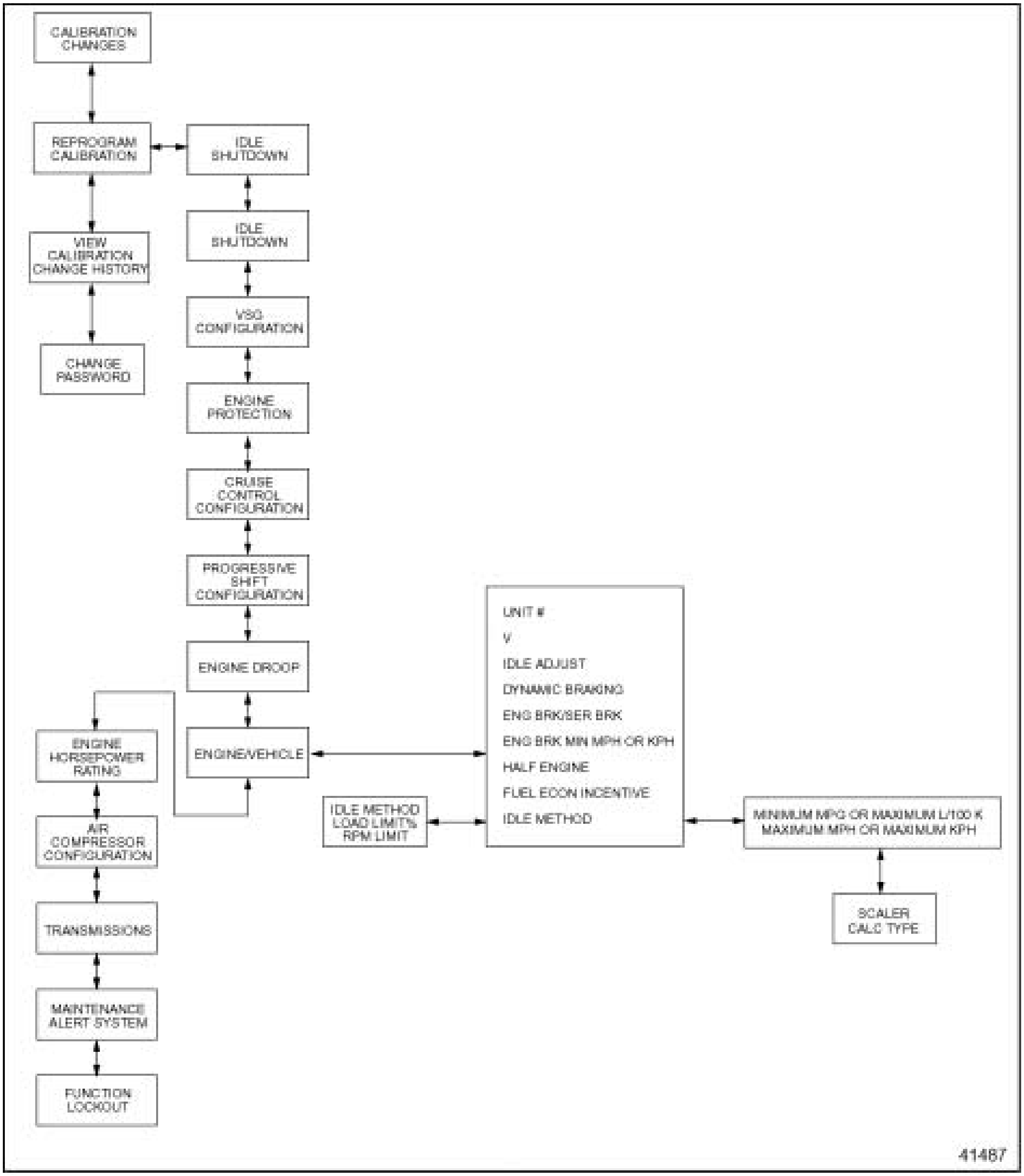


Figure 7-5 Reprogram Calibration Selections

7.3.8 SWITCH/LIGHT STATUS

Perform the following steps to view the Switch/Light status stored within the ECM:

1. Press FUNC until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press ENTER.
3. Press  until SWITCH/LIGHT STATS is shown on the screen.

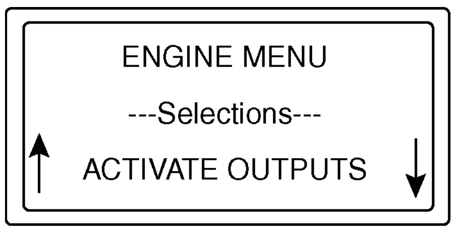
4. Then press ENTER.

The switch/light status lists the current status of each of the ECM digital inputs and outputs. This list will also display the receiver ECM #1 and receiver ECM #2 digital input and output status.

7.3.9 ACTIVATE OUTPUTS

1. Press FUNC until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press ENTER.
3. Press  until ACTIVATE OUTPUTS is shown on the screen.



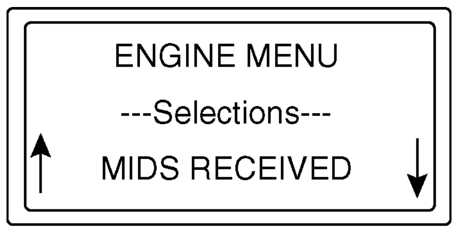
4. Then press ENTER.

The Activate Outputs menu option allows each of the digital outputs and PWM outputs to be toggled to the opposite state. This will allow testing of lights and relays to ensure proper operation.

7.3.10 MIDS RECEIVED

1. Press  until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press .
3. Press  until MIDS RECEIVED is shown on the screen.



4. Then press .

The MIDS RECEIVED will display the current device that the DDR is receiving messages from as listed in Table 7-9.

Display	Description
MID 128: ENGINE	Single ECM Applications
MID 175: ENGINE R1	Dual ECM Application - first Receiver ECM
MID 183: ENGINE R2	Triple ECM Application - second Receiver ECM

Table 7-9 MIDS RECEIVED Display and Description

7.3.11 RESET COMPONENTS

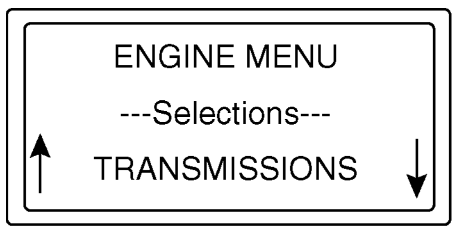
This function is only available for DDEC III engines.

7.3.12 TRANSMISSIONS

Perform the following steps to view/change the Transmission information stored within the ECM:

1. Press FUNC until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press ENTER.
3. Press  until TRANSMISSIONS is shown on the screen.



4. Then press ENTER.
5. Use  and  to scroll through the TRANSMISSIONS menu.

The menus are available under TRANSMISSIONS are:

- ESS TRANSMISSION
- TOP 2 TRANSMISSION

7.3.13 RESET AFR TABLE

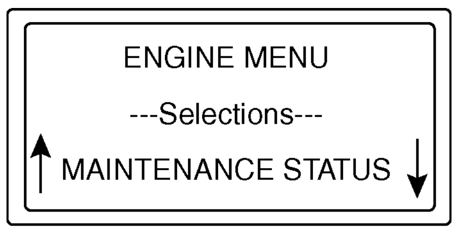
This function is used on natural gas engines to reset the Air Fuel Ratio (AFR) Learn table.

7.3.14 MAINTENANCE STATUS

Perform the following steps to view the Maintenance Status menu:

1. Press FUNC until the SELECT DESIRED MENU appears on the screen.

2. Select ENGINE and press ENTER.
3. Press  until MAINTENANCE STATUS is shown on the screen.



4. Then press ENTER.
5. Use  and  to scroll through the MAINTENANCE STATUS menu.

The menus are available under MAINTENANCE STATUS are:

- ☐ MAINTENANCE STATUS
- ☐ CLEAR MAINTENANCE CODES

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7.4 DETROIT DIESEL DIAGNOSTIC LINK

The Detroit Diesel Diagnostic Link™ (DDDL) is a sophisticated PC software package supporting the setting up, maintenance and repair of engines using the DDEC IV ECM. For additional information, refer to the on-line Help within the program.

7.4.1 CALIBRATION

You can use the DDDL to:

- ☐ Read and display the current calibration from an ECM.
- ☐ Create a calibration for the ECM on an individual engine.
- ☐ Save a single calibration with an ECM password so that the same calibration can be used conveniently for a fleet of vehicles with the same password, or can be used by a technician who does not have access to the password.
- ☐ Change the engine rating of a vehicle.
- ☐ Set the injector calibration when you replace the injectors.
- ☐ View an audit trail of ECM and injector calibration changes.

7.4.2 DIAGNOSTICS AND MAINTENANCE

You can use the Detroit Diesel Diagnostic Link to:

- ☐ Monitor a wide range of parameters while connected live to the ECM .
- ☐ Select a group of these parameters and plot how they have varied over the last two minutes.
- ☐ Take and save a snapshot of how the parameters vary over a period of time, so that you can replay the snapshot for detailed analysis.
- ☐ Monitor fault codes as they occur while connected live to the ECM. You can also clear any inactive fault codes stored in the ECM.
- ☐ Take a snapshot recording the fault codes occurring over a period of time, and relate their occurrence to the values of measurements made by the ECM.
- ☐ Test for the effect on performance of cutting out individual cylinders.
- ☐ View a record of the injector timings.
- ☐ Set the ECM output functions to particular values to support troubleshooting.
- ☐ Display specific troubleshooting help for any fault codes that occur, or have occurred.
- ☐ View engine and trip totals, and reset the trip counters in the ECM.
- ☐ Reset the ECM counters monitoring component usage when you replace the components.

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7.5 DDEC REPROGRAMMING SYSTEM

The DDEC Reprogramming System (DRS) is composed of Programming Software, DDECcomm Mainframe Communications software, all the hardware required to connect a Personal Computer to the ECM, and a user manual explaining the use of the software. The DRS software is used to reprogram calibrations, modify customer calibration values, upgrade ECM software versions, update injector calibration codes, and program blank ECMs. The DDECcomm software is used to communicate via modem to the DDC Mainframe computer which stores all the DDEC Calibrations.

7.5.1 REQUIREMENTS

The DRS and DDECcomm software require a Personal Computer which meets certain minimum requirements. These minimum requirements include a 80486 - 33 MHz microprocessor with 8 MB of RAM and at least 530 KB of DOS conventional memory, a modem, and the Windows 95 Operating System. DDC also sells kits which include a Laptop PC, please contact your Detroit Diesel representative for current Laptop specifications. The part numbers for the kits are listed in Table 7-10.

Kit	Part Number
DDEC Reprogramming System	MRS7500
DDEC Reprogramming System with Laptop PC	MRS7500-L

Table 7-10 Mini Reprogramming System Part Numbers

7.5.2 DRS PROGRAMMING SOFTWARE

The DRS software requires that the PC be started in the DOS mode of operation. It is not possible to reprogram an ECM by starting a DOS session from within Windows.

7.5.3 ECM PROGRAMMING MENU

There are several menu choices on the ECM Programming Menu. A menu option is selected by using the up and down arrows to highlight the choice and then pressing the space bar or the enter key to actuate it. The following sections describe these menu options.

Program ECM

Reprogram ECMs with a customer calibration that has previously been downloaded from the DDC mainframe computer. The customer configurable parameters are retained through this type of a reprogramming.

Program Fleet ECM

Reprogram fleet units from a single customer calibration that has previously been downloaded from the DDC mainframe computer. The customer configurable parameters are retained through this type of a reprogramming.

Program ECM With Mainframe Data

Reprogram ECMs with a customer calibration that has previously been downloaded from the DDC mainframe computer. Unlike the standard Program ECM option, this option will overwrite the customer configurable parameters, resulting in a calibration exactly like the one created by the factory.

Display Available ECM S/W Versions

Displays ECM software versions that are available on the PC. These versions are used to electronically upgrade ECM software for DDEC III and IV.

Display Customer Calibration

Displays electronic parameter settings currently programmed in an ECM.

Update Calibration at DDC

This function is used to store the ECM's electronic parameters on the PC. After performing this option, the Upload History function in the DDEC Mainframe Communications Program (DDECcomm) can be used to send the ECM data to the DDC mainframe computer.

Display Station Log File

Displays a file containing system usage information.

Update Customer Calibration

Similar to the Display Customer Calibration option, this option allows the electronic parameters to be updated. A customer password is required to perform this function. The following groups of information, listed in Table 7-11, can be modified.

Parameters That Can Be Updated		
Air Compressor	Output Config	VSG Configuration
Auto Cruise Resume	Idle Adjustment	Vehicle Number
CLS Polarity	Idle Shutdown	Function Lockout
Cruise Control	Rating	Lockout Password
Cruise Switch VSG	Rating Receiver #1	Fan Timer
Customer Password	Rating Receiver #2	Engine Brakes
Droop	Rating Password	ESS Config
Dynamic Braking	Progressive Shift	Half Engine Idle
Engine Protection	Transmission	TOP 2 Switch
Receiver Protection	Vehicle Spd Limiting	Fuel Quality Factor
Fire Truck	Vehicle Spd Sensor	Low Gear Torque Limiting
Fuel Econ Incentive	Vehicle ID Number	Sensor Configuration
Input Config	__	__

Table 7-11 Parameters that can be Updated with the Update Customer Calibration Option

Update Logon Parameters

This option was used to configure the communication parameters when the DOS communications package was used. The only parameter used by the Windows DDECcomm software is the Logon ID.

Upgrade ECM Software

New versions of DDEC ECM software may be programmed into customer's ECMs with this option. There is a nominal charge each time this function is performed.

Update Injector Calibration

This option displays a graphical representation of the engine allowing the injector calibration code to be updated. An injector password is required.

Display Downloaded Units

This menu item displays the Unit Numbers of the engines which have been downloaded from the mainframe and are available for programming.

Update ECM Accumulators

Update ECM with engine data such as idle hours, engine hours, cruise hours, miles, etc.

Print ECM Parameters

This menu item queries the ECM for the Customer Calibration information and formats it into a report which can be printed out on a printer attached to the parallel port on the computer.

DDC Mainframe Interface Menu

This option was used to select the DOS-based DDC Mainframe Interface Menu which loaded a separate communications program to communicate to the DDC server. This functionality has been replaced by the Windows 95 program DDECcomm which uses the quicker File Transfer Protocol to communicate with the server.

7.5.4 DDECCOMM

DDECcomm is a Win95 program which can be invoked by selecting the DDEC Server Interface icon on the Windows desktop or through the Start button via Programs | DDEC Electronic Controls | DDEC Communications. The following menu options are available in this program.

Download Engine Serial Calibration(s)

This option is used to download any changed or desired unit calibrations from the DDC mainframe computer. These calibrations are stored on the PC for a maximum of 14 days, after that period they are automatically deleted.

Download Fleet Calibration(s)

This option allows the download of a single "fleet" unit from the mainframe to the PC. This "fleet" unit calibration may be used to program multiple units in a fleet via the Program Fleet ECM option discussed above.

Upload History

This option takes the programming history on the PC and uploads it to the DDC mainframe. This allows DDC to maintain a current image of the calibration status should further service be required. The history file must first be created by running the Update Calibration at DDC menu option in the DRS Programming Software.

Display Available ECM S/W Versions

Displays ECM software versions that are available on the PC. These versions are used to electronically upgrade ECM software for DDEC III and IV.

Display Station Log File

Displays a file containing system usage information.

Display Downloaded Units

This menu item displays the Unit Numbers of the engines which have been downloaded from the mainframe and are available for programming.

Update Logon Parameters

This option is used to configure the system. All user information may be updated when this option is selected.

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7.6 DDEC ENGINE PROTECTION SIMULATION KIT

The DDEC Engine Protection Simulation Kit is used to reduce diagnostic troubleshooting time for DDEC sensors. The normal use for these false sensors is to simulate an engine fault that would result in the engine protection system triggering a code in the DDEC ECM. This kit can also be used for testing and verification of the engine shutdown system, fan control outputs, and coolant level outputs. This will also be useful in simulating an engine protection fault to show customers how the DDEC protection system will react in the event of a failure that would normally cause damage to the engine.

To use, plug the simulator into the connector currently used for the appropriate sensor. Start and run the engine and DDEC will trigger the appropriate code for that fault.

The DDEC Engine Protection Simulation Kit components and part numbers are listed in Table 7-12.

Component	Part Number
Coolant Low Level Simulator	23524785
High Oil/Coolant Temperature Simulator	23524787
Low Oil Pressure Simulator	23524786

Table 7-12 DDEC Engine Protection Simulation Kit, P/N: 23526923

The High Crankcase Pressure Simulator (P/N: 23524784) is for the Series 4000 only and is not included in kit.

7.6.1 COOLANT LEVEL LOW SIMULATOR

This simulator is preset to advise the ECM that the coolant is low. Use only for DDEC III or IV. This simulator can be used to:

- ☐ Verify protection function.
- ☐ Test low coolant level light output to ensure it is configured to the correct output and correct polarity (activates the output).
- ☐ Determine if the actual sensor is bad/shorted. A bad/shorted CLS can result in other fault codes.

7.6.2 HIGH OIL/COOLANT TEMPERATURE SIMULATOR

This simulator is preset to provide a 250°F (121°C) signal to the ECM. Use for any DDEC. This simulator can be used to:

- ☐ Test coolant temperature shutdown logic/protection.
- ☐ Test oil temperature shutdown logic/protection.
- ☐ Test coolant temperature high output.
- ☐ Test oil temperature high output.

- ☐ Fake coolant temperature high to test fan control circuit.
- ☐ Fake oil temperature high to test fan control circuit.

7.6.3 LOW OIL PRESSURE SIMULATOR

This simulator is preset to provide oil pressure signal of 0 psi (0 kPa). This simulator can be used to:

- ☐ Provide a known pressure (oil pressure) for engine protection testing.
- ☐ Provide a known pressure (fuel pressure) for fault code testing.
- ☐ Provide a known pressure (coolant pressure) for engine protection testing.
- ☐ Verify if correct output is configured for low oil pressure (activates the output).
- ☐ Test current OPS to determine if a shorted sensor is causing other codes.
- ☐ Test current FPS to determine if a shorted sensor is causing other codes.
- ☐ Test current CPS to determine if a shorted sensor is causing other codes.

7.6.4 HIGH CRANKCASE PRESSURE SIMULATOR (SERIES 4000 ONLY)

The High Crankcase Pressure Simulator (P/N: 23524784) is not included in the kit. This simulator is preset to provide a crankcase pressure signal of 12 psi / 83 kPa.

7.7 DDEC MANUALS

The following DDC manuals provide more information about troubleshooting and specific DDEC features:

- ☐ *Construction & Industrial EDM and AIM Installation and Troubleshooting* (7SA801)
- ☐ *Construction & Industrial EDM and AIM User Manual* (6SE710)
- ☐ *ProDriver User Manual* (6SE701)
- ☐ *ProDriver DC User Manual* (6SE703)
- ☐ *Electronic Fire Commander Installation and Troubleshooting*(6SE476)
- ☐ *Engine Synchro Shift™ Troubleshooting* (6SE498)
- ☐ *Optimized Idle - DDEC III/IV - Installation and Troubleshooting*(7SA741)
- ☐ *DDEC III/IV Single ECM Troubleshooting (6SE497)*
- ☐ *DDEC III/IV Multi-ECM Troubleshooting (6SE496)*
- ☐ *IRIS User and Installation Guide* (6SE36)
- ☐ *Ether Start Installation*(7SA727)
- ☐ *Data Hub User Manual* (6SE704)
- ☐ *Data Hub RDI User Manual* (6SE714)

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8 APPLICATIONS

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8.1 APPLICATION CODE SYSTEM

DDC Application Engineering, Product Engineering, and DDEC Engineering work together to establish and define the Electronic Control Module (ECM) functions and the electronic parameters that are maintained by the DDEC Application Code System (ACS). DDC Application Engineering creates application codes (6N4C groups) that define defaults and validation ranges for the ECM features. ACS provides the flexibility to customize engine speed governing and control, engine protection, and communications. DDC Product Distribution and Distributors use the application codes to process and further customize customers' orders.

This section contains a blank copy of the "DDEC ACS Worksheet." This worksheet may be used by the OEM, or distributor, to specify desired DDEC parameters and help determine the proper 6N4C group. These parameters include:

- ☐ Type of transmission or powertrain
- ☐ Engine speed governing
  - ☐ Idle speed
  - ☐ High idle speed
  - ☐ Droop
  - ☐ Cruise Control options
- ☐ Engine protection strategy
- ☐ DDEC digital inputs
- ☐ DDEC digital outputs

DDEC Nonroad Application Specification

6N4C Group	
(To be assigned by DDC Application Engineering)	

Transmission (The transmission codes are listed in Table 8-1on page 8-7.)				
Transmission Code:				

Governing				
Type (Circle One)		VSG Only	LSG Only	VSG & LSG
Number of VSG Throttle Locations (0, 1, or 2)				
Number of LSG Throttle Locations (0, 1, or 2)				
VSG MAX RPM	400 to 2500 RPM			
VSG MIN RPM	400 to 2500 RPM			
VSG ALT MIN RPM	400 to 2500 RPM			
VSG DROOP	0 to 300 RPM			
HOT IDLE	400 to 2500 RPM			
COLD IDLE	750 to 1050 RPM			
LSG DROOP	0 to 300 RPM			
Idle Operation at Zero VSG	Yes	No		
Note: VSG ALT MIN RPM must be greater than VSG MIN RPM. LSG DROOP must be greater than or equal to VSG DROOP.				

Cruise Switch VSG				
Cruise Switch VSG (Circle One)		Yes		No
Initial Speed	400 to 2500			
RPM Increment	0 to 250			

Idle Timer Shutdown				
Idle Timer Shutdown (Circle One)		Yes		No
Time	1 to 99 Minutes			
Operates On		Idle Only		Idle & VSG
Override		Yes		No

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Engine Protection (Circle required option)				
Coolant Temperature		Shutdown	Rampdown	Warning
Coolant Level		Shutdown	Rampdown	Warning
Coolant Pressure		Shutdown	Rampdown	Warning
Oil Pressure		Shutdown	Rampdown	Warning
Oil Temperature		Shutdown	Rampdown	Warning
Aux. Stop 1		Shutdown	Rampdown	Warning
Aux. Stop 2		Shutdown	Rampdown	Warning
Crankcase Pressure		Shutdown	Rampdown	Warning
Intercooler Temperature		Shutdown	Rampdown	Warning
Engine Overtemperature Protection		Yes		No
Air Temperature Reduction		Yes		No
Continuous Override		Yes		No

Fan Controls (Circle required options)					
Digital Fan Type:	None	Single	Dual	2-Speed	PWM

Engine Brakes (circle required option)				
Engine Brake Type:	None	Jake Brake	KD Brake	DVB

Engine Brake Cruise				
Engine Brake Cruise (Circle One)		Yes		No
Engine Brake Low	1 to 10 MPH			
Increment	1 to 5 MPH			

Vehicle Speed Sensor				
Vehicle Speed Sensor (VSS) (Circle One)		Yes		No
VSS Sensor Type (Circle One)		Transmission		Wheel
VSS Signal Type (Circle One)		Open Collect		Magnetic
Number of Teeth		2 to 200		
Tire Revolutions Per Mile		100 to 1000		
Axle Ratio:				
Final Gear Ratio:				

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Vehicle Speed Limit				
Vehicle Speed Limit (Circle One)		Yes		No
Max. Speed	20 to 127 MPH			
Overspeed with Fuel	0 to 127 MPH			
Overspeed w/o Fuel	0 to 127 MPH			

Cruise Control				
Cruise Control (Circle One)		Yes		No
Auto Resume (Circle One)		Yes		No
Min. Speed	20 to 127 MPH			
Max. Speed	20 to 127 MPH			

Air Compressor Controls				
Air Compressor Controls (Circle One)		Yes		No
Load Pressure				
Unload Pressure				
Range 1 Min. Pressure				
Range 1 Max. Pressure				
Range 2 Min. Pressure				
Range 2 Max. Pressure				
Range 3 Min. Pressure				
Range 3 Max. Pressure				

Other Options (Circle required options)			
Fuel Economy Incentive	Yes		No
Pressure Governor System	Yes		No
Progressive Shift	Yes		No

DDEC Nonroad Application Specification

Configuration Of Digital Inputs (A list of Digital Input options and codes is listed in Table 8-2 on page 8-7.)		
VIH Pin Number	VIH Wire Number	Customer Selection
E1	451	
F1	542	
G1	528	
H1	523	
J1	541	
F2	544	
G2	543	
H2	524	
J2	531	
K2	583	
G3	545	
K3	979	

Configuration Of Digital Outputs (A list of Digital Output options and codes is listed in Table 8-3 on page 8-8.)		
VIH Pin Number	VIH Wire Number	Customer Selection
A1	988	
A2	555	
F3	499	
Sensor Harness Pin Number	Sensor Harness Wire Number	Customer Selection
W3	563	
X3	564	
Y3	565	

Refer to section 5.34, "Transmission Interface," for further details of the transmission definition.

Transmission Type	Code	Transmission Type	Code
Manual	00	RS9	17
Allison Hydraulic	01	RSX9-A	18
Voith	03	RSX9-B	19
Z-F Ecomat	04	RSX9-R	20
Allison Electronic	09	RS10	21
Allison WT	12	RSX10	22
Other Automatic	14	RSX10-C	23
GE Statex III	15	GE Propulsion System	31
Autoshift / J1939	16		
Note: If application has no transmission enter code "00"			

Table 8-1 Transmission Options and Codes

Refer to section 4.1, "Digital Inputs," for a detailed description of each digital input option.

Description	Code	Description	Code
None	00	Resume / Accel On	22
Engine Brake Low	01	Cruise Enable	23
Engine Brake High	02	PGS System Enable	24
Aux. Shutdown # 1	03	SEO / Diagnostic Request	25
Aux. Shutdown # 2	04	Engine Brake Disable	26
Park Brake Interlock	05	Transmission Retarder Status	27
Idle Validation	06	Dual Throttle	28
Throttle Kickdown	07	A/C Fan Status	29
Pressure RPM Mode	08	N/A	30
Throttle Inhibit	09	Aux CLS	31
External Engine Synchronization	10	Fan Control Override	32
RPM Freeze	11	VSG Station Change	33
Rating Switch # 1	12	VSG Station Complement	34
Rating Switch # 2	13	Air Load Switch	35
Limiting Torque Curve	14	N/A	36
Diagnostic Request	15	N/A	37
Alt Min VSG / Fast Idle	16	In Neutral Switch (ESS)	38
Service Break Release	17	In Gear Switch (ESS)	39
Clutch Released	18	KD Brake	40
Set / Coast On	20	VSG Inhibit	42

Table 8-2 Digital Input Options and Codes

Refer to section 4.2, "Digital Outputs," for a detailed description of each digital output option.

