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.

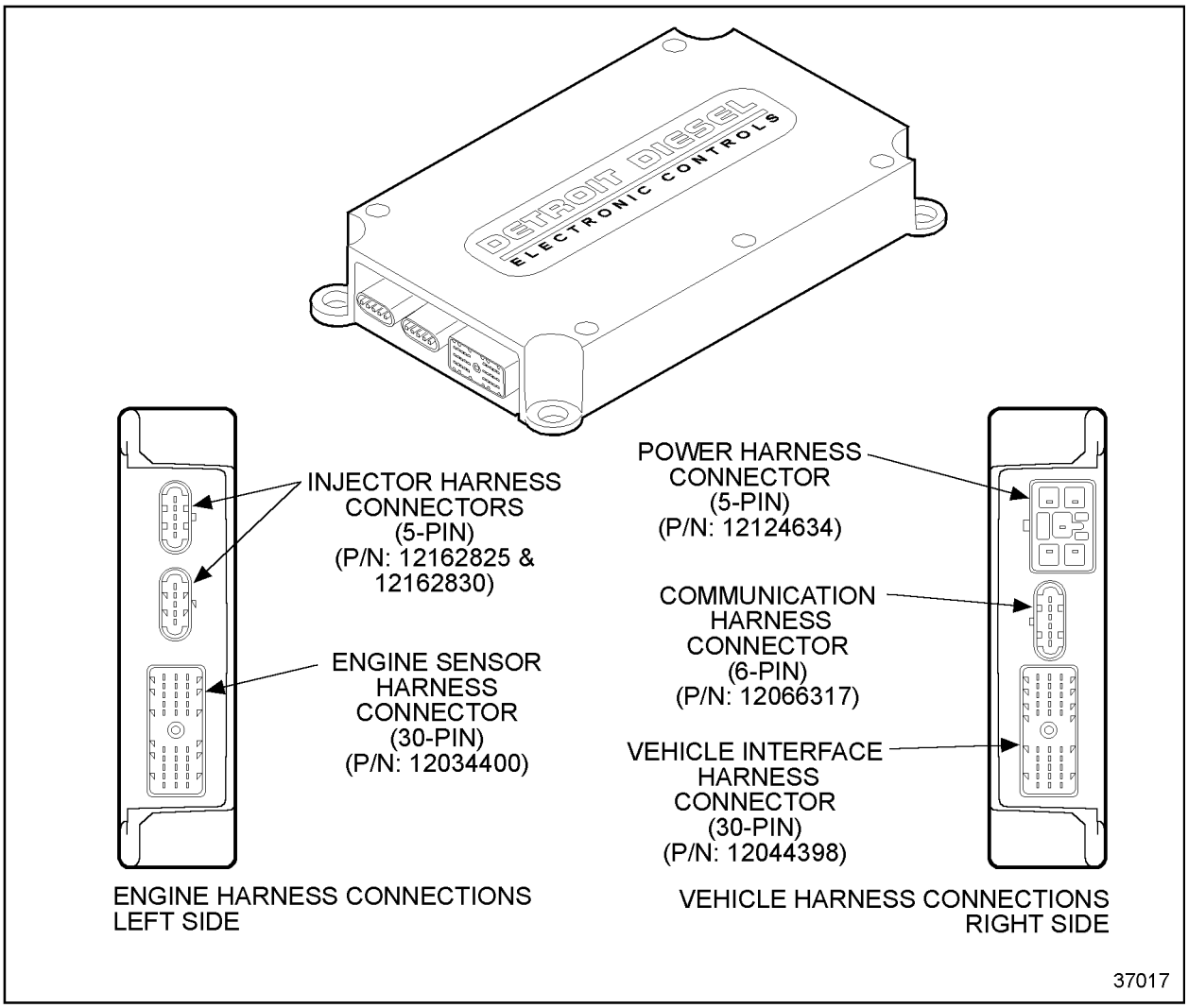

Figure 3-1 The Electronic Control Module

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.

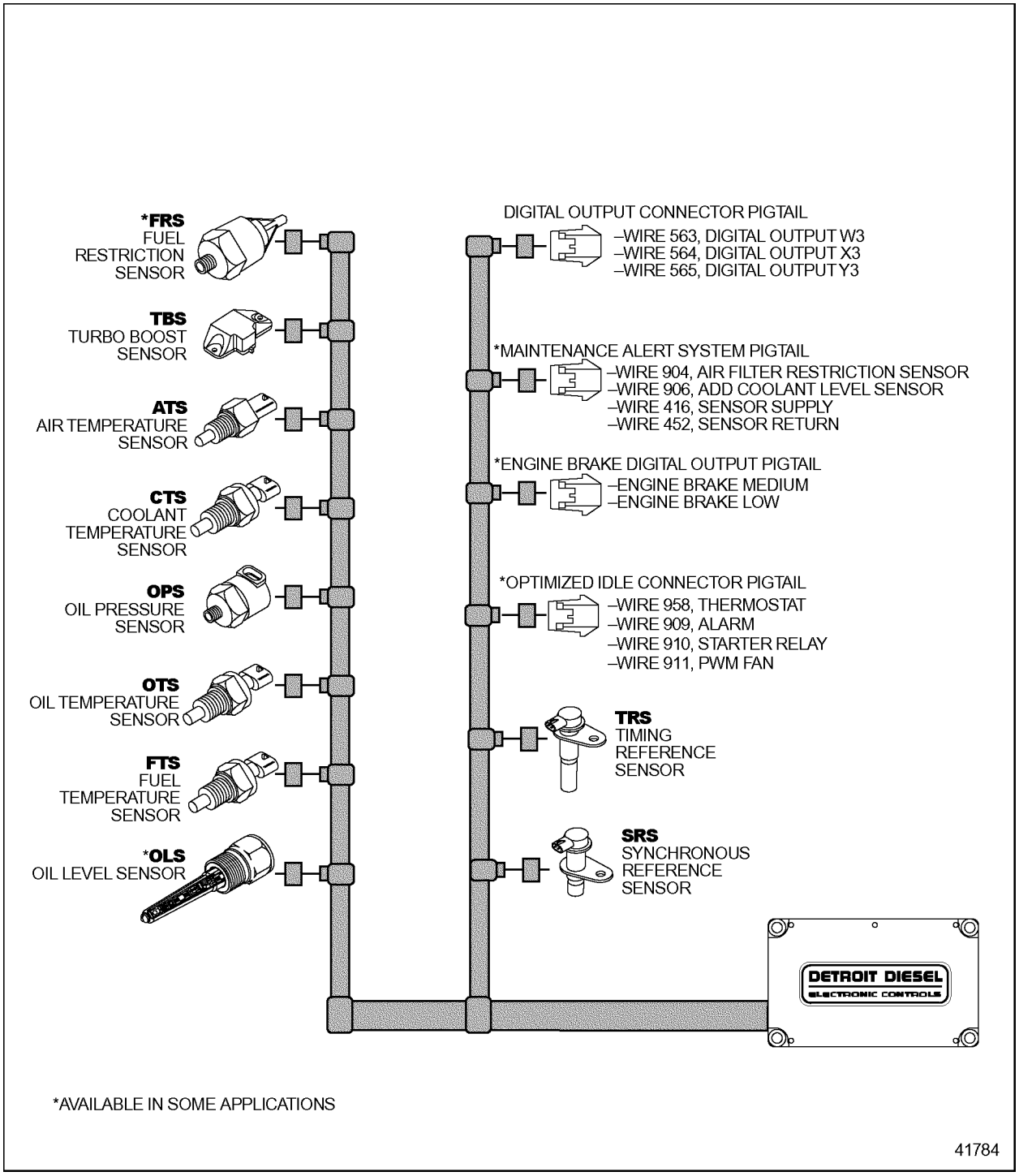

Figure 3-2 A Typical On-highway Engine Sensor Harness

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

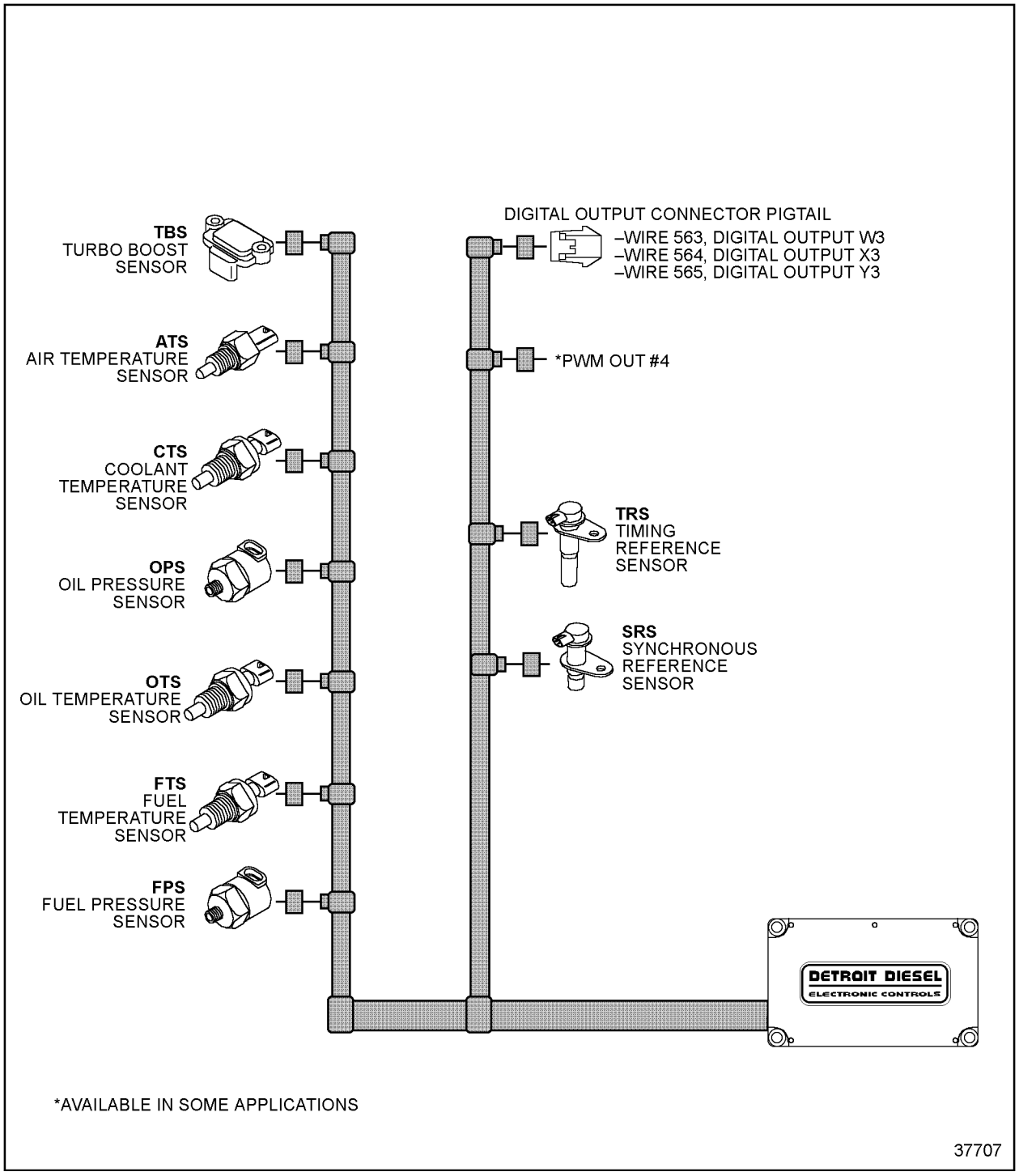

Figure 3-3 A Typical Series 60 Construction and Industrial Engine Sensor Harness

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

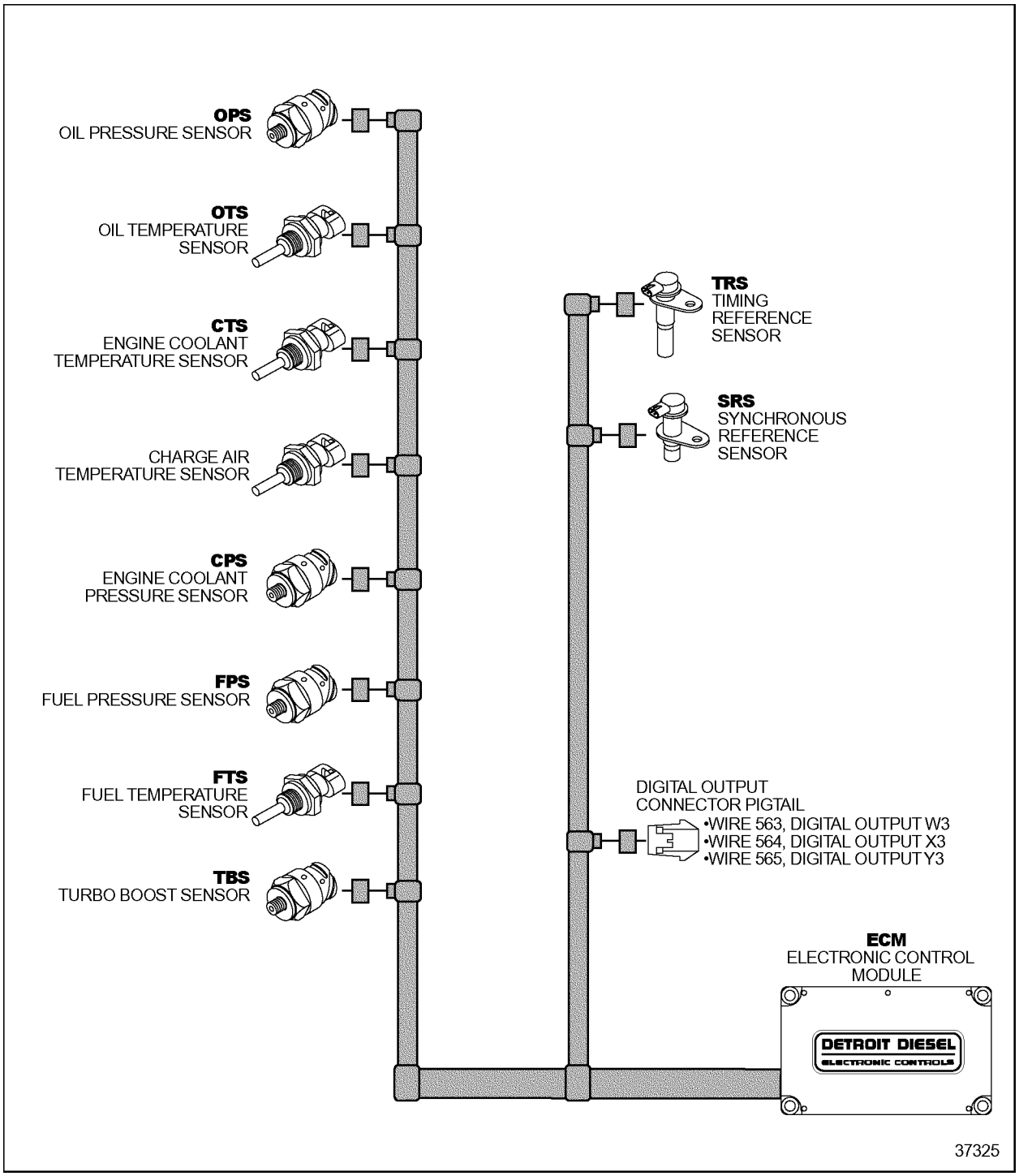

Figure 3-4 A Typical Series 2000 Single-ECM Construction and Industrial Engine Sensor Harness

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

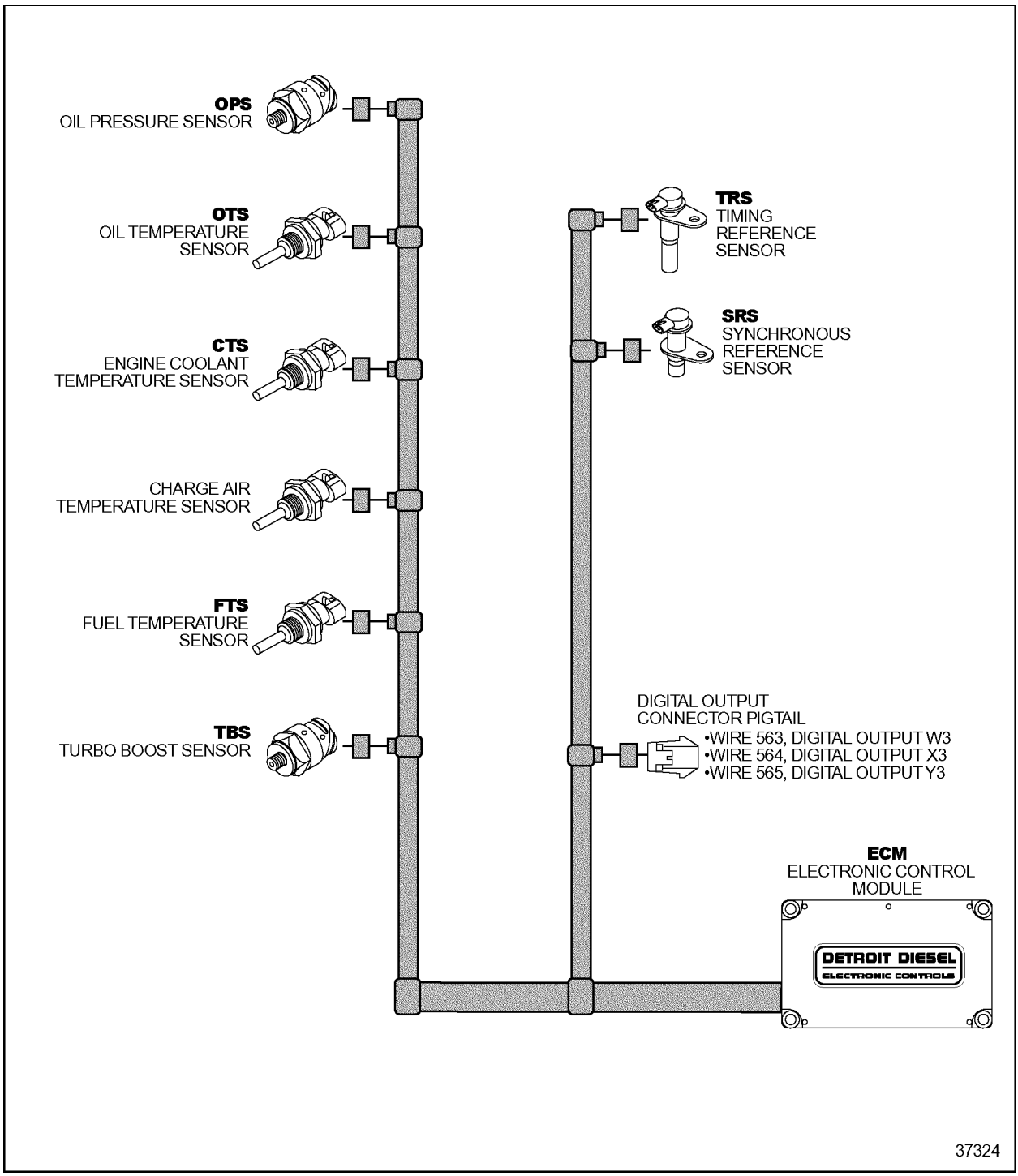

Figure 3-5 Series 2000 Single ECM Genset Engine Sensor Harness

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.

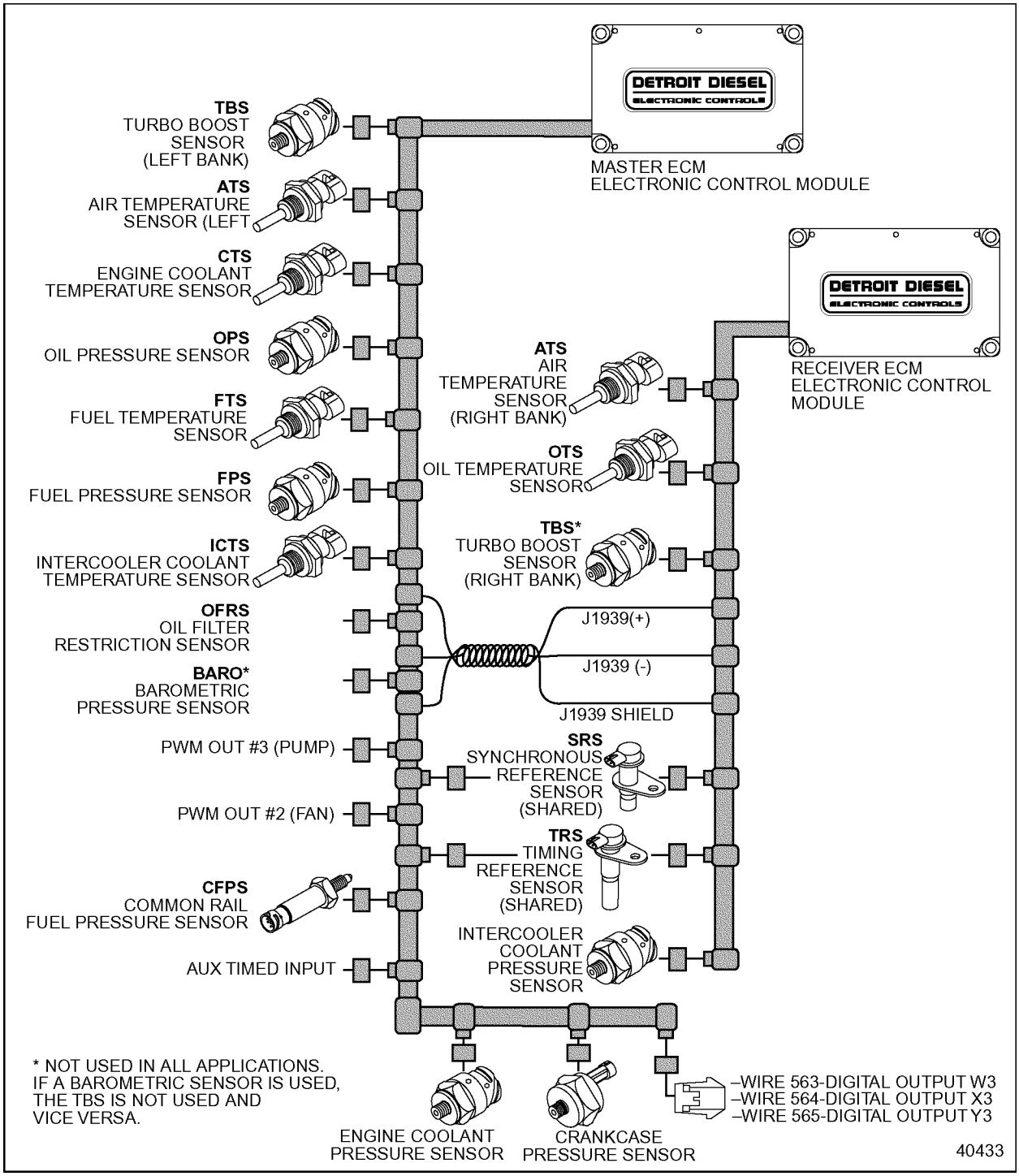

Figure 3-6 A Typical Series 4000 Multi-ECM Engine Sensor Harness

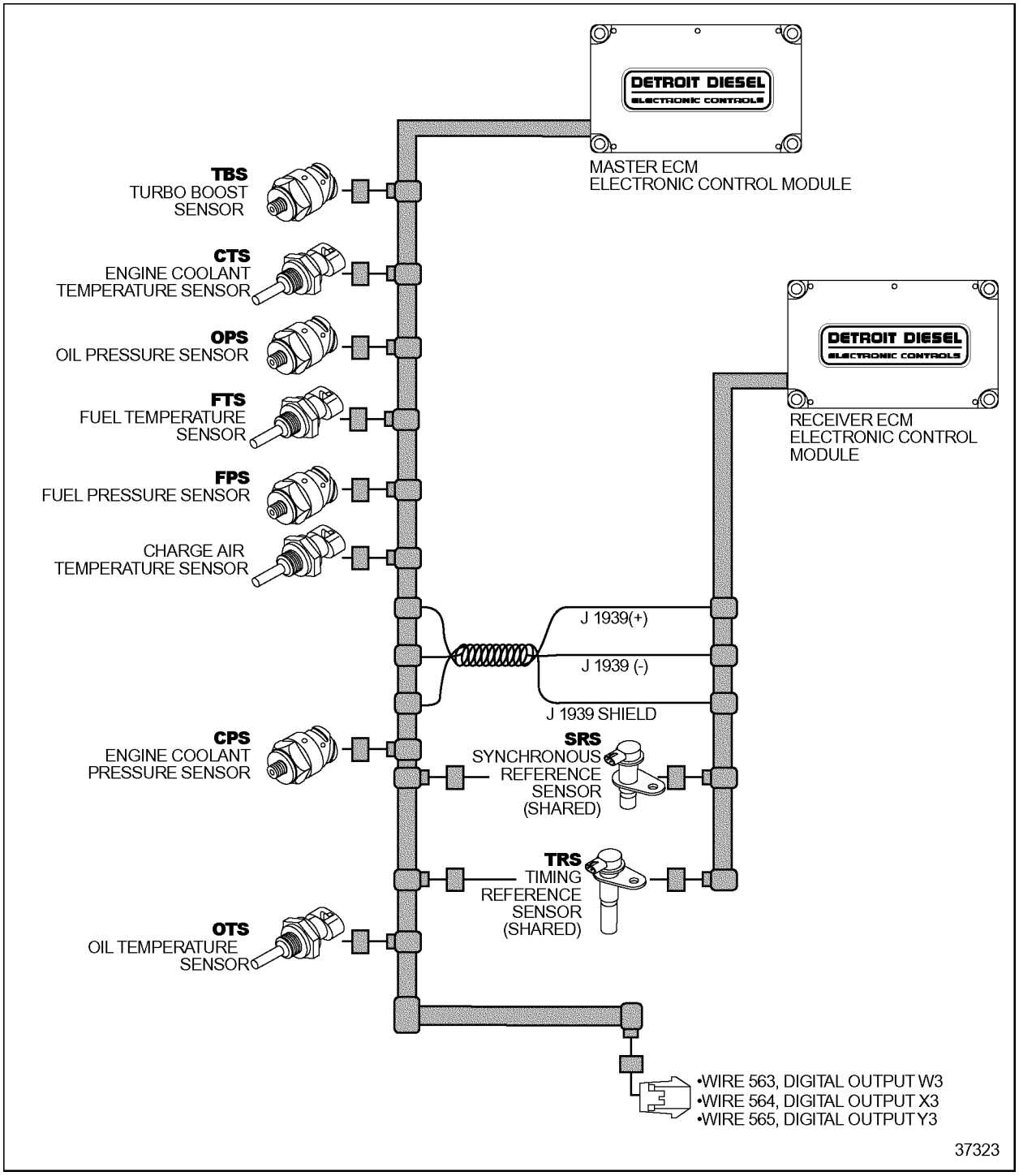

Figure 3-7 A Typical Series 2000 Multi-ECM Engine Sensor Harness

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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.