Description	Code	Description	Code
No Function	00	Coolant Temp. High Light	20
N/A	01	Air Compressor Solenoid	21
N/A	02	Crankcase Pressure High	22
Low DDEC Voltage	03	Coolant Pressure Low Light	23
External Engine Synchronization Active	04	Ether Start	24
PSG Pressure Mode Light	05	N/A	25
Vehicle Power Shutdown	06	Optimized Idle Light	26
Starter Lockout	07	N/A	27
External Engine Brake Enable	08	ESS Low Range	28
Transmission Retarder Enable	09	ESS High Range	29
Coolant Level Low Light	10	Shift Solenoid (TOP2)	30
Cruise Active Light	11	Shift Lockout (TOP2)	31
N/A	12	Gas Throttle Actuator	32
Fan Control # 1	13	Fuel Supply Solenoid	33
Fan Control # 2	14	KD Brake Solenoid	34
Deceleration Light	15	Sequential Turbo	35
Engine Brake Active	16	Natural Gas Knock Shutdown	36
VSG Active Indication	17	Cold Engine Signal (S4000)	37
Oil Pressure Low Light	18	Engine Overspeed Signal	39
Oil Temperature High Light	19		

Table 8-3 Digital Output Options and Codes

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8.2 TYPICAL ON-HIGHWAY APPLICATION

This section contains typical parameter settings for on-highway truck applications and the pin assignments for the Vehicle Interface Harness and the Engine Sensor Harness as listed in the Verification Report on the following pages.

The Digital Input and Digital Output ports can be configured for a variety of software options. The location of the connector pin for each software option can be specified at the time of engine order, by VEPS or the Distributor Reprogramming Station. For more information on software options, refer to section 4.1, "Digital Inputs" and section 4.2, "Digital Outputs."

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DDEC III/IV ENGINE SUMMARY

Series I60	DDEC Appl Group	06N04C0126	DDEC IV HIGHWAY TRK EPL W/O JAKE BRAKE
	Base group	06N04D6437	370-430 HP STD RAT 1999 DDEC IV LINE HAUL 12L S60
	Hp Group	06N04M7109	400HP@1800RPM 1056 1999 LINE HAUL TRK 12L S60 (155OFTLB)

PWM Trans 0 MANUAL		VSG Max RPM	1600	Hot Idle	600
VSG Cruise Switch	YES	VSG Min RPM	600	Cold Idle	2500
Init Speed	1000	VSG Alt Min RPM	600	Max Droop	150
RPM Increment	25	VSG is Primary	NO	LSG Droop	125
				VSG Droop	0
IDLE SHUTDOWN	YES	Time	5 MIN		
		Operates On	IDLE & VSG GOVERNOR		
Maximum Security	NO	Override	NO		
Minimum Security	NO	Min Temp	75 DEGC	Max Temp	75 DEGC
ENGINE PROTECTION		Digital Fan	SINGLE	FUEL ECONOMY INCENTIVE	
Coolant Temp	SHUTDOWN	PWM Fan	NONE	Min MPG	N/A
Coolant Level	SHUTDOWN	Dynamic Brk	NO	Max MPH	0
Coolant Pressure	DISABLED			Conv. Factor	N/A
R1 Coolant Prs		Engine Brakes	NONE	Calc. Type	N/A
Crankcase Prs	DISABLED	Eng Brake Cruise	NO		
Override	YES	Eng Brake Low	3		
Intercool Temp	DISABLED	Increment	2		
Oil Press	SHUTDOWN				
Override		Data Pages	NO		
Oil Temp	SHUTDOWN	Optimized Idle	NO		
R1 Oil Temp		Fan Timer	180 SEC		
Aux Stop 1	SHUTDOWN				
Aux Stop 2	SHUTDOWN	Full Power Override	NO		
Vehicle Speed Sensor	YES	Cruise Control	YES	Press Gov System	NO
VSS Sensor Type	TRANS	AutoResume	NO	Cavitation Timeout	
VSS Signal Type	MAGNETIC	Min Speed	30	Pump Press Incr	
Num Teeth	16	Max Speed	65	Eng Spd Incr	
Tire Rev/Mile	500			Integral Gain	
Axle Ratio	3.55	ATI Port	NONE	Prop Gain	
Final Gear Ratio	1				
Vehicle Speed Limit	YES	Digital Torque Curve		1	
Max Speed	68	Starter Lockout Enable Speed		500	
Overspeed with Fuel	0	Starter Lockout Disable Speed		60	
Overspeed w/o Fuel	0				
PROGRESSIVE SHIFT	NO				
Low Gear #1 Max MPH		Max RPM		Turn-off RPM	
Low Gear #2 Max MPH		Max RPM		Turn-off RPM	
High Gear Max MPH		Max RPM			
Air Comp. System	NO	R1 Min Pressure		R1 Max Pressure	
Load Pressure		R2 Min Pressure		R2 Max Pressure	
Unload Pressure		R3 Min Pressure		R3 Max Pressure	
Pressure Increment		% Integral Gain		Prop Gain	

PIN	WIRE#	Fn	
E1	#451	32	FAN CONTROL OVERRIDE
F1	#542	29	A/C FAN STATUS
G1	#528	25	SEO/DIAGNOSTIC REQUEST
H1	#523	03	AUX SHUTDOWN #1
J1	#541	20	SET/COAST ON
F2	#544	23	CRUISE ENABLE
G2	#543	17	SERVICE BRAKE RELEASED
H2	#524	05	PARK BRAKE INTERLOCK
J2	#531	18	CLUTCH RELEASED
K2	#583	00	NONE
G3	#545	22	RESUME/ACCEL ON
K3	#979	00	NONE

VIH PIN	Wire#	Fn	Reverse Polarity	
A1	#988	10	NO	COOLANT LEVEL LOW LIGHT
A2	#555	13	YES	FAN CONTROL #1
F3	#499	06	NO	VEHICLE POWER SHUTDOWN

ESH PIN	Wire#	Fn	Reverse Polarity	
W3	#563	00	NO	NO FUNCTION
X3	#564	00	NO	NO FUNCTION
Y3	#565	00	NO	NO FUNCTION

8.3 TYPICAL INDUSTRIAL APPLICATION - UNDERGROUND HAUL TRUCK

This section contains typical parameter settings for a Series 2000 underground haul truck industrial application and the pin assignments for the Vehicle Interface Harness and the Engine Sensor Harness as listed in the Verification Report on the following pages.

The Digital Input and Digital Output ports can be configured for a variety of software options. The location of the connector pin for each software option can be specified at the time of engine order, by VEPS or the Distributor Reprogramming Station. For more information on software options, refer to section 4.1, "Digital Inputs" and section 4.2, "Digital Outputs."

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DDEC III/IV ENGINE SUMMARY

Series 2000	DDEC Appl Group	06N04C0721	DDEC III/IV APPL OFF-HWY WITH LSG ONLY S2000
	Base group	06N04D0292	575 HP STD RATING 1997 8V S2000 INDUSTRIAL
	Hp Group	06N04M1211	575HP@2100 18435 1997 MINE DDEC3 8V S2000 INDUSTRIAL

PWM Trans 9		VSG Max RPM	2100	Hot Idle	600
VSG Cruise Switch	NO	VSG Min RPM	600	Cold Idle	700
Init Speed	1000	VSG Alt Min RPM	600	Max Droop	150
RPM Increment	25	VSG is Primary	NO	LSG Droop	150
				VSG Droop	125
IDLE SHUTDOWN	NO	Time	5 MIN		
		Operates On	IDLE GOVERNOR ONLY		
Maximum Security	NO	Override	NO		
Minimum Security	NO	Min Temp	75 DEGC	Max Temp	75 DEGC
ENGINE PROTECTION		Digital Fan	NONE	FUEL ECONOMY INCENTIVE	
Coolant Temp	RAMPDOWN	PWM Fan	NONE	Min MPG	N/A
Coolant Level	RAMPDOWN	Dynamic Brk	NO	Max MPH	0
Coolant Pressure	RAMPDOWN			Conv. Factor	N/A
R1 Coolant Prs		Engine Brakes	NONE	Calc. Type	N/A
Crankcase Prs	DISABLED	Eng Brake Cruise	NO		
Override	YES	Eng Brake Low	2		
Intercool Temp	DISABLED	Increment	1		
Oil Press	RAMPDOWN				
Override	YES	Data Pages	YES		
Oil Temp	RAMPDOWN	Optimized Idle	NO		
R1 Oil Temp		Fan Timer	180 SEC		
Aux Stop 1	SHUTDOWN				
Aux Stop 2	RAMPDOWN	Full Power Override	YES		
Vehicle Speed Sensor	NO	Cruise Control	NO	Press Gov System	NO
VSS Sensor Type		Auto Resume		Cavitation Timeout	
VSS Signal Type		Min Speed		Pump Press Incr	
Num Teeth		Max Speed		Eng Spd Incr	
Tire Rev/Mile				Integral Gain	
Axle Ratio		ATI Port	NONE	Prop Gain	
Final Gear Ratio					
Vehicle Speed Limit	NO	Digital Torque Curve		1	
Max Speed		Starter Lockout Enable Speed		500	
Overspeed with Fuel		Starter Lockout Disable Speed		60	
Overspeed w/o Fuel					
PROGRESSIVE SHIFT	NO				
Low Gear #1 Max MPH		Max RPM		Turn-off RPM	
Low Gear #2 Max MPH		Max RPM		Turn-off RPM	
High Gear Max MPH		Max RPM			
Air Comp. System	NO	R1 Min Pressure		R1 Max Pressure	
Load Pressure		R2 Min Pressure		R2 Max Pressure	
Unload Pressure		R3 Min Pressure		R3 Max Pressure	
Pressure Increment		% Integral Gain		Prop Gain	

PIN	WIRE#	Fn	
E1	#451	00	NONE
F1	#542	00	NONE
G1	#528	25	SEO/DIAGNOSTIC REQUEST
H1	#523	00	NONE
J1	#541	01	ENGINE BRAKE LOW
F2	#544	03	AUX SHUTDOWN #1
G2	#543	09	THROTTLE INHIBIT
H2	#524	04	AUX SHUTDOWN #2
J2	#531	00	NONE
K2	#583	00	NONE
G3	#545	02	ENGINE BRAKE MED
K3	#979	28	DUAL THROTTLE (LSG)

VIH PIN	Wire#	Fn	Reverse Polarity	
A1	#988	20	NO	COOLANT TEMP HIGH LIGHT
A2	#555	08	NO	EXT BRAKE ENABLE
F3	#499	07	NO	STARTER LOCKOUT

ESH PIN	Wire#	Fn	Reverse Polarity	
W3	#563	00	NO	NO FUNCTION
X3	#564	00	NO	NO FUNCTION
Y3	#565	00	NO	NO FUNCTION

8.4 TYPICAL INDUSTRIAL APPLICATION - AIR COMPRESSOR

This section contains typical parameter settings for a Series 60 air compressor industrial application and the pin assignments for the Vehicle Interface Harness and the Engine Sensor Harness as listed in the Verification Report on the following pages.

The Digital Input and Digital Output ports can be configured for a variety of software options. The location of the connector pin for each software option can be specified at the time of engine order, by VEPS or the Distributor Reprogramming Station. For more information on software options, refer to section 4.1, "Digital Inputs" and section 4.2, "Digital Outputs."

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DDEC III/IV ENGINE SUMMARY

Series	DDEC Appl Group	06N04C0726	DDEC III APPL AIR COMPRESSOR
I60	Base group	06N04D6396	450/475 HP DDEC IV NON-ROAD 12L S60
	Hp Group	06N04M7079	475HP@2100RPM 5012 1998 DDEC IV NON-ROAD S60 (1550 FTLB)

PWM Trans 0		VSG Max RPM	2100	Hot Idle	1000
VSG Cruise Switch	NO	VSG Min RPM	600	Cold Idle	2500
Init Speed	1000	VSG Alt Min RPM	600	Max Droop	150
RPM Increment	25	VSG is Primary	YES	LSG Droop	150
				VSG Droop	125
IDLE SHUTDOWN	NO	Time	5 MIN		
		Operates On	IDLE GOVERNOR ONLY		
Maximum Security	NO	Override	NO		
Minimum Security	NO	Min Temp	75 DEGC	Max Temp	75 DEGC
ENGINE PROTECTION		Digital Fan	NONE	FUEL ECONOMY INCENTIVE	
Coolant Temp	SHUTDOWN	PWM Fan	NONE	Min MPG	N/A
Coolant Level	SHUTDOWN	Dynamic Brk	NO	Max MPH	0
Coolant Pressure	DISABLED			Conv. Factor	N/A
R1 Coolant Prs		Engine Brakes	NONE	Calc. Type	N/A
Crankcase Prs	DISABLED	Eng Brake Cruise	NO		
Override	YES	Eng Brake Low	2		
Intercool Temp	DISABLED	Increment	1		
Oil Press	SHUTDOWN				
Override	YES	Data Pages	YES		
Oil Temp	SHUTDOWN	Optimized Idle	NO		
R1 Oil Temp		Fan Timer	180 SEC		
Aux Stop 1	SHUTDOWN				
Aux Stop 2	SHUTDOWN	Full Power Override	NO		
Vehicle Speed Sensor	NO	Cruise Control	NO	Press Gov System	NO
VSS Sensor Type		Auto Resume		Cavitation Timeout	
VSS Signal Type		Min Speed		Pump Press Incr	
Num Teeth		Max Speed		Eng Spd Incr	
Tire Rev/Mile				Integral Gain	
Axle Ratio		ATI Port	NONE	Prop Gain	
Final Gear Ratio					
Vehicle Speed Limit	NO	Digital Torque Curve		1	
Max Speed		Starter Lockout Enable Speed		500	
Overspeed with Fuel		Starter Lockout Disable Speed		60	
Overspeed w/o Fuel					
PROGRESSIVE SHIFT	NO				
Low Gear #1 Max MPH		Max RPM		Turn-off RPM	
Low Gear #2 Max MPH		Max RPM		Turn-off RPM	
High Gear Max MPH		Max RPM			
Air Comp. System	YES	R1 Min Pressure	60	R1 Max Pressure	135
Load Pressure	7	R2 Min Pressure	60	R2 Max Pressure	150
Unload Pressure	14	R3 Min Pressure	30	R3 Max Pressure	60
Pressure Increment	4	% Integral Gain	64	Prop Gain	32

PIN	WIRE#	Fn	
E1	#451	00	NONE
F1	#542	35	AIR LOAD SWITCH
G1	#528	00	NONE
H1	#523	12	RATING SWITCH #1
J1	#541	00	NONE
F2	#544	13	RATING SWITCH #2
G2	#543	00	NONE
H2	#524	00	NONE
J2	#531	22	RESUME/ACCEL ON
K2	#583	00	NONE
G3	#545	20	SET/COAST ON
K3	#979	00	NONE

VIH

PIN	Wire#	Fn	Reverse Polarity	
A1	#988	00	NO	NO FUNCTION
A2	#555	00	NO	NO FUNCTION
F3	#499	21	NO	AIR COMP SOLENOID

ESH

PIN	Wire#	Fn	Reverse Polarity	
W3	#563	00	NO	NO FUNCTION
X3	#564	00	NO	NO FUNCTION
Y3	#565	00	NO	NO FUNCTION

8.5 TYPICAL INDUSTRIAL APPLICATION - ON-HIGHWAY CRANE

This section contains typical parameter settings for on-highway crane applications and the pin assignments for the Vehicle Interface Harness and the Engine Sensor Harness as listed in the Verification Report on the following pages.

The Digital Input and Digital Output ports can be configured for a variety of software options. The location of the connector pin for each software option can be specified at the time of engine order, by VEPS or the Distributor Reprogramming Station. For more information on software options, refer to section 4.1, "Digital Inputs" and section 4.2, "Digital Outputs."

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DDEC III/IV ENGINE SUMMARY

Series I60	DDEC Appl Group	06N04C0760	DDEC IV CRANE W/JAKE EPL
	Base group	06N04D6431	370-430 HP STD RAT 1999 LINE HAUL 11L S60
	Hp Group	06N04M7103	400HP@2100RPM 1053 1999 LINE HAUL TRK 12L S60 (1450FTLB)

PWM Trans 0		VSG Max RPM	2100	Hot Idle	700
VSG Cruise Switch	NO	VSG Min RPM	700	Cold Idle	2500
Init Speed	1000	VSG Alt Min RPM	1500	Max Droop	125
RPM Increment	25	VSG is Primary	NO	LSG Droop	100
				VSG Droop	0
IDLE SHUTDOWN	NO	Time	5 MIN		
		Operates On	IDLE & VSG GOVERNOR ONLY		
Maximum Security	NO	Override	NO		
Minimum Security	NO	Min Temp	75 DEGC	Max Temp	75 DEGC

ENGINE PROTECTION		Digital Fan	SINGLE	FUEL ECONOMY INCENTIVE	
Coolant Temp	WARNING	PWM Fan	NONE	Min MPG	N/A
Coolant Level	WARNING	Dynamic Brk	NO	Max MPH	0
Coolant Pressure	DISABLED			Conv. Factor	N/A
R1 Coolant Prs		Engine Brakes	JAKE	Calc. Type	N/A
Crankcase Prs	DISABLED	Eng Brake Cruise	YES		
Override	YES	Eng Brake Low	5		
Intercool Temp	DISABLED	Increment	2		
Oil Press	WARNING				
Override	YES	Data Pages	YES		
Oil Temp	WARNING	Optimized Idle	NO		
R1 Oil Temp		Fan Timer	180 SEC		
Aux Stop 1	WARNING				
Aux Stop 2	WARNING	Full Power Override	NO		

Vehicle Speed Sensor	YES	Cruise Control	YES	Press Gov System	NO
VSS Sensor Type	TRANS	AutoResume	YES	Cavitation Timeout	
VSS Signal Type	MAGNETIC	Min Speed	30	Pump Press Incr	
Num Teeth	16	Max Speed	60	Eng Spd Incr	
Tire Rev/Mile	501			Integral Gain	
Axle Ratio	5.87	ATI Port	NONE	Prop Gain	
Final Gear Ratio	1.0				
Vehicle Speed Limit	NO	Digital Torque Curve		1	
Max Speed		Starter Lockout Enable Speed		500	
Overspeed with Fuel		Starter Lockout Disable Speed		60	
Overspeed w/o Fuel					

PROGRESSIVE SHIFT	NO				
Low Gear #1 Max MPH		Max RPM		Turn-off RPM	
Low Gear #2 Max MPH		Max RPM		Turn-off RPM	
High Gear Max MPH		Max RPM			

Air Comp. System	NO	R1 Min Pressure		R1 Max Pressure	
Load Pressure		R2 Min Pressure		R2 Max Pressure	
Unload Pressure		R3 Min Pressure		R3 Max Pressure	
Pressure Increment		% Integral Gain		Prop Gain	

PIN	WIRE#	Fn	
E1	#451	01	ENGINE BRAKE LOW
F1	#542	02	ENGINE BRAKE MED
G1	#528	18	CLUTCH RELEASED
H1	#523	23	CRUISE ENABLE
J1	#541	20	SET/COAST ON
F2	#544	22	RESUME/ACCEL ON
G2	#543	17	SERVICE BRAKE RELEASED
H2	#524	12	RATING SWITCH #1
J2	#531	13	RATING SWITCH #2
K2	#583	25	SEO/DIAGNOSTIC REQUEST
G3	#545	16	ALT MIN VSG/FAST IDLE
K3	#979	09	THROTTLE INHIBIT

VIH PIN	Wire#	Fn	Reverse Polarity	
A1	#988	00	NO	NO FUNCTION
F3	#555	24	NO	ETHER START
A2	#499	13	YES	FAN CONTROL #1

ESH PIN	Wire#	Fn	Reverse Polarity	
W3	#563	00	NO	NO FUNCTION
X3	#564	00	NO	NO FUNCTION
Y3	#565	00	NO	NO FUNCTION

8.6 TYPICAL GENSET APPLICATIONS

This section contains typical Verification Reports parameter settings and pin assignments for generator sets. For 1,500 RPM genset applications, refer to section 8.6.1 and for 1,800 RPM genset applications, refer to section 8.6.2. For more detailed information on the engine governors, refer to section , "Throttle Control/Governors."

8.6.1 1,500 RPM GENSET

The Verification Report on the following pages contains typical parameter settings for 1,500 RPM genset applications, the pin assignments for the Vehicle Interface Harness and the Engine Sensor Harness.

The Digital Input and Digital Output ports can be configured for a variety of software options. The location of the connector pin for each software option can be specified at the time of engine order, by VEPS or the Distributor Reprogramming Station. For more information on software options, refer to section 4.1, "Digital Inputs" and section 4.2, "Digital Outputs."

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DDEC III/IV ENGINE SUMMARY

Series S2000	DDEC Appl Group	06N04C0742	APPLCATION DDEC IIV GEN SET 1500 RPM
	Base group	06N04D0377	730 HP STD RATING 1997 12V S2000 INDUSTRIAL
	Hp Group	06N04M1169	730HP@1500RPM 8413 1997 DDEC III INDUSTRIAL S2000

PWM Trans 0		VSG Max RPM	1575	Hot Idle	600
VSG Cruise Switch	NO	VSG Min RPM	1425	Cold Idle	2500
Init Speed	1000	VSG Alt Min RPM	1500	Max Droop	120
RPM Increment	25	VSG is Primary	YES	LSG Droop	120
				VSG Droop	0
IDLE SHUTDOWN	NO	Time	5 MIN		
		Operates On	IDLE GOVERNOR ONLY		
Maximum Security	NO	Override	NO		
Minimum Security	NO	Min Temp	75 DEGC	Max Temp	75 DEGC

ENGINE PROTECTION		Digital Fan	SINGLE	FUEL ECONOMY INCENTIVE	
Coolant Temp	SHUTDOWN	PWM Fan	NONE	Min MPG	N/A
Coolant Level	SHUTDOWN	Dynamic Brk	NO	Max MPH	0
Coolant Pressure	DISABLED			Conv. Factor	N/A
R1 Coolant Prs	DISABLED	Engine Brakes	NONE	Calc. Type	N/A
Crankcase Prs	DISABLED	Eng Brake Cruise	NO		
Override	YES	Eng Brake Low	2		
Intercool Temp	DISABLED	Increment	1		
Oil Press	SHUTDOWN				
Override	YES	Data Pages	YES		
Oil Temp	WARNING	Optimized Idle	NO		
R1 Oil Temp	DISABLED	Fan Timer	180 SEC		
Aux Stop 1	WARNING				
Aux Stop 2	WARNING	Full Power Override	NO		

Vehicle Speed Sensor	NO	Cruise Control	NO	Press Gov System	NO
VSS Sensor Type		Auto Resume		Cavitation Timeout	
VSS Signal Type		Min Speed		Pump Press Incr	
Num Teeth		Max Speed		Eng Spd Incr	
Tire Rev/Mile				Integral Gain	
Axle Ratio		ATI Port	NONE	Prop Gain	
Final Gear Ratio					
Vehicle Speed Limit	NO	Digital Torque Curve		1	
Max Speed		Starter Lockout Enable Speed		500	
Overspeed with Fuel		Starter Lockout Disable Speed		60	
Overspeed w/o Fuel					

PROGRESSIVE SHIFT	NO				
Low Gear #1 Max MPH		Max RPM		Turn-off RPM	
Low Gear #2 Max MPH		Max RPM		Turn-off RPM	
High Gear Max MPH		Max RPM			

Air Comp. System	NO	R1 Min Pressure		R1 Max Pressure	
Load Pressure		R2 Min Pressure		R2 Max Pressure	
Unload Pressure		R3 Min Pressure		R3 Max Pressure	
Pressure Increment		% Integral Gain		Prop Gain	

PIN	WIRE#	Fn	
E1	#451	00	NONE
F1	#542	16	ALT MIN VSG/FAST IDLE
G1	#528	00	NONE
H1	#523	00	NONE
J1	#541	00	NONE
F2	#544	00	NONE
G2	#543	00	NONE
H2	#524	25	SEO/DIAGNOSTIC REQUEST
J2	#531	00	NONE
K2	#583	00	NONE
G3	#545	00	NONE
K3	#979	00	NONE

VIH PIN	Wire#	Fn	Reverse Polarity	
A1	#988	18	NO	OIL PRESSURE LOW LIGHT
A2	#555	13	YES	FAN CONTROL #1
F3	#499	00	NO	NONE

ESH PIN	Wire#	Fn	Reverse Polarity	
W3	#563	19	NO	OIL TEMP HIGH LIGHT
X3	#564	00	NO	NO FUNCTION
Y3	#565	20	NO	COOLANT TEMP HIGH LIGHT

8.6.2 1,800 RPM GENSET

The Verification Report on the following pages contains typical parameter settings for 1,800 RPM genset applications, the pin assignments for the Vehicle Interface Harness and the Engine Sensor Harness.

The Digital Input and Digital Output ports can be configured for a variety of software options. The location of the connector pin for each software option can be specified at the time of engine order, by VEPS or the Distributor Reprogramming Station. For more information on software options, refer to section 4.1, "Digital Inputs" and section 4.2, "Digital Outputs."

DATE: VERIFICATION REPORT
SALES ORDER NUMBER:

DDEC III/IV ENGINE SUMMARY

Series S2000	DDEC Appl Group	06N04C0725	APPLICATION DDEC IV GEN SET 1800 RPM
	Base group	06N04D0376	910 HP STD RATING 1997 12V S2000 INDUSTRIAL
	Hp Group	06N04M1168	910HP@1800RPM 8412 1997 DDEC III INDUSTRIAL S2000

PWM Trans 0		VSG Max RPM	1890	Hot Idle	600
VSG Cruise Switch	NO	VSG Min RPM	1710	Cold Idle	2500
Init Speed	1000	VSG Alt Min RPM	1800	Max Droop	120
RPM Increment	25	VSG is Primary	YES	LSG Droop	120
				VSG Droop	0
IDLE SHUTDOWN	NO	Time	5 MIN		
		Operates On	IDLE GOVERNOR ONLY		
Maximum Security	NO	Override	NO		
Minimum Security	NO	Min Temp	75 DEGC	Max Temp	75 DEGC
ENGINE PROTECTION		Digital Fan	SINGLE	FUEL ECONOMY INCENTIVE	
Coolant Temp	SHUTDOWN	PWM Fan	NONE	Min MPG	N/A
Coolant Level	SHUTDOWN	Dynamic Brk	NO	Max MPH	0
Coolant Pressure	DISABLED			Conv. Factor	N/A
R1 Coolant Prs	DISABLED	Engine Brakes	NONE	Calc. Type	N/A
Crankcase Prs	DISABLED	Eng Brake Cruise	NO		
Override	YES	Eng Brake Low	2		
Intercool Temp	DISABLED	Increment	1		
Oil Press	SHUTDOWN				
Override	YES	Data Pages	YES		
Oil Temp	WARNING	Optimized Idle	NO		
R1 Oil Temp	DISABLED	Fan Timer	180 SEC		
Aux Stop 1	WARNING				
Aux Stop 2	WARNING	Full Power Override	NO		
Vehicle Speed Sensor	NO	Cruise Control	NO	Press Gov system	NO
VSS Sensor Type		Auto Resume		Cavitation Timeout	
VSS Signal Type		Min Speed		Pump Press Incr	
Num Teeth		Max Speed		Eng Spd Incr	
Tire Rev/Mile				Integral Gain	
Axle Ratio		ATI Port	NONE	Prop Gain	
Final Gear Ratio					
Vehicle Speed Limit	NO	Digital Torque Curve		1	
Max Speed		Starter Lockout Enable Speed		500	
Overspeed with Fuel		Starter Lockout Disable Speed		60	
Overspeed w/o Fuel					
PROGRESSIVE SHIFT	NO				
Low Gear #1 Max MPH		Max RPM		Turn-off RPM	
Low Gear #2 Max MPH		Max RPM		Turn-off RPM	
High Gear Max MPH		Max RPM			
Air Comp. System	NO	R1 Min Pressure		R1 Max Pressure	
Load Pressure		R2 Min Pressure		R2 Max Pressure	
Unload Pressure		R3 Min Pressure		R3 Max Pressure	
Pressure Increment		% Integral Gain		Prop Gain	

PIN	WIRE#	Fn	
E1	#451	00	NONE
F1	#542	16	ALT MIN VSG/FAST IDLE
G1	#528	00	NONE
H1	#523	00	NONE
J1	#541	00	NONE
F2	#544	00	NONE
G2	#543	00	NONE
H2	#524	00	NONE
J2	#531	00	NONE
K2	#583	00	NONE
G3	#545	25	SEO/DIAGNOSTIC REQUEST
K3	#979	00	NONE

VIH

PIN	Wire#	Fn	Reverse Polarity	
A1	#988	18	NO	OIL PRESSURE LOW LIGHT
A2	#555	13	YES	FAN CONTROL #1
F3	#499	20	NO	COOLANT TEMP HIGH LIGHT

ESH

PIN	Wire#	Fn	Reverse Polarity	
W3	#563	19	NO	OIL TEMP HIGH LIGHT
X3	#564	00	NO	NO FUNCTION
Y3	#565	00	NO	NO FUNCTION

8.7 TYPICAL FIRE TRUCK APPLICATION

This section contains typical parameter settings for Fire Truck applications and the pin assignments for the Vehicle Interface Harness and the Engine Sensor Harness as listed in the Verification Report on the following pages.

The Digital Input and Digital Output ports can be configured for a variety of software options. The location of the connector pin for each software option can be specified at the time of engine order, by VEPS or the Distributor Reprogramming Station. For more information on software options, refer to section 4.1, "Digital Inputs" and section 4.2, "Digital Outputs."

DATE: VERIFICATION REPORT

SALES ORDER NUMBER:

- -

DDEC III ENGINE SUMMARY

Series	DDEC Appl Group	06N04C0507	DDEC III/IV APPL FIRETRUCK W/PGS/EOP OFF JB
I60	Base group	06N04D6429	470/500 HP PREM RAT 1999 DDEC IV LINE HAUL 12L S60
	Hp Group	06N04M7095	470HP@2100RPM 1045 1999 LINE HAUL PREM 12L S60 (155OFTLB)

PWM Trans 12 ALLISON WT		VSG Max RPM	2100	Hot Idle	600
VSG Cruise Switch	NO	VSG Min RPM	600	Cold Idle	750
Init Speed	1000	VSG Alt Min RPM	600	Max Droop	150
RPM Increment	25	VSG is Primary	NO	LSG Droop	125
				VSG Droop	0
IDLE SHUTDOWN	NO	Time	5 MIN		
		Operates On	IDLE GOVERNOR ONLY		
Maximum Security	NO	Override	NO		
Minimum Security	NO	Min Temp	75 DEGC	Max Temp	75 DEGC

ENGINE PROTECTION		Digital Fan	SINGLE	FUEL ECONOMY INCENTIVE	
Coolant Temp	WARNING	PWM Fan	NONE	Min MPG	N/A
Coolant Level	WARNING	Dynamic Brk	NO	Max MPH	0
Coolant Pressure	DISABLED			Conv. Factor	N/A
R1 Coolant Prs		Engine Brakes	JAKE	Calc. Type	N/A
Crankcase Prs	DISABLED	Eng Brake Cruise	NO		
Override	YES	Eng Brake Low	2		
Intercool Temp	DISABLED	Increment	1		
Oil Press	WARNING				
Override	YES	Data Pages	NO		
Oil Temp	WARNING	Optimized Idle	NO		
R1 Oil Temp		Fan Timer	180 SEC		
Aux Stop 1	WARNING				
Aux Stop 2	WARNING	Full Power Override	NO		

Vehicle Speed Sensor	NO	Cruise Control	NO	Press Gov system	YES
VSS Sensor Type		AutoResume		Cavitation Timeout	5
VSS Signal Type		Min Speed		Pump Press Incr	4
Num Teeth		Max Speed		Eng Spd Incr	25
Tire Rev/Mile				Integral Gain	10
Axle Ratio		ATI Port	NONE	Prop Gain	.75
Final Gear Ratio					
Vehicle Speed Limit	NO	Digital Torque Curve		1	
Max Speed		Starter Lockout Enable Speed		500	
Overspeed with Fuel		Starter Lockout Disable Speed		60	
Overspeed w/o Fuel					

PROGRESSIVE SHIFT	NO				
Low Gear #1 Max MPH		Max RPM		Turn-off RPM	
Low Gear #2 Max MPH		Max RPM		Turn-off RPM	
High Gear Max MPH		Max RPM			

Air Comp. System	NO	R1 Min Pressure		R1 Max Pressure	
Load Pressure		R2 Min Pressure		R2 Max Pressure	
Unload Pressure		R3 Min Pressure		R3 Max Pressure	
Pressure Increment		% Integral Gain		Prop Gain	

PIN	WIRE#	Fn	
E1	#451	15	DIAGNOSTIC REQUEST
F1	#542	16	ALT MIN VSG/FAST IDLE
G1	#528	00	NONE
H1	#523	08	PRESSURE/RPM MODE
J1	#541	20	SET/COAST ON
F2	#544	26	ENGINE BRAKE DISABLE
G2	#543	24	PGS SYSTEM ENABLE
H2	#524	09	THROTTLE INHIBIT
J2	#531	05	PARK BRAKE INTERLOCK
K2	#583	02	ENGINE BRAKE MED
G3	#545	22	RESUME/ACCEL ON
K3	#979	01	ENGINE BRAKE LOW

VIH

PIN	Wire#	Fn	Reverse Polarity	
A1	#988	16	NO	ENGINE BRAKE ACTIVE
A2	#555	11	NO	CRUISE ACTIVE LIGHT
F3	#499	05	NO	PGS ACTIVE LIGHT

ESH

PIN	Wire#	Fn	Reverse Polarity	
W3	#563	10	NO	COOLANT LEVEL LOW LIGHT
X3	#564	08	NO	EXT BRAKE ENABLE
Y3	#565	07	NO	STARTER LOCKOUT

8.8 DDEC REQUIREMENTS FOR GASEOUS HAZARDOUS ENVIRONMENTS

A hazardous environment DDEC package has been developed that meets North American, European, and Asian hazardous environment certification requirements. The DDEC system has been certified for operation in Class 1 Division 2 or Group II Zone 2 (Category 3) hazardous gaseous environments for all gas groups. The means used to obtain compliance vary somewhat between engine series due to engine hardware differences. Engine series currently available for Class I Division 2 and Group II Zone 2 hazardous environments include Series 60, Series 50 and Series 2000.

The information provided is necessary to install a DDEC IV engine certified and/or listed for Class 1 Division 2 or Group II Zone 2 (Category 3) categories hazardous environments. The information is intended to supplement current DDEC requirements as listed in this manual.

This section is written for those familiar with hazardous environment applications. It is the responsibility of the installer to procure the standards that are discussed in this section in order to ensure their compliance with the appropriate standard.

CAUTION:

Explosion Hazard — Substitution of components may impair suitability for Class 1 Division 2. UL1604

CAUTION:

Explosion Hazard — Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

CAUTION:

Explosion Hazard — Substitution of components may impair suitability for Group II Zone 2 (Category 3).
EN 50021, EN 50014, and EN 50028

8.8.1 HAZARDOUS GASEOUS ENVIRONMENT OVERVIEW

The following information should be used to provide a broad overview of Hazardous Environments only, it is not intended to be a definitive reference guide.

Hazardous Environment Classification - North America

Class I: Hazardous location due to the presence of flammable substances such as gases or vapors.

Division 1: Danger can be present during normal functioning, during repair or maintenance, or where a fault may cause the simultaneous failure of electrical equipment.

Division2: Combustible material is present but confined to a closed container or system, or an area adjacent to a Division 1 location.

Hazardous Environment Classification - Europe

Group II: Hazardous location due to the presence of flammable substances such as gases or vapors.

Zone 1 (Category 2): An area in which an explosive air/gas mixture is LIKELY to occur in normal operation.

Zone 2 (Category 3): An area in which an explosive air/gas mixture is UNLIKELY to occur; but, if it does, only for short periods of time.

Gas Classification

Gas classifications are made on the basis of the gas or vapors ease of ignition.

North America: Groups A - D

- A Is Most Stringent (readily ignitable)
- D Is Least Stringent (more difficult to ignite)

Europe: Groups C - A

- C Is Most Stringent (readily ignitable)
- A Is Least Stringent (more difficult to ignite)

Refer to section 3.18 for the DDC-supplied hardware IP code.

Ingress Protection

Ingress protection specifies the degree of protection:

- From contact with live or moving parts
- Against the intrusion of solid foreign bodies or liquid into a component

The codes for the level of protection is listed in Table 8-4.

Degree of Protection	Solid Bodies	Degree of Protection	Liquid
0	No Protection	0	No Protection
1	Objects > 50 mm	1	Vertically Dripping Water
2	Objects > 12mm	2	Angled Dripping Water
3	Objects > 2.5 mm	3	Sprayed Water
4	Objects > 1.0 mm	4	Splashed Water
5	Dust Protected	5	Water Jets
6	Dust Tight	6	Heavy Seas
		7	Effects of Immersion
		8	Indefinite Immersion

Table 8-4 Ingress Protection Codes

Example: Protection degree is specified by a code such as IP64. The first numeral (6) defines the degree of protection against contact with live or moving parts and against the intrusion of solid foreign bodies. The second numeral (4) defines the degree of protection against the intrusion of liquid. Therefore, IP64 is a dust tight device that is resistant to splashed water.

Temperature Classification

The maximum surface temperature must be lower than the minimum ignition temperature of the gas present. Temperature classifications are listed in Table 8-5.

Maximum Surface Temperature (°C)	Temperature Classification
450°C	T1
300°C	T2
200°C	T3
135°C	T4
100°C	T5
85°C	T6

Table 8-5 Temperature Classification

Detroit Diesel provides two options, which have been certified by both Nemko and Underwriters Laboratories for use in Group II Zone 2 (Category 3) and Class 1 Division 2 for all types of combustible gases. Refer to section 8.8.2 for certification information.

8.8.2 DDEC IV SYSTEM CERTIFICATION

Detroit Diesel has been awarded Class I Division 2 and Group II Zone 2 (Category 3) certification for the DDEC IV System for all gas groups.

Class I Division 2 Certification

The DDEC IV System has been investigated by Underwriters Laboratories Inc.® in accordance with the following standards for safety as indicated on the certificate of compliance (see Figure 8-1):

- ☐ UL 508
- ☐ UL 1604
- ☐ CSA C22.2 No. 14
- ☐ CSA C22.2 No. 213

A copy of these standards can be obtained from Underwriters Laboratories Inc.

UNDERWRITERS LABORATORIES INC.®

(1) **CERTIFICATE OF COMPLIANCE**

(2) UL Certificate Number **99.14939**

(3) This certificate is issued for: **Process Control Equipment**

Type/Model: **DDEC IV Electronic Control System**

(4) Issued to: **Detroit Diesel Corp.**
13400 Outer Dr. West
Detroit, MI 48239

(5) Report Reference: **E202737, Issued 12 April 2000**

(6) This product has been investigated by Underwriters Laboratories Inc.® in accordance with the following Standard(s) for Safety indicated on this Certificate:

UL 508, UL 1604
CSA C22.2 No. 14, CSA C22.2 No. 213

(7) The product marking shall include the following information:

Class I, Division 2, Groups A, B, C, and D, T6

(8) Only those products bearing the UL Recognized Component Marking for the US and Canada should be considered as being covered by UL's Listing and Follow-Up Service meeting the appropriate requirements for the US and Canada.

The UL Recognized Component Marking for the US and Canada generally includes: the UL Recognized Component Mark with the "C" and "US" identifiers, cURus, and the manufacturer's identification and catalog number, model number, or other product designation as specified under "Marking" for the particular Recognition as published in the appropriate UL Directory. THE FINAL ACCEPTANCE OF THE COMPONENT IS DEPENDENT UPON ITS INSTALLATION AND USE IN COMPLETE EQUIPMENT SUBMITTED TO UNDERWRITERS LABORATORIES INC.

LOOK FOR THE UL RECOGNIZED COMPONENT MARKING ON THE PRODUCT

Signed: Issued: 12 April, 2000

Paul T. Kelly
Associate Managing Engineer

This certificate may only be reproduced in its entirety and without alterations.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096 (USA)
Phone: +1-847-272-8800, x42326 Fax: +1-847-272-9475 E-mail: hazloc@ul.com Website: http://www.ul.com/hazloc/

40409

Figure 8-1 Certificate of Compliance from Underwriters Laboratories Inc.

Group II Zone 2 (Category 3) Certification

Detroit Diesel has been awarded the product conformity certificates for the DDEC IV System by Nemko®, the Test Laboratory accredited by the Norwegian Metrology and Accreditation Service, for compliance with the following harmonized European Standard(s):

- ☐ CENELEC EN 50021: 1999 for the DDEC IV Electronic Control Module (see Figure 8-2and Figure 8-3)
- ☐ CENELEC EN 50019; 1994 and CENELEC EN 50014; 1997 + A1:1999 + A2:1999 for the top of the cylinder head with rocker cover (see Figure 8-4, Figure 8-5 and Figure 8-6)
- ☐ CENELEC EN 50014; 1997 + A1:1999 + A2:1999 and CENELEC EN 50019; 1994 and CENELEC EN 50028; 1987 for the Electronic Unit Injector (EUI) and the Electronic Unit Pump (EUP) (see Figure 8-7 and Figure 8-8)

The DDEC IV System and electronic components have been certified for the Group II Zone 2 (Category 3) T4, and Groups A, B, and C hazardous environments.

Detroit Diesel has been awarded the Type Approval Certificate for the DDEC IV System by Det Norske Veritas (DNV) for compliance with Det Norske Veritas Rules for Classification of Ships and Mobile Offshore Units (see Figure 8-9, Figure 8-10, Figure 8-11).

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Nemko

Ex

1. **PRODUCT CONFORMITY CERTIFICATE**

2. Nemko Certificate reference: **Nemko Nr. Ex 00.118**

3. This Certificate is issued for the following electrical equipment.

Apparatus or system:	**Electronic Control Device**
Certified type:	**DDEC IV ECM**

4. Manufactured by: **Detroit Diesel Corporation**
13400 Outer Drive
West Detroit
Michigan 48239-4001/U.S.A.

Applicant: **Detroit Diesel Corporation**
13400 Outer Drive
West Detroit
Michigan 48239-4001/U.S.A.

5. This electrical apparatus or system and any acceptable variations thereto are specified in the Annex and possible Supplement(s) to this Certificate and in the descriptive documents therein referred to.

6. Nemko, being accredited Test Laboratory by the Norwegian Metrology and Accreditation Service, confirms that the apparatus has been found to comply with the following harmonized European Standard(s):
CENELEC EN 50021: 1999

and has successfully met the type verification and test requirements of these standards.

A confidential test report has been completed on these verifications and tests.

Test Report: **199938125**

7. The code for the electrical apparatus is: **EEx nAL IIC T4**

8. By marking the supplied electrical apparatus, the manufacturer attests on his own responsibility that this electrical apparatus complies with the descriptive documents referred to in the Annex to this Certificate.

Total number of pages in the Annex to this Certificate: **1**

This Certificate may only be reproduced in its entirety and without change.

Oslo, 2000-04-19

for Rolf Hoel Head of Section for Ex-equipment	Håkon S. Håkonsen Certification Engineer

Nemko AS P.O. Box 73, Blindern N-0314 Oslo, Norway	Office address Gaustadalléen 30 0373 Oslo	Telephone +47 22 96 03 30 Enterprise number:	Fax +47 22 96 05 50 NO 974404532

40412

Figure 8-2 Nemko Component Certificate for ECM

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Nemko

Ex

Nemko Nr. Ex 00.118 Date: 2000-04-19

ANNEX TO PRODUCT CONFORMITY CERTIFICATE

Description of the Equipment

The DDEC IV ECM is an electronic control device for a diesel or gas engine made by Detroit Diesel Corporation. The device is mounted inside an enclosure of stainless steel that fulfils the relevant requirements of EN 50021 and EN 60529, IP66.

Energy limited outlet for sensors and throttle control. Non sparking outlet for injector solenoids. The whole system will always be a mounted part on a Detroit Diesel engine and it is the customers responsibility to provide communication and supply connection to the DDEC IV ECM according to the relevant requirements of EN 50021.

All cable entries used on the enclosure must fulfil the relevant requirements of EN 50021.

This certificate for DDEC IV ECM is only valid when the DDEC IV ECM is mounted on a diesel or gas engine made by Detroit Diesel.

In the parts list all the permissible sensors and throttle controls for safe use are listed.

Ambient Temperatures

-40°C≥T_a≥+55°C

Types Covered by this Certificate

DDEC IV Electronic Control Module	12V Only
DDEC IV Electronic Control Module	12/24V
DDEC IV Electronic Control Module (S4K)	12/24V
DDEC IV ECM (Natural Gas)	12/24V

Descriptive Documents

Drawings

No.	Title	Rev.	Date	Sheets
70D41400U	Outline Assembley DDEC	AK	1999-08-02	2
63D41709L	DDEC3A-6cyl 6DD4307307E02	AJ	08-1999	4
63D41940L	DDEC3A-8cyl 6DD4308E02	AK	08-1999	4
63D41944L	DDEC-S4000 6DD4309E02	AK	08-1999	4
63D41947L	DDEC3A-8Cyl NG 6DD4310E02	AK	08-1999	4
39789			undated	1

Parts List

No.	Title	Rev.	Date	Sheets
	Parts Description		undated	3

Nemko AS
P.O. Box 73, Blindern
N-0314 Oslo, Norway

Office address
Gaustadalléen 30
0373 Oslo

Telephone
+47 22 96 03 30
Enterprise number:

Fax
+47 22 96 05 50
NO 974404532

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Figure 8-3 Annex for Nemko Component Certificate for ECM

Page 1 of 1

Nemko

1. CERTIFICATE OF CONFORMITY

2. Nemko Certificate reference: **Nemko Nr. Ex 00E119**

3. This Certificate is issued for the following electrical equipment, intended for use in potentially explosive atmospheres:

   Apparatus or system: **Diesel Engine Top of Cylinder Head with Rocker Cover**

   Certified type: **S 60**

4. Manufactured by: **Detroit Diesel Corporation, 13400 Outer Drive, West Detroit, Michigan 48239-4001/U.S.A.**

   Applicant, on behalf of the manufacturer: **Detroit Diesel Corporation, 13400 Outer Drive, West Detroit, Michigan 48239-4001/U.S.A.**

5. This electrical apparatus or system and any acceptable variations thereto are specified in the Annex and possible Supplement(s) to this Certificate and in the descriptive documents therein referred to.

6. Nemko, being an Approved Certification Body in accordance with Article 14 of the Council Directive of the European Communities of 18. December 1975(76/117/EEC), confirms that the apparatus has been found to comply with the following harmonized European Standards:

   and has successfully met the type verification and test requirements of these standards.

   A confidential test report has been completed on these verifications and tests.

   Test Report: **200006163**

7. The code for the electrical apparatus is: **EEx em II T4**

8. By marking the supplied electrical apparatus, the manufacturer attests on his own responsibility that this electrical apparatus complies with the descriptive documents referred to in the Annex to this Certificate and has satisfied routine verifications and tests required in the harmonized European Standards referred to in point 6 above.

9. This electrical apparatus may be marked with the distinctive community mark as printed on this certificate, and specified in Annex II of the Council's Directive of 16. January 1984 (84/47/EEC).

   Total number of pages in the Annex to this Certificate: **1**

   This Certificate may only be reproduced in its entirety and without change.

Oslo, 2000-04-19

for Rolf Hoel
Head of Section for Ex-equipment

Håkon S. Håkonsen
Certification Engineer

Nemko AS	Office address	Telephone	Fax
P.O. Box 73, Blindern	Gaustadalléen 30	+47 22 96 03 30	+47 22 96 05 50
N-0314 Oslo, Norway	0373 Oslo	Enterprise number:	NO 974404532

40414

Figure 8-4 Nemko Component Certificate for Diesel Engine Top of Cylinder Head with Rocker Cover for Series 60 and Series 50

Nemko

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Nemko Nr. Ex 00E119 Date: 2000-04-19

ANNEX TO CERTIFICATE OF CONFORMITY

Diesel engine top of cylinder head with six injectors with component certified solenoids mounted, covered by a rocker cover.

The rocker cover is a two-piece rocker cover of cast aluminium.

Technical data
12/24V

Ambient Temperature
-40°C≥T_a≥+55°C

Information
If a breather shall be mounted it must be according to EN 50014 and EN 50019.

Descriptive Documents
Drawings

No.	Title	Rev.	Date	Sheets
23523212	Cover-Rocker (Lower)	E	1999-11-19	
23513426	Cover-Rocker (Upper)	4	1995-01-28	
3522269	Series 60 Rocker Cover Gasket	A15	1998-10-27	
23511991	Gasket-Rocker Cover (Upper)	4	1995-10-17	
23516322	Gasket-Rocker Cover		1994-10-14	
23527016	6063-TK74 S60 Hazardous		2000-02-18	7
23526904	Adapter-Injector Wire	B	2000-01-05	
1205 9485	Grommet	A	1985-05-01	
23522271	Bolt-Spacer		Undated	

Parts List

No.	Title	Rev.	Date	Sheets
	Parts Description		undated	1

Nemko AS
P.O. Box 73, Blindern
N-0314 Oslo, Norway

Office address
Gaustadalléen 30
0373 Oslo

Telephone
+47 22 96 03 30
Enterprise number:

Fax
+47 22 96 05 50
NO 974404532

40415

Figure 8-5 Annex for Nemko Component Certificate for Diesel Engine Top of Cylinder Head with Rocker Cover for Series 60 and Series 50

Nemko

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Nemko Nr. Ex 00E119

Date: 2000-11-24

SUPPLEMENT 1 TO CERTIFICATE OF CONFORMITY

Description
The Certificate is extended to include a one-piece rocker cover of Vinyl Ester painted with Clearcoat, Water Borne Enamel or Polyurethane.

Certified Type
S60

Technical Data
12/24V

Ambient Temperature
-20°C ≥ T_a ≥ +55°C

Descriptive Documents
Drawings

Name/Title	Drawing No.	Rev.	Date	Sheets
Cover Assembly Rocker (Vinyl Ester)	23522272	E	1999-01-12	3

Parts List

Name/Title	No.	Rev.	Date	Sheets
Part Description (Rocker Cover)		-	-	1

Test Report
200006163

Oslo, 2000-11-24

Rolf Hoel
Certification Manager

Håkon S. Håkonsen
Certification Engineer

Nemko AS
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41011

Figure 8-6 Supplement 1 for Nemko Component Certificate for Diesel Engine Top of Cylinder Head with Rocker Cover for Series 60 and Series 50

Nemko

Page 1 of 1

1. COMPONENT CERTIFICATE

2. Nemko Certificate reference: **Nemko Nr. Ex 99E385U**

3. This Certificate is issued for the following component, intended for use in potentially explosive atmospheres:

Component category:	**Solenoid**
Certified type:	**EUI and EUP**

4. Manufactured by: **Diesel Technology**
P.O. Box 888653/4300-44th St. S.E.
Kentwood, Michigan 49588-8653
U.S.A.

Applicant, on behalf of the manufacturer: **Detroit Diesel Corporation**
13400 Outer Drive
West Detroit
Michigan 48239-4001/U.S.A.

5. This electrical component and any acceptable variations thereto are specified in the Annex and possible Supplement(s) to this Certificate and in the descriptive documents therein referred to.

6. Nemko, being an Approved Certification Body in accordance with Article 14 of the Council Directive of the European Communities of 18. December 1975(76/117/EEC), confirms that the component has been found to comply with the following harmonized European Standards:
CENELEC EN 50014: 1997 + A1:1999 + A2:1999, CENELEC EN 50019: 1994 and CENELEC EN 50028: 1987

and has successfully met the type verification and test requirements of these standards.

A confidential test report has been completed on these verifications and tests.

Test Report: **199918275**

7. The code for the component is: **EEx me II**

8. By marking the supplied electrical component, the manufacturer attests on his own responsibility that this electrical component complies with the descriptive documents referred to in the Annex to this Certificate and has satisfied routine verifications and tests required in the harmonized European Standards referred to in point 6 above.

9. This Certificate should not be regarded as a Certificate of Conformity, but it may be used by a Certification Authority to establish the acceptability of the component as a part of a certified equipment.This electrical component shall not be marked with the distinctive community mark specified in Annex II of the Council's Directive 84/47/EEC of 16. January 1984.

Total number of pages in the Annex to this Certificate: **1**

This Certificate may only be reproduced in its entirety and without change.

Oslo, 2000-04-03

Rolf Hoel	Håkon S. Håkonsen
Head of Section for Ex-equipment	Certification Engineer

Nemko AS	Office address	Telephone	Fax
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N-0314 Oslo, Norway	0373 Oslo	Enterprise number:	NO 974404532

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Figure 8-7 Nemko Component Certificate for EUI and EUP Solenoids

Nemko

Page 1 of 1

Nemko Nr. Ex 99E385U Date: 2000-04-03

ANNEX TO COMPONENT CERTIFICATE

Description of the Component
These solenoids are interchangeable parts of electronic injectors for diesel engines.
Terminals are made for cable lugs with a keyhole.
The maximum permissible temperature on the surface is 120°C.

Technical Data
12V or 24V

Descriptive Documents
Type EUI

5237317	1999-11-08
5234887	1989-09-19
5234923	1989-01-14

Type EUP

5237336	2000-01-13
5236290	1995-08-23
5236301	1995-08-23
5236294	1995-08-23

Special Conditions for Safe Use
The solenoids must only be connected to type DDEC ECM control device.

Routine test
Routine tests shall be performed according to relevant parts in clause 7 of EN 50028.