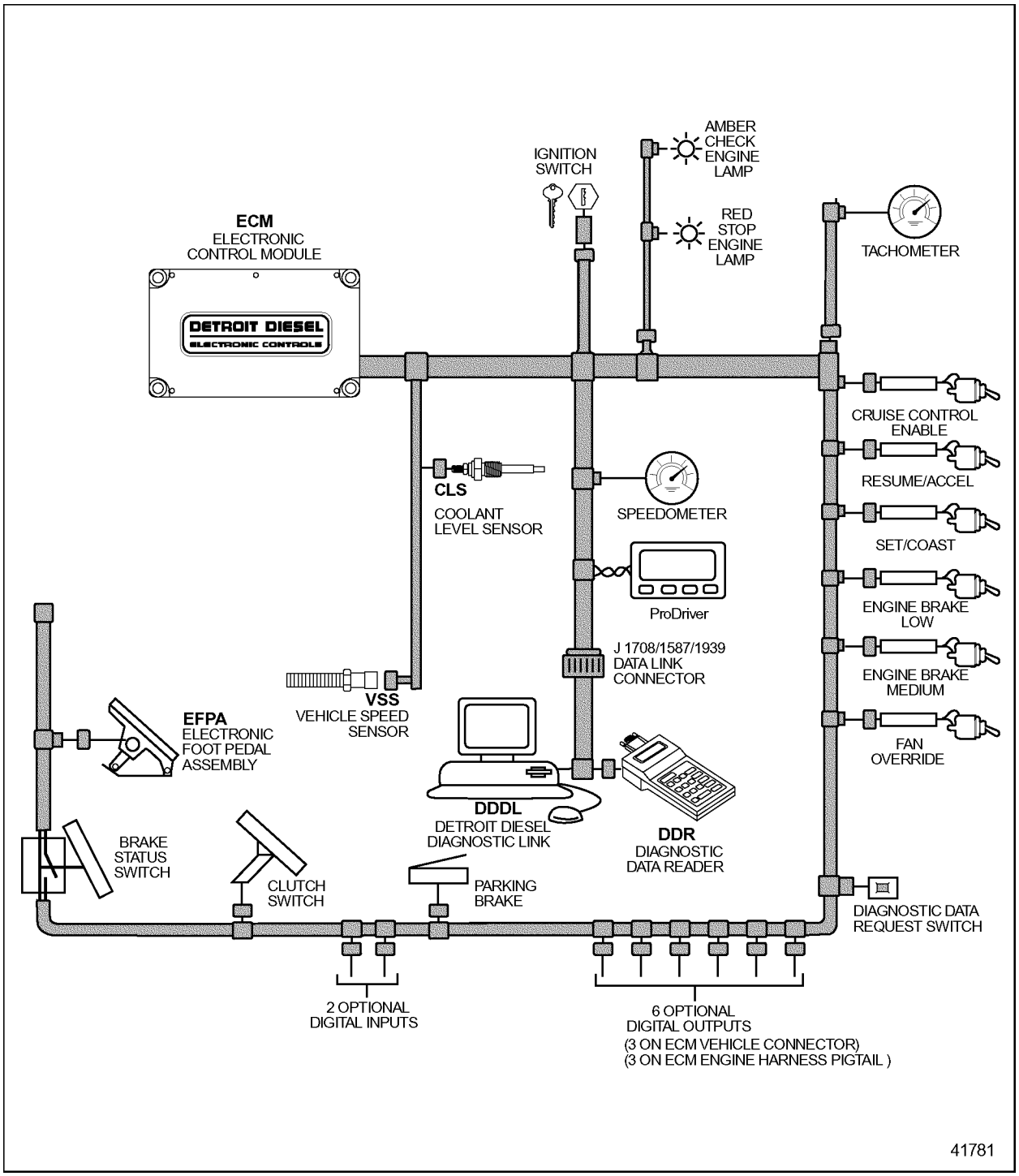

Figure 3-8 Typical On-highway Vehicle Interface Harness

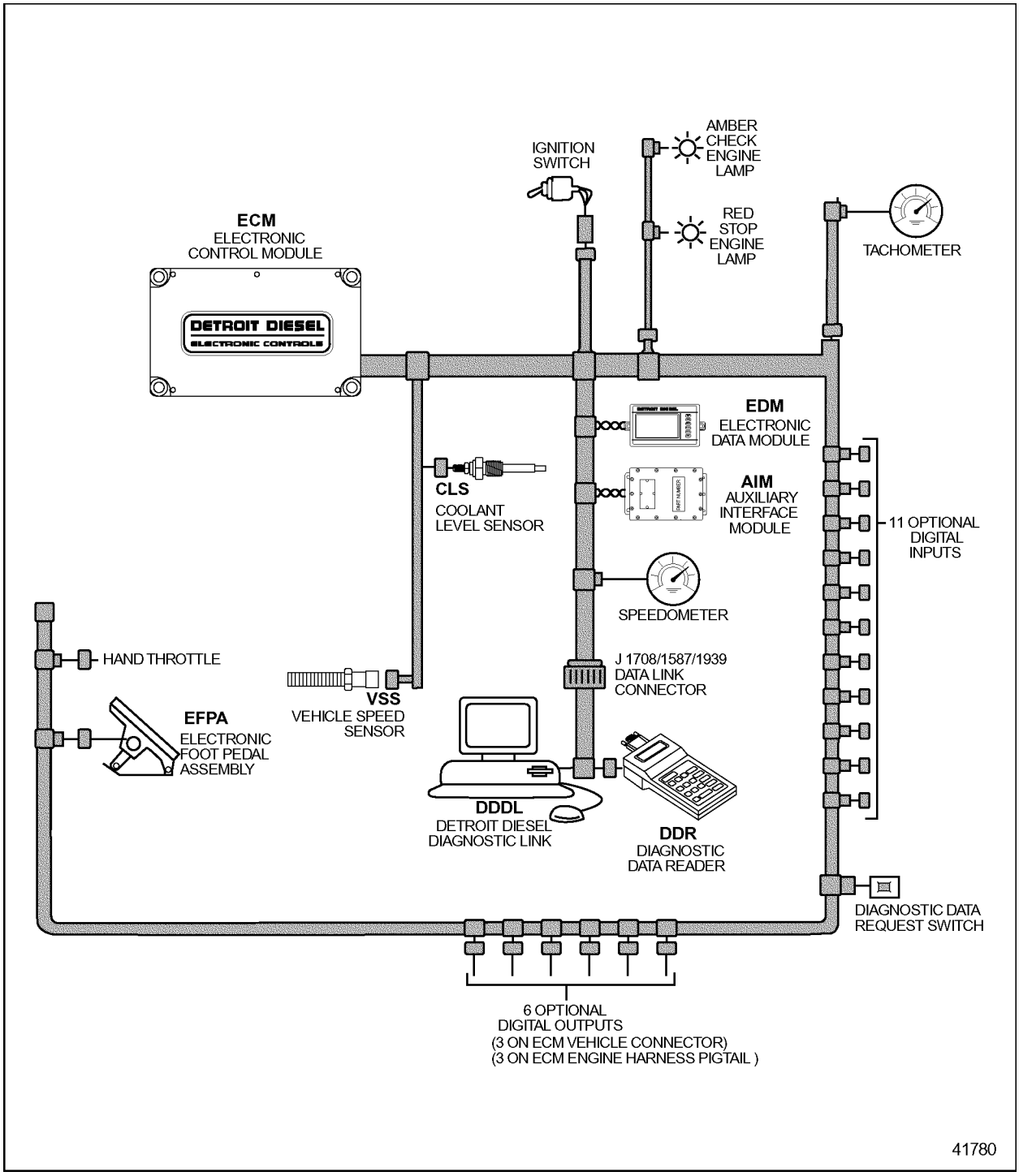

Figure 3-9 Typical Construction and Industrial Vehicle Interface Harness

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.

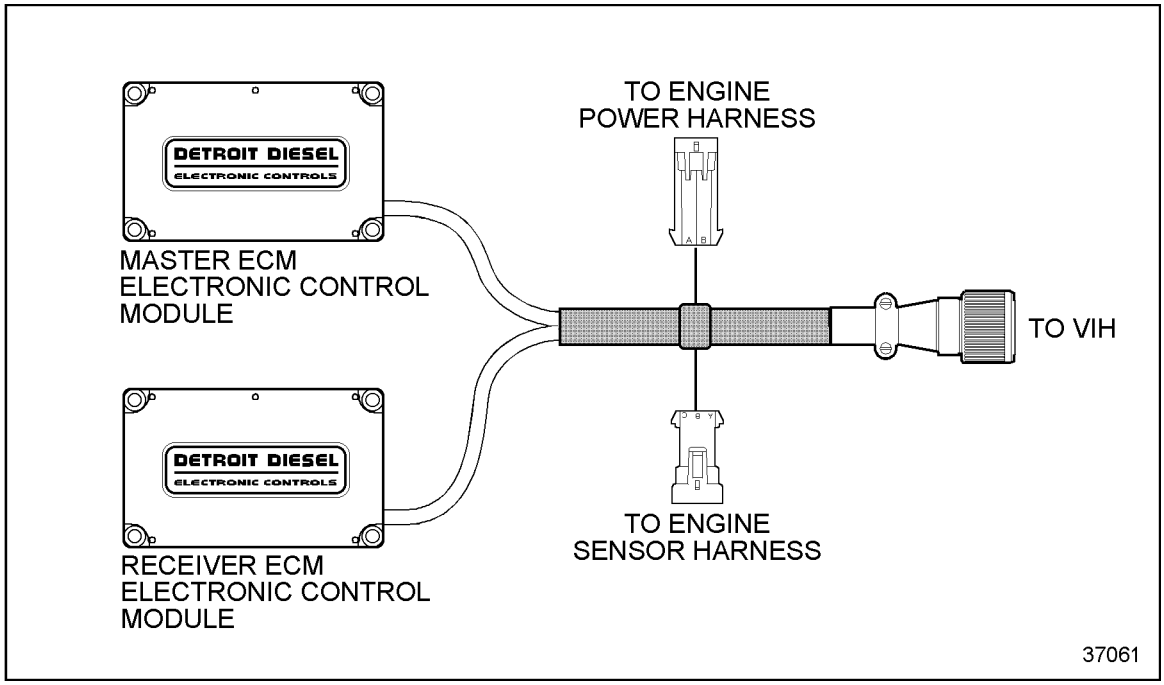

Figure 3-10 A Typical Multi-ECM Engine Interface Harness

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.

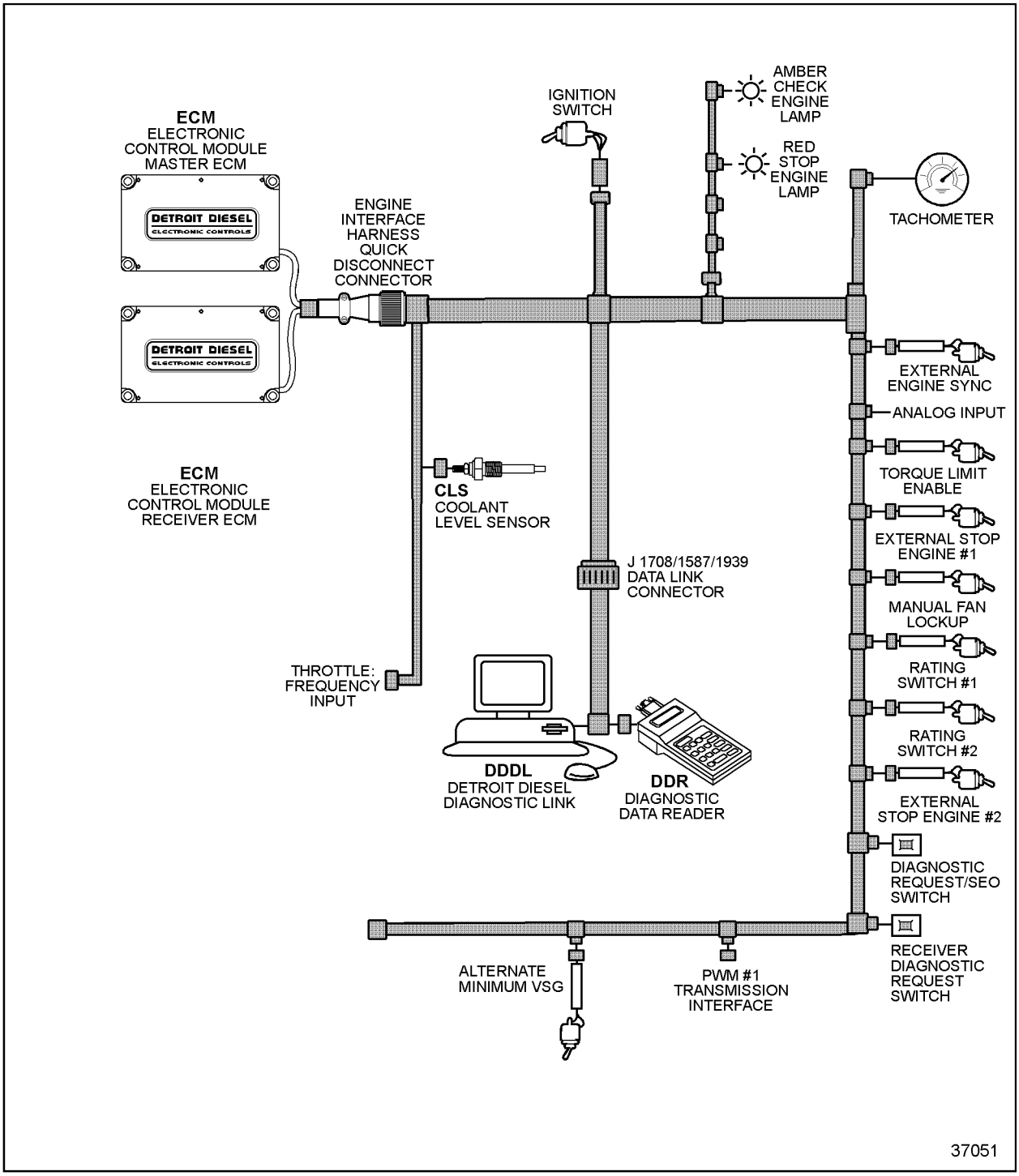

Figure 3-11 Typical Multi-ECM Construction and Industrial Vehicle Interface Harness Schematic - Series 4000

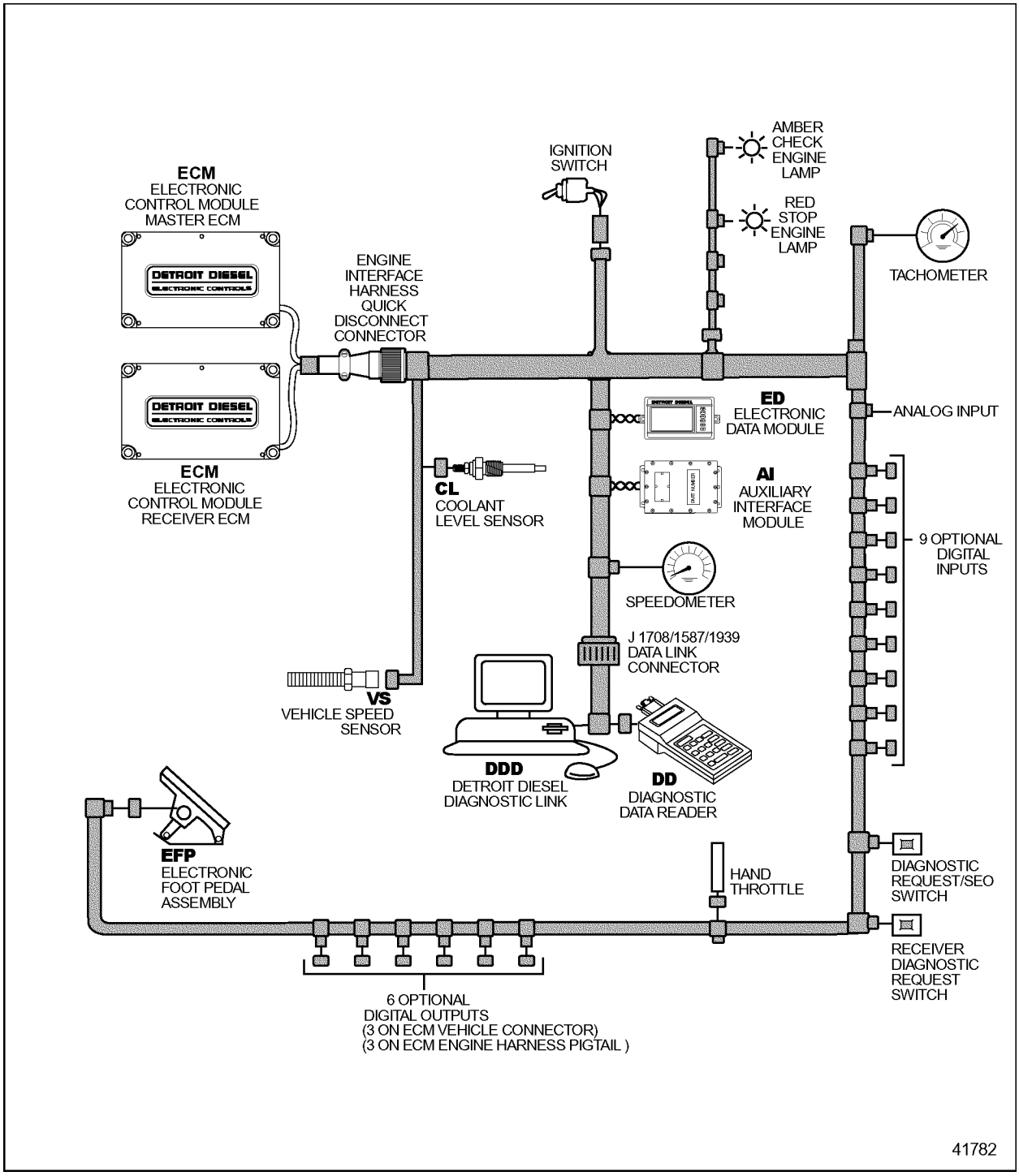

Figure 3-12 Typical Multi ECM Construction and Industrial Vehicle Interface Harness Schematic - Series 2000

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 $0 \leq E_{out} \leq V_{battery.}$

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 $0 \leq E_{out} \leq V_{battery.}$

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.

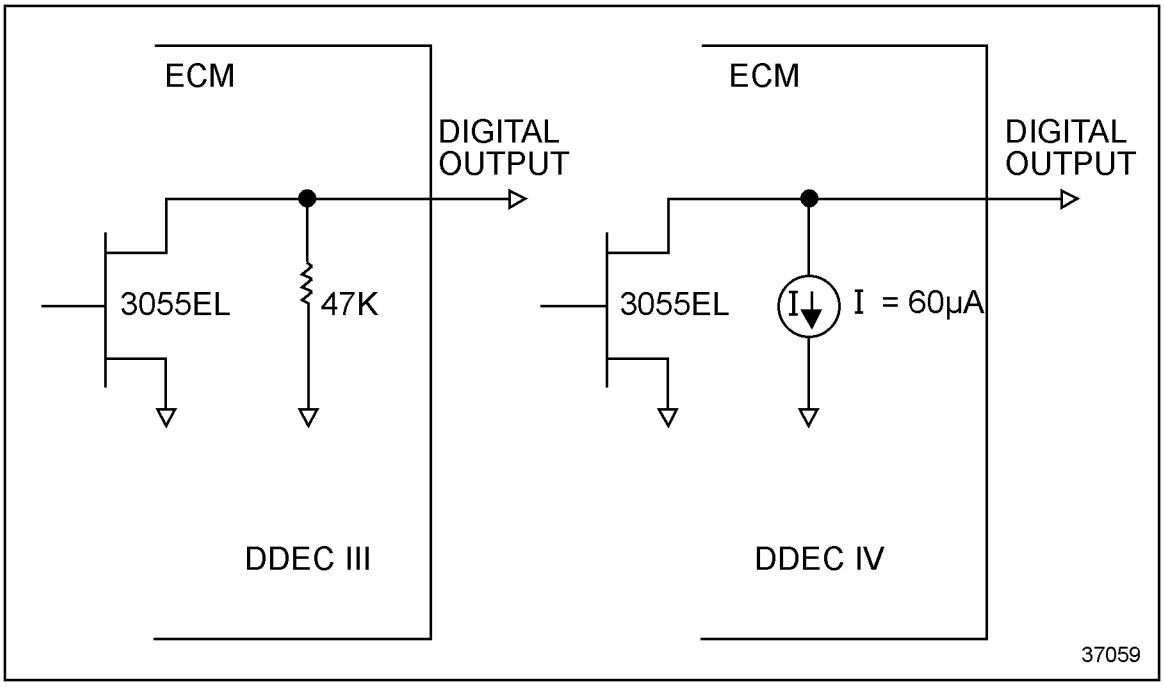

Figure 3-13 DDEC III and DDEC IV Internal Digital Output Circuits

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).