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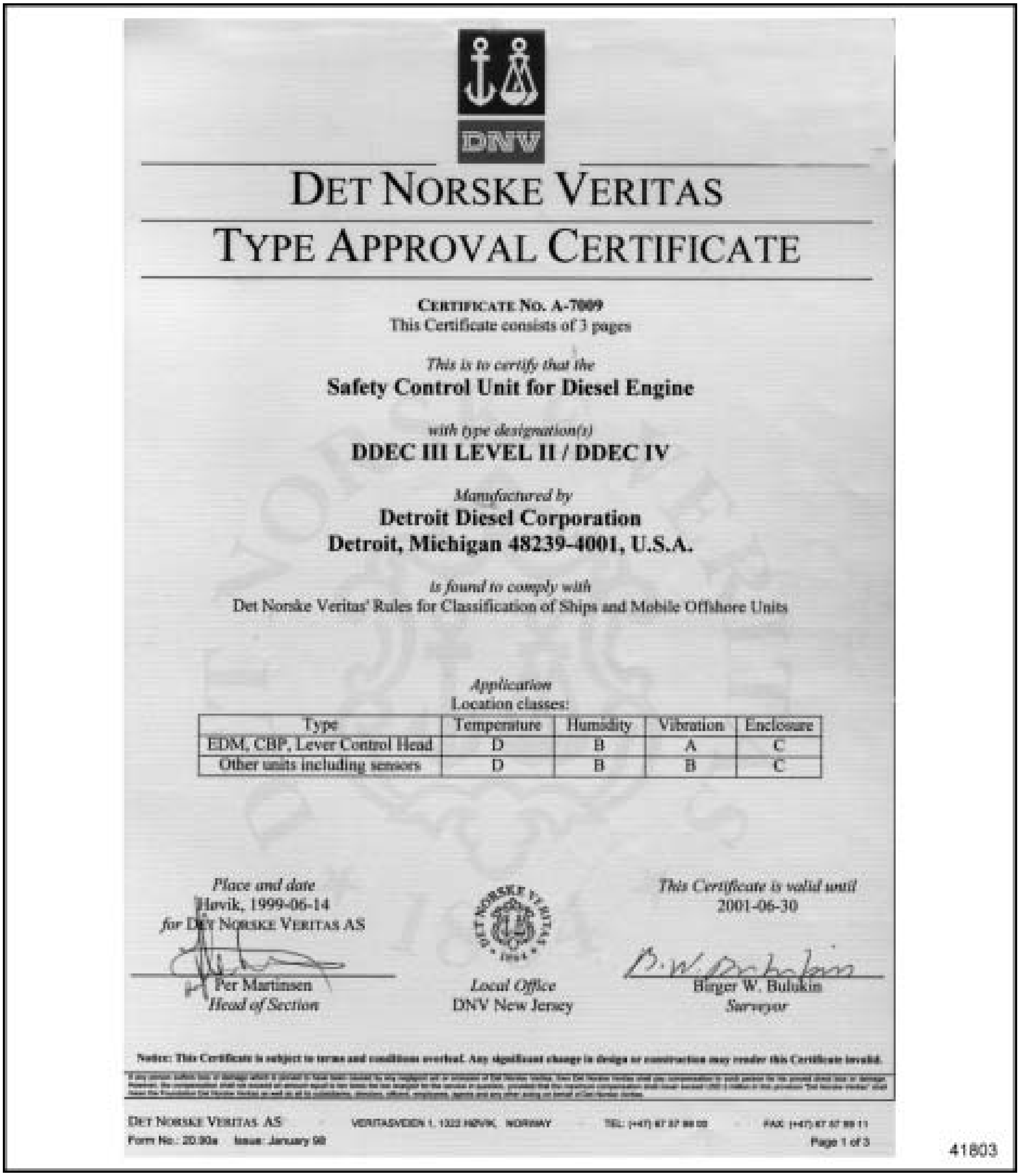
N-0314 Oslo, Norway	0373 Oslo	Enterprise number:	NO 974404532

40411

Figure 8-8 Annex for Nemko Component Certificate for EUI and EUP Solenoids



DNV

DET NORSKE VERITAS

TYPE APPROVAL CERTIFICATE

CERTIFICATE NO. A-7009
This Certificate consists of 3 pages

This is to certify that the
Safety Control Unit for Diesel Engine

with type designation(s)
DDEC III LEVEL II / DDEC IV

Manufactured by
Detroit Diesel Corporation
Detroit, Michigan 48239-4001, U.S.A.

is found to comply with
Det Norske Veritas' Rules for Classification of Ships and Mobile Offshore Units

Application
Location classes:

Type	Temperature	Humidity	Vibration	Enclosure
EDM, CBP, Lever Control Head	D	B	A	C
Other units including sensors	D	B	B	C

Place and date
Høvik, 1999-06-14
for DET NORSKE VERITAS AS

Per Martinsen
Head of Section

Local Office
DNV New Jersey

This Certificate is valid until
2001-06-30

Birger W. Bulukin
Surveyor

Notice: This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.

DET NORSKE VERITAS AS VERITASVEIEN 1, 1322 HØVIK, NORWAY TEL: (+47) 67 57 99 00 FAX: (+47) 67 57 99 11
Form No.: 20.90a Issue: January 98 Page 1 of 3

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Figure 8-9 DNV Type Approval Certificate, Page 1 of 3

DNV

Cert. No.: A-7009
File No.: 852.90

Product description

Type: DDEC III Level II, consisting of the following modules:

Part number	Short code	Description	Equivalent parts (*)
23517857	EDM	Electronic Display Module	
23520053		Single Lever Control Head	23512035 23512036 23510175 23510176 23518505 23512041 23512042 23520053 23520179 23512039 23512040 23512037 23512043 23512038 23512044 23520177 23520178 23520180 23520177 23520178 23520180 23520181 23520182 23520183 23523111
23517557	CBP	Control Button Panel	23512578 23520440 23512478 23506934 23519974 23512579 23506933 23519499 23517500 23517557
23517552	CSIM	Control Station Interface Module	
23517558	EBP	Emergency Backup Power Module	
23519569	EBPM	Emergency Backup Power Module	
23517868	ERIM	Engine Room Interface Module	
23519500	EGIM	Electric GearInterfaceModule	
23517554		Gear Actuator	
23520162		Backup Actuator	
23517555		Troll Actuator	
23519565	MIM	Marine Interface Module, Single	
23519566	MIM	Marine Interface Module, Multi	23519567 23519568 23522236
23519570	LCP	Local Control Panel	
23518743	ECM	DDEC III Electronic Control Module	
23519308	ECM	DDEC IV Electronic Control Module, Master	23519307
23519309	ECM	DDEC IV Electronic Control Module, Receiver	23519310
SK-110.. ,SK-11137, SK-10659, 2352(1535/1552), 2351(3604/2192)		Cable Harness (16 different items)	
23515250	ATS	Air Temp. Sensor	
23514708	CTS	Coolant Temp. Sensor	
23518092	FTS/OTS	Fuel Oil Temp. Sensor	
	OPS	Oil Press. Sensor	
	CLS	Coolant Level Sensor	
	TBS	Turbo Bost Sensor	
08929388	TRS	Timing Reference Sensor	
08929387	SRS	Synchronous Reference Sensor	

* Equivalent parts are of same specific design and make as the one to the left in the table.

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Figure 8-10 DNV Type Approval Certificate, Page 2 of 3

DNV

Cert. No.: A-7009
File No.: 852.90

Application/Limitation

Approval of sensors are only valid in connection with this application.
Sufficient mechanical protection of sensors to be ensured for marine installations and open applications.
Test procedures for periodical maintenance and testing in agreement with DNV Rules to be provided by the manufacturer.

Type Approval documentation

The approval is based on the following documentation:

Ring binder: 18SA372 9710 - DDEC III Marine Level II Bridge Control Application and Installation. Dated 1997

Environmental test reports:
Ring binders: Environmental Test of DDEC Bridge Controls and ECM for Marine Society Approval/ DDEC III & DDEC IV Engineering Report Volume 1 & 2.

Tests carried out

Req. tests acc. to C.N.2.4 carried out. All applicable EMI tests according to CE Marine Directive carried out.

Certificate retention survey

The scope of the retention/renewal survey is to verify that the conditions stipulated for the type approval is complied with and that no alterations are made to the product design or choice of components.

- The main elements of the survey to be dealt with:
- Ensure that components used comply with type approved documents and/or referenced component specifications.
- Review of possible changes in design, components, performance and make sure that such changes do not affect the type approval given.
- Review of manufacturing process and make sure that any changes do not affect the type approval.
- Ensure traceability between manufacturer marking and the type approval certificate.
- Ensure that type approved documentation are available.

Survey to be performed only by renewal .

END OF CERTIFICATE

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Form No.: 20.90a   Issue: January 98   Page 3 of 3

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Figure 8-11 DNV Type Approval Certificate, Page 3 of 3

8.8.3 PRODUCT MARKINGS

The certified system and/or components must have labels that identify the system/components as certified. The labels needed are listed in Table 8-6.

Hazardous Environment Classification	Placement	Part Number
Class I Division 2	DDEC IV ECM (see Figure 8-12)	23528426
Group II Zone 2 (Category 3)	DDEC IV ECM (see Figure 8-13)	23528451
Group II Zone 2 (Category 3)	Top of the Cylinder Head with the Aluminum Rocker Cover (Series 60/Series 50 only) (see Figure 8-14)	23528427
Group II Zone 2 (Category 3)	Top of the Cylinder Head with the Vinyl Rocker Cover (Series 60 only) (see Figure 8-15)	23528955
Group II Zone 2 (Category 3)	DDEC IV ECM (see Figure 8-16)	23528908
Group II Zone 2 (Category 3)	Top of the Cylinder Head with the Vinyl Rocker Cover (Series 60 only) (see Figure 8-17)	23528907

Table 8-6 Temperature Classification

Class I Division 2

This label for the ECM has a UL Recognized Component marking for the U.S. and Canada which includes the "US" and "C" identifiers, UL Recognized Component symbol, and Detroit Diesel's product designation "Detroit Diesel Electronic Control System (DDEC IV)" (see Figure 8-12). The part number is 23528426

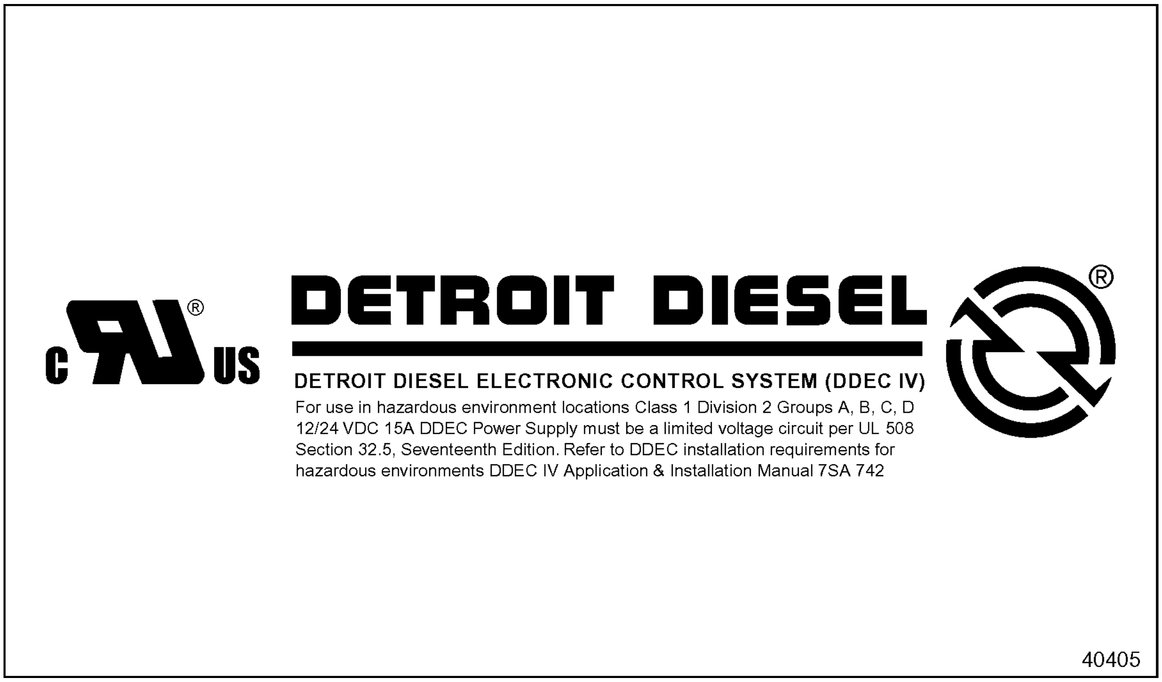

Figure 8-12　Class 1 Division 2 UL Label for the ECM

Group II Zone 2 (Category 3)

There are five Group II Zone 2 (Category 3) labels with specific codes to be placed on the following components:

- ☐ DDEC IV ECM: EEx nAL IIC T4 (see Figure 8-13) - P/N: 23528451
- ☐ Diesel Engine Top of the Cylinder Head with Aluminum Rocker Cover (Series 60 and Series 50): EEx em II T4 (see Figure 8-14) - P/N: 23528427
- ☐ Diesel Engine Top of the Cylinder Head with Vinyl Rocker Cover (Series 60): EEx em II T4 (see Figure 8-15) - P/N: 23528955
- ☐ DDEC IV ECM Warning (see Figure 8-16) - P/N: 23528908
- ☐ Diesel Engine Top of Cylinder Head with Vinyl Rocker Cover (Series 60) Warning (see Figure 8-17) - P/N: 23528907

Figure 8-13 Group II Zone 2 (Category 3) DDEC IV ECM Label

Figure 8-14 Group II Zone 2 (Category 3) Top of the Cylinder Head with Aluminum Rocker Cover Label — Series 60 and Series 50

Figure 8-15 Group II Zone 2 (Category 3) Top of the Cylinder Head with Vinyl Rocker Cover Label — Series 60

Figure 8-16 DDEC IV ECM Warning Label

Figure 8-17 Diesel Engine Top of the Cylinder Head with Vinyl Rocker Cover Warning Label – Series 60

8.8.4 APPLICABLE STANDARDS

The following standards are applicable to Division 2 and to Zone 2.

Class I Division 2

UL 508-Industrial Control Equipment

UL 1604 - Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations

CSA C22.2 No. 14

CSA C22.2 No. 213

Group II Zone 2 (Category 3)

CENELEC EN 50014; 1997 + A1:1999 + A2:1999 Electrical apparatus for potentially explosive atmospheres – General Requirements

CENELEC EN 50021; 1999 Electrical apparatus for potentially explosive atmospheres – TYPE N

CENELEC EN 50019; 1994 Electrical apparatus for potentially explosive atmospheres Increased safety ‘e'

CENELEC EN 50028; 1987 Electrical apparatus for potentially explosive atmospheres Part 8. Encapsulation ‘m'

8.8.5 TEMPERATURES

Ambient Temperature rating for DDEC System: $-40^{\circ}C \leq T_a \leq +55^{\circ}C$.

DDEC engines shall not be installed in environments requiring temperature classifications exceeding T4 (i.e. T5 or T6).

8.9 TYPICAL INDUSTRIAL APPLICATION - HAZARDOUS ENVIRONMENT PETROLEUM

This section contains typical parameter settings for a Series 60 hazardous environment petroleum industrial application. The pin assignments for the Vehicle Interface Harness and the Engine Sensor Harness are listed in the Verification Report on the following pages.

Many ACS/6N4C groups can be used for Hazardous Environment Petroleum applications depending on customer requirements. However, a unique ACS/6N4C group, 06N04C0784, has been created for Series 60 Offshore for Hazardous Environments.

8.9.1 HAZARDOUS ENVIRONMENT PETROLEUM UNIQUE 6N4C GROUP

The unique 06N04C0784 group includes:

- ☐ Engine Overtemperature Protection
- ☐ Exhaust Temperature Sensor Configuration
- ☐ Engine Overspeed Digital Output
- ☐ High Coolant Temperature Light and Low Oil Pressure Light Digital Outputs

Engine Overtemperature Protection (EOP) is additional logic programmed into the ECM and used in conjunction with standard temperature protection. When EOP is part of the engine calibration, engine power and /or speed is reduced as a function of temperature. The CEL illuminates and a fault code is logged when the EOP calibrated temperature is reached. If the temperature does not decrease as power/speed is reduced, the SEL will illuminate when a still higher temperature is reached. The subsequent action taken by the ECM depends on customer selection of one of the following:

- ☐ Warning Only
- ☐ 30 Second Rampdown
- ☐ Shutdown

Power reduction is based on the average power/speed in use prior to the fault condition. Refer to section 4.1.3, "Engine Protection," for more information.

Exhaust Temperature Sensor configuration is included in 06N04C0784. The DDEC Exhaust Temperature Sensor, available in an OEM installed kit, has previously been available for certain applications such as buses. The Exhaust Temperature Sensor configuration for hazardous environments is available only as part of the unique 06N04C0784 group.

The Exhaust Temperature Sensor helps prevent damage by providing early warning of excessive exhaust temperature. The Exhaust Temperature Sensor, placed in the exhaust gas cooler of a hazardous environment DDEC engine, will provide torque reduction if the exhaust gas temperature approaches 200°C. The torque reduction may bring the exhaust temperature down low enough for the operator to continue running the engine and complete a job. If the temperature does not drop below 200°C, DDEC will shut down the engine. Refer to section 3.14.22, "Exhaust Temperature Sensor," for installation information.

The Engine Overspeed digital output provides a signal when a calibrated enable engine speed is exceeded. The digital output remains grounded until the engine speed reaches or drops below another calibrated speed. The battery ground output signal can be used to drive a warning light or alarm and/or control a shutdown device. A code will be logged. The enable speed is set to 2310 rpm and the disable speed is set to 600 rpm. Refer to section 4.2, "Digital Outputs," for additional information.

The digital output for a High Coolant Temperature Light is switched to battery ground with the CEL when the coolant temperature is above the Check Engine Code value (212°F). The Low Oil Pressure Light digital output is switched to battery ground with the CEL and SEL when the oil pressure is below the Stop Engine Code value. Refer to section 4.2 , "Digital Outputs," for additional information.

The Digital Input and Digital Output ports can be configured for a variety of additional software options. The location of the connector pin for each software option can be specified at the time of engine order, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming Station. For more information on software options, refer to section 4.1, "Digital Inputs," and section 4.2, "Digital Outputs."

DATE: VERIFICATION REPORT
SALES ORDER NUMBER:

- -

DDEC III/IV ENGINE SUMMARY

Series	DDEC Appl Group	06N04C0784	DDEC III/IV APPL OFF-HWY WITH LSG ONLY S60
I60	Base group	06N04D7067	500 HP PREMIUM RAT 2000 DDEC IV WAT CLD INDST S60
	Hp Group	06N04M7303	500HP@2100RPM 5030 2000 DDEC IV WAT CLD INDST S60 (1650 FTLB)

PWM Trans Manual		VSG Max RPM	2100	Hot Idle	600
VSG Cruise Switch	NO	VSG Min RPM	600	Cold Idle	700
Init Speed	1000	VSG Alt Min RPM	600	Max Droop	150
RPM Increment	25	VSG is Primary	YES	LSG Droop	150
				VSG Droop	125
IDLE SHUTDOWN	NO	Time	5 MIN		
		Operates On	IDLE GOVERNOR ONLY		
Maximum Security	NO	Override	NO		
Minimum Security	NO	Min Temp	75 DEGC	Max Temp	75 DEGC

ENGINE PROTECTION		Digital Fan	NONE	FUEL ECONOMY INCENTIVE	
Coolant Temp	RAMPDOWN	PWM Fan	NONE	Min MPG	N/A
Coolant Level	RAMPDOWN	Dynamic Brk	NO	Max MPH	0
Coolant Pressure				Conv. Factor	N/A
R1 Coolant Prs		Engine Brakes	NONE	Calc. Type	N/A
Crankcase Prs	DISABLED	Eng Brake Cruise	NO		
Override	YES	Eng Brake Low	2		
Intercool Temp	DISABLED	Increment	1		
Oil Press	RAMPDOWN				
Override	YES	Data Pages	YES		
Oil Temp	RAMPDOWN	Optimized Idle	NO		
R1 Oil Temp		Fan Timer	180 SEC		
Aux Stop 1	SHUTDOWN				
Aux Stop 2	RAMPDOWN	Full Power Override	YES		

Vehicle Speed Sensor	NO	Cruise Control	NO	Press Gov System	NO
VSS Sensor Type		Auto Resume		Cavitation Timeout	
VSS Signal Type		Min Speed		Pump Press Incr	
Num Teeth		Max Speed		Eng Spd Incr	
Tire Rev/Mile				Integral Gain	
Axle Ratio		ATI Port	NONE	Prop Gain	
Final Gear Ratio					
Vehicle Speed Limit	NO	Digital Torque Curve		1	
Max Speed		Starter Lockout Enable Speed		500	
Overspeed with Fuel		Starter Lockout Disable Speed		60	
Overspeed w/o Fuel					

PROGRESSIVE SHIFT	NO		
Low Gear #1 Max MPH		Max RPM	Turn-off RPM
Low Gear #2 Max MPH		Max RPM	Turn-off RPM
High Gear Max MPH		Max RPM	

Air Comp. System	NO	R1 Min Pressure	R1 Max Pressure
Load Pressure		R2 Min Pressure	R2 Max Pressure
Unload Pressure		R3 Min Pressure	R3 Max Pressure
Pressure Increment		% Integral Gain	Prop Gain

PIN	WIRE#	Fn	
E1	#451	00	NONE
F1	#542	00	NONE
G1	#528	25	SEO/DIAGNOSTIC REQUEST
H1	#523	00	NONE
J1	#541	00	NONE
F2	#544	03	AUX SHUTDOWN #1
G2	#543	00	NONE
H2	#524	04	AUX SHUTDOWN #2
J2	#531	33	VSG STATION CHANGE
K2	#583	34	VSG STATION COMPLEMENT
G3	#545	00	NONE
K3	#979	20	NONE

VIH

PIN	Wire#	Fn	Reverse Polarity	
A1	#988	00	NO	NO FUNCTION
A2	#555	00	NO	NO FUNCTION
F3	#499	00	NO	NO FUNCTION

ESH

PIN	Wire#	Fn	Reverse Polarity	
W3	#563	00	NO	HIGH COOLANT TEMP
X3	#564	00	NO	LOW OIL PRESSURE
Y3	#565	00	NO	ENGINE OVERSPEED SIGNAL

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APPENDIX A: CODES

The codelisted may not be used in all applications. A default value in the normal operating range is used by the ECM to provide for engine operation if a sensor failure is present.

DDC Code # (Flashed)	PID	SID	FMI	Description
--	240	--	2	Fram Checksum Incorrect
--	251	--	10	Clock Module Abnormal Rate
--	251	--	13	Clock Module Fault/Failure
--	--	253	13	Incompatible Calibration Version
--	--	254	0	External Failed RAM
--	--	254	1	Internal Failed RAM
--	--	254	6	Entered Boot Via Switches
11	187	--	4	Variable Speed Governor Sensor Voltage Low
11	187	--	7	Variable Speed Governor Switch System Not Responding
12	187	--	3	Variable Speed Governor Sensor Voltage High
13	111	--	4	Coolant Level Sensor Input Voltage Low
13	111	--	6	Add Coolant Level Sensor Input Voltage Low
14	52	--	3	Intercooler Coolant Temperature Sensor Input Voltage High
14	110	--	3	Coolant Temperature Sensor Input Voltage High
14	175	--	3	Oil Temperature Sensor Input Voltage High
15	52	--	4	Intercooler Coolant Temperature Sensor Input Voltage Low
15	110	--	4	Coolant Temperature Sensor Input Voltage Low
15	175	--	4	Oil Temperature Sensor Input Voltage Low
16	111	--	3	Coolant Level Sensor Input Voltage High
16	111	--	5	Add Coolant Level Sensor Input Voltage High
17	72	--	3	Throttle Plate Position Sensor Input Voltage High
17	51	--	3	Throttle Position Sensor Input Voltage High
18	72	--	4	Bypass Position Sensor Input Voltage Low
18	51	--	4	Throttle Plate Position Sensor Input Voltage Low
21	91	--	3	Throttle Position Sensor Input Voltage High
22	91	--	4	Throttle Position Sensor Input Voltage Low
23	174	--	3	Fuel Temperature Sensor Input Voltage High
23	--	65	3	Oxygen Content Circuit Input Voltage High
24	174	--	4	Fuel Temperature Sensor Input Voltage Low
24	--	65	4	Oxygen Content Circuit Input Voltage Low
25	--	--	--	Reserved for ‘‘No Codes"
26	--	25	11	Aux. Shutdown #1 Active
26	--	61	11	Aux. Shutdown #2 Active
27	171	--	3	Ambient Air Temperature Sensor Input Voltage High (Release 2.00 or later only)

DDC Code # (Flashed)	PID	SID	FMI	Description
27	172	--	3	Air Temperature Sensor Input Voltage High
27	105	--	3	Intake Manifold Temperature Sensor Input Voltage High
28	171	--	4	Ambient Air Temperature Circuit Failed Low (Release 2.00 or later only)
28	172	--	4	Air Temperature Sensor Input Voltage Low
28	105	--	4	Intake Manifold Temperature Sensor Input Voltage Low
31	--	51	3	Aux. Output #3 Open Circuit (High Side) - S3
31	--	51	4	Aux. Output #3 Short To Ground (High Side) - S3
31	--	51	7	Aux. Output #3 Mechanical System Fail - S3
31	--	52	3	Aux. Output #4 Open Circuit (High Side) - T3
31	--	52	4	Aux. Output #4 Short To Ground (High Side) - T3
31	--	52	7	Aux. Output #4 Mechanical System Fail - T3
32	--	238	4	SEL Open Circuit
32	--	238	3	SEL Short to Battery (+)
32	--	239	3	CEL Short to Battery (+)
32	--	239	4	CEL Open Circuit
33	102	--	3	Turbo Boost Pressure Sensor Input Voltage High
34	102	--	4	Turbo Boost Pressure Sensor Input Voltage Low
35	100	--	3	Oil Pressure Sensor Input Voltage High
35	19	--	3	High Range Oil Pressure Sensor Input Voltage High
36	100	--	4	Oil Pressure Sensor Input Voltage Low
36	19	--	4	High Range Oil Pressure Sensor Input Voltage Low
37	94	--	3	Fuel Pressure Sensor Input Voltage High
37	18	--	3	High Range Fuel Pressure Sensor Input Voltage High
37	95	--	3	Fuel Restriction Sensor Input Voltage High
38	94	--	4	Fuel Pressure Sensor Input Voltage Low
38	18	--	4	High Range Fuel Pressure Sensor Input Voltage Low
38	95		4	Fuel Restriction Sensor Input Voltage Low
39	--	152	7	EGR Valve Not Responding (Release 29.0 or later)
39	--	153	7	VNT Vanes Not Responding (Release 29.0 or later)
41	--	21	0	Too Many SRS (missing TRS)
42	--	21	1	Too few SRS (missing SRS)
43	111	--	1	Coolant Level Low
44	52	--	0	Intercooler Coolant Temperature High
44	110	--	0	Coolant Temperature High
44	172	--	0	Air Inlet Temperature High
44	175	--	0	Oil Temperature High
44	105	--	0	Intake Manifold Temperature High
45	100	--	1	Oil Pressure Low