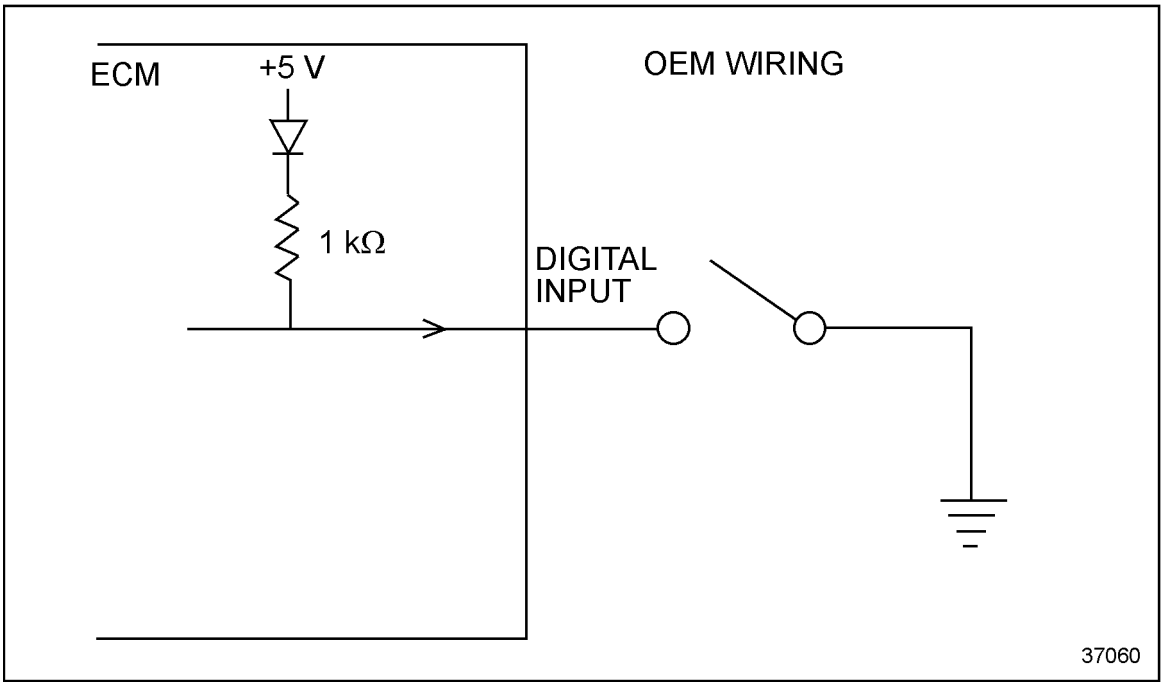

Figure 3-14 DDEC IV Digital Input Circuit

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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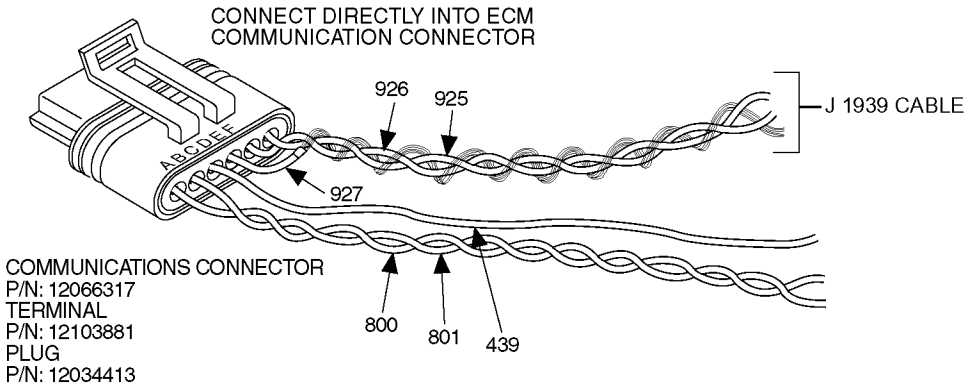
3.5 COMMUNICATION HARNESS

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.

31839

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.

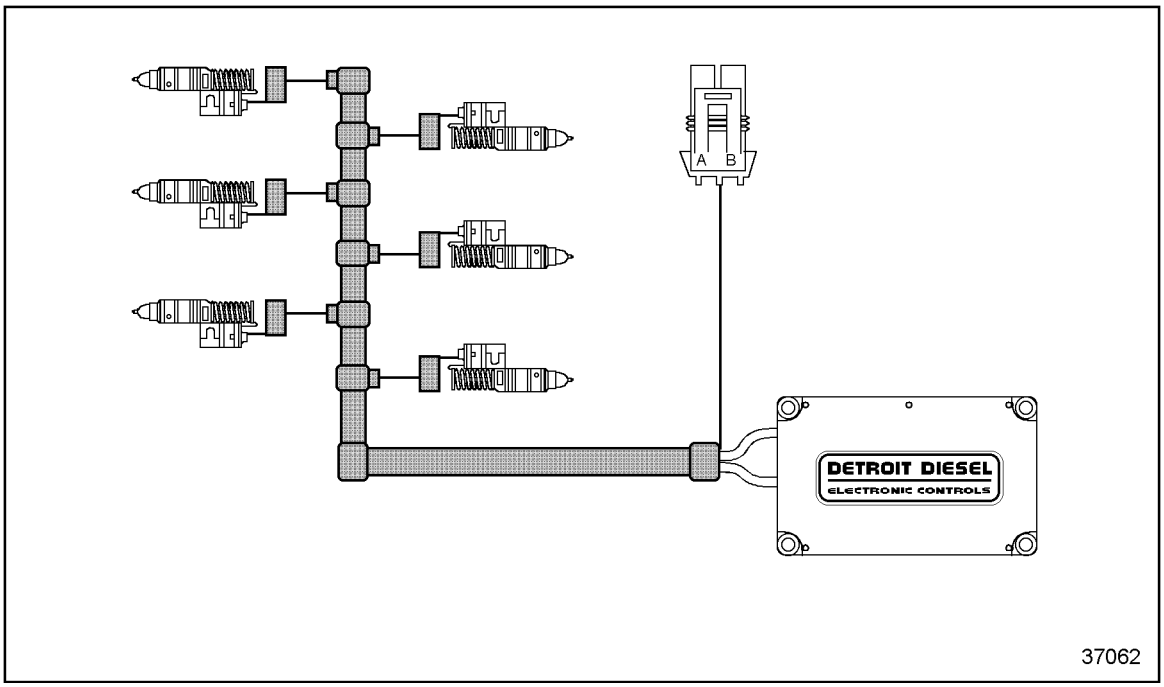


Figure 3-16 Typical On-highway Injector Harness

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.

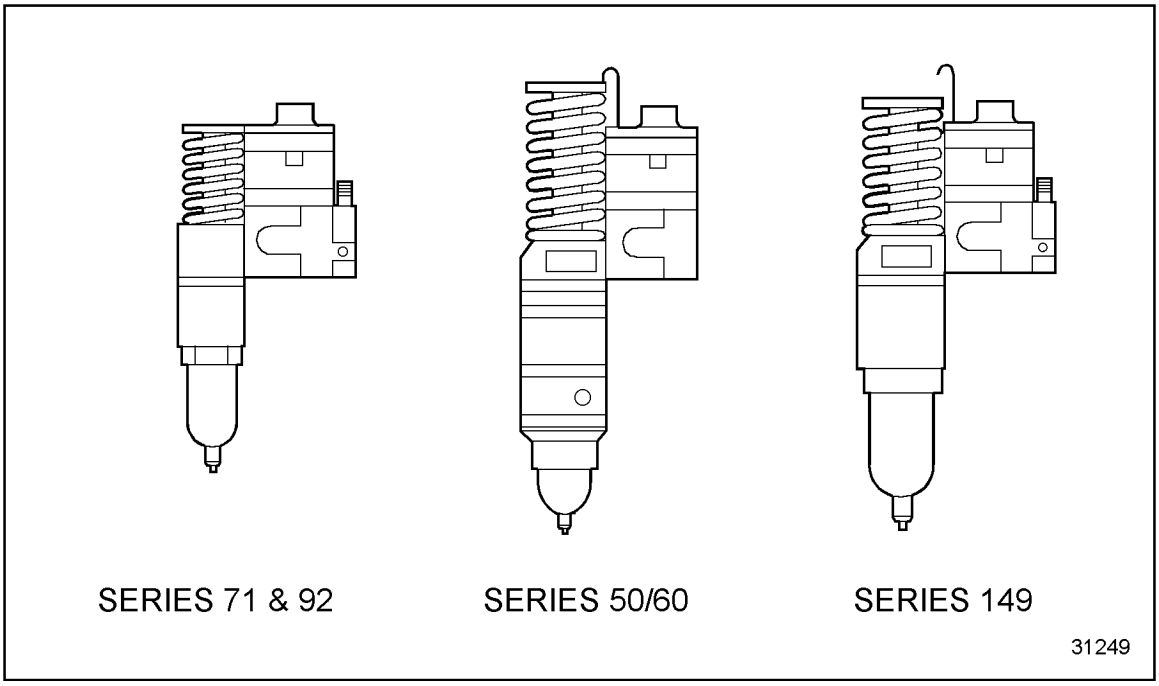


Figure 3-17 The Electronic Unit Injector

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.

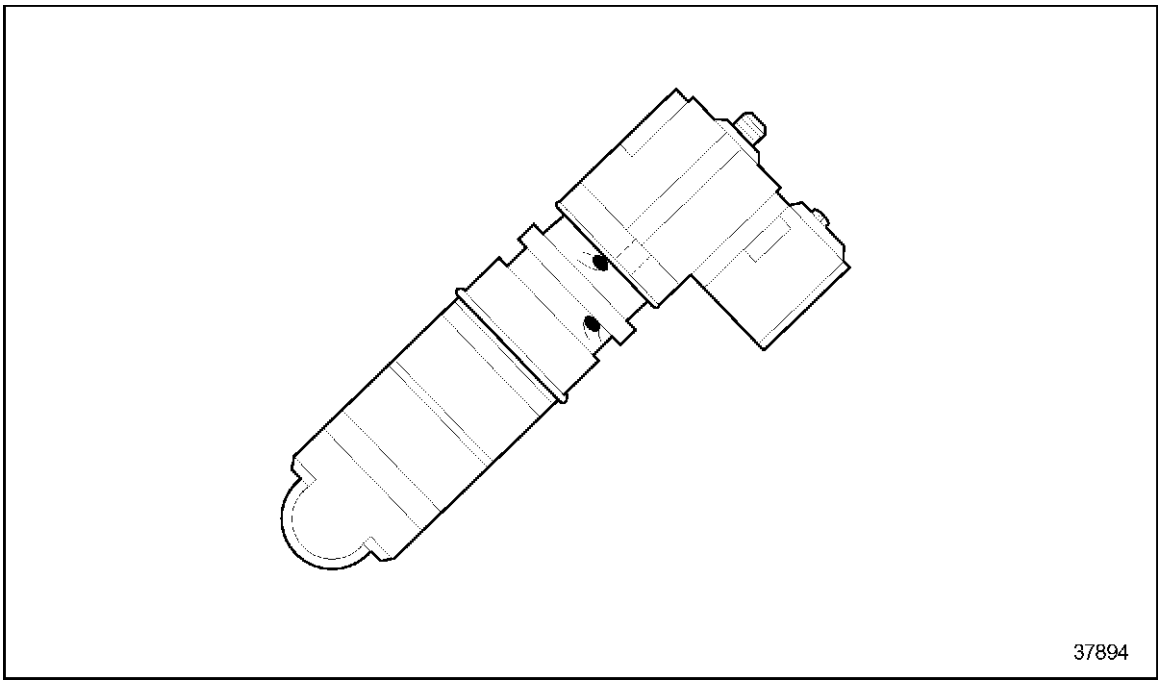


Figure 3-18 Electronic Unit Pump Assembly

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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.

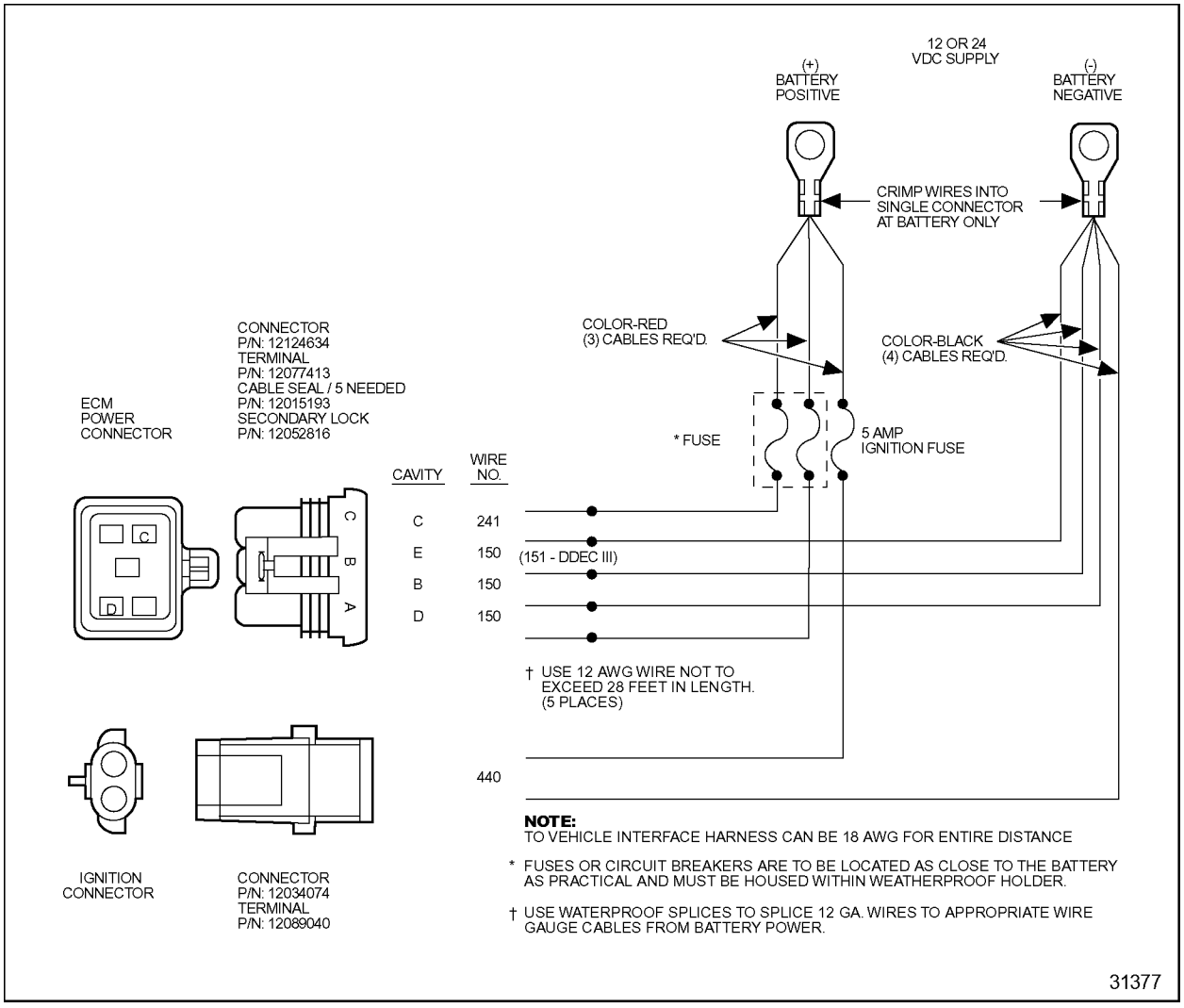

Figure 3-19 Power Harness - Single-ECM, Dual-Fuses

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. (mΩ)	International (mΩ)
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).

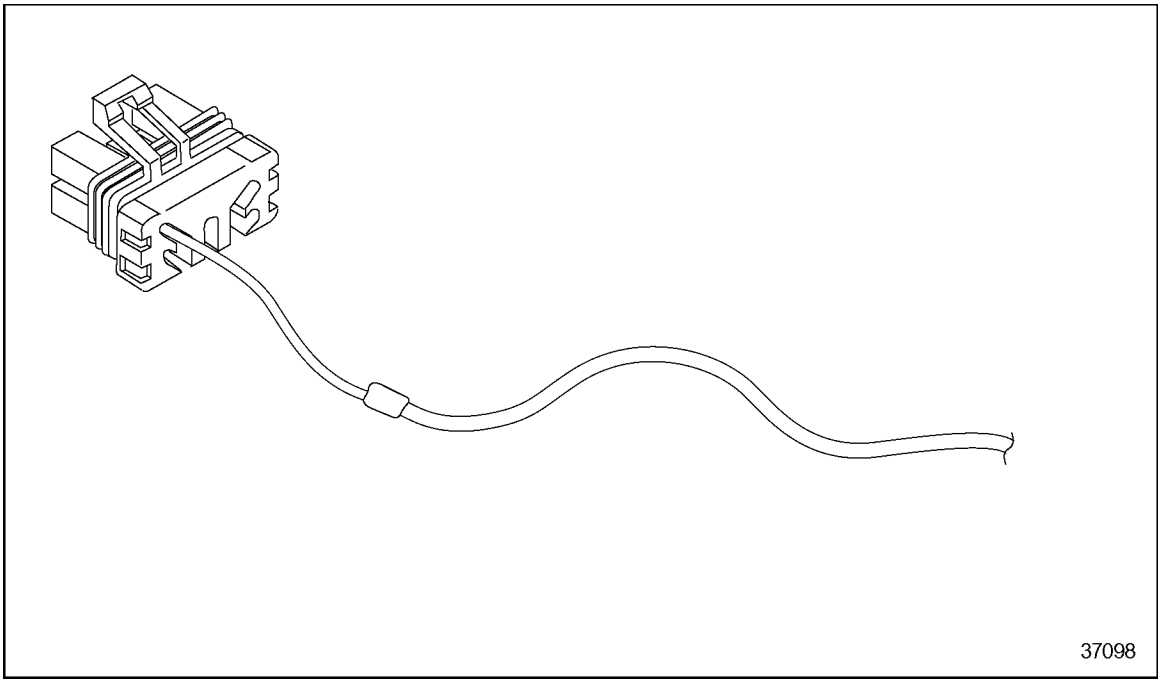

Figure 3-20 Spliced Power Connector Wire

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.

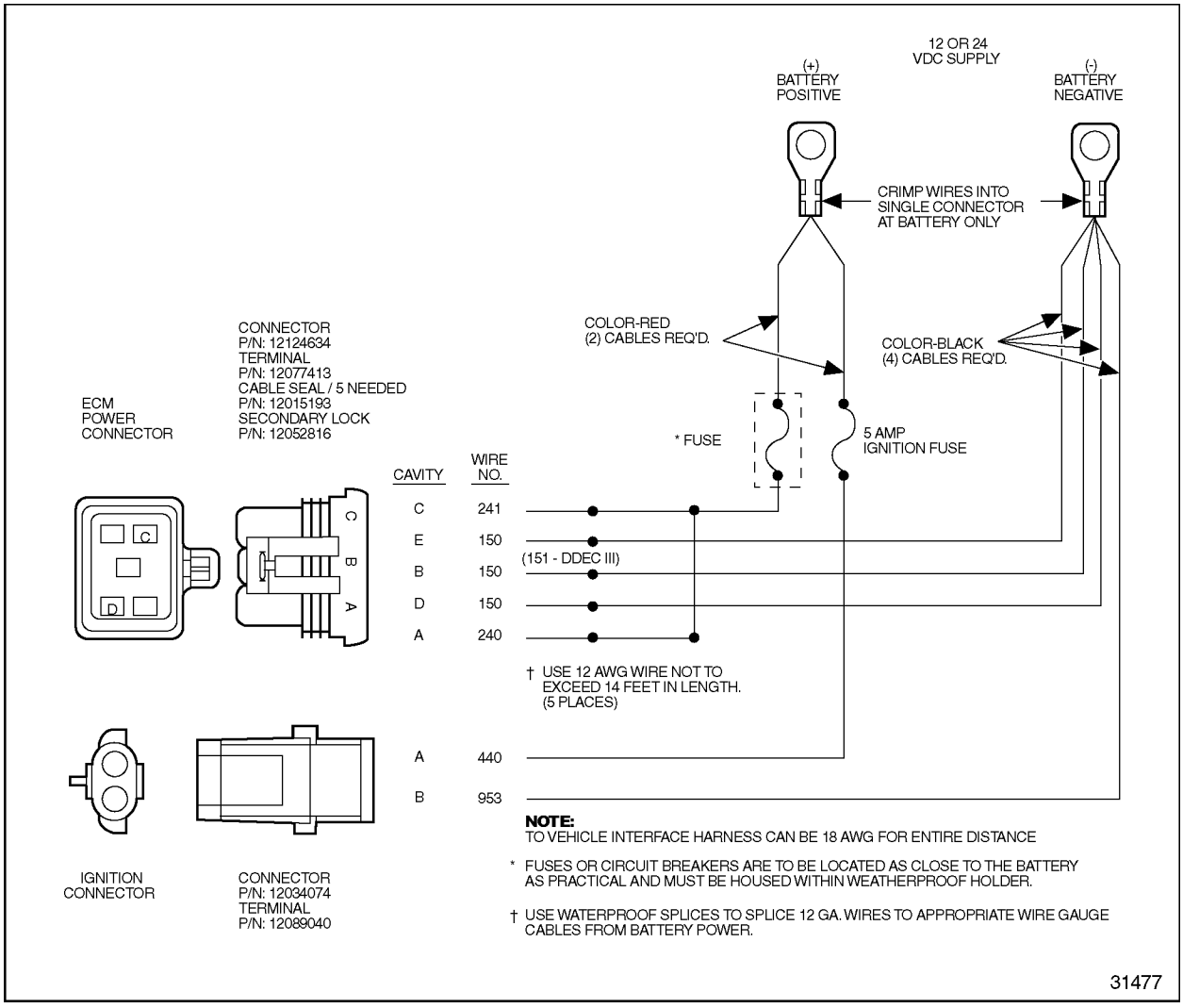

Figure 3-21 Power Harness - Single-ECM, Single-Fuse

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).

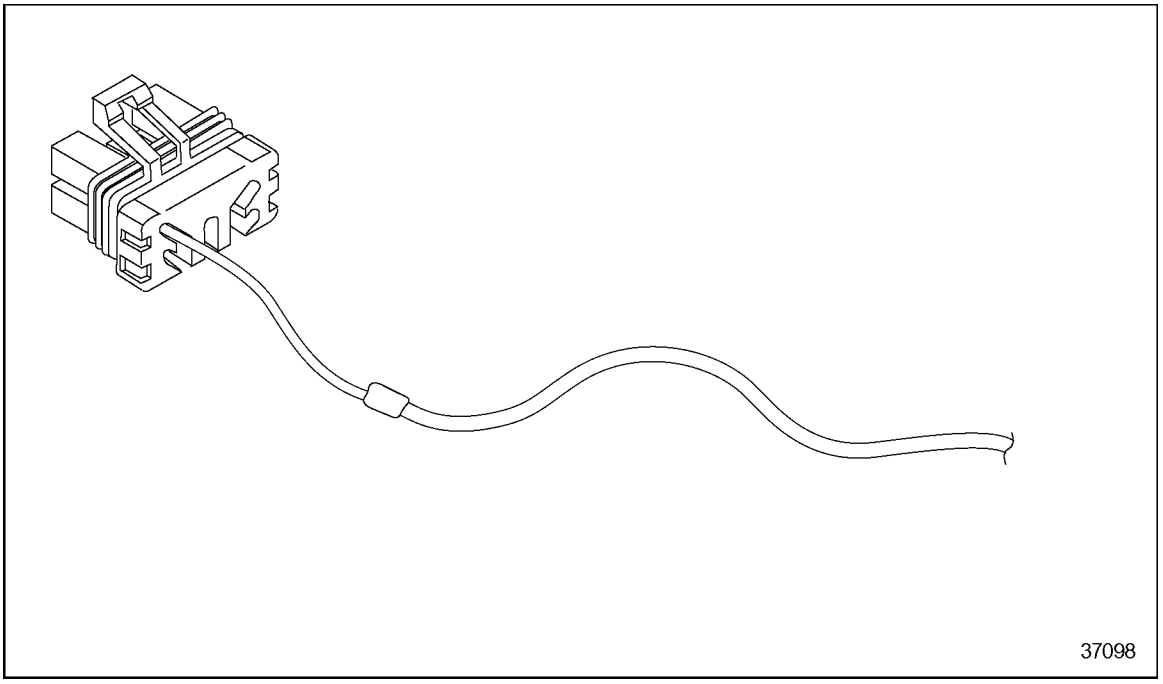

Figure 3-22 Spliced Power Connector Wire

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.

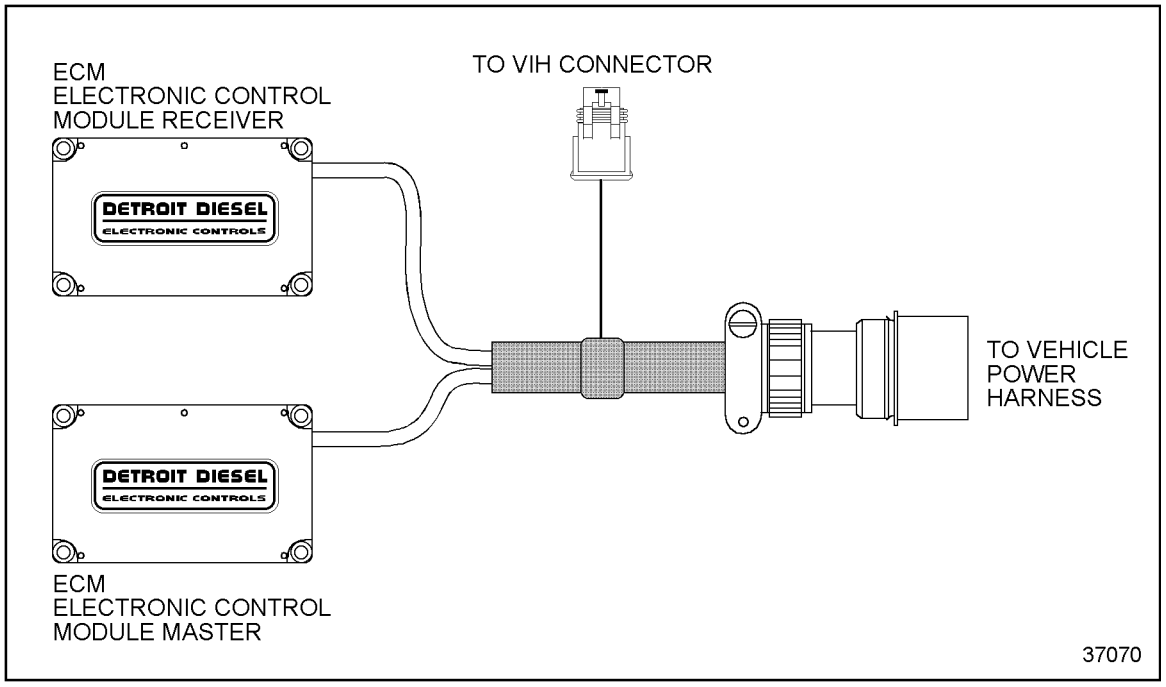

Figure 3-23 The Multi-ECM Engine Power Harness

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.

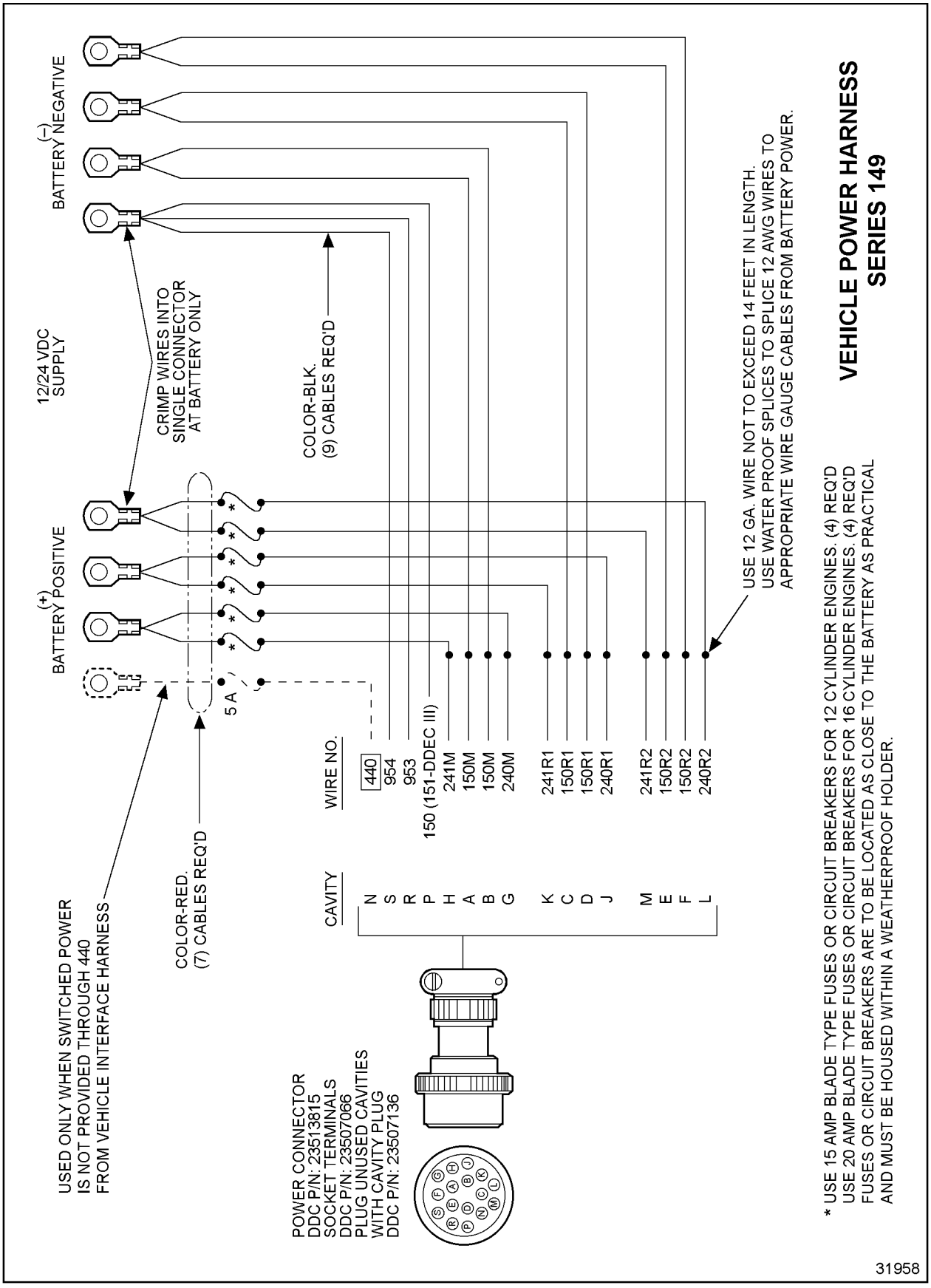

Figure 3-24 Series 149 Vehicle Power Harness

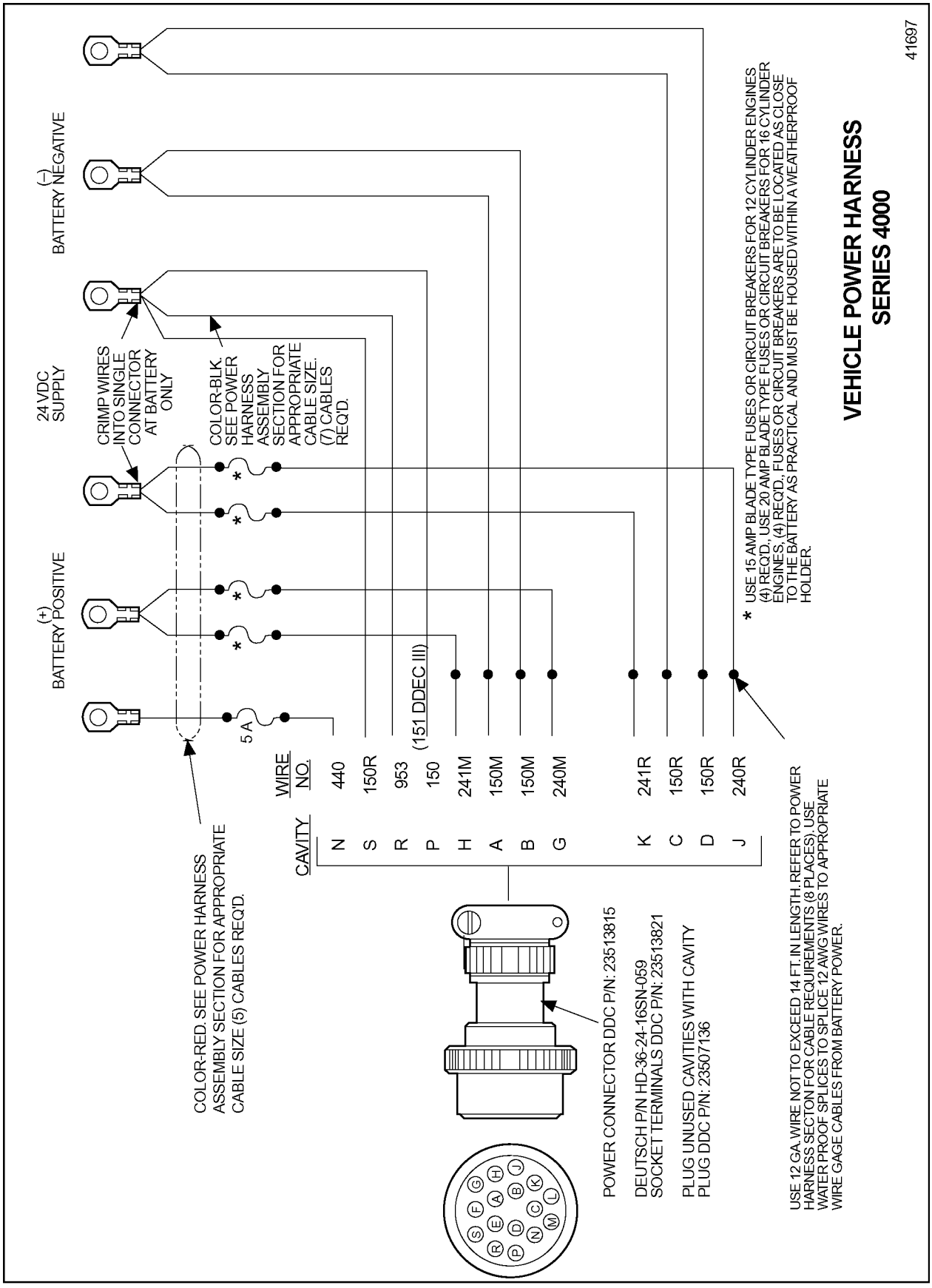

Figure 3-25 Series 4000 Vehicle Power Harness

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).

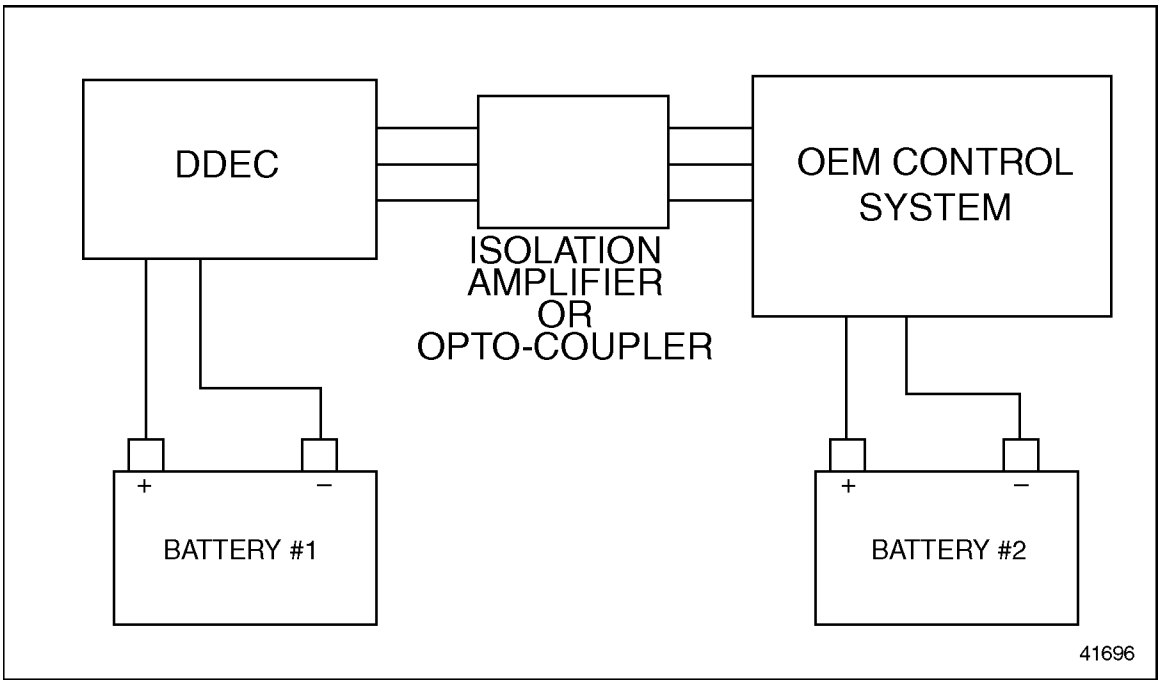

Figure 3-26 DDEC Circuit Isolated Using an Isolation Amplifier

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

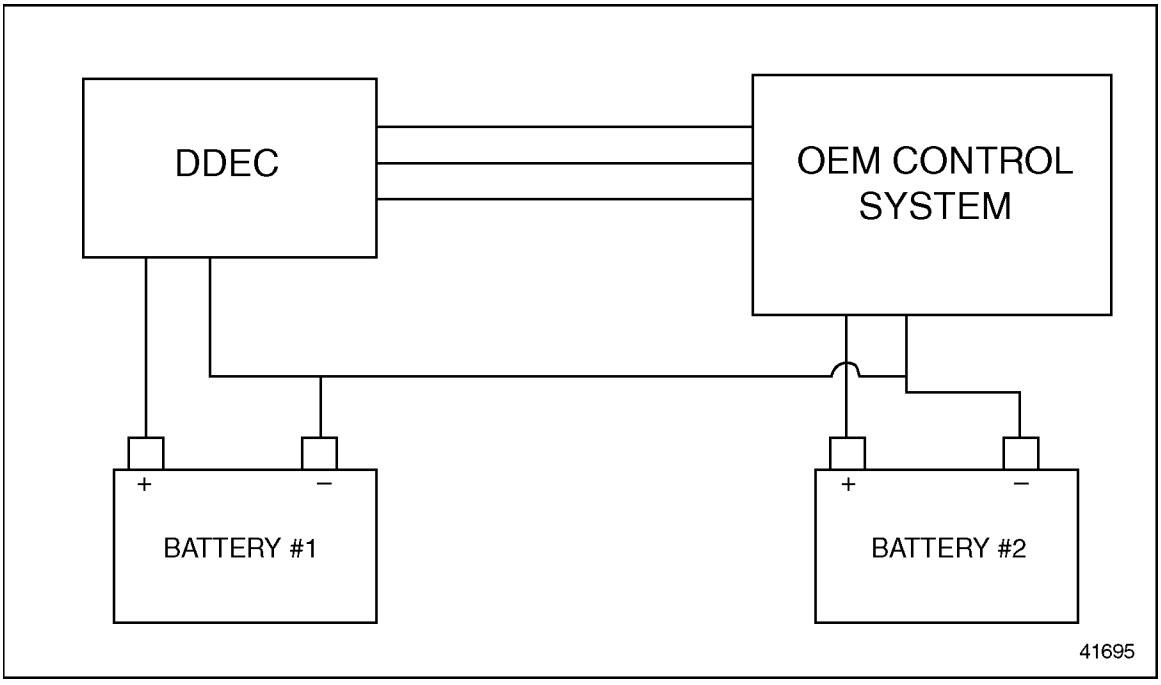

Figure 3-27 Battery System Grounds Connected Using a High Ampacity Cable

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.

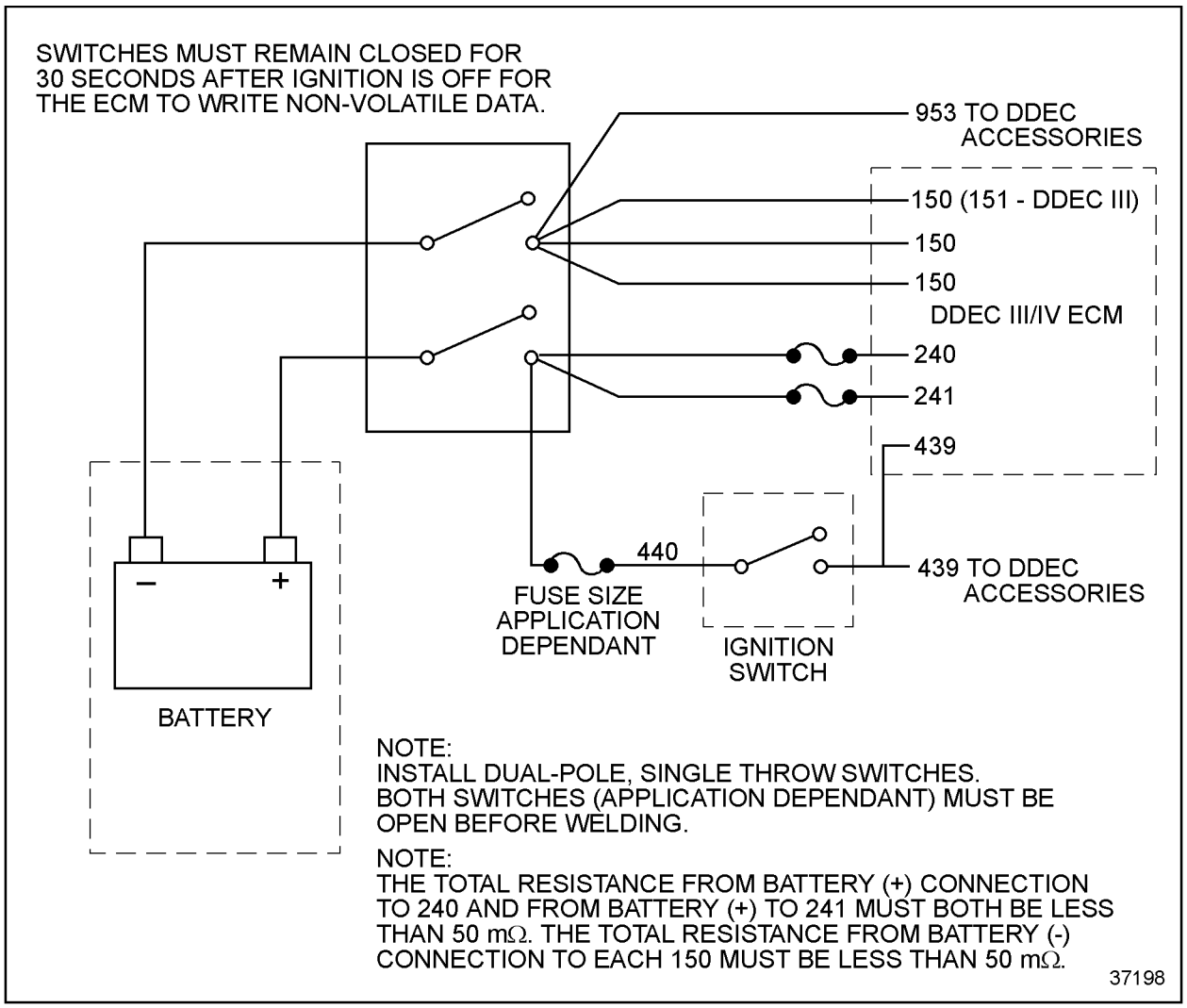

Figure 3-28 Main Power Supply Shutdown 12 or 24 Volt Systems

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).