DDC Code # (Flashed)	PID	SID	FMI	Description
45	19	--	1	High Range Oil Pressure Low
46	168	--	1	ECM Battery Voltage Low
46	--	214	1	RTC Backup Battery Voltage Low (Release 29.0 or later)
46	--	232	1	Sensor supply Voltage Low
47	94	--	0	Fuel Pressure High
47	102	--	0	Turbo Boost Pressure High
47	106	--	0	Air Inlet Pressure High
47	164	--	0	Injection Control Pressure High
47	18	--	0	High Range Fuel Pressure High
48	18	--	1	High Range Fuel Pressure Low
48	94	--	1	Fuel Pressure Low
48	106	--	1	Air Inlet Pressure Low
48		154	1	EGR Temperature Low (Release 29.0 or later)
48		155	1	EGR Delta Pressure Low (Release 29.0 or later)
48	164	--	1	Injection Control Pressure Low
52	--	254	12	A/D Conversion Fail
53	--	253	2	Nonvolatile Checksum Incorrect
53	--	253	12	EEPROM Write Error
53	--	253	13	Out of Calibration
54	84	--	12	Vehicle Speed Sensor Fault
55	--	216	14	Other ECU Fault (Release 27.0 or later) (This fault is logged in conjunction with another fault to indicate missing information from another ECU.)
55	--	231	12	J1939 Data Link Fault
55	--	248	8	Proprietary Data Link Fault (Master)
55	--	248	9	Proprietary Data Link Fault (Receiver)
56	--	250	12	J1587 Data Link Fault
57	--	249	12	J1922 Data Link Fault
58	92	--	0	Torque Overload
61	--	xxx	0	Injector xxx Response Time Long
62	--	26	3	Aux. Output #1 Short to Battery (+) - F3
62	--	26	4	Aux. Output #1 Open Circuit - F3
62	--	40	3	Aux. Output #2 Short to Battery (+) - A2
62	--	40	4	Aux. Output #2 Open Circuit - A2
62	--	53	3	Aux. Output #5 Short to Battery (+) - W3
62	--	53	4	Aux. Output #5 Open Circuit - W3
62	--	54	3	Aux. Output #6 Short to Battery (+) - X3
62	--	54	4	Aux. Output #6 Open Circuit - X3
62	--	55	3	Aux. Output #7 Short to Battery (+) - Y3
62	--	55	4	Aux. Output #7 Open Circuit - Y3
62	--	56	3	Aux. Output #8 Short to Battery (+) - A1
62	--	56	4	Aux. Output #8 Open Circuit - A1

DDC Code # (Flashed)	PID	SID	FMI	Description
62	--	26	7	Aux. Output #1 Mechanical System Not Responding Properly -F3
62	--	40	7	Aux. Output #2 Mechanical System Not Responding Properly -A2
62	--	53	7	Aux. Output #5 Mechanical System Not Responding Properly - W3
62	--	54	7	Aux. Output #6 Mechanical System Not Responding Properly - X3
62	--	55	7	Aux. Output #7 Mechanical System Not Responding Properly - Y3
62	--	56	7	Aux. Output #8 Mechanical System Not Responding Properly - A1
63	--	57	3	PWM #1 Short to Battery (+)
63	--	57	4	PWM #1 Open Circuit
63	--	58	3	PWM #2 Short to Battery (+)
63	--	58	4	PWM #2 Open Circuit
63	--	59	3	PWM #3 Short to Battery (+)
63	--	59	4	PWM #3 Open Circuit
63	--	60	3	PWM #4 Short to Battery (+)
63	--	60	4	PWM #4 Open Circuit
63	--	57	0	PWM #1 Above Normal Range
63	--	57	1	PWM #1 Below Normal Range
63	--	58	0	PWM #2 Above Normal Range
63	--	58	1	PWM #2 Below Normal Range
63	--	59	0	PWM #3 Above Normal Range
63	--	59	1	PWM #3 Below Normal Range
63	--	60	0	PWM #4 Above Normal Range
63	--	60	1	PWM #4 Below Normal Range
64	103	--	8	Turbo Speed Sensor Input Failure
64	103	--	0	Turbo Overspeed
65	51	--	0	Throttle Plate Position Above Normal Range
65	51	--	1	Throttle Plate Position Below Normal Range
65	51	--	2	Throttle Plate Position Erratic
65	51	--	7	Throttle Plate Not Responding
65	107	--	3	Air Filter Restriction Sensor Voltage High
65	107	--	4	Air Filter Restriction Sensor Voltage Low
66	--	76	0	Engine Knock Level Above Normal Range
66	--	76	3	Engine Knock Level Sensor Input Voltage High
66	--	76	4	Engine Knock Level Sensor Input Voltage Low
66	--	76	7	Engine Knock Level Sensor Not Responding
66	99	--	3	Oil Filter Restriction Sensor Voltage High
66	99	--	4	Oil Filter Restriction Sensor Voltage Low
67	109	--	3	Coolant Pressure Sensor Input Voltage High
67	109	--	4	Coolant Pressure Sensor Input Voltage Low

DDC Code # (Flashed)	PID	SID	FMI	Description
67	106	--	3	Air Inlet Pressure Sensor Input Voltage High
67	106	--	4	Air Inlet Pressure Sensor Input Voltage Low
67	20	--	3	High Range Coolant Pressure Sensor Input Voltage High
67	20	--	4	High Range Coolant Pressure Sensor Input Voltage Low
68	--	230	6	TPS Idle Validation Circuit Fault (short to ground)
68	--	230	5	TPS Idle Validation Circuit Fault (open circuit)
71	--	xxx	1	Injector xxx Response Time Short
72	84	--	0	Vehicle Overspeed
72	84	--	11	Vehicle Overspeed (Absolute)
72	--	65	0	Oxygen Content Too High
72	--	65	1	Oxygen Content Too Low
73	--	151	14	ESS Transmission Stuck in Gear
73	--	226	11	Transmission Neutral Switch Failure (ESS Transmission)
73	--	227	2	Aux Analog Input Data Erratic, Intermittent, or Incorrect (ESS Transmission)
73	--	227	3	Aux Analog Input #1 Voltage High (ESS Transmission)
73	--	227	4	Aux Analog Input #1 Voltage Low (ESS Transmission)
73	--	77	0	Gas Valve Position Above Normal Range
73	--	77	1	Gas Valve Position Below Normal Range
73	--	77	3	Gas Valve Position Input Voltage High
73	--	77	4	Gas Valve Position Input Voltage Low
73	--	77	7	Gas Metering Valve Not Responding
73	107	--	0	Air Filter Restriction High
74	99	--	0	Oil Filter Restriction High
74	70	--	4	Optimized Idle Safety Loop Short to Ground
75	168	--	0	ECM Battery Voltage High
75	--	214	0	RTC Backup Battery Voltage High (Release 29.0 or later)
75	--	232	0	Sensor Supply Voltage High
76	121	--	0	Engine Overspeed With Engine Brake
77	3	–	0	Cylinder Head Temperature Above Range (Release 31.0 or later)
77	19	–	0	Extended Range Oil Pressure Above Range (Release 31.0 or later)
77	20	–	0	Extended Range Coolant Pressure Above Range (Release 31.0 or later)
77	72	–	0	Bypass Blower Door Position Above Range (Release 31.0 or later)
77	72	–	1	Bypass Blower Door Position Below Range (Release 31.0 or later)
77	73	–	1	Pump Pressure Below Range (Release 31.0 or later)

DDC Code # (Flashed)	PID	SID	FMI	Description
77	81	–	0	Exhaust Back Pressure Above Range (Release 31.0 or later)
77	81	–	1	Exhaust Back Pressure Below Range (Release 31.0 or later)
77	81	–	3	Exhaust Back Pressure Failed High (Release 31.0 or later)
77	81	–	4	Exhaust Back Pressure Failed Low (Release 31.0 or later)
77	81	–	12	Exhaust Back Pressure at Rampdown Threshold (Release 31.0 or later)
77	95	–	1	Fuel Filter Differential Pressure Below Range (Release 31.0 or later)
77	99	–	1	Oil Filter Differential Pressure Below Range (Release 31.0 or later)
77	100	–	0	Engine Oil Pressure Above Range (Release 31.0 or later)
77	102	–	1	Turbo Boost Pressure Below Range (Release 31.0 or later)
77	105	–	1	Inlet Manifold Temperature Below Range (Release 31.0 or later)
77	107	–	1	Air Filter Differential Pressure Below Range (Release 31.0 or later)
77	108	–	0	Barometric Pressure Above Range (Release 31.0 or later)
77	108	—	1	Barometric Pressure Below Range (Release 31.0 or later)
77	109	—	0	Coolant Pressure Above Range (Release 31.0 or later)
77	110	—	1	Coolant Temperature Below Range (Release 31.0 or later)
77	110	—	0	Coolant Level Above Range (Release 31.0 or later)
77	171	—	0	Ambient Air Temperature Above Range (Release 31.0 or later)
77	171	—	1	Ambient Air Temperature Below Range (Release 31.0 or later)
77	172	—	1	Air Inlet Temperature Below Range (Release 31.0 or later)
77	174	—	0	Fuel Temperature Above Range
77	174	—	0	Fuel Temperature Below Range
77	175	—	1	Engine Oil Temperature Below Range (Release 31.0 or later)
77	177	—	0	Transmission Oil Temperature Above Range (Release 31.0 or later)
77	177	—	1	Transmission Oil Temperature Below Range (Release 31.0 or later)
77	177	—	3	Transmission Oil Temperature Failed High (Release 31.0 or later)
77	177	—	4	Transmission Oil Temperature Failed Low (Release 31.0 or later)
77	222	—	14	Anti-Theft Fault Present (Release 31.0 or later)
77	251	—	10	Clock Module Abnormal Rate of Change (Release 31.0 or later)

DDC Code # (Flashed)	PID	SID	FMI	Description
77	251	—	13	Clock Module Failure (Release 31.0 or later)
77	252	—	10	Clock Module Abnormal Rate of Change (Release 31.0 or later)
77	252	—	13	Clock Module Failure (Release 31.0 or later)
78	86	--	14	Cruise Control/Adaptive Cruise Control Fault (Release 27.0 or later)
81	--	20	3	Timing Actuator (Dual Fuel) Input Voltage High
81	98	--	3	Oil Level Sensor Input Voltage High
81	101	--	3	Crankcase Pressure Sensor Input Voltage High
81	153	--	3	Extended Crankcase Pressure Input Voltage High (Release 27.0 or later)
81	154	--	3	EGR Temperature Input Voltage High (Release 29.0 or later)
81	155	--	3	EGR Delta Pressure Input Voltage High (Release 29.0 or later)
81	164	--	3	Injection Control Pressure Circuit Voltage High
81	173	--	3	Exhaust Temperature Sensor Input Voltage High
82	--	20	4	Timing Actuator (Dual Fuel) Input Voltage Low
82	98	--	4	Oil Level Sensor Input Voltage Low
82	101	--	4	Crankcase Pressure Sensor Input Voltage Low
82	153	--	4	Extended Crankcase Pressure Input Voltage Low (Release 27.0 or later)
82	154	--	4	EGR Temperature Input Voltage Low (Release 29.0 or later)
82	155	--	4	EGR Delta Pressure Input Voltage Low (Release 29.0 or later)
82	164	--	4	Injection Control Pressure Sensor Input Voltage Low
82	173	--	4	Exhaust Temperature Sensor Input Voltage Low
83	98	--	0	Oil Level High
83	101	--	0	Crankcase Pressure High
83	153	--	0	Extended Crankcase Pressure High (Release 27.0 or later)
83	154	--	0	EGR Gas Temperature High
83	155	--	0	EGR Delta Pressure High
83	173	--	0	Exhaust Temperature High
83	73	--	0	Pump Pressure High
84	98	--	1	Oil Level Low
84	101	--	1	Crankcase Pressure Low
84	153	--	1	Extended Crankcase Pressure Low (Release 27.0 or later)
85	190	--	0	Engine Overspeed
85	190	--	14	Engine Overspeed Signal (Release 28.0 or later)
86	73	--	3	Pump Pressure Sensor Input Voltage High
86	108	--	3	Barometric Pressure Sensor Input Voltage High
87	73	--	4	Pump Pressure Sensor Input Voltage Low

DDC Code # (Flashed)	PID	SID	FMI	Description
87	108	--	4	Barometric Pressure Sensor Input Voltage Low
88	109	--	1	Coolant Pressure Low
88	20	--	1	High Range Coolant Pressure Low
89	95	--	0	Fuel Restriction High
89	111	--	12	Maintenance Alert Coolant Level Fault

A.1 PIDS

The codes listed are sorted by PID.

PID	FMI	DDC Code # (Flashed)	Description
3	0	77	Cylinder Head Temperature Above Range (Release 32.0 or later)
18	0	47	High Range Fuel Pressure High
18	1	48	High Range Fuel Pressure Low
18	3	37	High Range Fuel Pressure Sensor Input Voltage High
18	4	38	High Range Fuel Pressure Sensor Input Voltage Low
19	0		Extended Range Oil Pressure Above Range (Release 31.0 or later)
19	1	45	High Range Oil Pressure Low
19	3	35	High Range Oil Pressure Sensor Input Voltage High
19	4	36	High Range Oil Pressure Sensor Input Voltage Low
20	0		Extended Range Coolant Pressure Above Range (Release 31.0 or later)
20	1	88	High Range Coolant Pressure Low
20	3	67	High Range Coolant Pressure Sensor Input Voltage High
20	4	67	High Range Coolant Pressure Sensor Input Voltage Low
51	0	65	Throttle Plate Position Above Normal Range
51	1	65	Throttle Plate Position Below Normal Range
51	2	65	Throttle Plate Position Erratic
51	3	17	Throttle Plate Position Sensor Input Voltage High
51	4	18	Throttle Plate Position Sensor Input Voltage Low
51	7	65	Throttle Plate Not Responding
52	0	44	Intercooler Coolant Temperature High
52	3	14	Intercooler Coolant Temperature Sensor Input Voltage High
52	4	15	Intercooler Coolant Temperature Sensor Input Voltage Low
70	4	74	Optimized Idle Safety Loop Short to Ground
72	0	77	Bypass Blower Door Position Above Range (Release 31.0 or later)
72	1	77	Bypass Blower Door Position Below Range (Release 31.0 or later)
72	3	17	Bypass Position Sensor Input Voltage High
72	4	18	Bypass Position Sensor Input Voltage Low
73	0	83	Pump Pressure High
73	1	77	Pump Pressure Below Range (Release 31.0 or later)
73	3	86	Pump Pressure Sensor Input Voltage High
73	4	87	Pump Pressure Sensor Input Voltage Low
81	0	77	Exhaust Back Pressure Above Range (Release 31.0 or later)
81	1	77	Exhaust Back Pressure Below Range (Release 31.0 or later)
81	3	77	Exhaust Back Pressure Failed High (Release 31.0 or later)
81	4	77	Exhaust Back Pressure Failed Low (Release 31.0 or later)
81	12	77	Exhaust Back Pressure at Rampdown Threshold (Release 31.0 or later)
84	0	72	Vehicle Overspeed

PID	FMI	DDC Code # (Flashed)	Description
84	11	72	Vehicle Overspeed (Absolute)
84	12	54	Vehicle Speed Sensor Fault
86	14	78	Cruise Control/Adaptive Cruise Control Fault (Release 27.0 or later)
91	3	21	Throttle Position Sensor Input Voltage High
91	4	22	Throttle Position Sensor Input Voltage Low
92	0	58	Torque Overload
94	0	47	Fuel Pressure High
94	1	48	Fuel Pressure Low
94	3	37	Fuel Pressure Sensor Input Voltage High
94	4	38	Fuel Pressure Sensor Input Voltage Low
95	0	89	Fuel Restriction High
95	1	77	Fuel Filter Differential Pressure Below Range (Release 31.0 or later)
95	3	37	Fuel Restriction Sensor Input Voltage High
95	4	38	Fuel Restriction Sensor Input Voltage Low
98	0	83	Oil Level High
98	1	84	Oil Level Low
98	3	81	Oil Level Sensor Input Voltage High
98	4	82	Oil Level Sensor Input Voltage Low
99	0	74	Oil Filter Restriction High
99	1	77	Oil Filter Differential Pressure Below Range (Release 31.0 or later)
99	3	66	Oil Filter Restriction Sensor Voltage High
99	4	66	Oil Filter Restriction Sensor Voltage Low
100	0	77	Engine Oil Pressure Above Range (Release 31.0 or later)
100	1	45	Oil Pressure Low
100	3	35	Oil Pressure Sensor Input Voltage High
100	4	36	Oil Pressure Sensor Input Voltage Low
101	0	83	Crankcase Pressure High
101	1	84	Crankcase Pressure Low
101	3	81	Crankcase Pressure Sensor Input Voltage High
101	4	82	Crankcase Pressure Sensor Input Voltage Low
102	0	47	Turbo Boost Pressure High
102	1	77	Turbo Boost Pressure Below Range (Release 31.0 or later)
102	3	33	Turbo Boost Pressure Sensor Input Voltage High
102	4	34	Turbo Boost Pressure Sensor Input Voltage Low
103	0	64	Turbo Overspeed
103	8	64	Turbo Speed Sensor Input Failure
105	0	44	Intake Manifold Temperature High
105	1	77	Inlet Manifold Temperature Below Range (Release 31.0 or later)
105	3	27	Intake Manifold Temperature Sensor Input Voltage High
105	4	28	Intake Manifold Temperature Sensor Input Voltage Low
106	0	47	Air Inlet Pressure High

PID	FMI	DDC Code # (Flashed)	Description
106	1	48	Air Inlet Pressure Low
106	3	67	Air Inlet Pressure Sensor Input Voltage High
106	4	67	Air Inlet Pressure Sensor Input Voltage Low
107	0	73	Air Filter Restriction High
107	1	77	Air Filter Differential Pressure Below Range (Release 31.0 or later)
107	3	65	Air Filter Restriction Sensor Voltage High
107	4	65	Air Filter Restriction Sensor Voltage Low
108	0	77	Barometric Pressure Above Range (Release 31.0 or later)
108	1	77	Barometric Pressure Below Range (Release 31.0 or later)
108	3	86	Barometric Pressure Sensor Input Voltage High
108	4	87	Barometric Pressure Sensor Input Voltage Low
109	0	77	Coolant Pressure Above Range (Release 31.0 or later)
109	1	88	Coolant Pressure Low
109	3	67	Coolant Pressure Sensor Input Voltage High
109	4	67	Coolant Pressure Sensor Input Voltage Low
110	0	44	Coolant Temperature High
110	0	77	Coolant Temperature Below Range (Release 31.0 or later)
110	1	77	Coolant Temperature Above Range (Release 31.0 or later)
110	3	14	Coolant Temperature Sensor Input Voltage High
110	4	15	Coolant Temperature Sensor Input Voltage Low
111	1	43	Coolant Level Low
111	3	16	Coolant Level Sensor Input Voltage High
111	4	13	Coolant Level Sensor Input Voltage Low
111	5	16	Add Coolant Level Sensor Input Voltage High
111	6	13	Add Coolant Level Sensor Input Voltage Low
111	12	89	Maintenance Alert Coolant Level Fault
121	0	76	Engine Overspeed With Engine Brake
153	3	81	Extended Crankcase Pressure Sensor Input Voltage High (Release 27.0 or later)
153	4	82	Extended Crankcase Pressure Sensor Input Voltage Low (Release 27.0 or later)
153	0	83	Extended Crankcase Pressure High (Release 27.0 or later)
153	1	84	Extended Crankcase Pressure Low (Release 27.0 or later)
164	0	47	Injection Control Pressure High
164	1	48	Injection Control Pressure Low
164	3	81	Injection Control Pressure Circuit Voltage High
164	4	82	Injection Control Pressure Sensor Input Voltage Low
168	0	75	ECM Battery Voltage High
168	1	46	ECM Battery Voltage Low
171	0	77	Ambient Air Temperature Above Range (release 31.0 or later)
171	1	77	Ambient Air Temperature Below Range (release 31.0 or later)
171	3	27	Ambient Air Temperature Sensor Input Voltage High (Release 2.00 or later only)

PID	FMI	DDC Code # (Flashed)	Description
171	4	28	Ambient Air Temperature Circuit Failed Low (Release 2.0 or later only)
172	0	44	Air Inlet Temperature High
172	1	77	Air Inlet Temperature Below Range (Release 31.0 or later)
172	3	27	Air Temperature Sensor Input Voltage High
172	4	28	Air Temperature Sensor Input Voltage Low
173	0	83	Exhaust Temperature High
173	3	81	Exhaust Temperature Sensor Input Voltage High
173	4	82	Exhaust Temperature Sensor Input Voltage Low
174	0	77	Fuel Temperature Above Range
174	1	77	Fuel Temperature Below Range
174	3	23	Fuel Temperature Sensor Input Voltage High
174	4	24	Fuel Temperature Sensor Input Voltage Low
175	0	44	Oil Temperature High
175	1	77	Engine Oil Temperature Below Range (Release 31.0 or later)
175	3	14	Oil Temperature Sensor Input Voltage High
175	4	15	Oil Temperature Sensor Input Voltage Low
177	0	77	Transmission Oil Temperature Above Range (Release 31.0 or later)
177	1	77	Transmission Oil Temperature Below Range (Release 31.0 or later)
177	3	77	Transmission Oil Temperature Failed High (Release 31.0 or later)
177	4	77	Transmission Oil Temperature Failed Low (Release 31.0 or later)
187	3	12	Variable Speed Governor Sensor Voltage High
187	4	11	Variable Speed Governor Sensor Voltage Low
187	7	11	Variable Speed Governor Switch System Not Responding
190	0	85	Engine Overspeed
190	14	85	Engine Overspeed Signal (Release 28.0 or later)
222	14	77	Anti-Theft Fault Present (Release 31.0 or later)
240	2	--	Fram Checksum Incorrect
251	10	77	Clock Module Abnormal Rate of Change (Release 31.0)
251	13	77	Clock Module Failure (Release 31.0)
252	10	77	Clock Module Abnormal Rate of Change (Release 31.0)
252	13	77	Clock Module Failure (Release 31.0)

A.2 SIDS

The codes listed are sorted by SID.

SID	FMI	DDC Code # (Flashed)	Description
xxx	0	61	Injector xxx Response Time Long
xxx	1	71	Injector xxx Response Time Short
20	3	81	Timing Actuator (Dual Fuel) Input Voltage High
20	4	82	Timing Actuator (Dual Fuel) Input Voltage Low
21	0	41	Too many SRS (missing TRS)
21	1	42	Too few SRS (missing SRS)
25	11	26	Aux. Shutdown #1 Active
26	3	62	Aux. Output #1 Short to Battery (+) - F3
26	4	62	Aux. Output #1 Open Circuit - F3
26	7	62	Aux. Output #1 Mechanical System Not Responding Properly - F3
40	3	62	Aux. Output #2 Short to Battery (+) - A2
40	4	62	Aux. Output #2 Open Circuit - A2
40	7	62	Aux. Output #2 Mechanical System Not Responding Properly - A2
51	3	31	Aux. Output #3 Open Circuit (High Side) - S3
51	4	31	Aux. Output #3 Short To Ground (High Side) - S3
51	7	31	Aux. Output #3 Mechanical System Fail - S3
52	3	31	Aux. Output #4 Open Circuit (High Side) - T3
52	4	31	Aux. Output #4 Short To Ground (High Side) - T3
52	7	31	Aux. Output #4 Mechanical System Fail - T3
53	3	62	Aux. Output #5 Short to Battery (+) - W3
53	4	62	Aux. Output #5 Open Circuit - W3
53	7	62	Aux. Output #5 Mechanical System Not Responding Properly - W3
54	3	62	Aux. Output #6 Short to Battery (+) - X3
54	4	62	Aux. Output #6 Open Circuit - X3
54	7	62	Aux. Output #6 Mechanical System Not Responding Properly - X3
55	3	62	Aux. Output #7 Short to Battery (+) - Y3
55	4	62	Aux. Output #7 Open Circuit - Y3
55	7	62	Aux. Output #7 Mechanical System Not Responding Properly - Y3
56	3	62	Aux. Output #8 Short to Battery (+) - A1
56	4	62	Aux. Output #8 Open Circuit - A1
56	7	62	Aux. Output #8 Mechanical System Not Responding Properly - A1
57	0	63	PWM #1 Above Normal Range
57	1	63	PWM #1 Below Normal Range
57	3	63	PWM #1 Short to Battery (+)
57	4	63	PWM #1 Open Circuit
58	0	63	PWM #2 Above Normal Range
58	1	63	PWM #2 Below Normal Range
58	3	63	PWM #2 Short to Battery (+)

SID	FMI	DDC Code # (Flashed)	Description
58	4	63	PWM #2 Open Circuit
59	0	63	PWM #3 Above Normal Range
59	1	63	PWM #3 Below Normal Range
59	3	63	PWM #3 Short to Battery (+)
59	4	63	PWM #3 Open Circuit
60	0	63	PWM #4 Above Normal Range
60	1	63	PWM #4 Below Normal Range
60	3	63	PWM #4 Short to Battery (+)
60	4	63	PWM #4 Open Circuit
61	11	26	Aux. Shutdown #2 Active
65	0	72	Oxygen Content Too High
65	1	72	Oxygen Content Too Low
65	3	23	Oxygen Content Circuit Input Voltage High
65	4	24	Oxygen Content Circuit Input Voltage Low
76	0	66	Engine Knock Level Above Normal Range
76	3	66	Engine Knock Level Sensor Input Voltage High
76	4	66	Engine Knock Level Sensor Input Voltage Low
76	7	66	Engine Knock Level Sensor Not Responding
77	0	73	Gas Valve Position Above Normal Range
77	1	73	Gas Valve Position Below Normal Range
77	3	73	Gas Valve Position Input Voltage High
77	4	73	Gas Valve Position Input Voltage Low
77	7	73	Gas Metering Valve Not Responding
151	14	73	ESS Transmission Stuck in Gear
152	7	39	EGR Valve Not Responding (Release 29.0 or later)
153	7	39	VNT Vanes Not Responding (Release 29.0 or later)
154	1	48	EGR Temperature Low (Release 29.0 or later)
154	3	81	EGR Temperature Low (Release 29.0 or later)
154	4	82	EGR Temperature Input Voltage Low (Release 29.0 or later)
154	0	83	EGR Gas Temperature High
155	1	48	EGR Delta Pressure Low (Release 29.0 or later)
155	3	81	EGR Delta Pressure Input Voltage High (Release 29.0 or later)
155	4	82	EGR Delta Pressure Input Voltage Low (Release 29.0 or later)
155	0	83	EGR Delta Pressure High
214	1	46	RTC Backup Battery Voltage Low (Release 29.0 or later)
214	0	75	RTC Backup Battery Voltage High (Release 29.0 or later)
216	14	55	Other ECU Fault (Release 27.0 or later) (This fault is logged in conjunction with another fault to indicate missing information from another ECU.)
226	11	73	Transmission Neutral Switch Failure (ESS Transmission)
227	2	73	Aux Analog Input Data Erratic, Intermittent, or Incorrect (ESS Transmission)
227	3	73	Aux Analog Input #1 Voltage High (ESS Transmission)