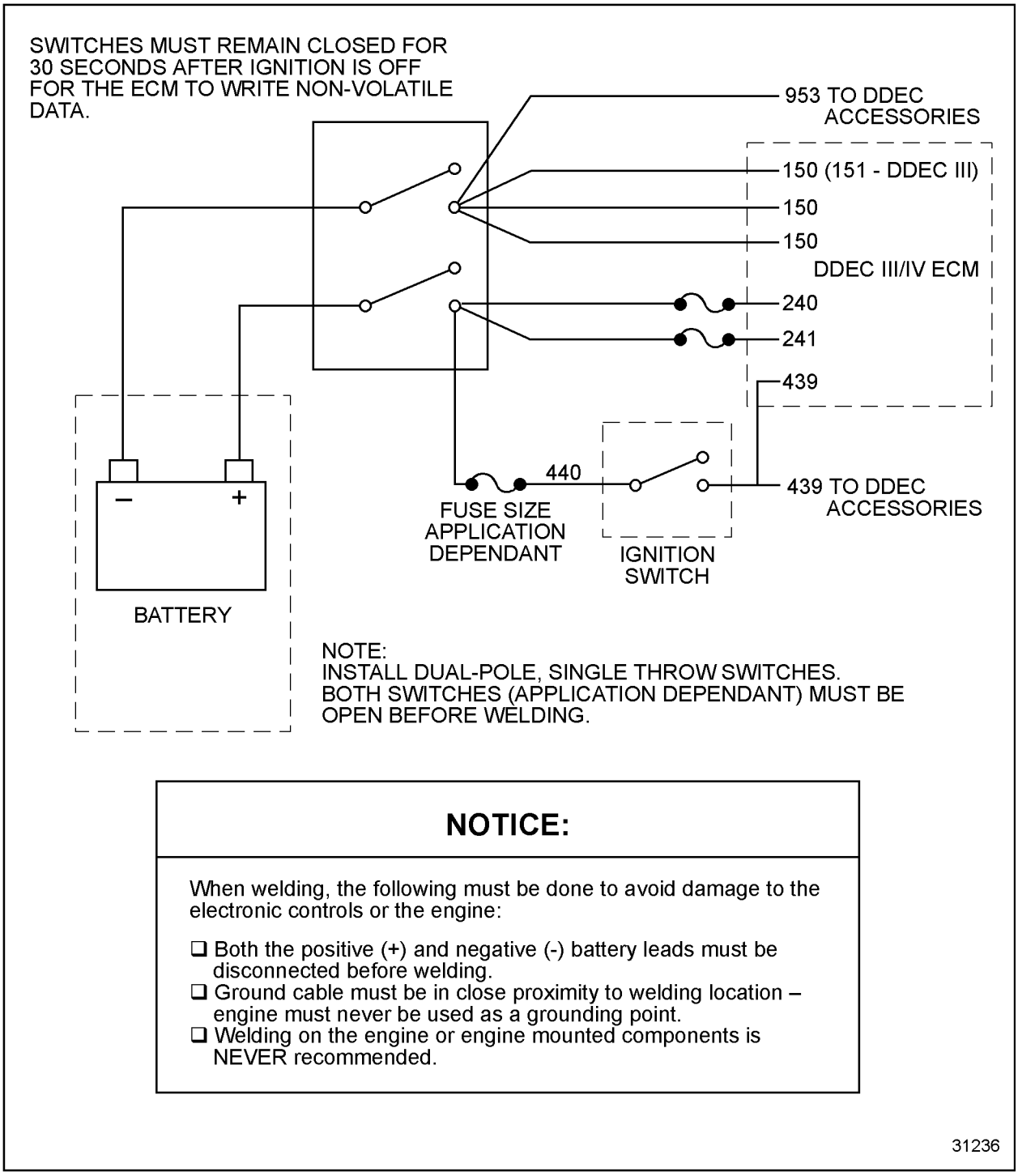

Figure 3-29 Welding Precaution

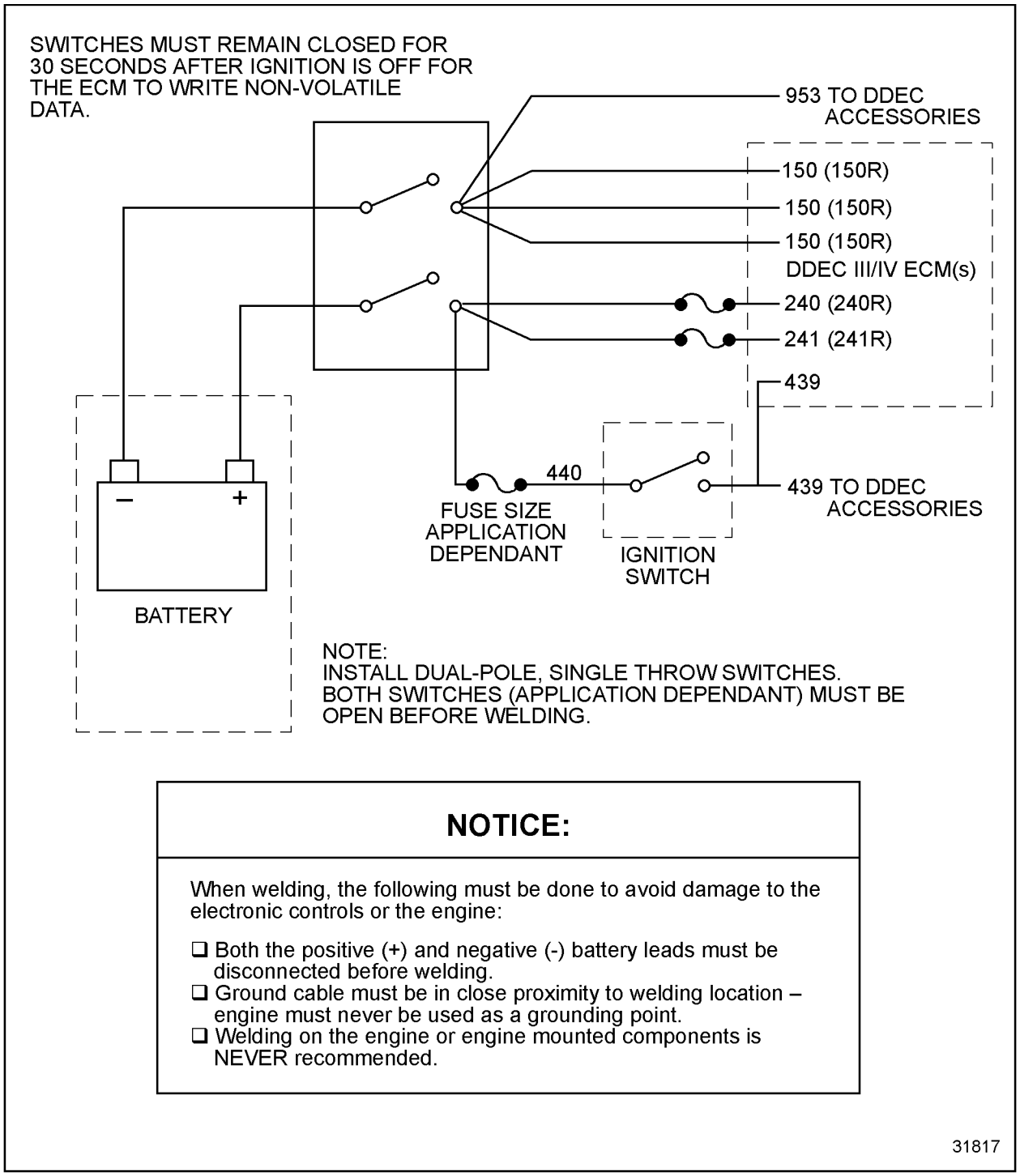

Figure 3-30 Welding Precaution - Multi-ECMs

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).

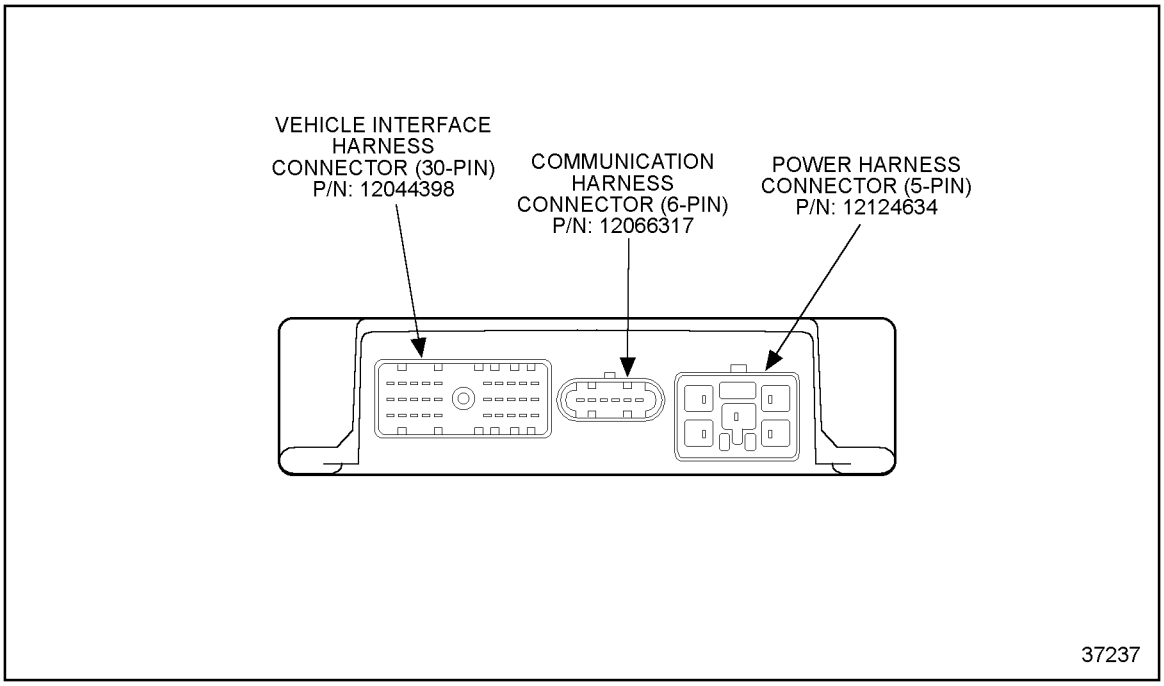

Figure 3-31 ECM Right Side, Vehicle Harness Connections

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.

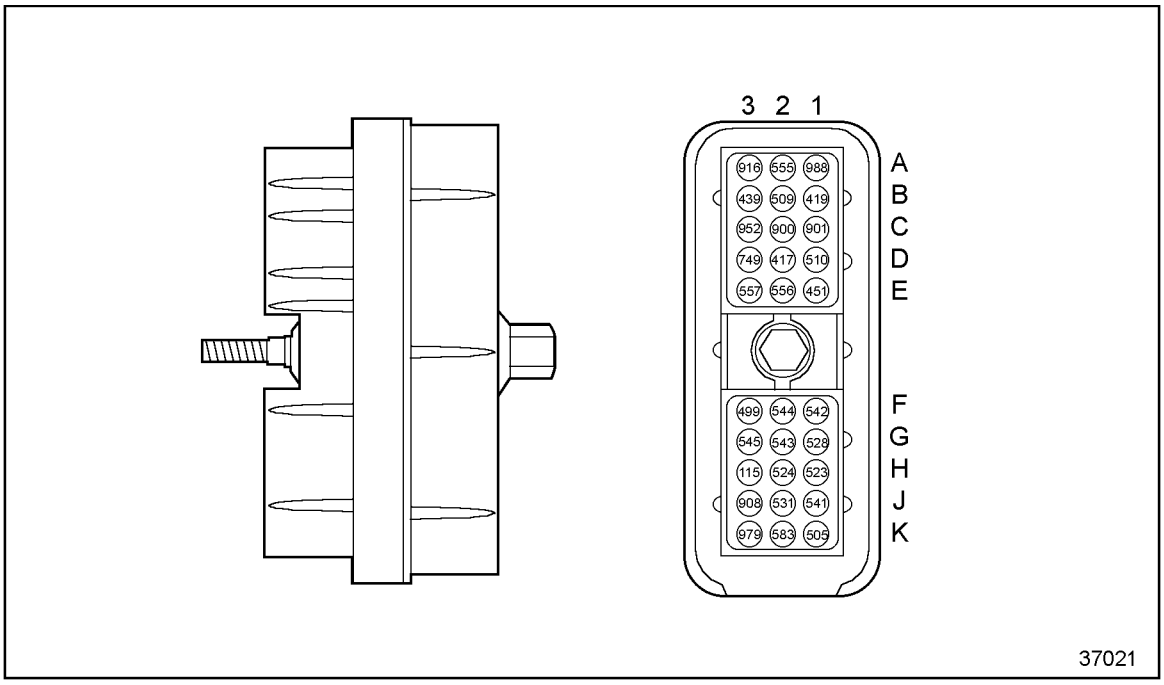

Figure 3-32 VIH-to-ECM Connector

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	
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	

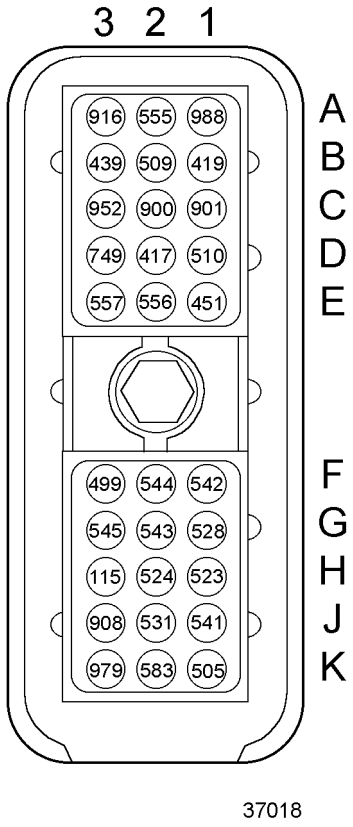

Table 3-24 Typical VIH-to-ECM Connector Pin Definitions

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.

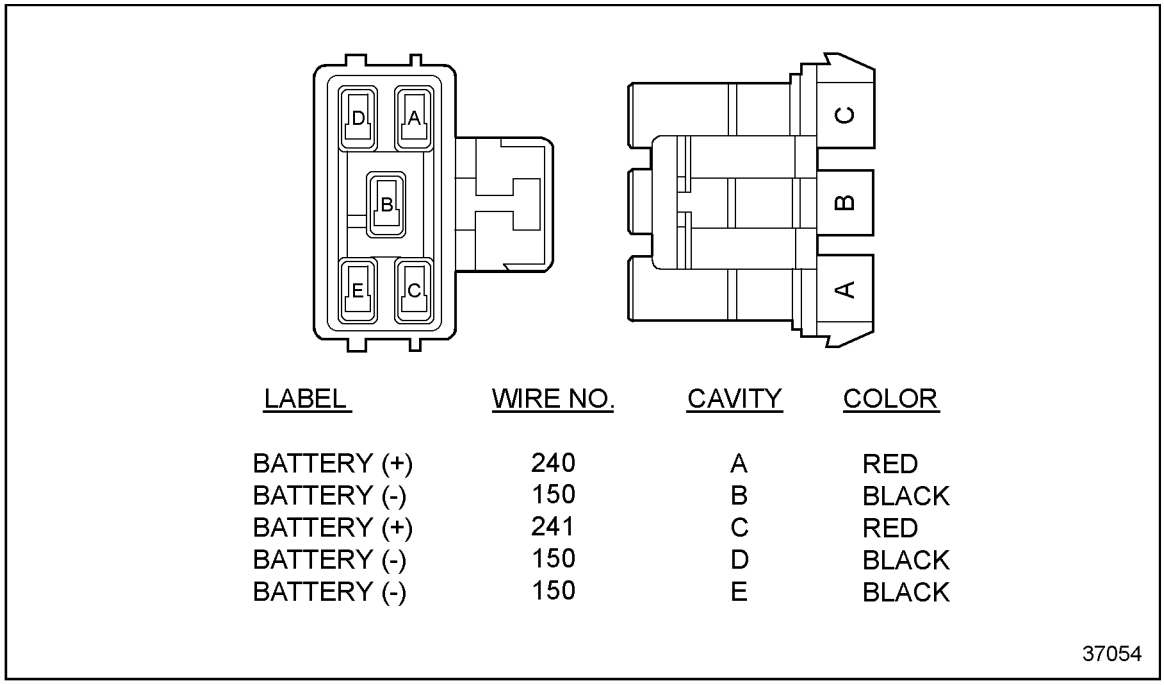

Figure 3-33 Five-Pin Power Harness Connector

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.

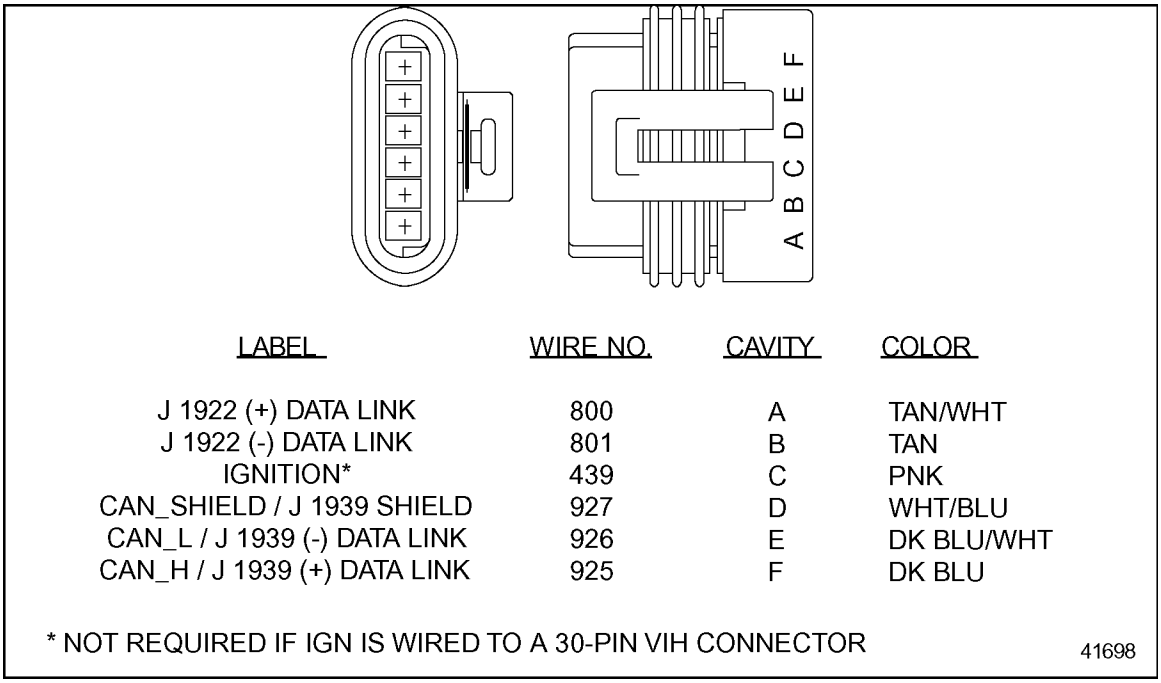

Figure 3-34 Communication Harness Connector

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			

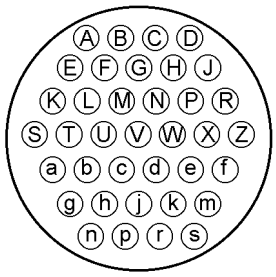

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Table 3-26 Recommended Interface Harness Connector Pin Definitions - Series 4000 and Series 149

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

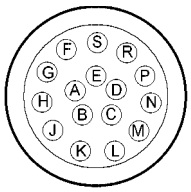

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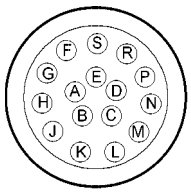
Table 3-27 Series 4000 - Recommended Vehicle Power Harness Connector Pin Definitions

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



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* 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).

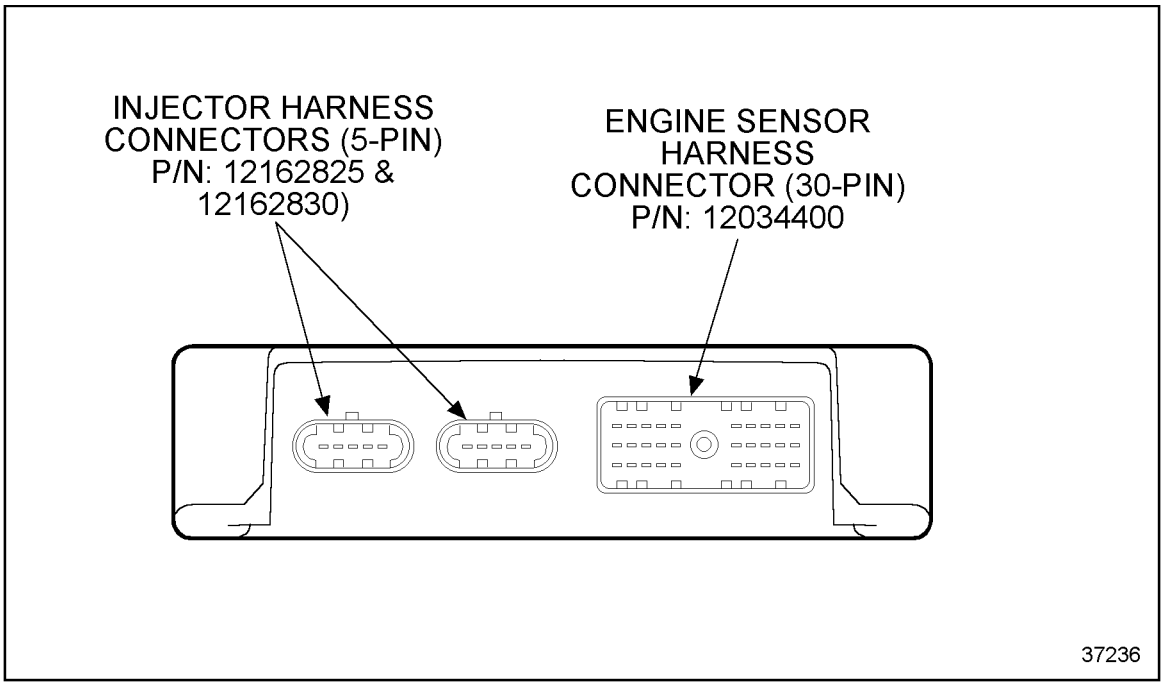


Figure 3-35 ECM Left Side, Engine Harness Connections

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.

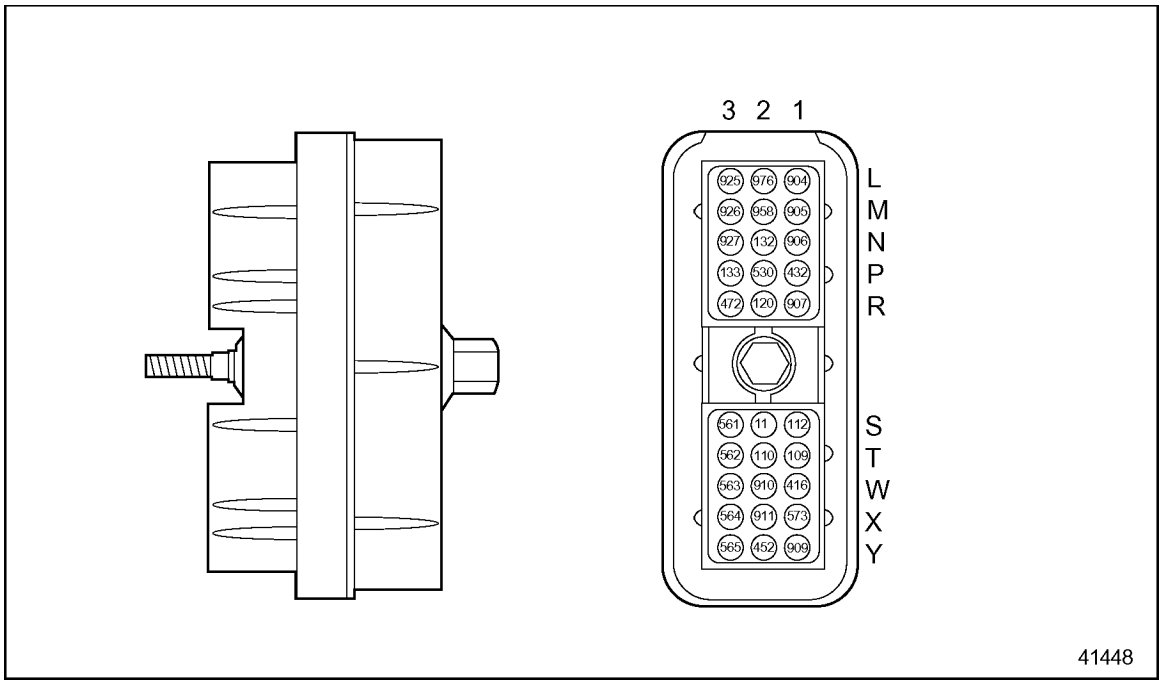


Figure 3-36 ESH-to-ECM Connector

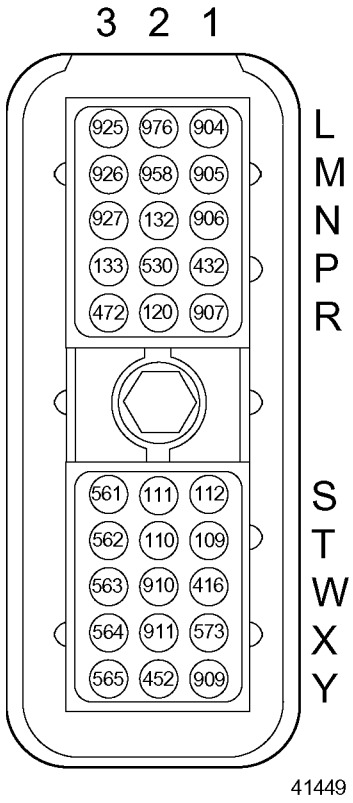
The 30-pin ESH-to-ECM connector, listed in Table 3-29, is a Metri-Pack 150 series pull-to-seat connector.

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.).

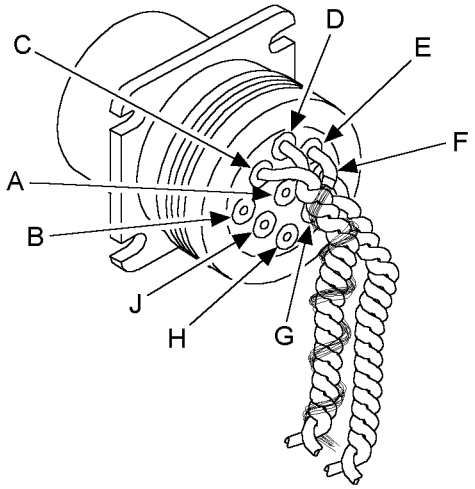
SAE J1939/J1587 Data Link Nine-pin Connector (Recommended)

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).

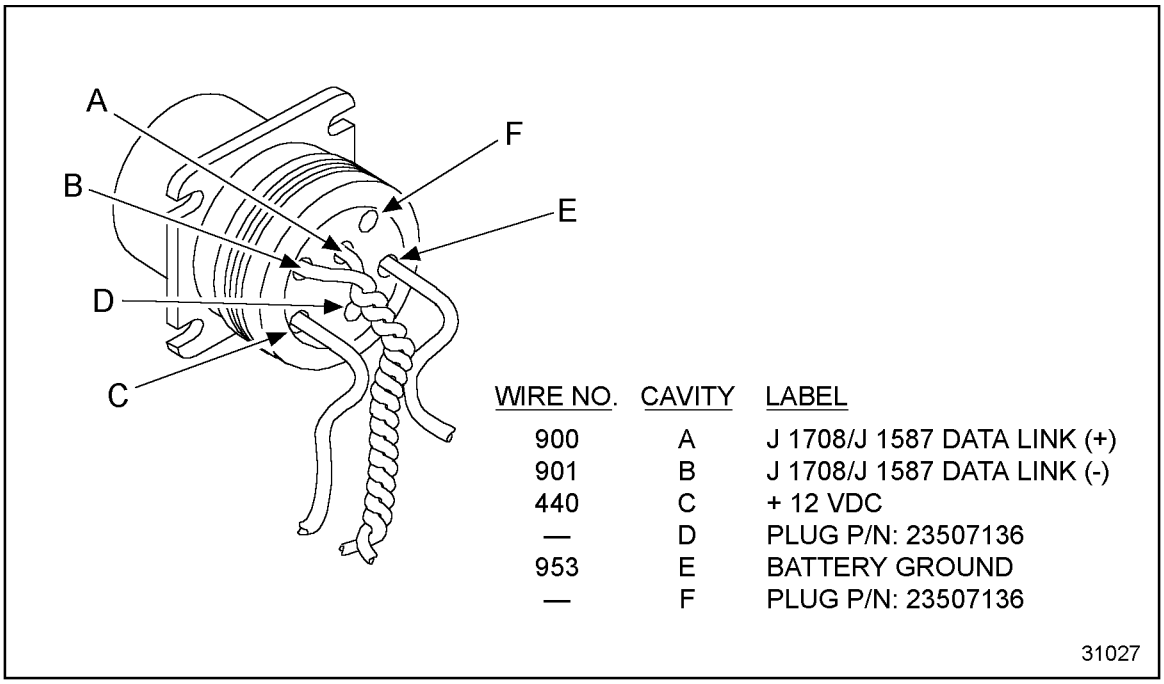

Figure 3-38 Wiring for Six-pin Data Link Connector

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 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 3-33 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).

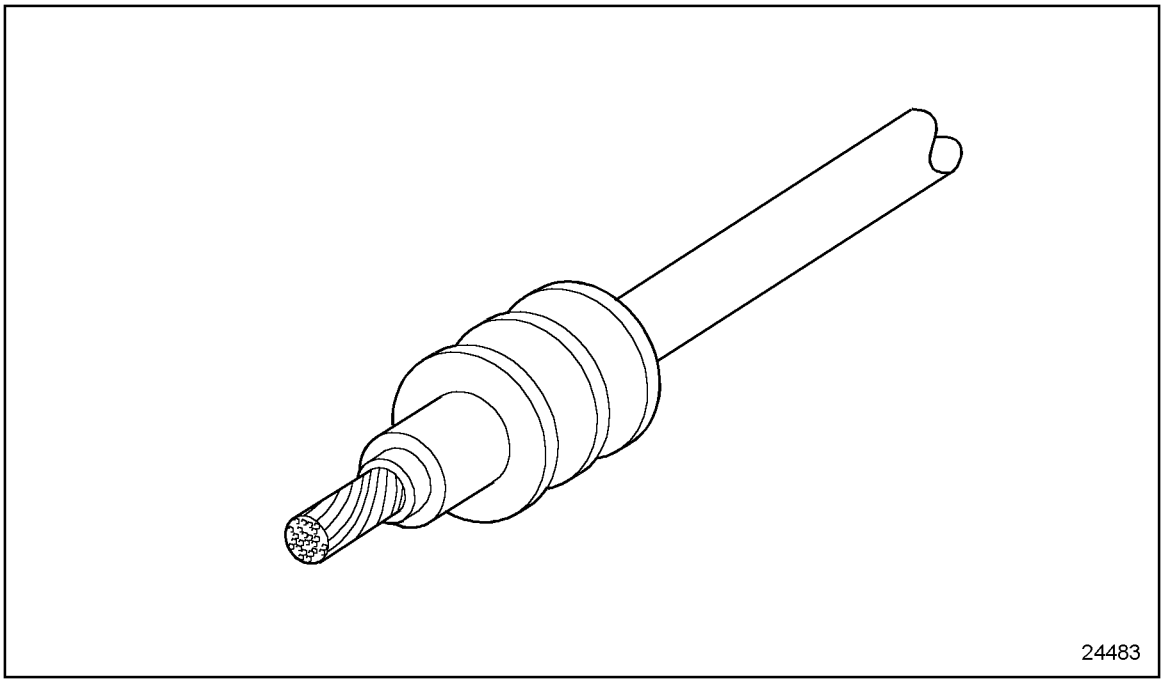


Figure 3-39 Seal Positioning

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).

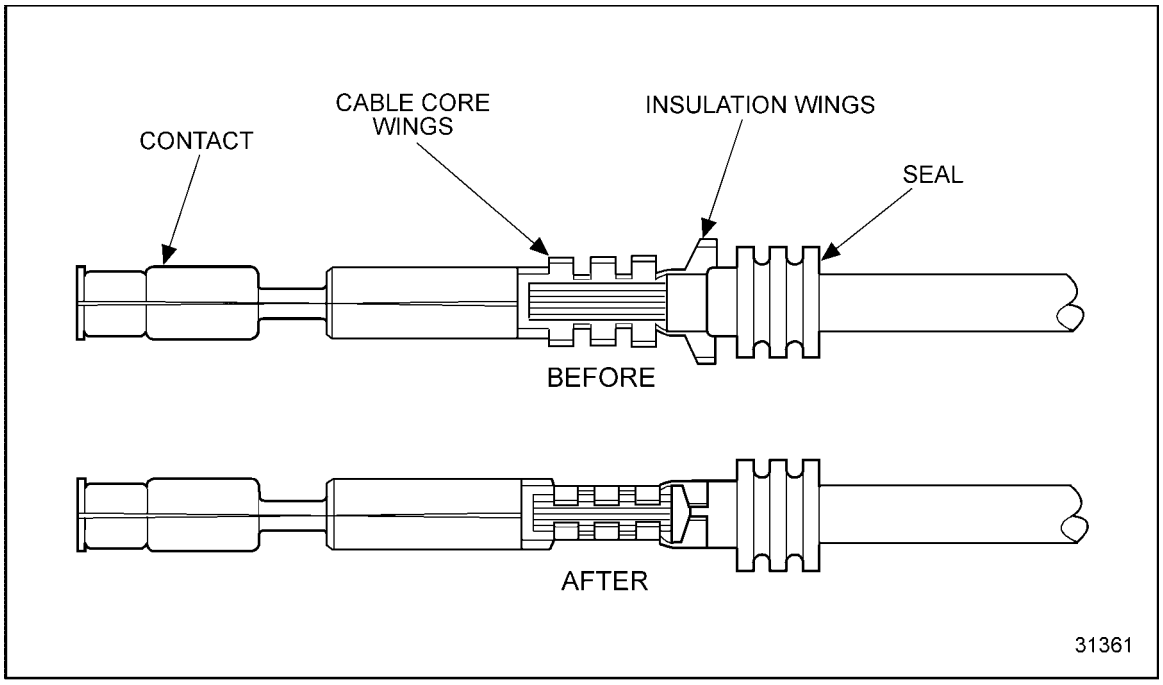


Figure 3-40 Terminal Installation (Shown with a Seal)

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.

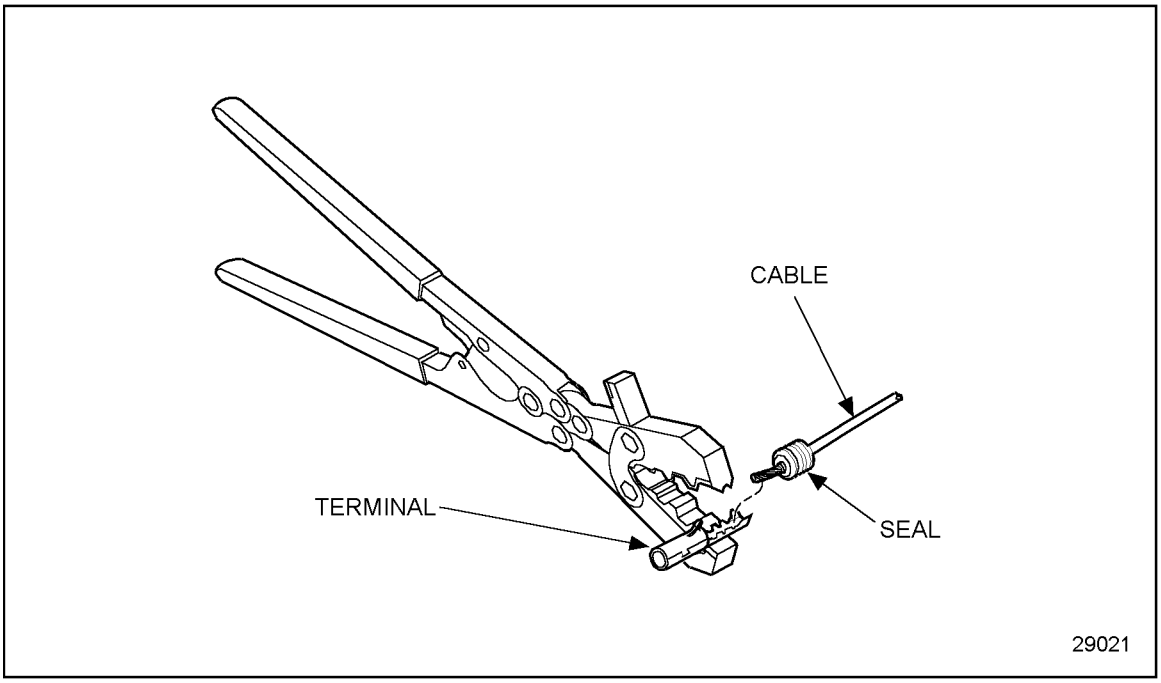


Figure 3-41 Terminal Position (Shown With a Seal)

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.

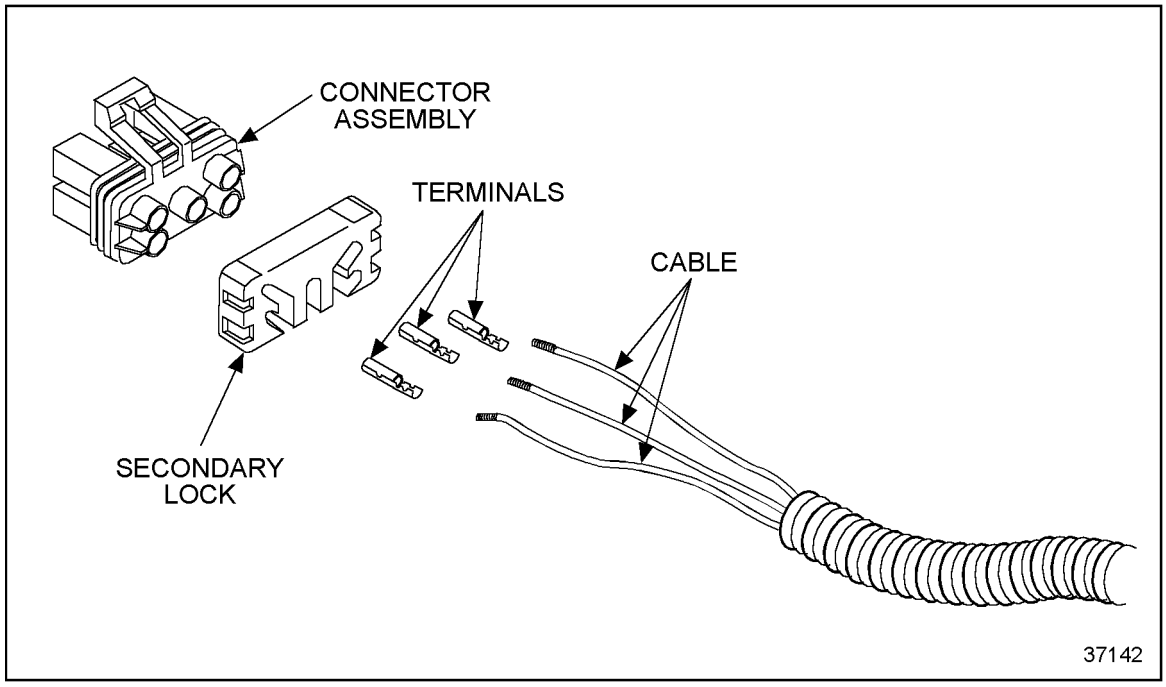


Figure 3-42 Typical Push-to-Seat Terminal Installation

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.

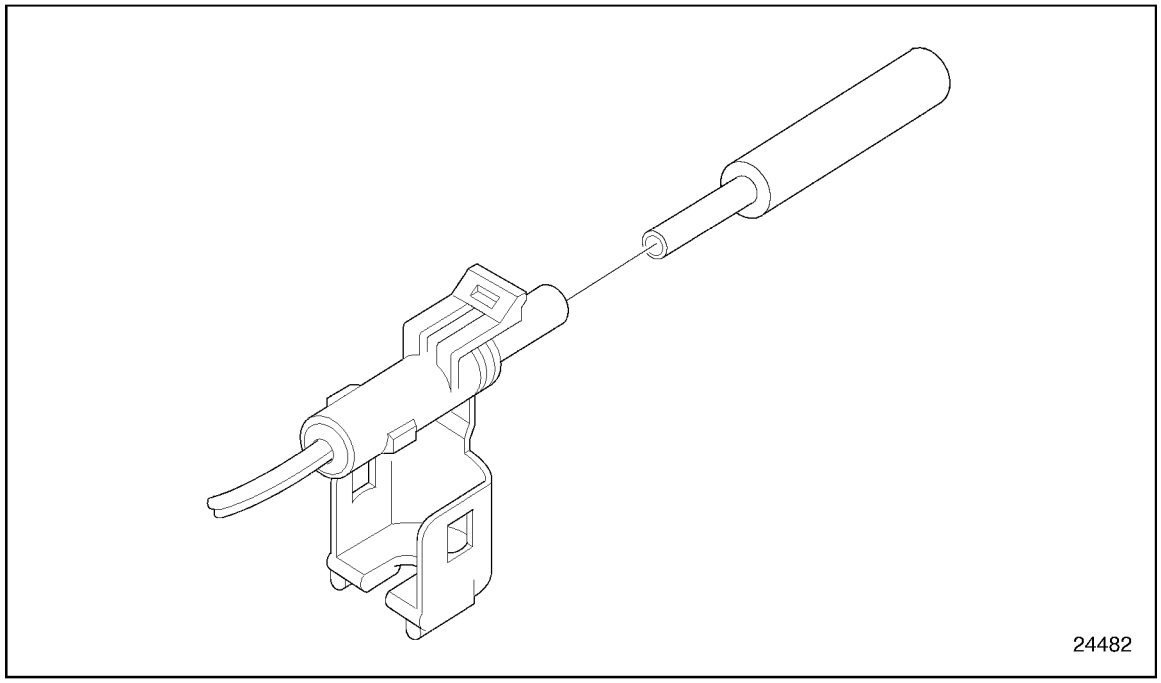


Figure 3-43 Removal Tool Procedure

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).

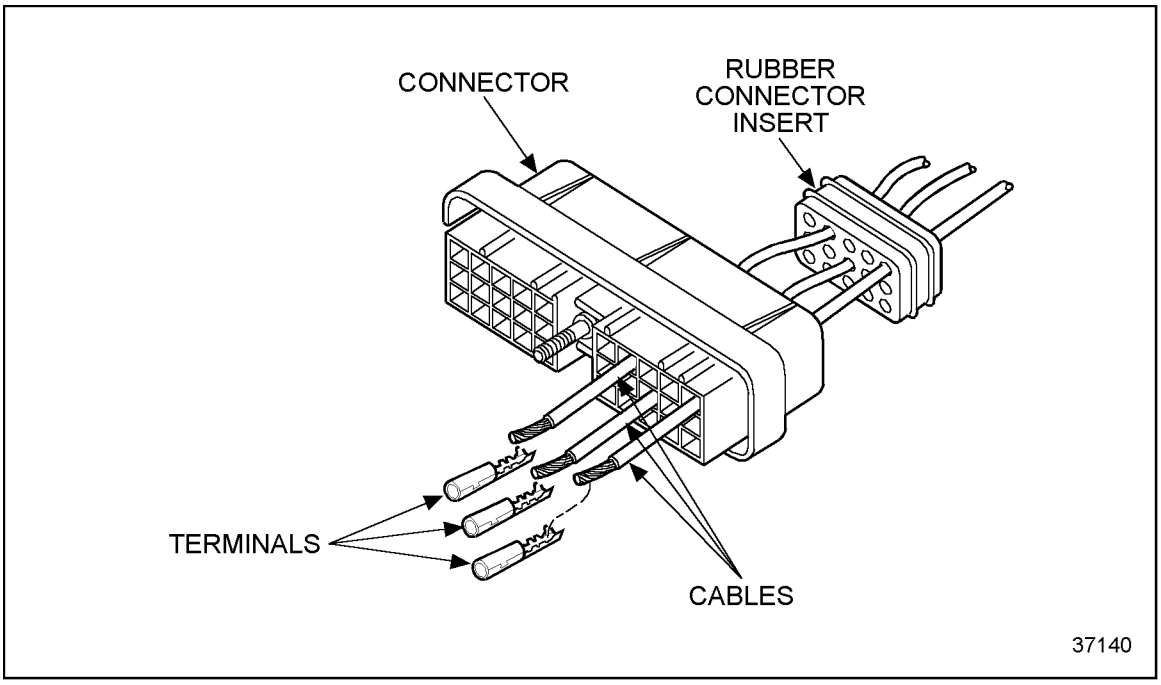


Figure 3-44 Wire Inserted Through the Connector

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).

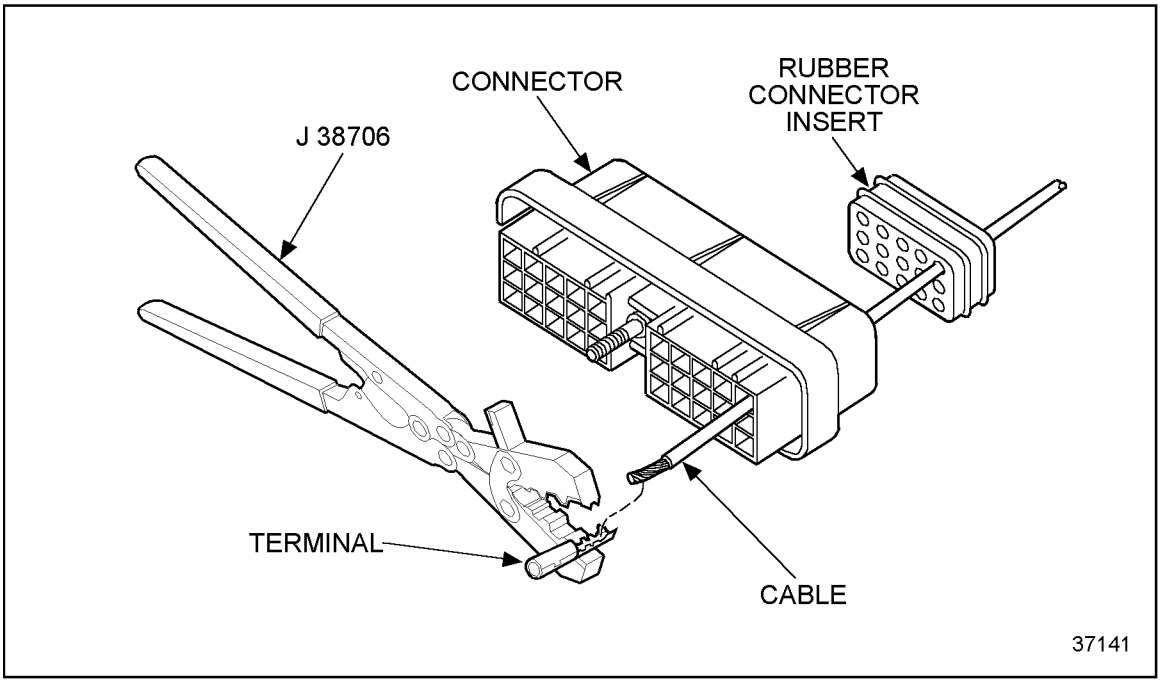


Figure 3-45 Typical Terminal Position

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).

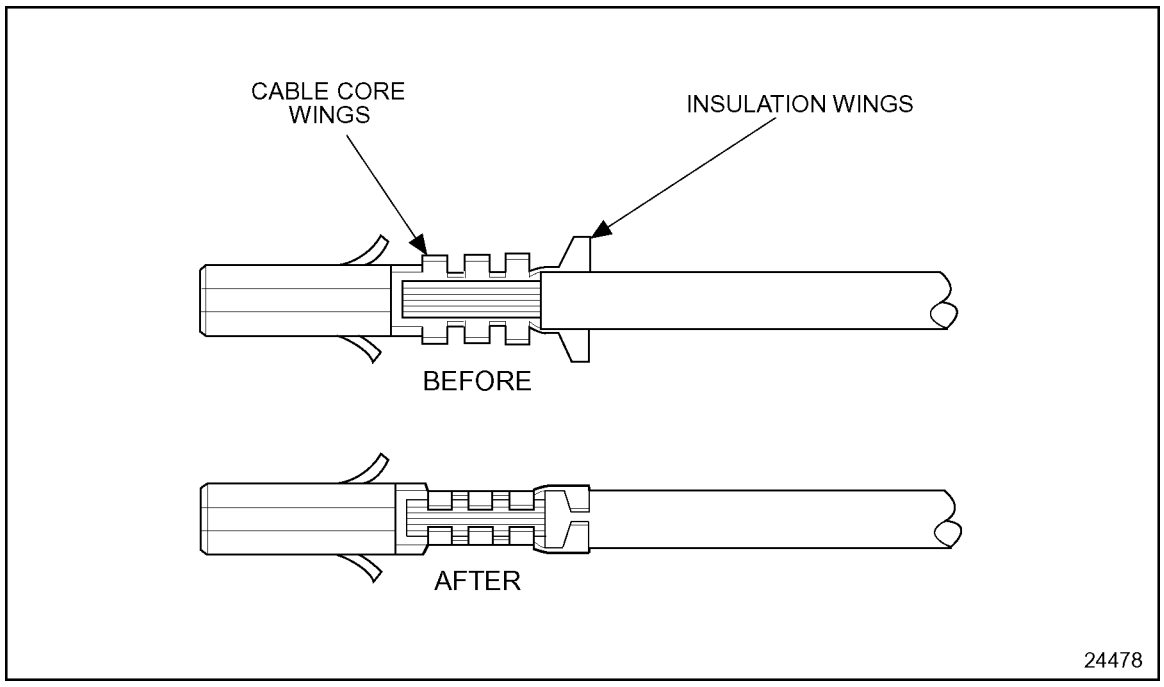


Figure 3-46 Typical Terminal Installation

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.