SID	FMI	DDC Code # (Flashed)	Description
227	4	73	Aux Analog Input #1 Voltage Low (ESS Transmission)
230	5	68	TPS Idle Validation Circuit Fault (open circuit)
230	6	68	TPS Idle Validation Circuit Fault (short to ground)
231	12	55	J1939 Data Link Fault
232	0	75	Sensor Supply Voltage High
232	1	46	Sensor supply Voltage Low
238	3	32	SEL Short to Battery (+)
238	4	32	SEL Open Circuit
239	3	32	CEL Short to Battery (+)
239	4	32	CEL Open Circuit
248	8	55	Proprietary Data Link Fault (Master)
248	9	55	Proprietary Data Link Fault (Receiver)
249	12	57	J1922 Data Link Fault
250	12	56	J1587 Data Link Fault
253	2	53	Nonvolatile Checksum Incorrect
253	12	53	EEPROM Write Error
253	13	--	Incompatible Calibration Version
253	13	53	Out of Calibration
254	0	--	External Failed RAM
254	1	--	Internal Failed RAM
254	6	--	Entered Boot Via Switches
254	12	52	A/D Conversion Fail

APPENDIX B: HARNESS WIRING DIAGRAMS

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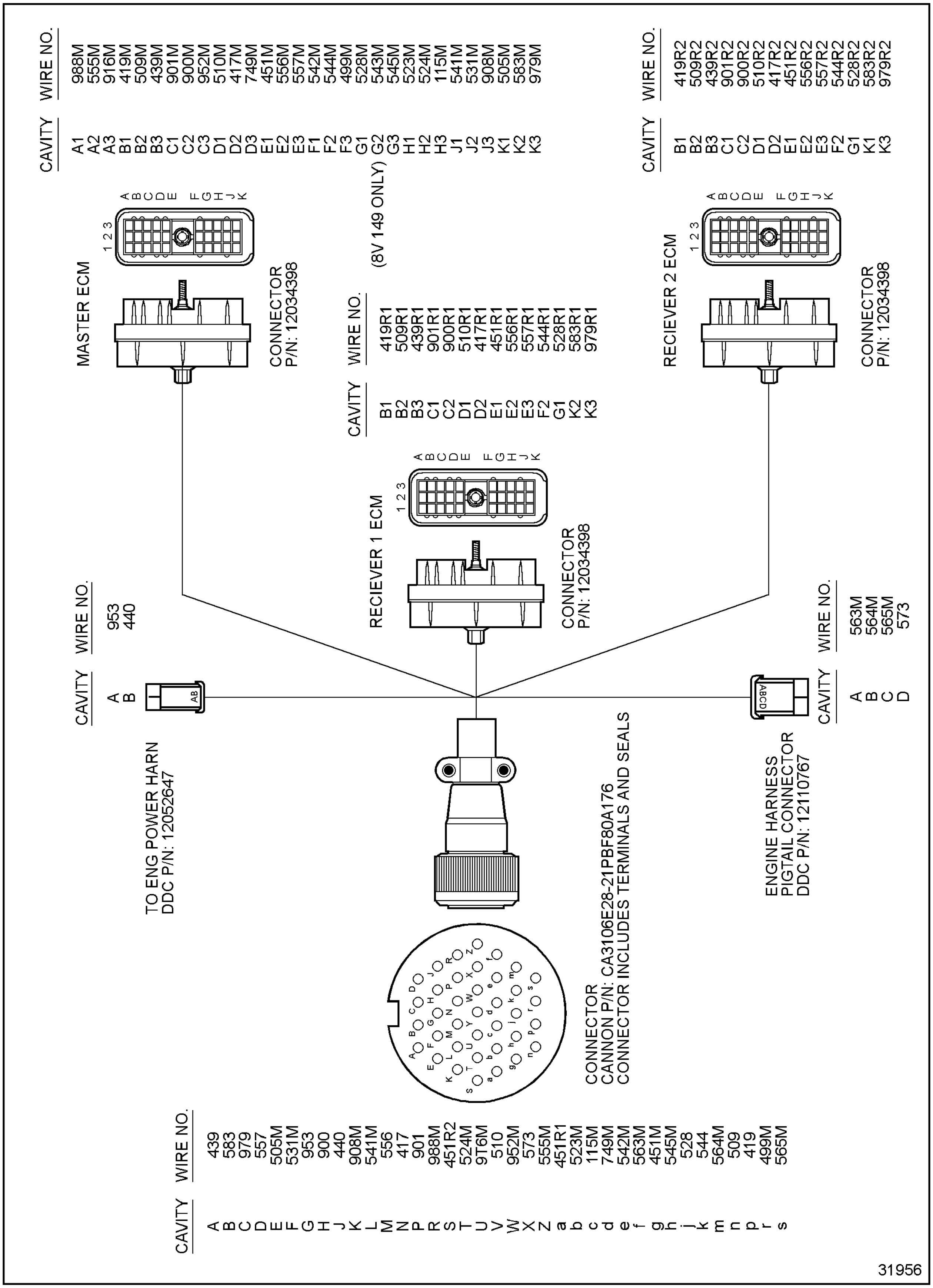
Figure B-13	Injector Harness Schematic - Series 50	B-15
Figure B-14	Injector Harness Schematic - Series 50 with Jake Brake	B-16
Figure B-15	Injector Harness Schematic - Series 2000-8V	B-17

The following harness schematics may be found on the DDC extranet:

- ☐ Vehicle Interface Harness
- ☐ Vehicle Interface Harness - Series 4000
- ☐ Vehicle Interface Harness - Series 2000 Single-ECM
- ☐ Vehicle Interface Harness - Series 2000 Multi-ECM (1 of 2)
- ☐ Vehicle Interface Harness - Series 2000 Multi-ECM (2 of 2)
- ☐ Engine Sensor Harness - Series 60/50
- ☐ Engine Sensor Harness - Series 4000-12V & 16V
- ☐ Engine Sensor Harness - Series 149
- ☐ Engine Sensor Harness - Series 2000-8V
- ☐ Engine Sensor Harness - Series 2000-12V & 16V
- ☐ Engine Interface Harness,-Series 2000, Multi-ECM
- ☐ Injector Harness Schematic - Series 71-12V and Series 149-12V
- ☐ Injector Harness Schematic - Series 92-12V
- ☐ Injector Harness Schematic - Series 92-16V
- ☐ Injector Harness Schematic - Series 149-16V
- ☐ Injector Harness Schematic - Series 149-20V
- ☐ Injector Harness Schematic - Series 4000-12V
- ☐ Injector Harness Schematic - Series 4000-16V
- ☐ Injector Harness Schematic - Series 2000-12V
- ☐ Injector Harness Schematic - Series 2000-16V
- ☐ 12V Series 4000 Marine Exhaust Temperature Sensors
- ☐ 8V Series 4000 Marine Exhaust Temperature Sensors
- ☐ 16V Series 4000 Marine Exhaust Temperature Sensors
- ☐ 12V and 16V Series 4000 Marine Engine Harness



Master ECM:

CAVITY	WIRE NO.
A1	988M
A2	555M
A3	916M
B1	419M
B2	509M
B3	439M
C1	901M
C2	900M
C3	952M
D1	510M
D2	417M
D3	749M
E1	451M
E2	556M
E3	557M
F1	542M
F2	544M
F3	499M
G1	528M
G2	543M
G3	545M
H1	523M
H2	524M
H3	115M
J1	541M
J2	531M
J3	908M
K1	505M
K2	583M
K3	979M

Reciever 1 ECM:

CAVITY	WIRE NO.
B1	419R1
B2	509R1
B3	439R1
C1	901R1
C2	900R1
D1	510R1
D2	417R1
E1	451R1
E2	556R1
E3	557R1
F2	544R1
G1	528R1
K2	583R1
K3	979R1

Reciever 2 ECM:

CAVITY	WIRE NO.
B1	419R2
B2	509R2
B3	439R2
C1	901R2
C2	900R2
D1	510R2
D2	417R2
E1	451R2
E2	556R2
E3	557R2
F2	544R2
G1	528R2
K1	583R2
K3	979R2

To Eng Power Harn:

CAVITY	WIRE NO.
A	953
B	440

Engine Harness Pigtail Connector:

CAVITY	WIRE NO.
A	563M
B	564M
C	565M
D	573

Cannon Connector:

CAVITY	WIRE NO.
A	439
B	583
C	979
D	557
E	505M
F	531M
G	953
H	900
J	440
K	908M
L	541M
M	556
N	417
P	901
R	988M
S	451R2
T	524M
U	9T6M
V	510
W	952M
X	573
Z	555M
a	451R1
b	523M
c	115M
d	749M
e	542M
f	563M
g	451M
h	545M
i	528
k	544
m	564M
n	509
p	419
r	499M
s	565M