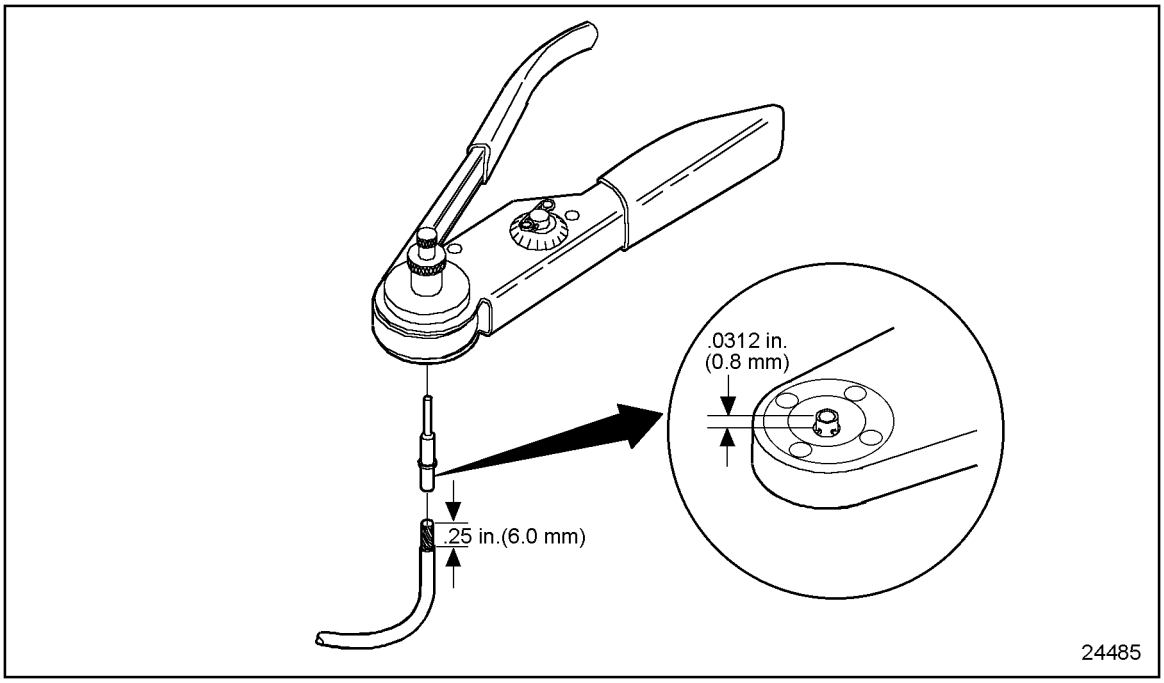


Figure 3-47 Setting Wire Gage Selector and Positioning the Contact

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.

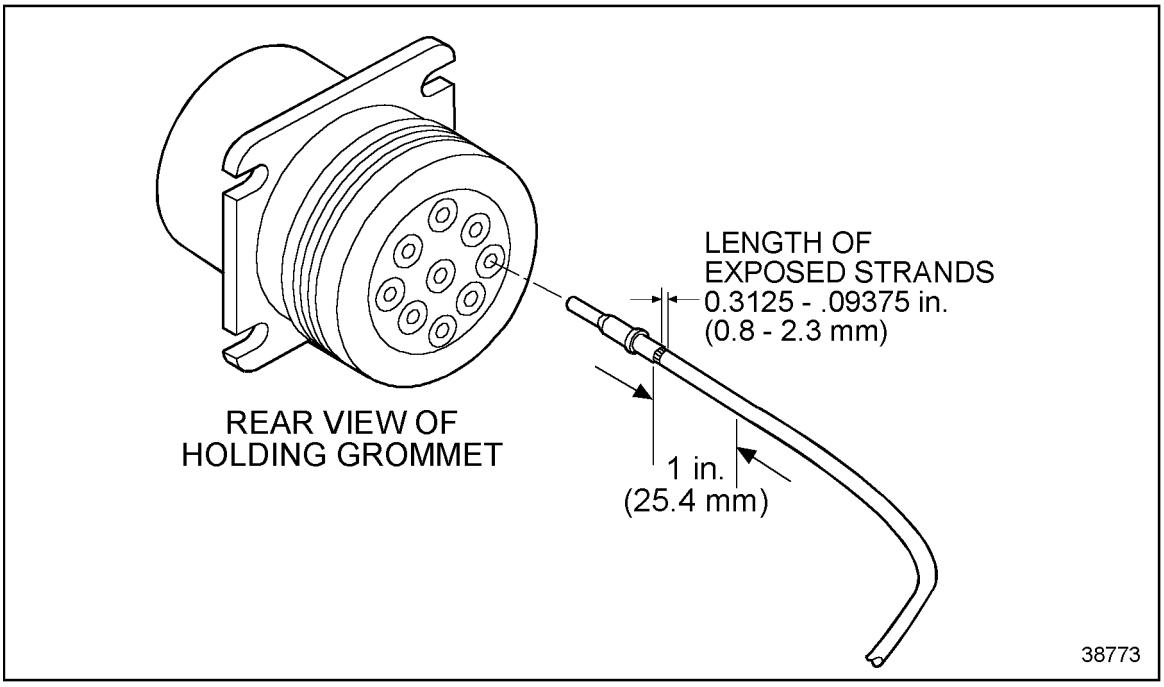


Figure 3-48 Pushing Contact Into Grommet

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.

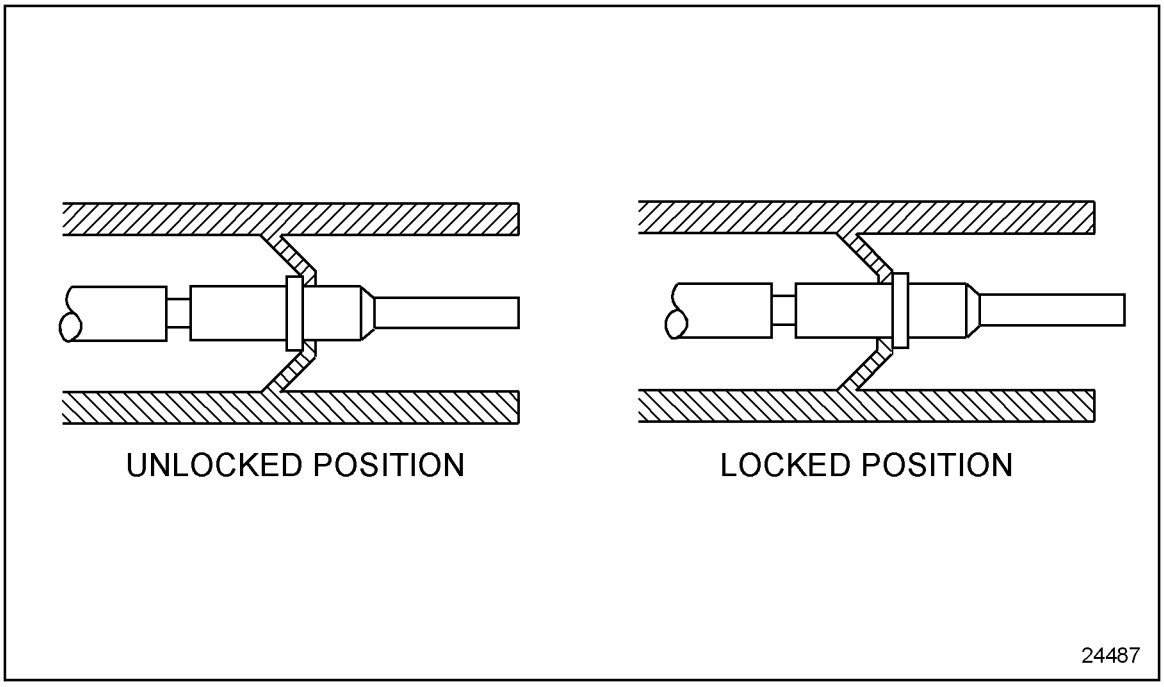


Figure 3-49 Locking Terminal Into Connector

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.

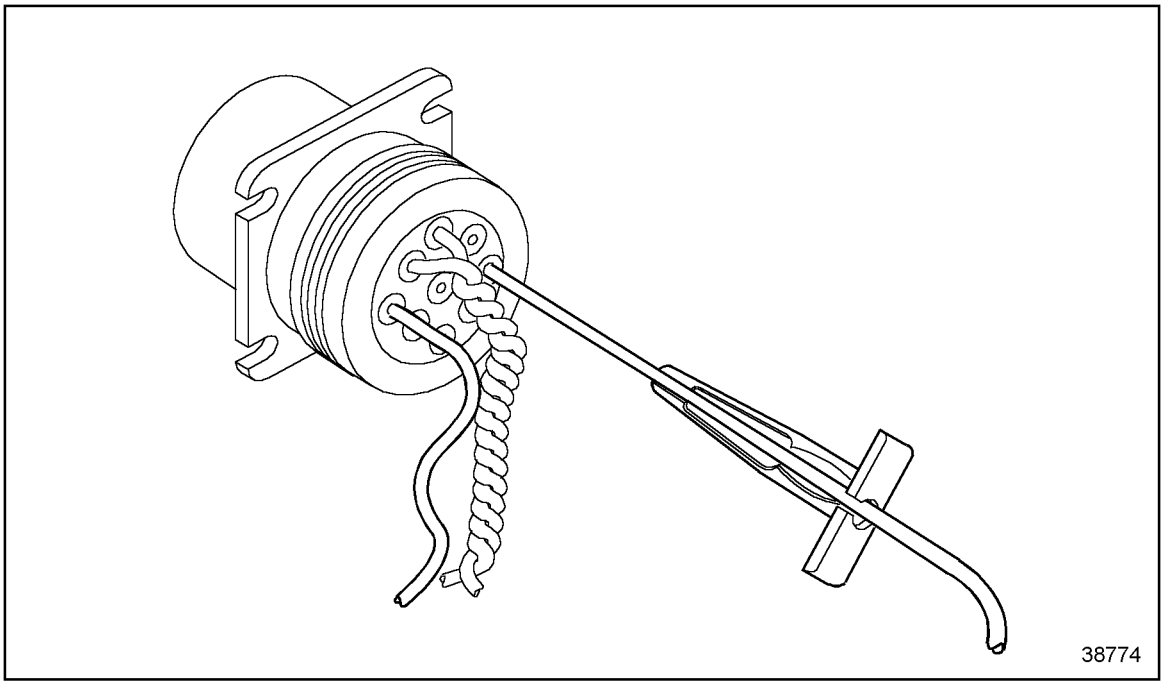


Figure 3-50 Removal Tool Position

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.

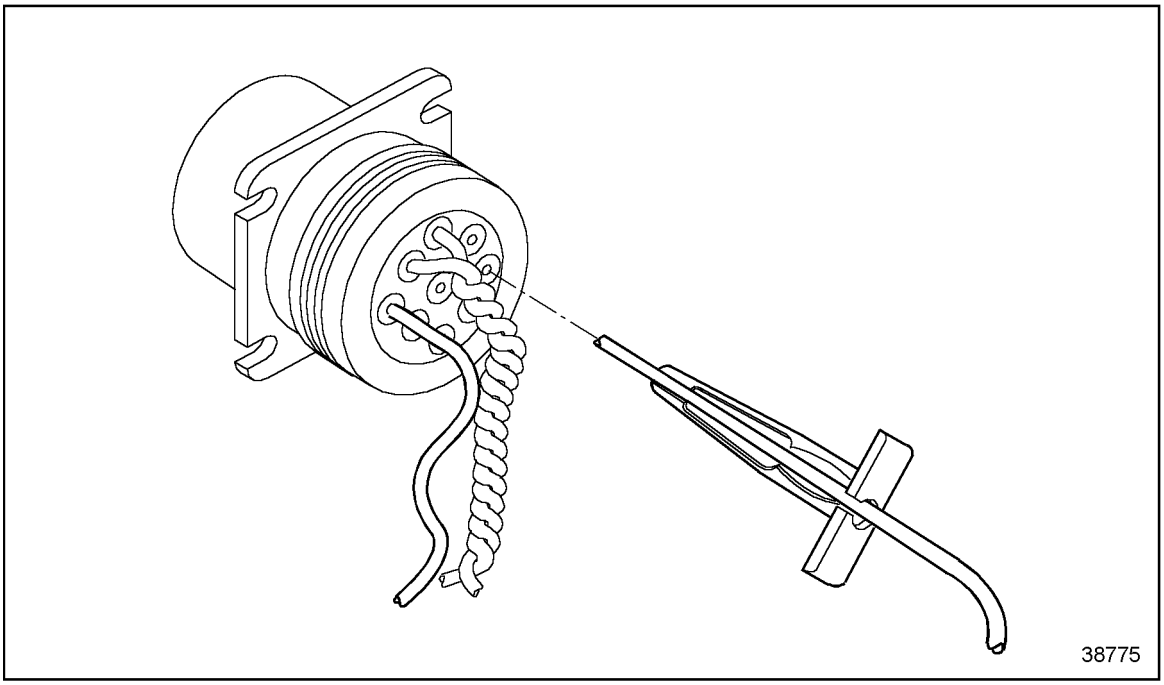


Figure 3-51 Removal Tool Insertion

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).

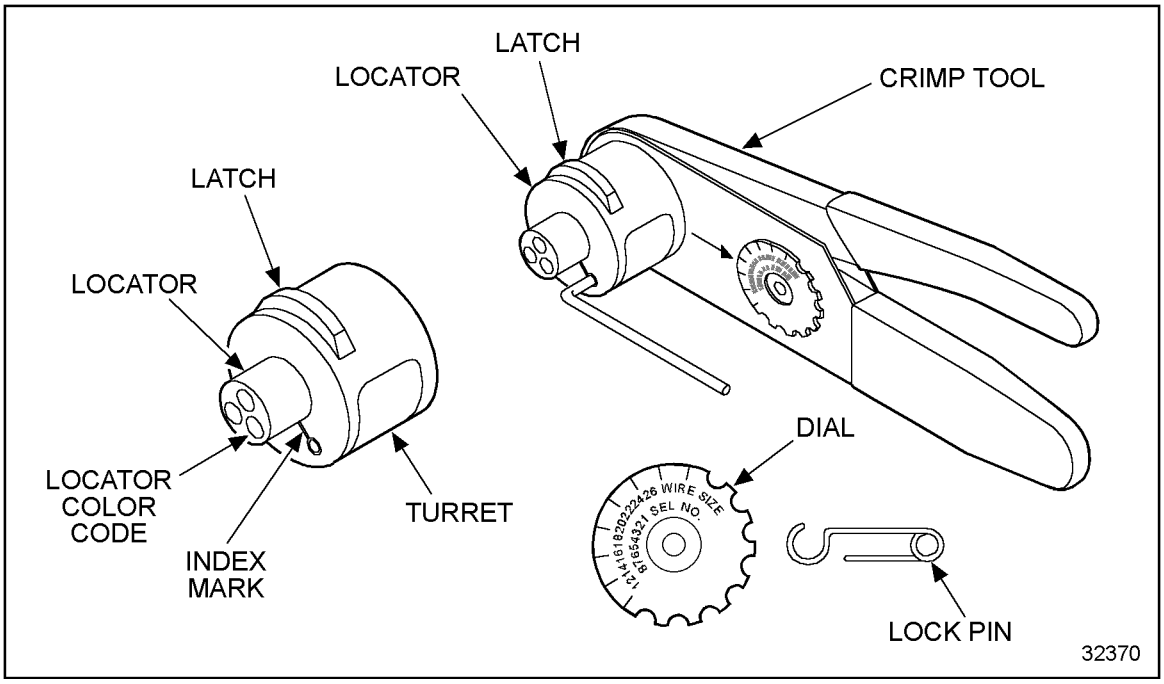


Figure 3-52 Hand Crimp Tool for 37-pin Connector Terminals

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).

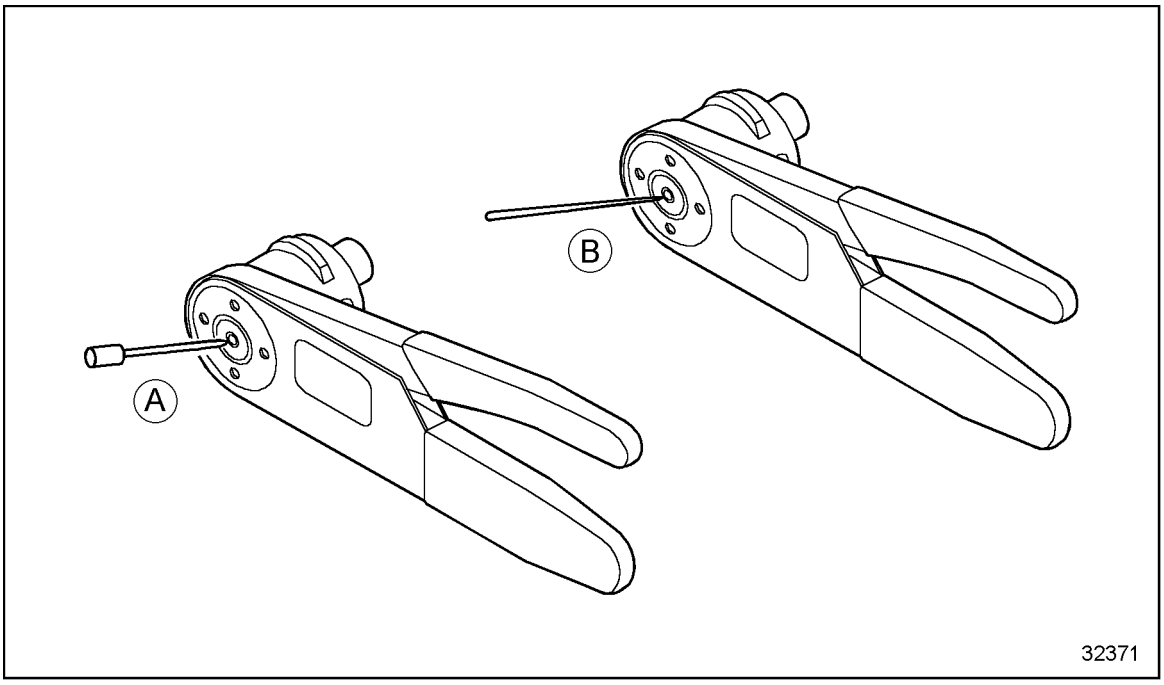


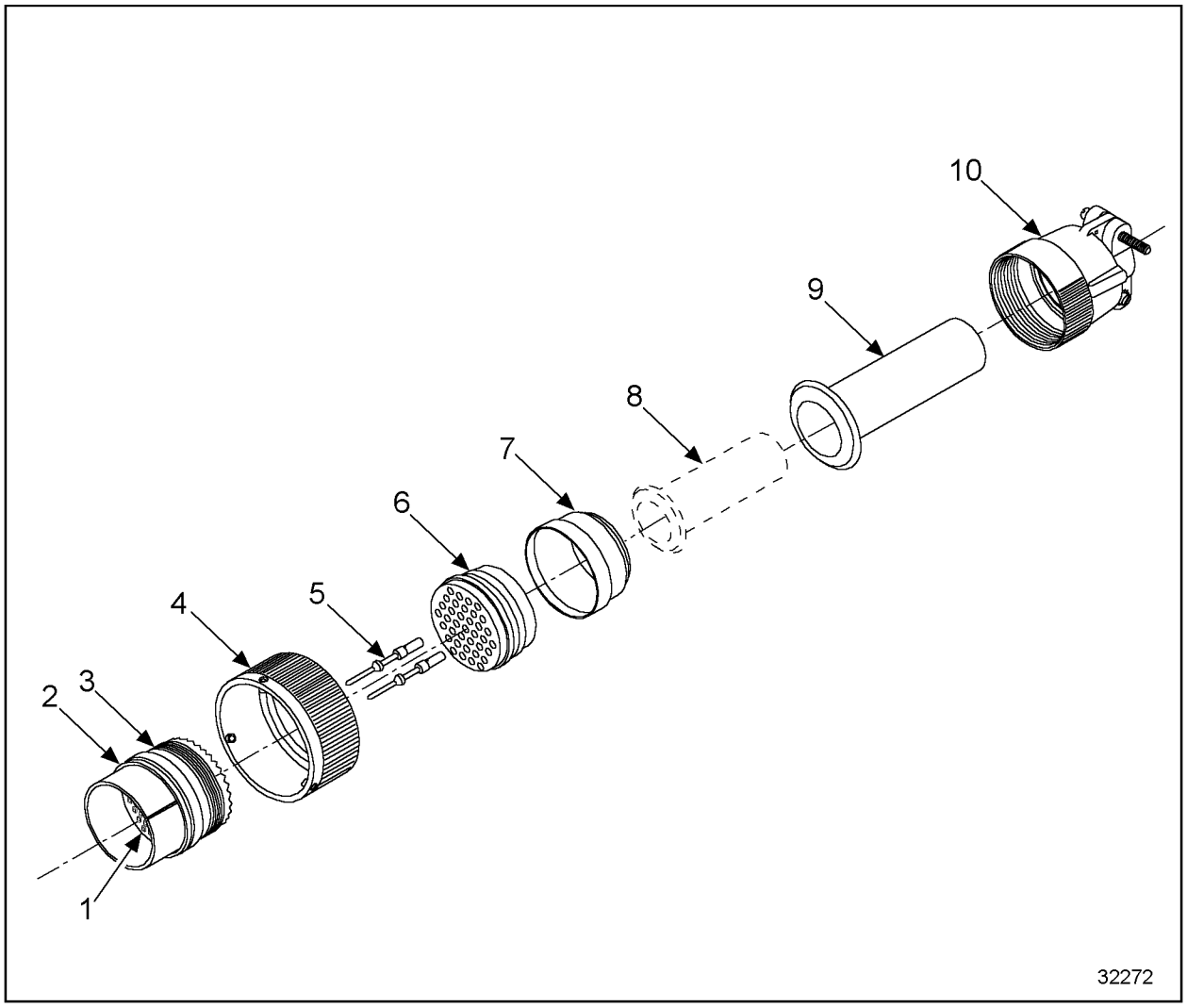
Figure 3-53 Inserting the Terminal and the Stripped Wire.

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).