Figure B-1 Engine Interface Harness - Series 149 Multi-ECMs

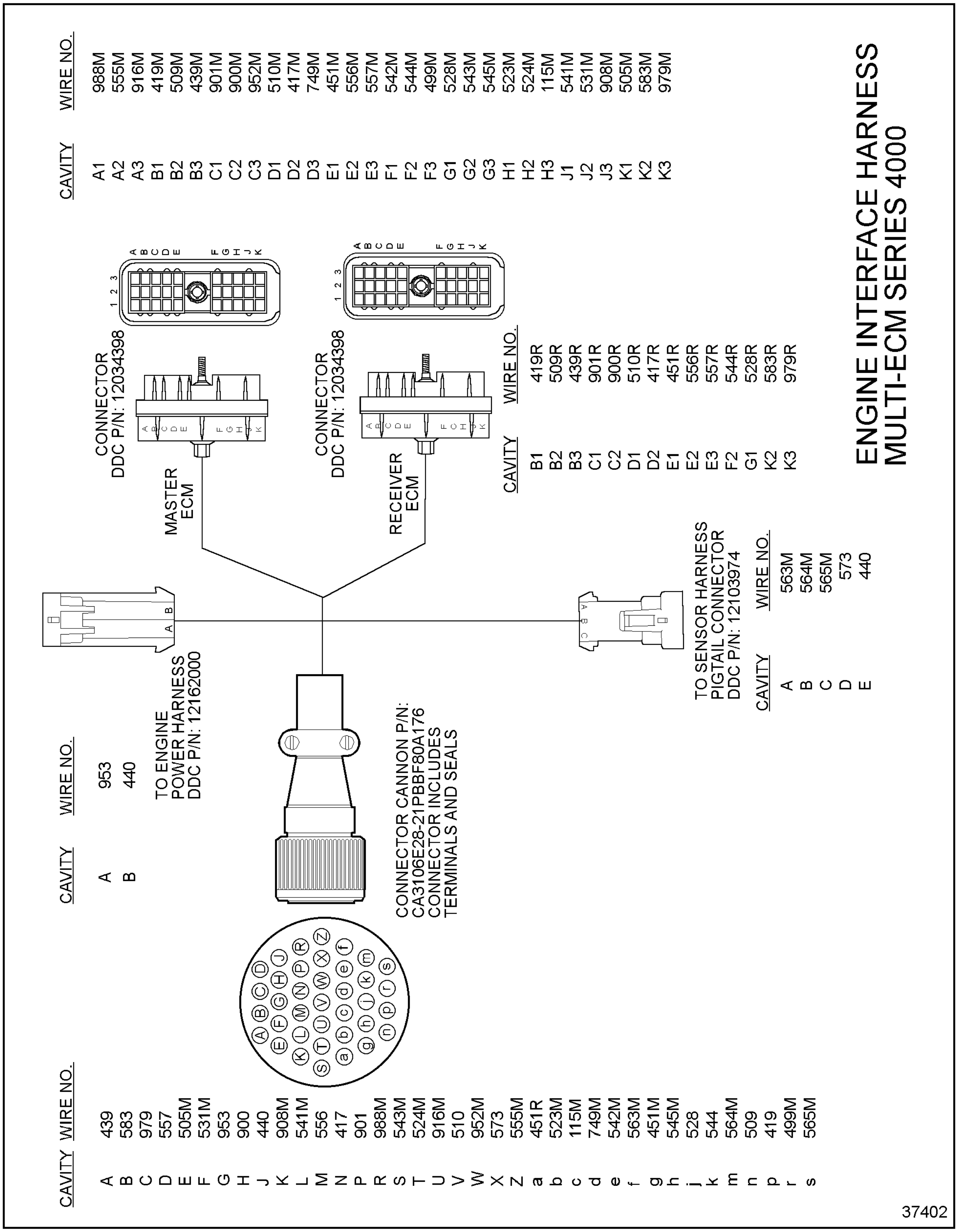


Figure B-2 Engine Interface Harness, Series 4000, Multi-ECM

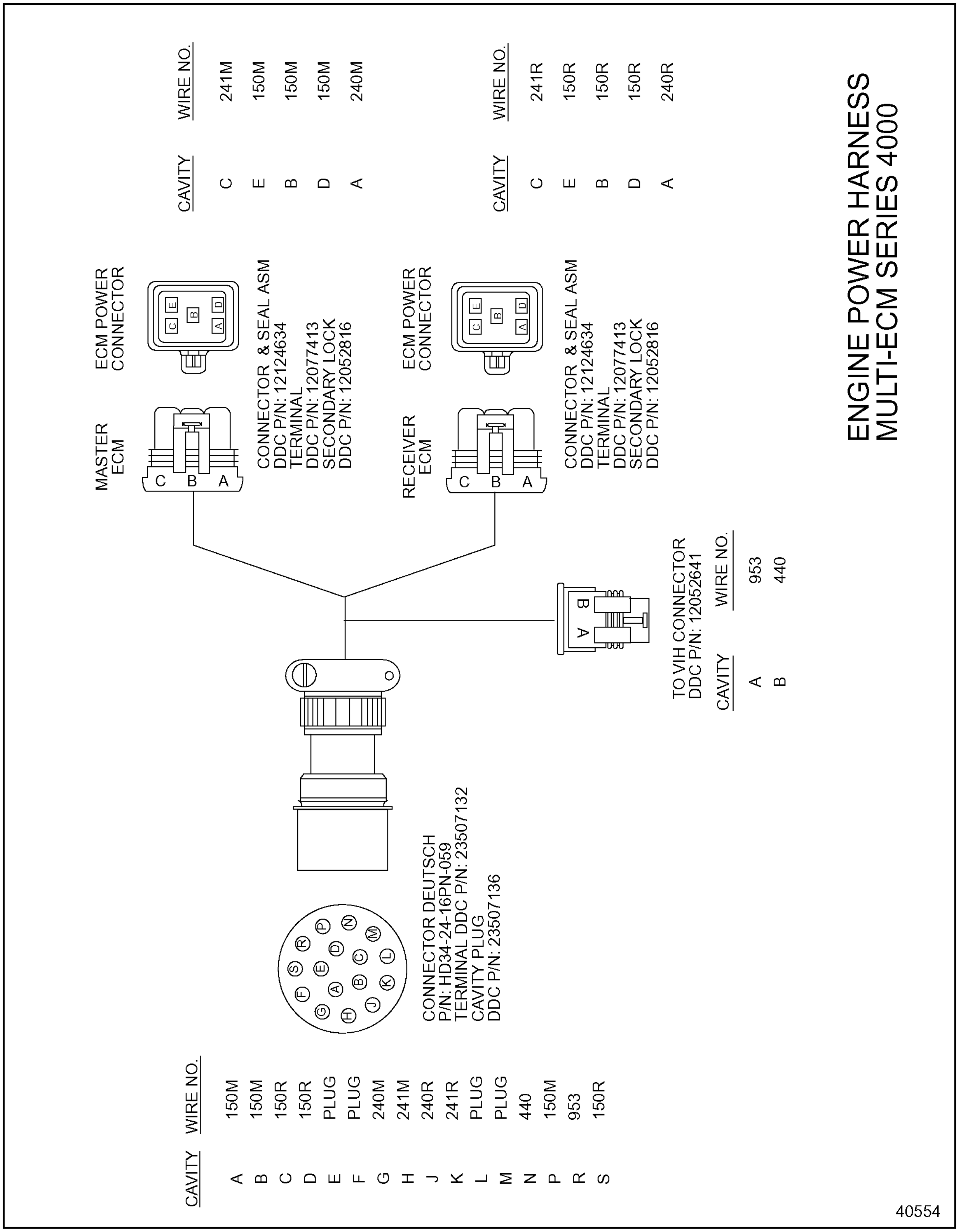


Figure B-3 Engine Power Harness- Series 4000, Multi-ECM

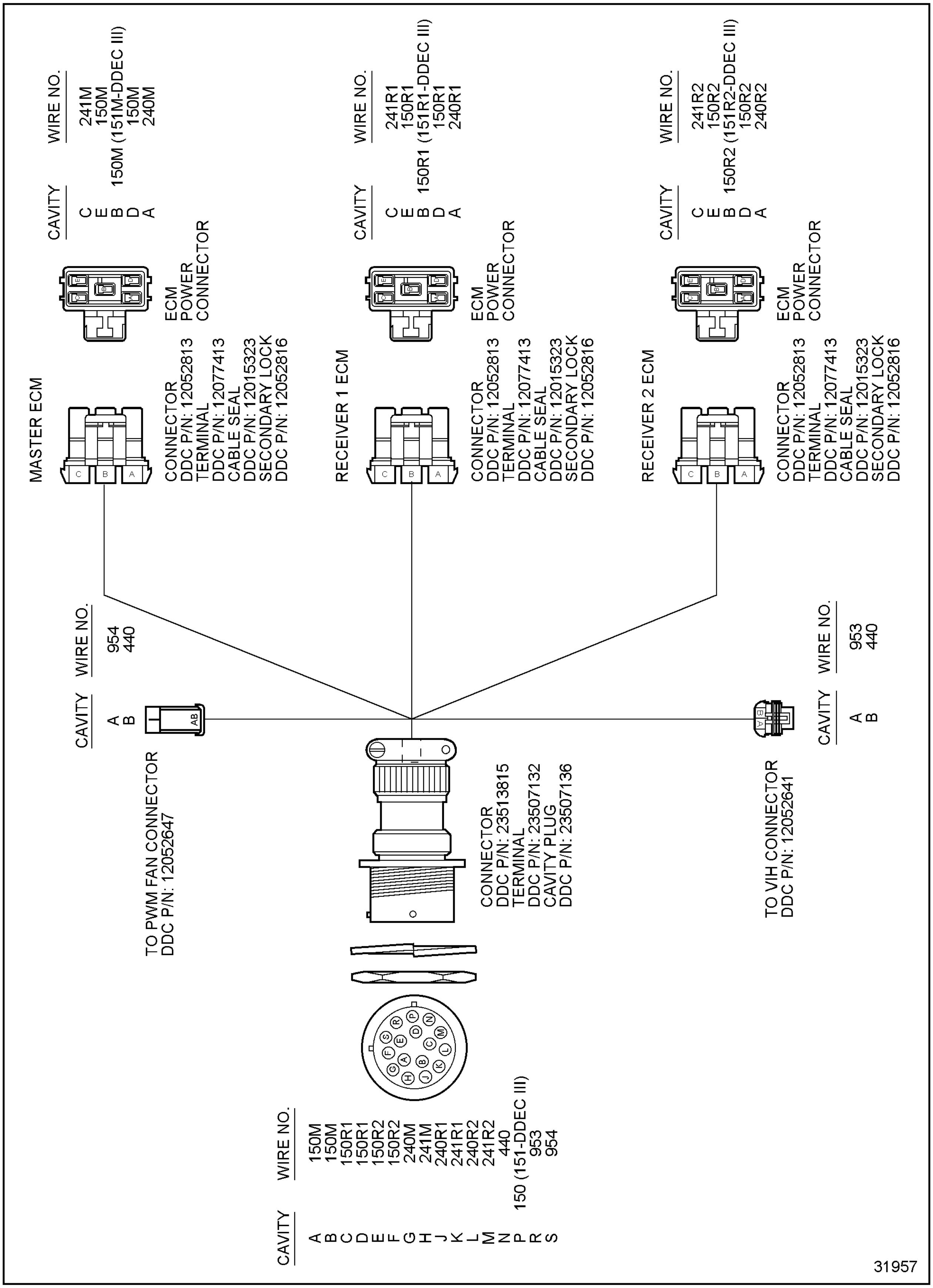


Figure B-4 Engine Power Harness — Series 149 Multi-ECM

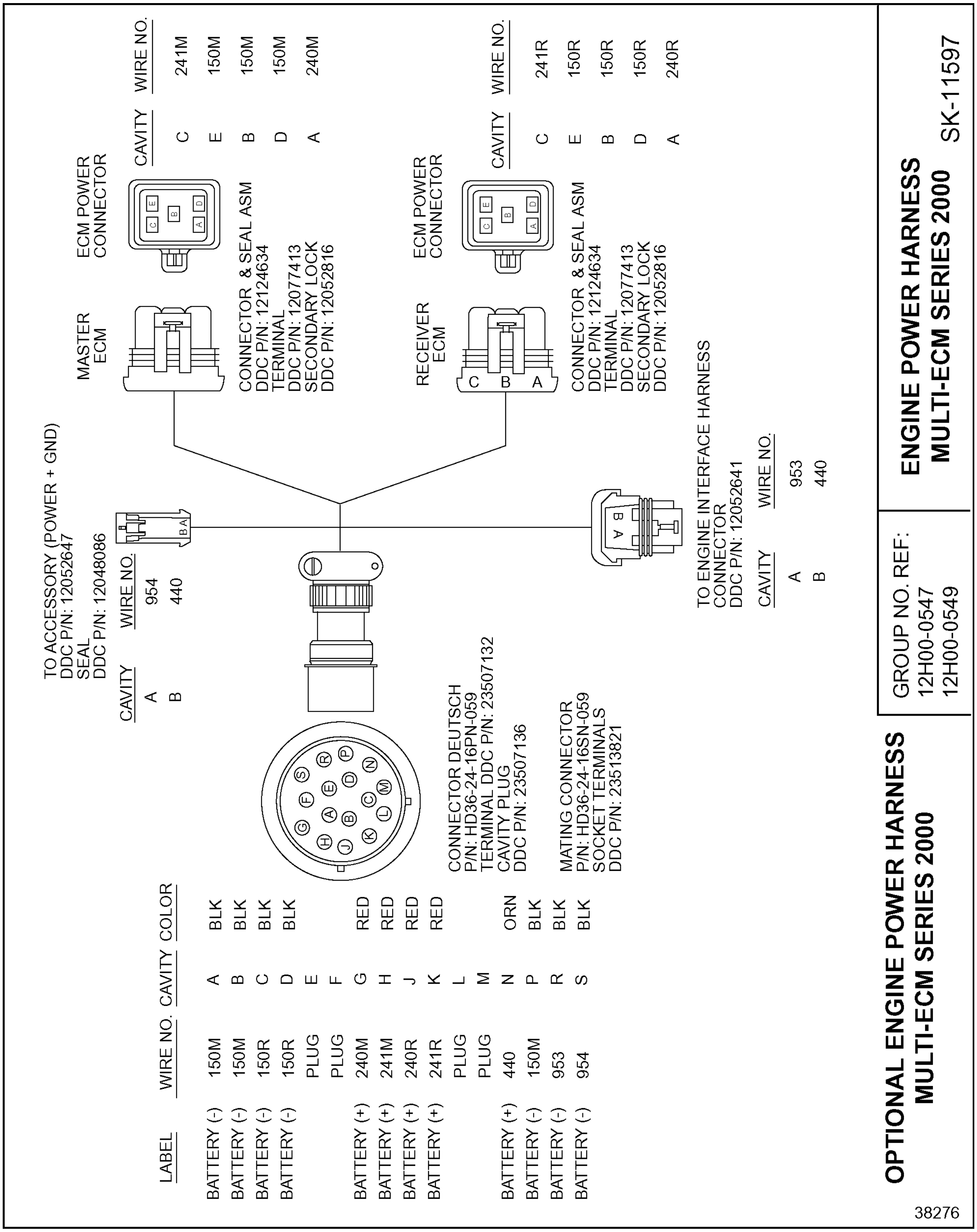


Figure B-5 Optional Engine Power Harness - Series 2000 Multi-ECM

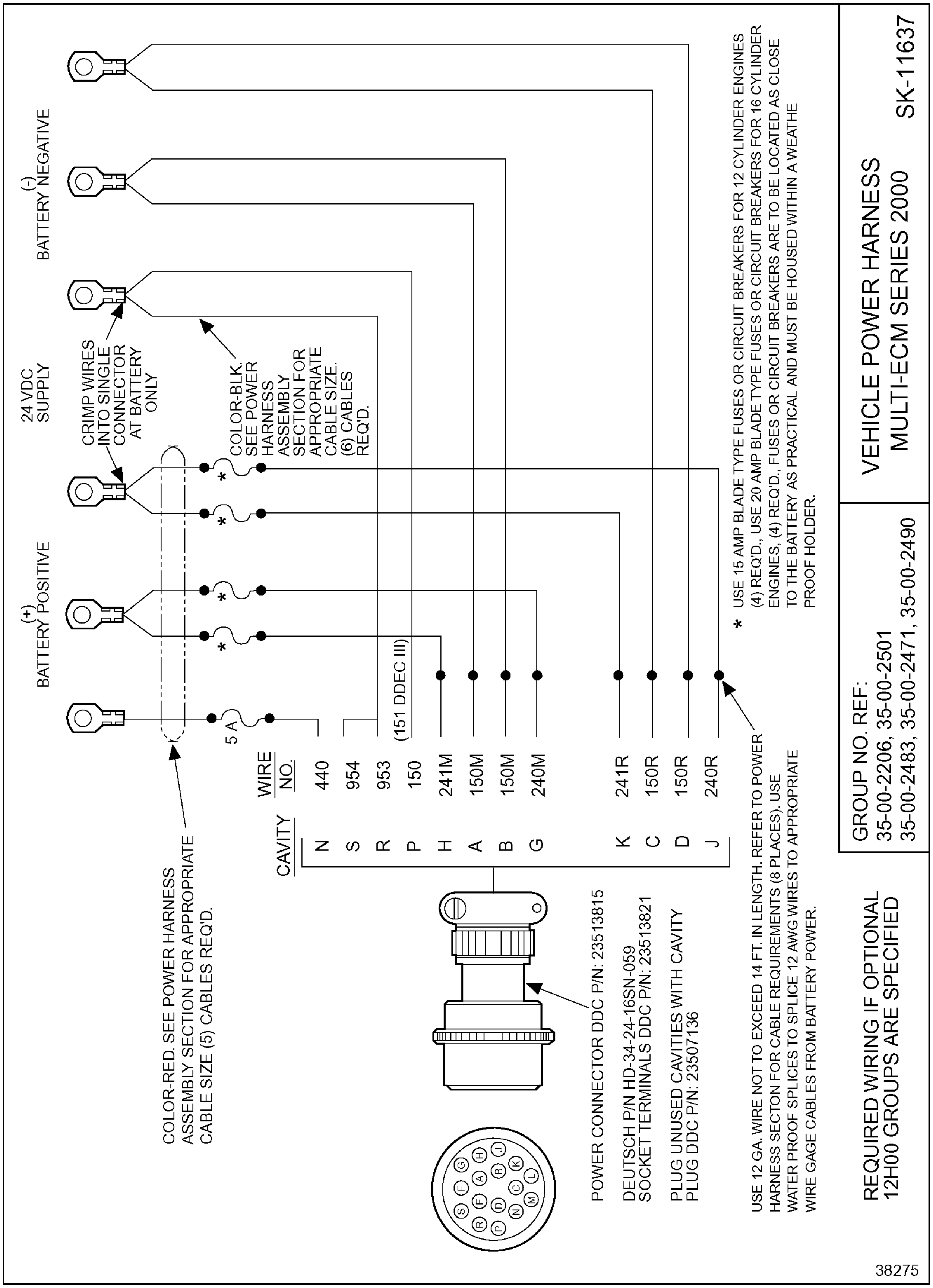


Figure B-6 Vehicle Power Harness - Series 2000, Multi-ECM

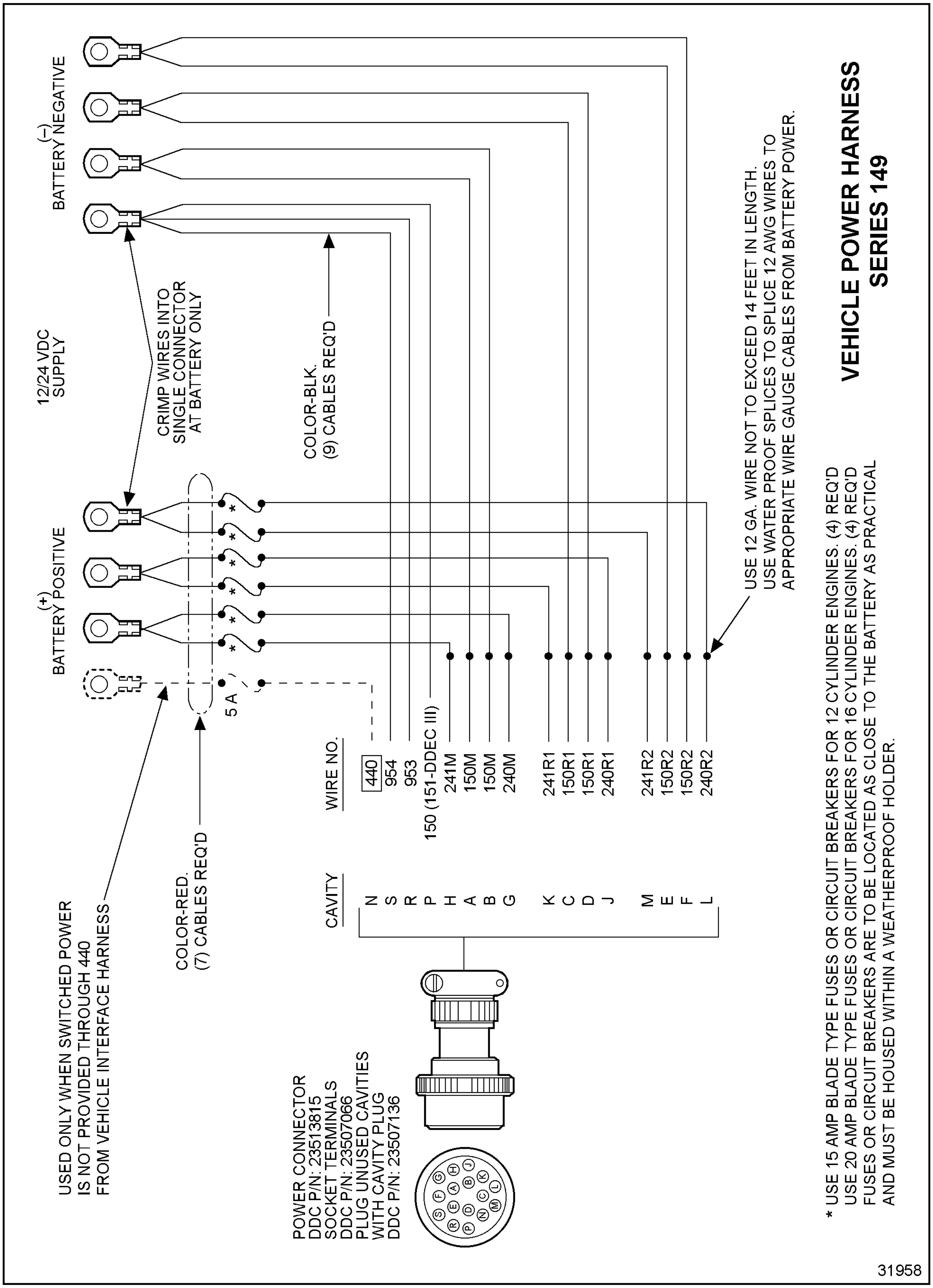


Figure B-7 Vehicle Power Harness - Series 149

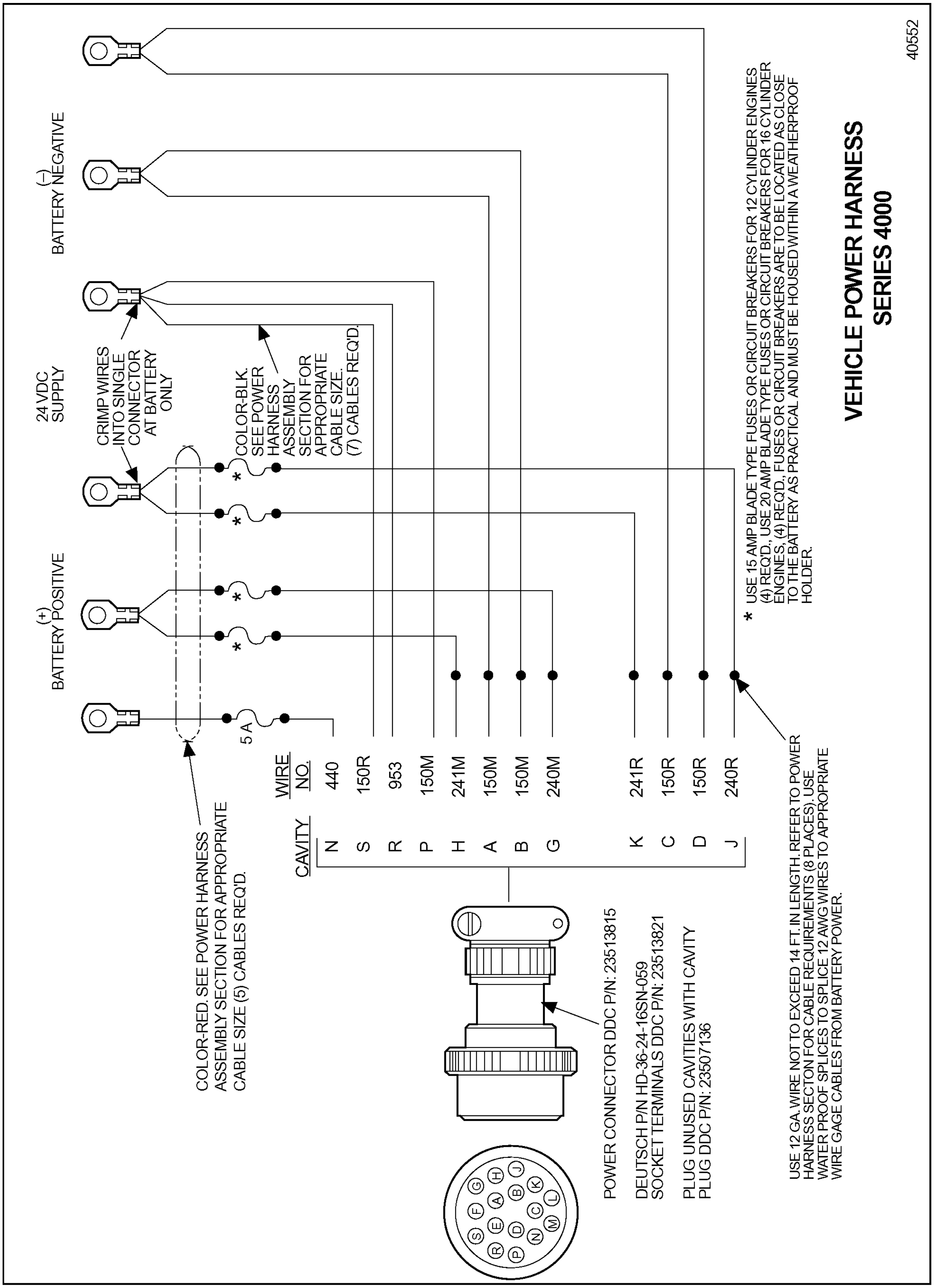


Figure B-8 Vehicle Power Harness - Series 4000

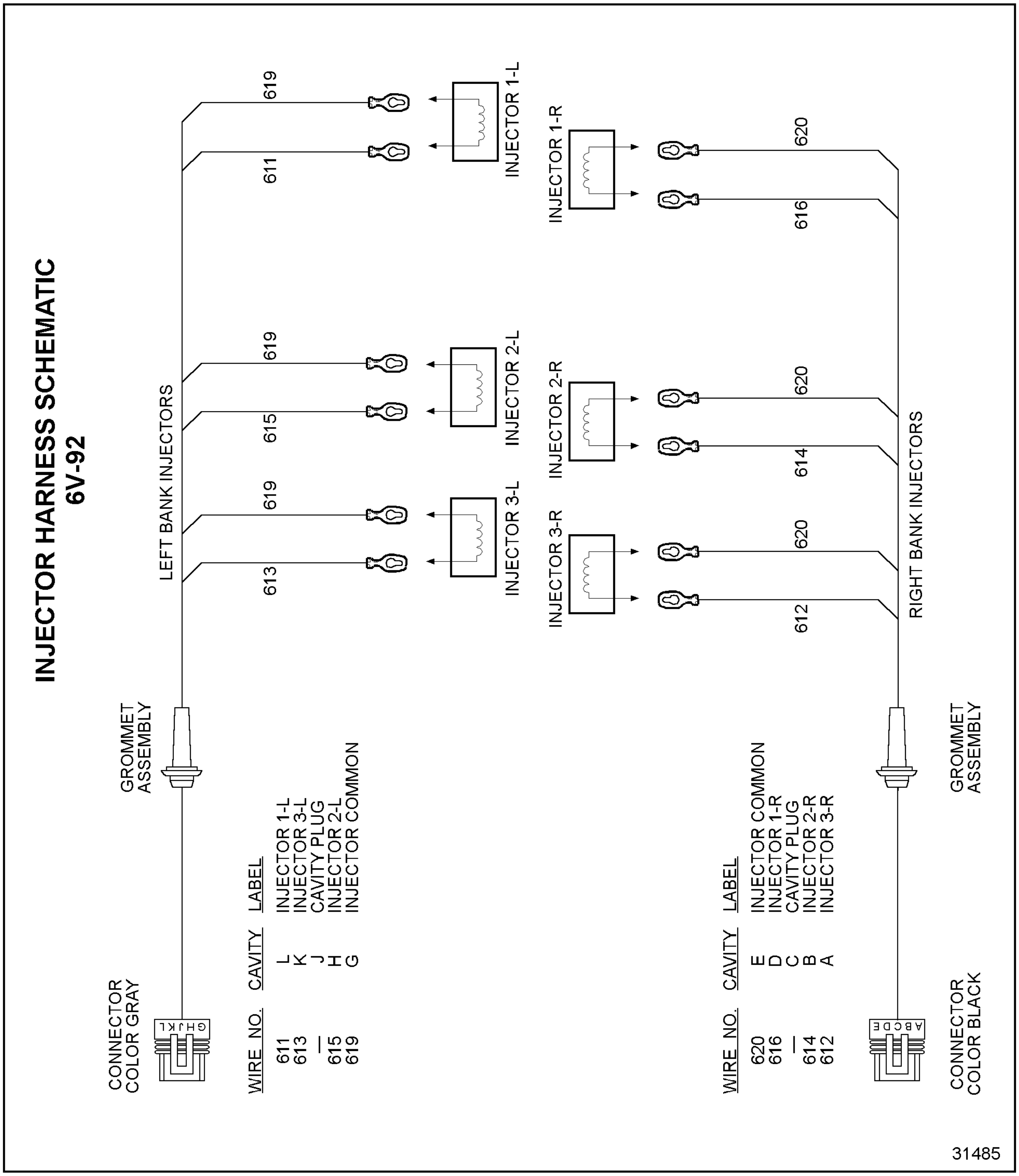


Figure B-9 Injector Harness Schematic - Series 92-6V

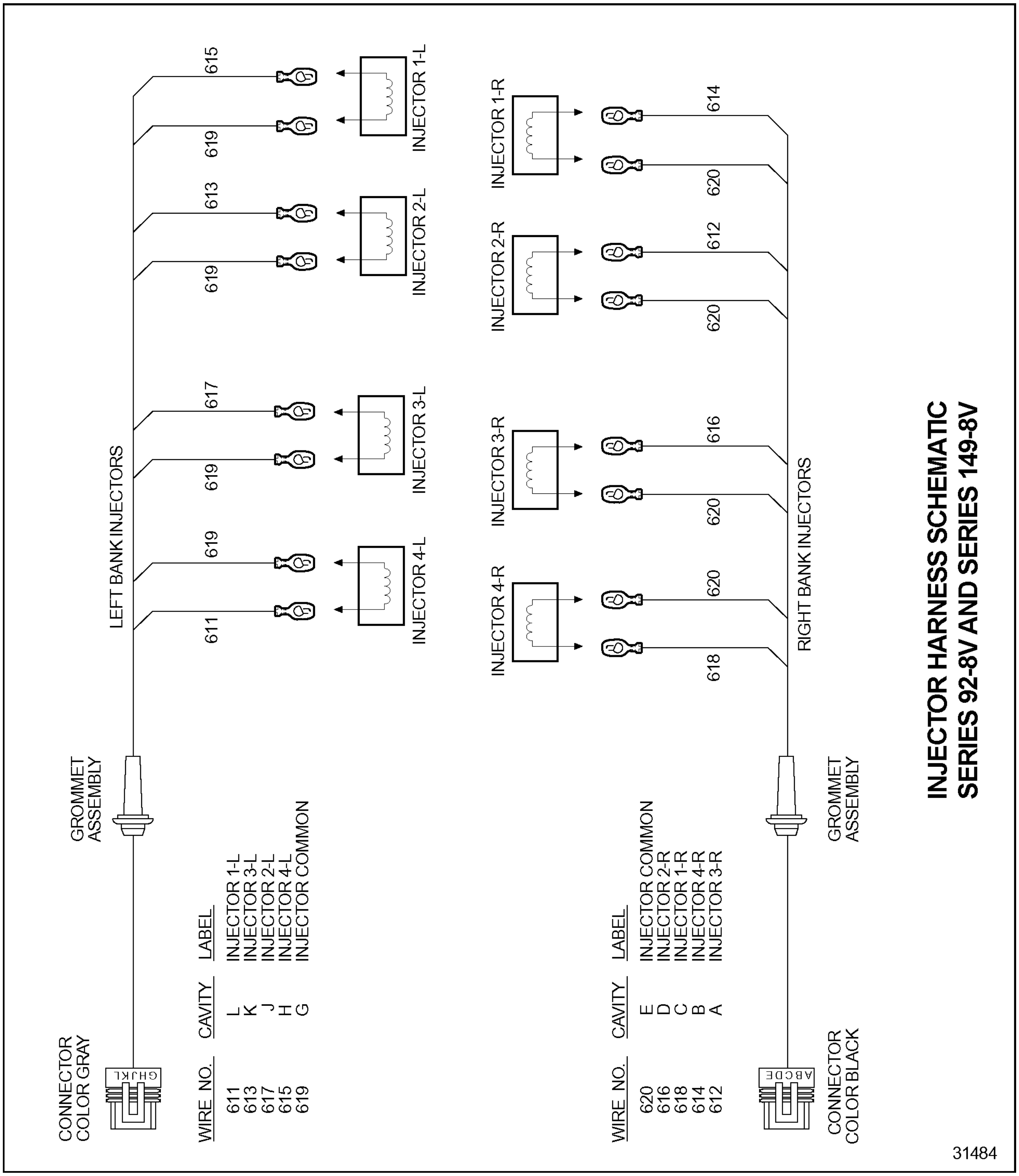


Figure B-10 Injector Harness Schematic -Series 92-8V and Series 149- 8V

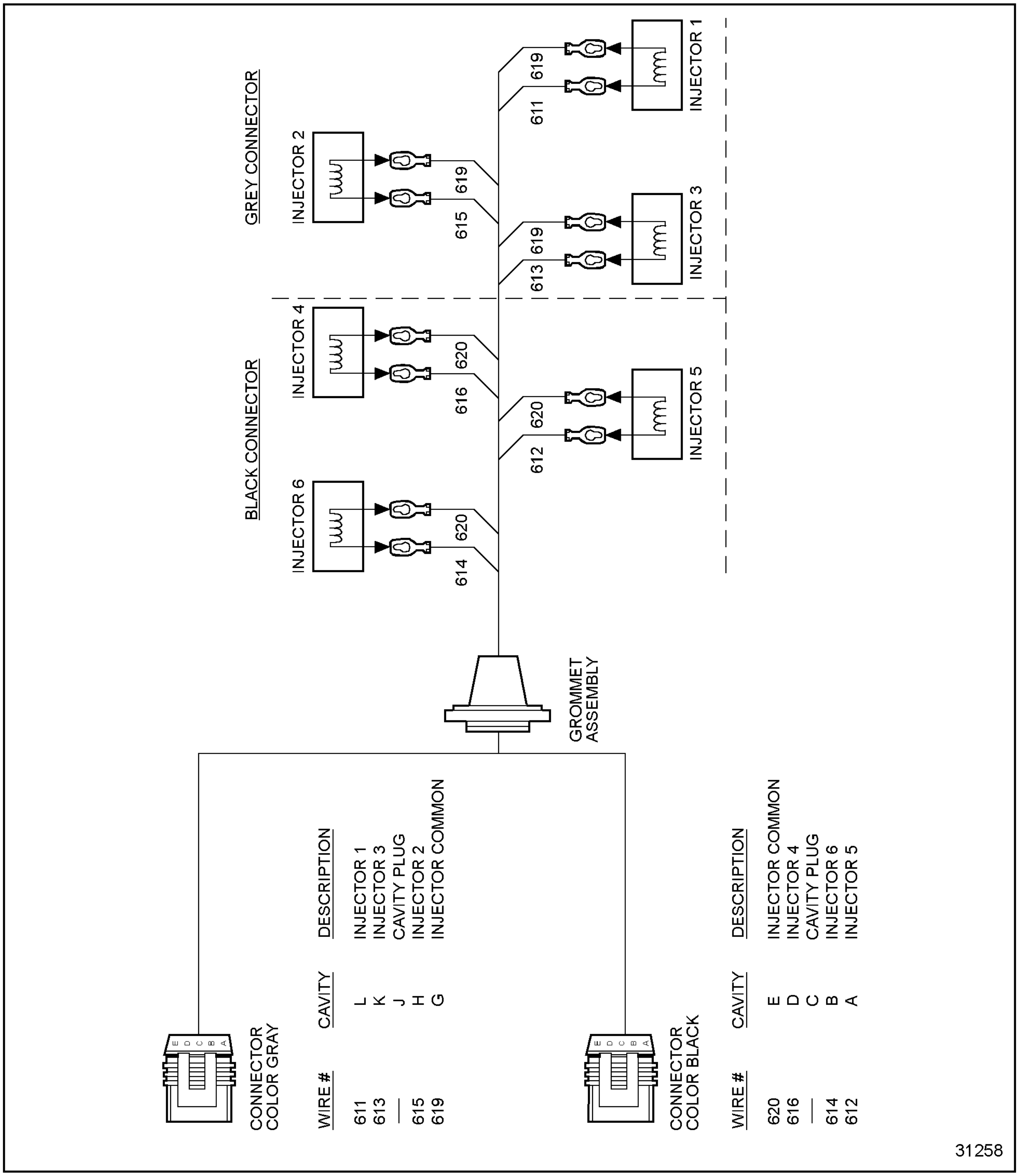


Figure B-11 Injector Harness Schematic - Series 60

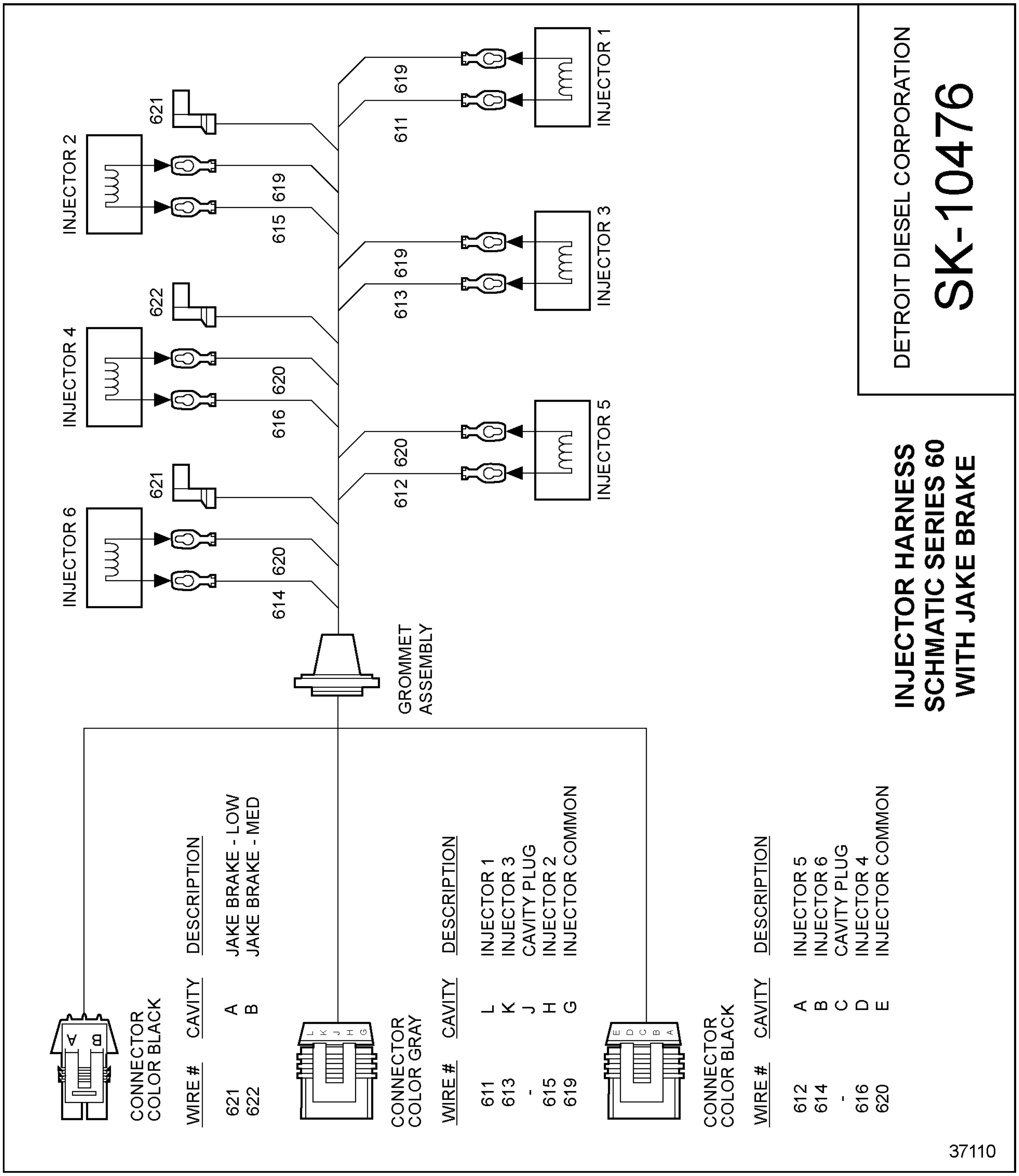


Figure B-12 Injector Harness Schematic - Series 60 with Jake Brake

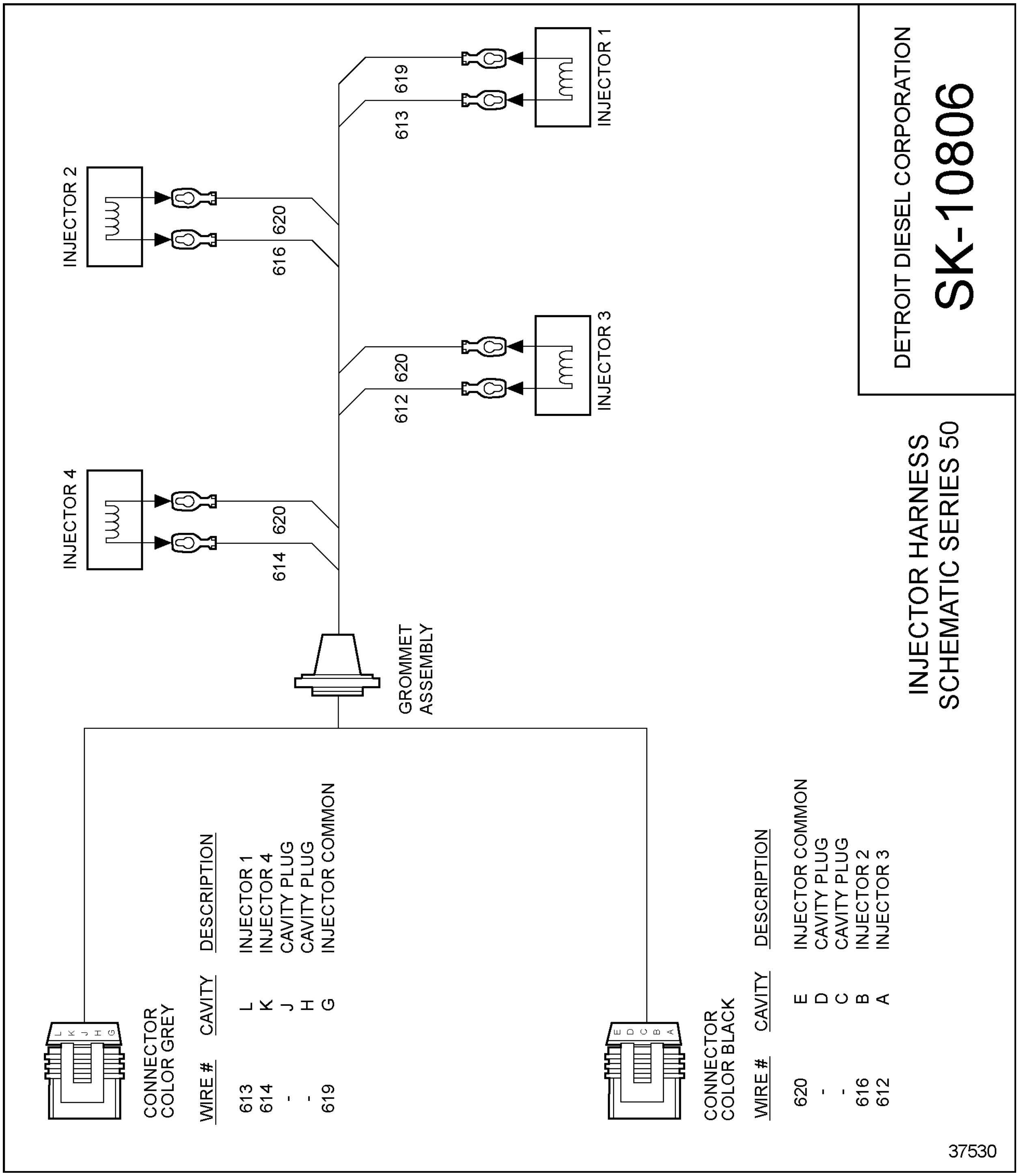


Figure B-13 Injector Harness Schematic - Series 50

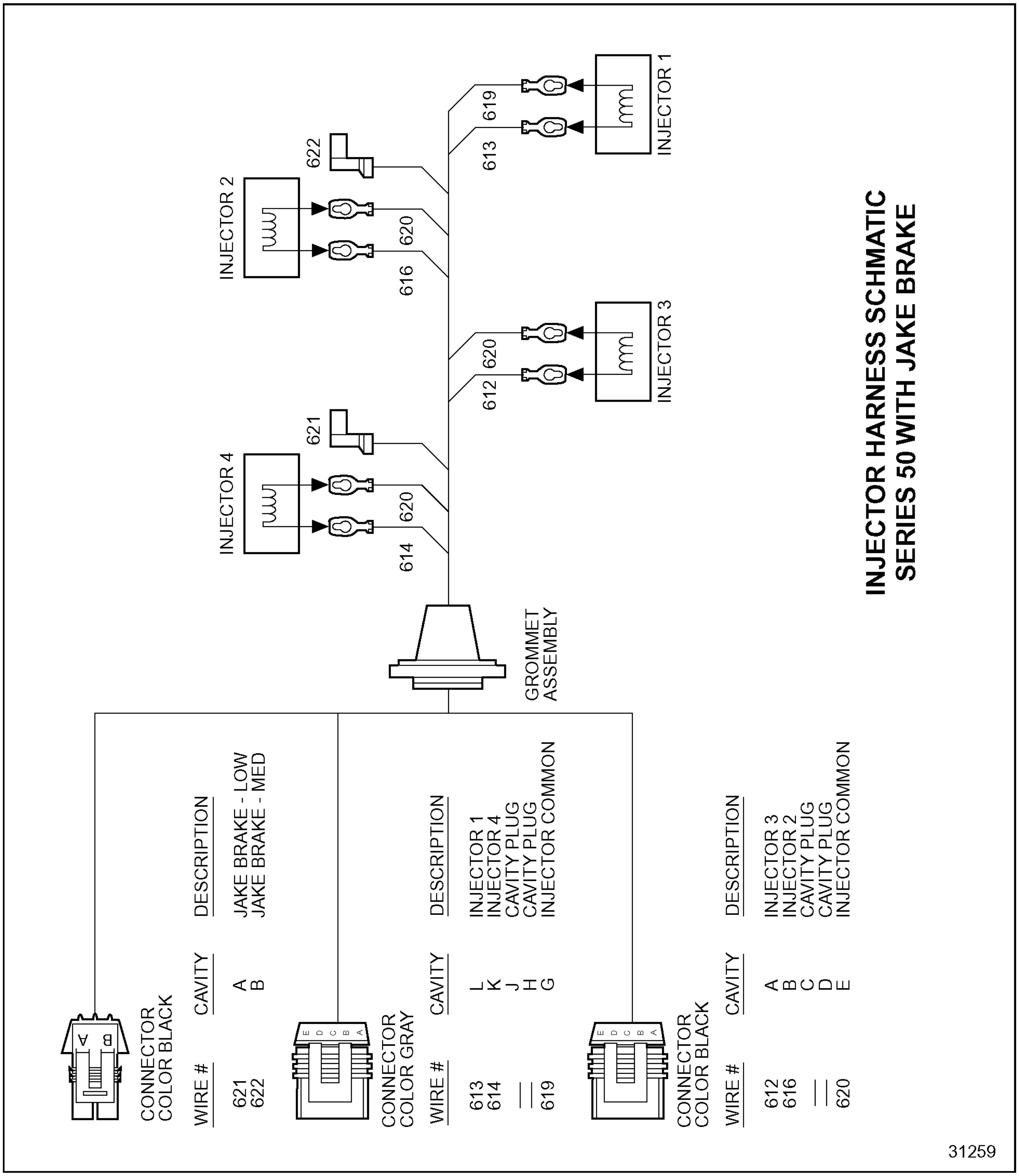


Figure B-14 Injector Harness Schematic - Series 50 with Jake Brake

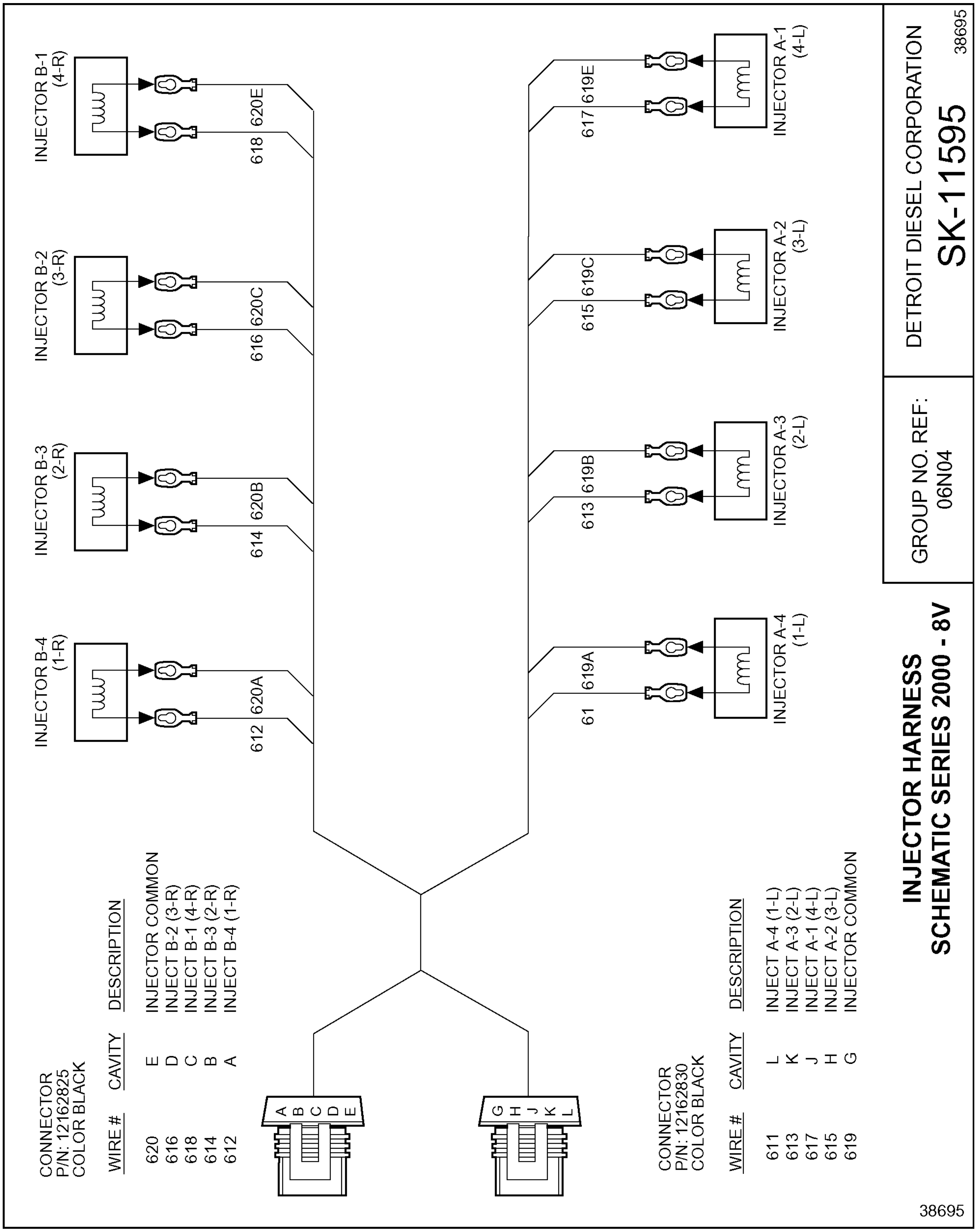
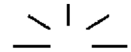


Figure B-15 Injector Harness Schematic - Series 2000-8V

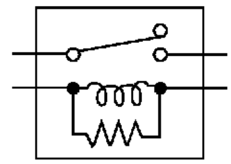
APPENDIX C: SYMBOLS

ALARM

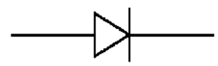


COIL

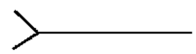
COIL, RELAY
Normally open single pole double throw relay



DIODE

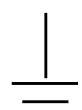


FEMALE TERMINAL

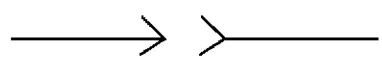


FUSE

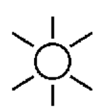
GROUND, BATTERY



INLINE CONNECTION



LIGHT

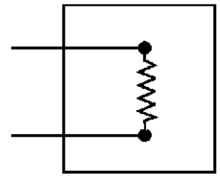


MALE TERMINAL

40396

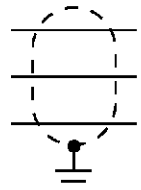
PICKUP, MAGNETIC

POTENTIOMETER

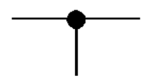


RESISTOR

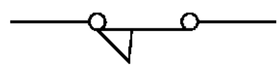
SHIELDED CABLE



SPLICE

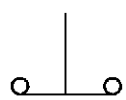


SWITCH, LIGHT
(Normally Closed)

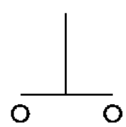


SWITCH, LIGHT
(Normally Open)

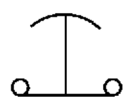
SWITCH, MOMENTARY
(Closed)



SWITCH, MOMENTARY
(Open)

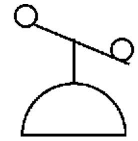


SWITCH, MUSHROOM-HEAD SAFETY
(Normally Closed)



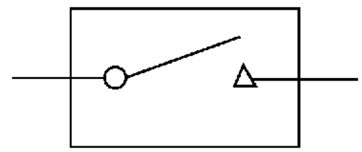
40397

SWITCH, PRESSURE
(Closes on Rising Pressure)

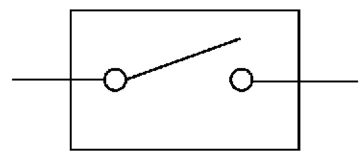


SWITCH, SAFETY INTERLOCKS
(Circuit Closing)

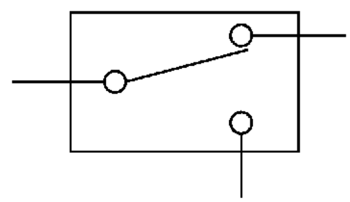
SWITCH, SINGLE POLE, SINGLE THROW
(With Spring Return)



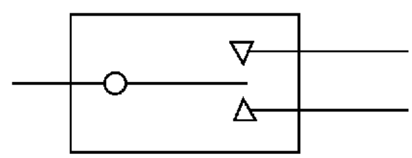
SWITCH, SINGLE POLE, SINGLE THROW
(Without Spring Return)



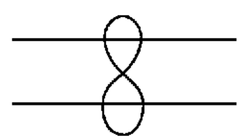
SWITCH, SINGLE POLE, DOUBLE THROW
(Without Spring Return)



SWITCH, SINGLE POLE, DOUBLE THROW
(With Double Spring Action)



TWISTED PAIR



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APPENDIX D: ACRONYMS

ABS	Anti-lock Braking System
ACLS	Add Coolant Level Sensor
ACS	Application Code System
ACPS	Air Compressor Pressure Sensor
AFRS	Air Filter Restriction Sensor
AIM	Auxiliary Interface Module
ATI	Aux Timed Input
ATS	Air Temperature Sensor
CEL	Check Engine Light
CFPS	Common Rail Fuel Pressure Sensor
CLS	Coolant Level Sensor
CPS	Coolant Pressure Sensor
CTS	Coolant Temperature Sensor
DDC	Detroit Diesel Corporation
DDDL	Detroit Diesel Diagnostic Link
DDEC	Detroit Diesel Electronic Controls
DDR	Diagnostic Data Reader
DRS	DDEC Reprogramming System
ECM	Electronic Control Module
EDM	Electronic Display Module

EFC	Electronic Fire Commander
EFPA	Electronic Foot Pedal Assembly
EEPROM	Electronically Erasable Programmable Read Only Memory
EOP	Engine Over Temperature Protection
ESH	Engine Sensor Harness
ESS	Engine Synchro Shift
ETS	Exhaust Temperature Sensor
EUI	Electronic Unit Injectors
EUP	Electronic Unit Pump
FEI	Fuel Economy Incentive
FMI	Failure Mode Identifier
FPS	Fuel Pressure Sensor
FRS	Fuel Restriction Sensor
FTS	Fuel Temperature Sensor
HEI	Half Engine Idle
ICPS	Intercooler Coolant Pressure Sensor
ICTS	Intercooler Coolant Temperature Sensor
IRIS	InfraRed Information System
ISD	Idle Shutdown
LSG	Limiting Speed Governor
OEM	Original Equipment Manufacturer
OI	Optimized Idle

OLS	Oil Level Sensor
OPS	Oil Pressure Sensor
OTS	Oil Temperature Sensor
MAS	Maintenance Alert System
MPG	Miles Per Gallon
MPH	Miles Per Hour
MID	Message IDentification Character
MUI	Mechanical Unit Injector
PGN	Parameter Group Number
PID	Parameter IDentification Character
PTO	Power Take-off
PSG	Pressure Sensor Governor
PVM	Pulse to Voltage Module
PW	Pulse Width
PWM	Pulse Width Modulated
SEL	Stop Engine Light
SEO	Stop Engine Override
SRS	Synchronous Reference Sensor
SID	Subsystem IDentification Character
TBS	Turbo Boost Sensor
TDC	Top Dead Center

TPS	Throttle Position Sensor
TRS	Timing Reference Sensor
VEPS	Vehicle Electronic Programming System
VIH	Vehicle Interface Harness
VIN	Vehicle Identification Number
VSG	Variable Speed Governor
VSL	Vehicle Speed Limiting
VSS	Vehicle Speed Sensor

APPENDIX E: VENDORS

Compatible engine accessories may be obtained from several vendors. This section provides vendors name, address.

FANS

Single-speed fans are available from:

Linnig Corp.
P.O. Box 2002
Tucker, GA 30084
Phone: (770) 414-9499

Index Sensors & Controls, Inc.
13205 Southeast 30th Street
Bellevue, WA 98005-4433
Phone: (206) 746-4049

Bendix (A division of Allied Signal)
901 Cleveland St.
P.O. Box 4016
Elyria, OH 44036
Phone: 1-800-AIR-BRAKE

Kysor
1100 Wright Street
Cadillac, MI 49601
Phone: (616) 779-7528

Horton, Inc.
2565 Walnut Street
Roseville, MN 55113
Phone: 1-800-621-1320

Two-speed fans are available from:

Linnig Corp
P.O. Box 2002
Tucker, GA 30084
Phone: (770) 414-9499

A variable speed fan is available from:

Rockford Powertrain, Inc.
1200 Windsor Road
Rockford, IL 61132-2908
Phone: (815) 633-7460

VEHICLE SPEED SENSORS

Wabash Technologies
1375 Swan Streets
Huntington, Indiana 46750-0829
Phone: 219-356-8300
Fax: 219-356-3846

Airpax Instruments
Phillips Technologies
150 Knotter Drive
Chesire, Connecticut 06410
Phone: 1- 800-643-0643

Electro Corporation
1845 57th Street
Sarasota, Florida 34243
Tel: 941-355-8411
Fax: 941-355-3120

ELECTRONIC FOOT PEDAL ASSEMBLEY

Williams Controls
14100 S.W. 72nd Avenue
Portland, Oregon 97223
Phone: (503) 684-8600

Bendix Heavy Vehicle Systems
901 Cleveland
Elyria, Ohio 44036
Phone: 1-800-AIR-BRAKE

King Controls
5100 West 36th Street
St. Louis Park, Minnesota 55416
Phone: (612) 922-6889

HAND THROTTLE

Morse Controls
21 Clinton Street
Hudson, Ohio 44236
Phone: (330) 653-7701
Fax: (330) 653-7799

DOCUMENTATION

SAE International
400 Commonwealth Drive
Warrendale, PA 15096
Attention: Publications
Phone: (412) 776-4970

DIAGNOSTIC DATA READER

Kent-Moore
28635 Mound Road
Warren, MI 48092
Phone: 1-800-328-6657

SHRINK WRAP

Alpha Wire Corporation
711 Lidgerwood Ave
P.O. Box 711
Elizabeth, New Jersey 07207-0711
Phone: 1-800-52ALPHA

Raychem Corporation, Corporate Division
300 Constitution Drive, Bldg. B
Menlo Park, CA 94025
Phone: (650)-361-2755

GLOSSARY

Add Coolant Level Sensor	Provides another coolant level sensor, higher in the top tank of the vehicle cooling system. Typically, this is used to recognize the coolant is low, but not low enough to activate the DDEC engine protection.
Air Temperature Sensor	An intake mounted sensor which provides air temperature information to the ECM. Located in the bottom middle of the air intake manifold on the Series 50 and Series 60 Engines.
Check Engine Light	A panel mounted yellow indicator light, provided by the vehicle OEM as standard.
Coolant Level Sensor	Activates the engine protection if the coolant level is low.
Coolant Temperature Sensor	Provides coolant level information to the ECM. Used for engine protection.
Communication Harness	This OEM supplied harness connects the ECM's J1922 and J1939 ports to other vehicle systems.
Cruise Control	Operates in either Engine or Vehicle Speed Mode and maintain a targeted speed (MPH or RPM) by increasing or decreasing fueling to maximize fuel economy and driveability.
Check Engine Light	A panel mounted yellow indicator light. Provided by the vehicle OEM as standard.
Customer Option Password	A 4 digit alphanumeric password to protect and change customer parameters in the DDR. This password is set with the DDR. This password does not protect the horsepower rating.
DDEC IV	Fourth generation of Detroit Diesel Electronic Controls.
Deceleration Light	Illuminates on the rear of the vehicle when you take your foot off the accelerator pedal to indicate that the vehicle is slowing down. Typically, this is used on the rear of a bus that operates in the city.
Diagnostic Request Switch	A switch that allows the yellow and red lights to flash two digit diagnostic codes when the engine is idling or off. The yellow light flashes inactive (or historic) codes. The

	red light flashes active codes. These two digit codes are defined on the DDEC diagnostic data reader pocket card. This can be the same switch as the stop engine override.
Electronic Control Module	The ECM includes control logic to provide overall engine management. The ECM continuously performs self diagnostic checks and monitors other system components
Electronic Fire Commander	A complete pressure governor control unit for DDEC IV engines. The EFC displays engine RPM, battery voltage, engine oil pressure, and either engine oil temperature or engine coolant temperature (programmable).
Electronic Unit Injector	Provides fuel delivery to the engine cylinders. The EUI controls injection timing and metering using a solenoid operated valve. The duration of valve closure determines the quantity of fuel injected.
Electronic Fire Commander	Designed for the fire fighting and emergency services market, EFC combines the DDEC Pressure Sensor Governor (PSG), a system monitor, and a pump panel display for vital engine operating parameters into one compact, durable package.
Engine Brakes Cruise Control	Provides cruise control compatibility with engine brakes. While in cruise control, the engine brakes will turn on and go off automatically in order to maintain the same cruise set speed.
Engine Brake LOW ON (Above Cruise Control)	The additional engine speed above the driver selected cruise speed that the low engine brakes (Jake Brakes) turn on.
Engine Brake Medium/High On (Increment)	Sets the engine brake medium and high limits to a vehicle speed above engine brake low.
Engine Fan Braking	Automatically engages the cooling fan clutch when all the engine brakes are on, (HIGH).
Engine Interface Harness	Used in multi-ECM applications is usually installed at the factory and delivered connected to all ECMs. Ends with a quick disconnect connector. The OEM VIH connects to the quick disconnect connector.
Engine Protection	Provides three levels of protection to the engine if it is operating out of the limits. These three levels are warning, rampdown, and shutdown. Coolant level,

coolant temperature, oil temperature, oil pressure, and two additional sensors provide protection to the engine. Typically, the additional sensors are used for high oil temperature in the automatic transmission, low oil level in the engine, and other vehicle systems that require the engine to shutdown.

Engine Over Temperature Protection The reduction in operating power from between the time the CEL and the SEL illuminates. For high coolant and/or oil temperature only.

Engine Overspeed Logs diagnostic code at 2500 RPM, DDC standard.

Engine Sensor Harness Connects the ECM to all engine sensors, facilitates the receipt of inputs and outputs signals, controlling the fuel injection process and engine speed.

Failure Mode Identifier The FMI describes the type of failure detected in the subsystem and identified by the PID or SID.

Fan Clutch Override Used to engage the cooling fan when desired. Fan Controls use the DDEC oil temperature, coolant temperature, or air temperature sensors to engage the cooling fan.

Fuel Pressure Sensor Provides fuel pressure information to the ECM. Used for diagnostics.

Fuel Temperature Sensor Provides fuel temperature information to the ECM. Used for determining hot fuel, and adjusting the calibration based on this temperature.

Half Engine Idle The engine idles on three of the cylinders to reduce the amount of white smoke on cold engine start-up.

High Range Max MPH Defines the minimum vehicle speed required to activate the high range max RPM function. This is used to encourage the driver to use high gear, while in cruise control.

High Range Max RPM Limits the maximum engine speed in the top range of gears, encouraging the driver to upshift to the next higher gear to increase vehicle speed. This function will determine the vehicle speed limit, unless a slower speed limit is selected for the vehicle speed limit parameter. During the shift sequence, the high range max MPH must be reached before the high range max RPM is achieved.

Horsepower Rating Password	A 4 digit alphanumeric password to protect and activate the horsepower rating in the ECM. This password is set with the DDR.
Horsepower Rating Security	Protects the multiple horsepower ratings in the ECM. Only one rating will be available with this feature turned on. This lock is set at the time of engine order from DDC or the OEM.
Idle Shutdown Override With Throttle	Allows the engine shutdown to be canceled by depressing the accelerator pedal while the yellow check engine light is flashing 90 seconds before engine shutdown.
Idle Time	The amount of time spent idling before the engine will automatically shutdown; set with the DDR.
Idle Timer Shutdown	Allows the engine to shutdown after a customer set time expires on idling (low idle or high idle or PTO).
Injector Harness	Installed at the factory and are delivered connected to the injection units and the ECMs.
InfraRed Information System	Provides infrared two-way communication between a vehicle and a PC.
Limiting Speed Governor	Maintains vehicle speed based on driver throttle input. The engine changes RPM to maintain a vehicle speed with the accelerator pedal.
Maintenance Alert System	Monitors engine fluid levels and filter restrictions and notifies the driver and/or technician when maintenance is required.
Maximum Security	Protects and locks out all of the programmed parameters in the ECM. This lock is set at the time of engine order from DDC or at the OEM. Feature settings cannot be changed with maximum security turned on.
Oil Pressure Sensor	Provides engine oil pressure to the ECM. Used for engine protection.
Oil Temperature Sensor	Provides the engine oil temperature to the ECM. Used for engine protection and fan controls.
Parameter Identification Character	A PID is a single byte character used in J1587 messages to identify the data byte(s) that follow.

PasSmart	Allows a fleet manager to enable a second Vehicle Limit Speed (VLS) above the normal VLS to assist while passing other vehicles on the highway. This second VLS is programmed for a limited duration during a given time period (interval).
Power Harness	Connects battery power (12 or 24 volts) and ground to the ECM and includes fuse(s) or circuit breaker(s). OEM supplied.
Power Take Off	A mechanical gear device used to divert engine horsepower to other machinery.
Progressive Shifting	Encourages the driver to shift in to a higher gear before the engine reaches governed speed. The Spec Manager program should be utilized to determine maximum vehicle speed. Typically, this is used on 2100 RPM rated engines.
Pressure Sensor Governor For Fire Trucks	Maintains a set water pressure on a fire truck water pump. The engine speed will vary to maintain a constant water pressure. This feature is in fire trucks.
Pressure Sensor Governor Light For Fire Trucks	Indicates that the Pressure Sensor Governor is active.
Pulse Width	The duration of time the injectors are fueling the engine, measured in degrees of rotation of the engine.
Pulse Width Modulated	A type of electrical signal output.
SAE J1587	Communication link used for DDR, Data Hub, ABS, etc.
SAE J1922	Communication link used for traction control systems and CEEMAT Fuller transmissions.
SAE J1939	Communication link used for multiple block engines and other vehicle systems.
Starter Lockout	Prevents the starter from activating after the engine is already running. Typically, this is used in buses.
Stop Engine Light	A panel mounted red indicator light provided by the OEM as standard.
Stop Engine Override	This switch allows an override of the engine protection system when toggled in the rampdown or shutdown mode

	every 30 seconds. This can be the same switch as the diagnostic request.
Subsystem Identification Character	A SID is a single byte character used to identify field-repairable or replaceable subsystems for which failures can be detected or isolated.
Synchronous Reference Sensor	Indicates a specific cylinder in the firing order; tells the ECM when the #1 cylinder is at top dead center of its stroke. DDC standard.
Timing Reference Sensor	Indicates crank position of every cylinder; tells the ECM where the rotation of the engine is or when to fuel each cylinder. DDC standard.
Throttle Inhibit	Disables the accelerator pedal by making it unresponsive when a switch is toggled. Typically, this is used in buses for when the doors are open, or when the pressure governor system is active in a fire truck.
Throttle Position Sensor	Converts the operator's hand throttle and/or foot pedal input into a signal for the ECM, better known as the accelerator pedal. This pedal, located on the floor of the vehicle cab, tells the ECM how much fuel is needed based on the driver input. Provided by the OEM, standard.
Top Dead Center	When the piston is at the top of the stroke nearest the head of the engine. The point at which the piston stops going up and starts going down.
Turbocharger Boost Sensor	Provides air pressure (atmospheric and boost) information from turbocharger to the ECM. This sensor is located in the air intake manifold. Used for white smoke and emissions. DDC standard.
Variable Speed Governor	Maintains a constant engine speed with varying loads. A variable speed governor is referred to as: high idle, fast idle, hand throttle, Vernier, voltage divider, power take off (PTO), cruise control, or cruise switch PTO.
Vehicle Electronic Programming System	A PC software package used to change the parameters to be programmed into the DDEC IV ECM. OEM supplied.
Vehicle Interface Harness	Connects the ECM to other vehicle systems.
Vehicle Power Shutdown	Allows the chassis power and DDEC power to shutdown after idling on low idle, high idle, or PTO for the set

idle time. The idle shutdown override with throttle will override the vehicle power shutdown. In addition, the vehicle power will shutdown after an engine protection shutdown. This can be overridden by the stop engine override switch.

Vehicle Speed Limiting The vehicle's fastest speed. limits the vehicle from going faster than a preset limit.

Vehicle Speed Maximum The fastest vehicle speed (MPH/KPH) the driver is allowed to travel on flat ground.

Vehicle Speed Sensor Tells the ECM how fast the vehicle is going. This magnetic pickup is located on the tail shaft of the transmission or on the rear drive wheel of the vehicle. Provided by the OEM. Required for cruise control, vehicle speed limiting, vehicle overspeed with/without throttle, progressive shift, and engine brakes. Optional.

Wire Comb A strain relief for the back of the VIH connector to prevent water from entering the connector from the back. Used in all Series 50, Series 149, and Industrial applications.

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