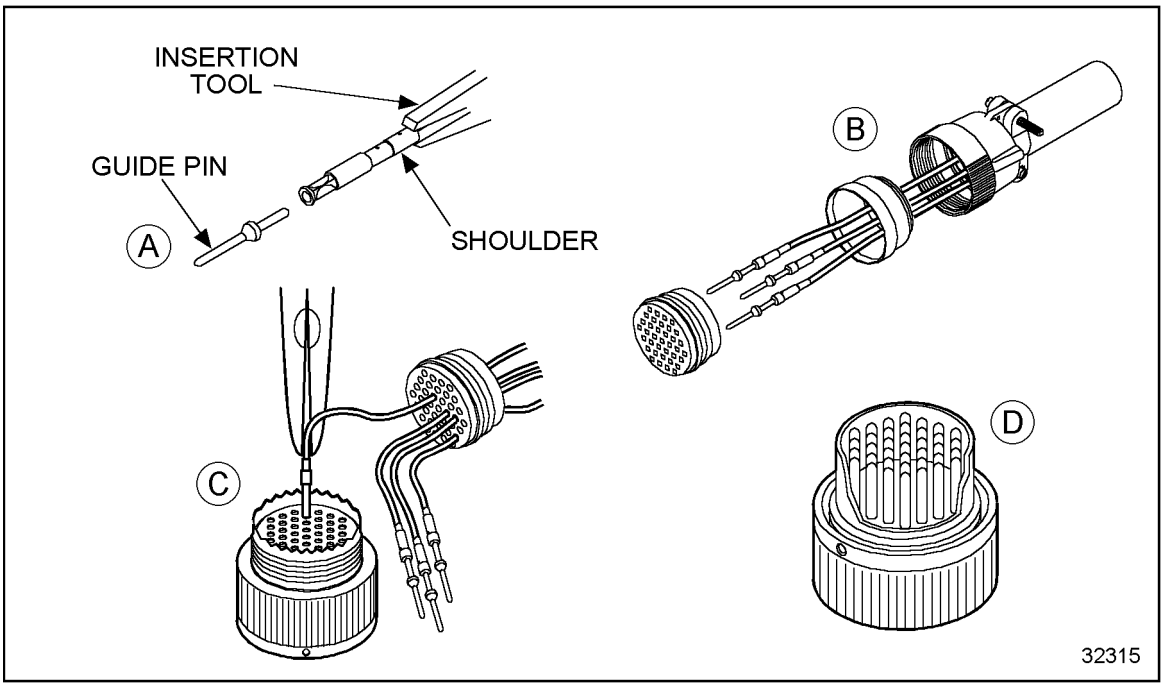
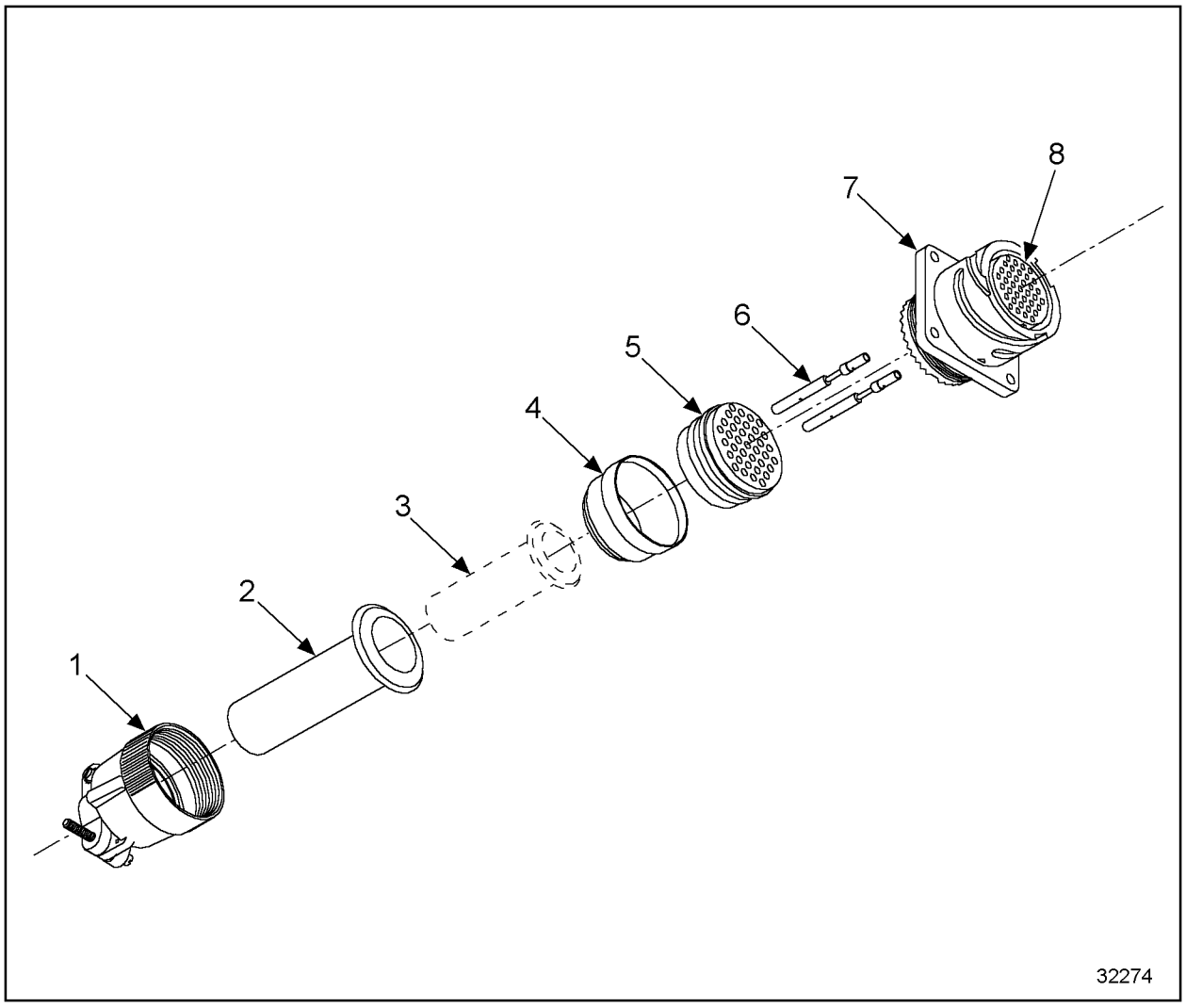


Figure 3-55 Inserting Terminals

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).

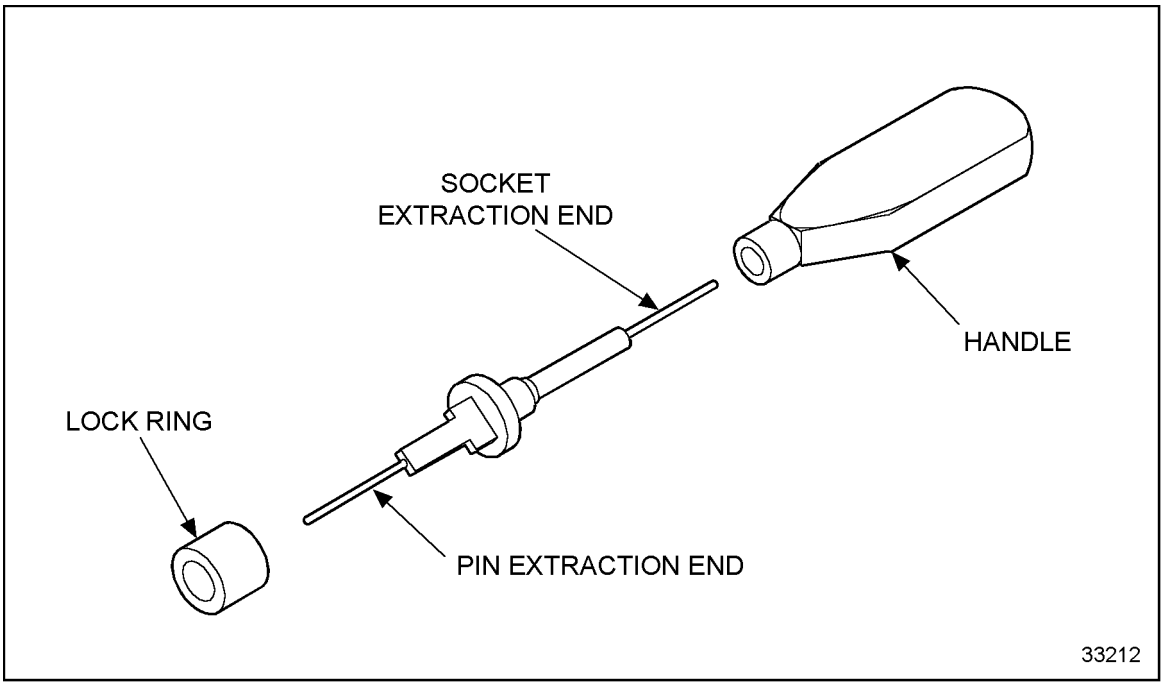


Figure 3-57 Extraction Tool

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).

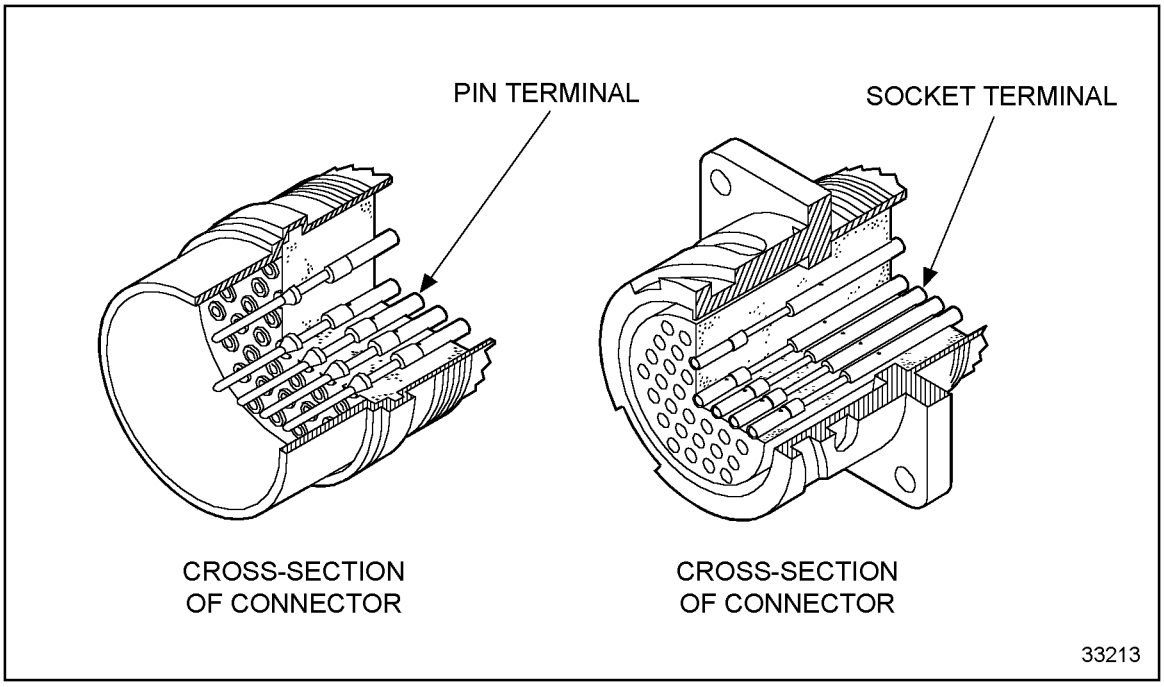


Figure 3-58 Connector Cross-section With Pin and Socket Terminals

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.

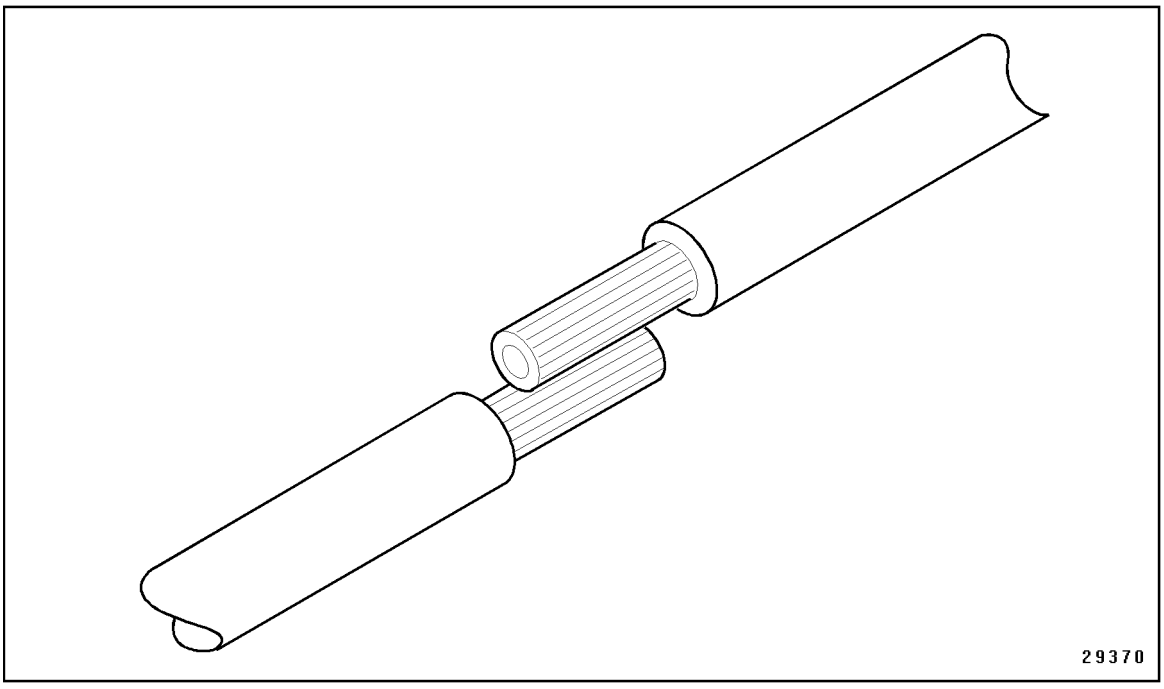


Figure 3-59 Positioning the Leads

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

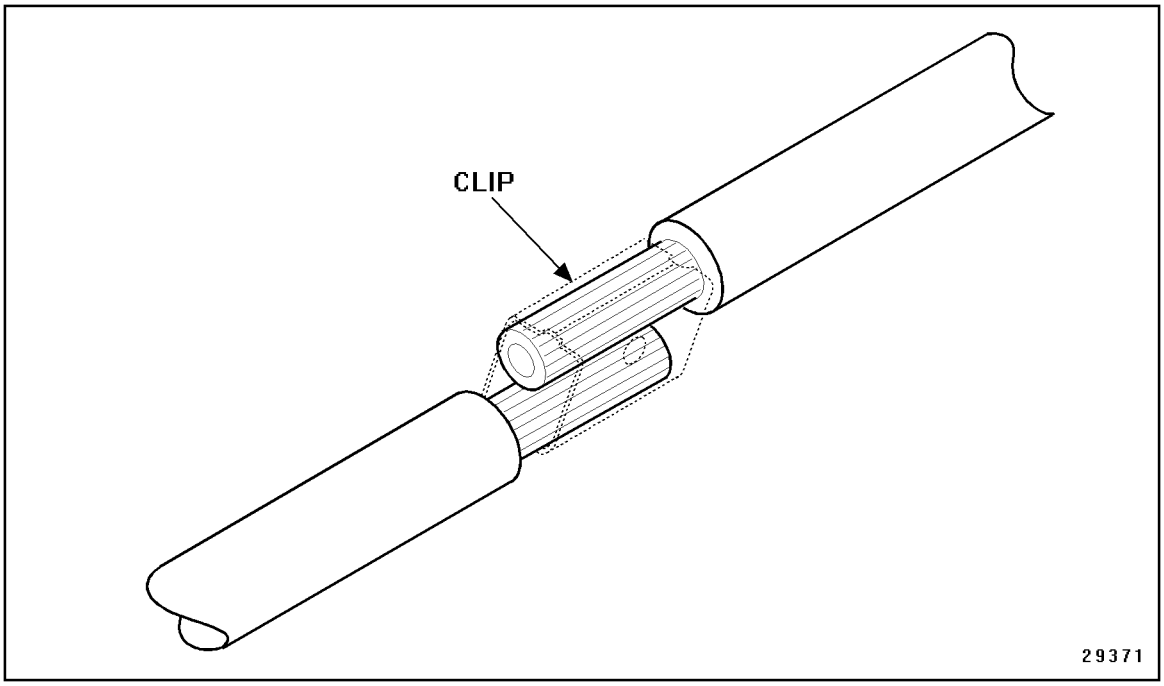


Figure 3-60 Securing the Leads With a Clip

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.

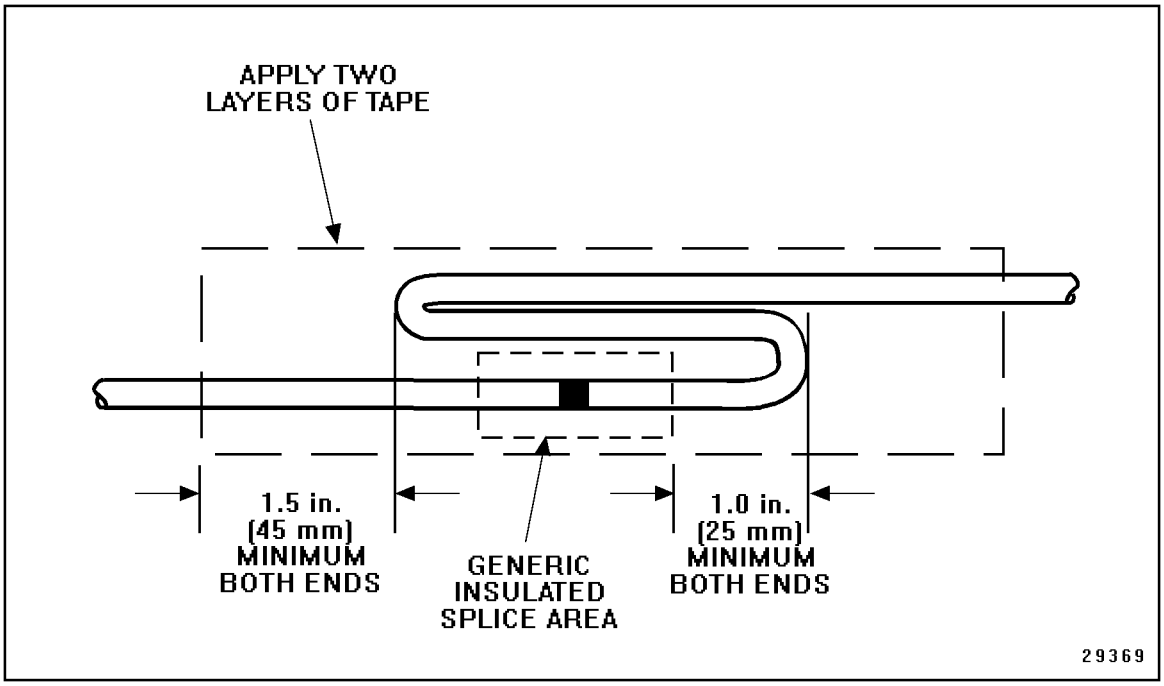


Figure 3-61 Recommended Strain Relief of Spliced Joint

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.

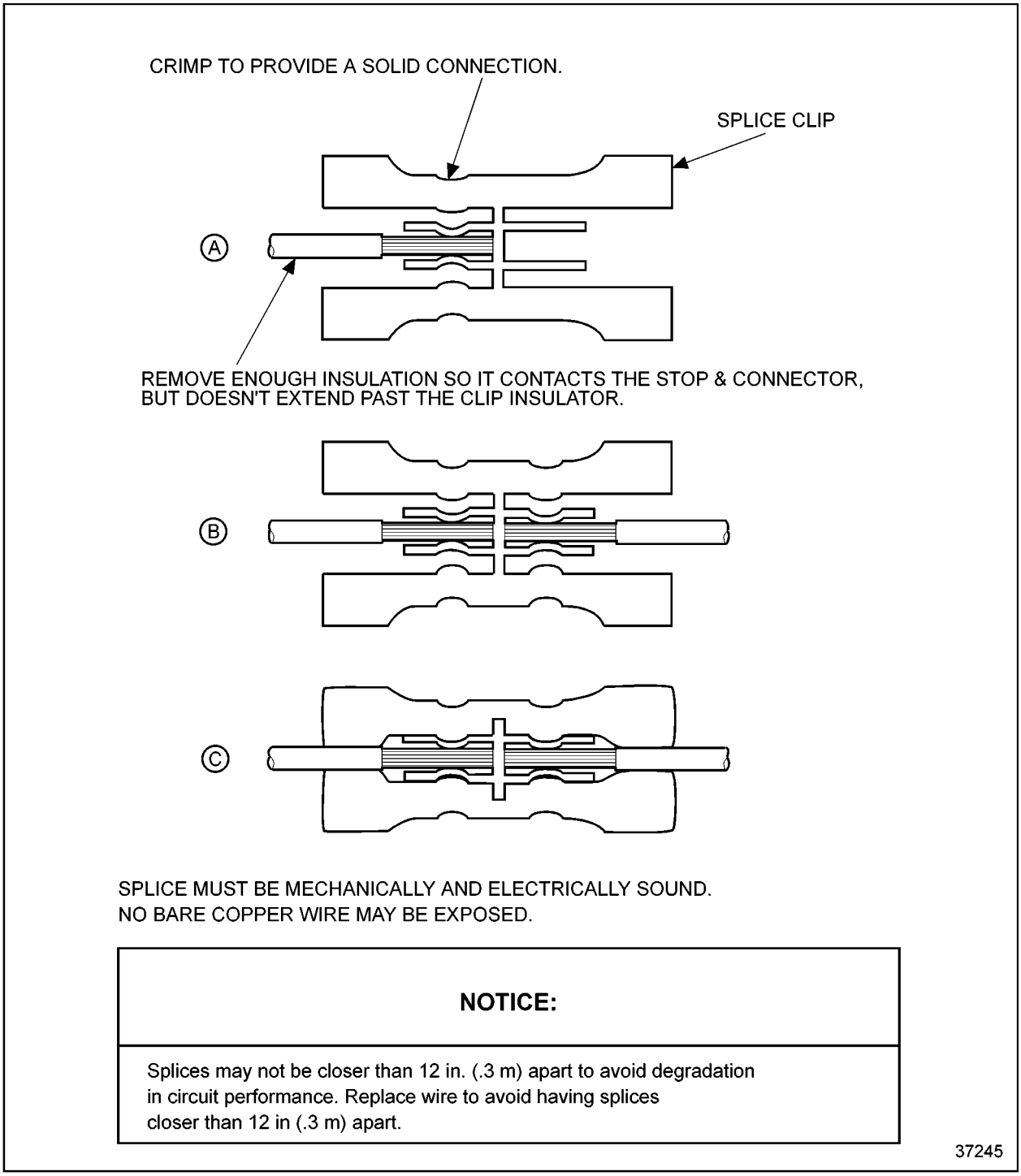


Figure 3-62 Splicing Straight Leads - Alternate Method 1

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.

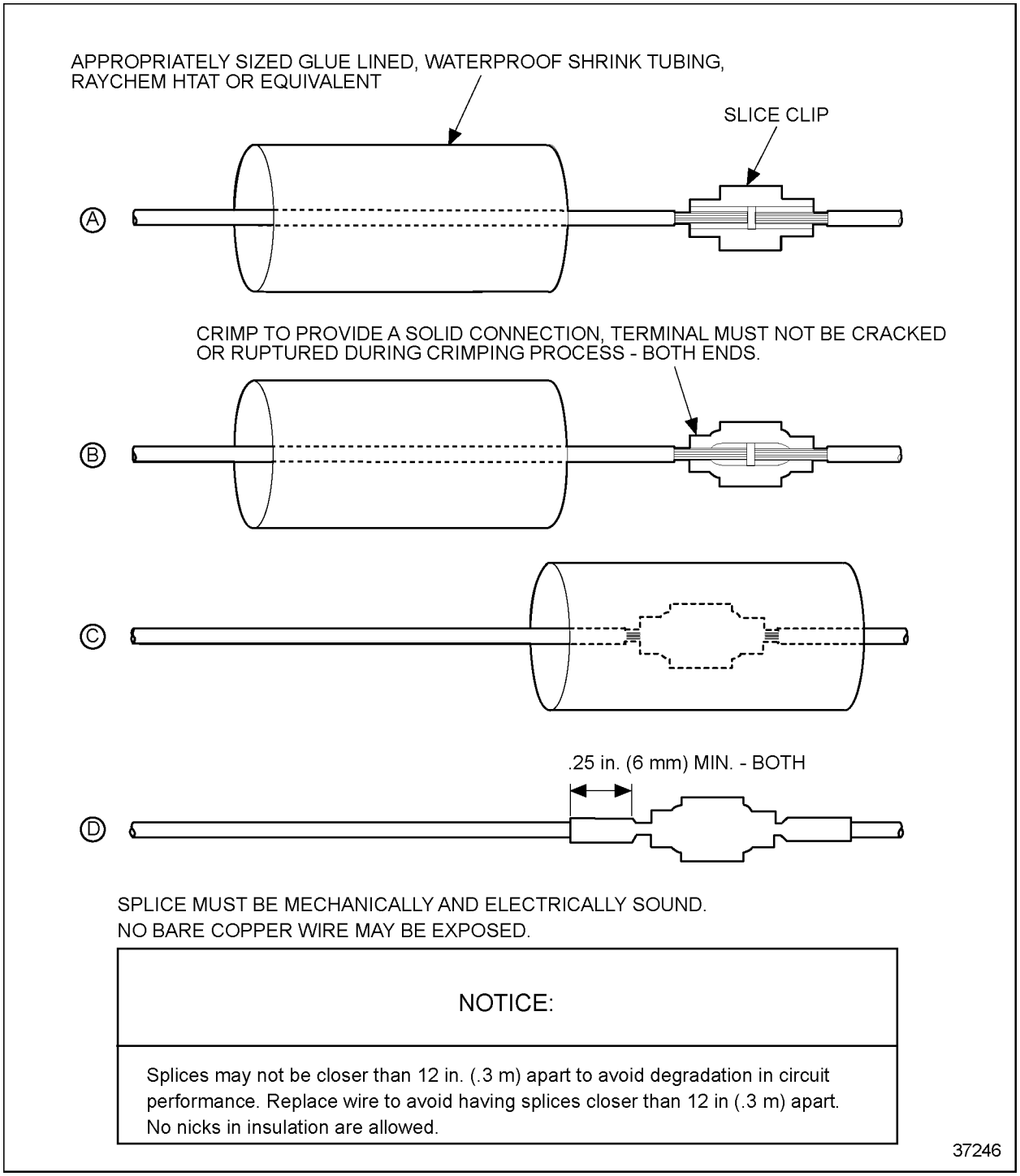


Figure 3-63 Splicing Straight Leads - Alternate Method 2

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.

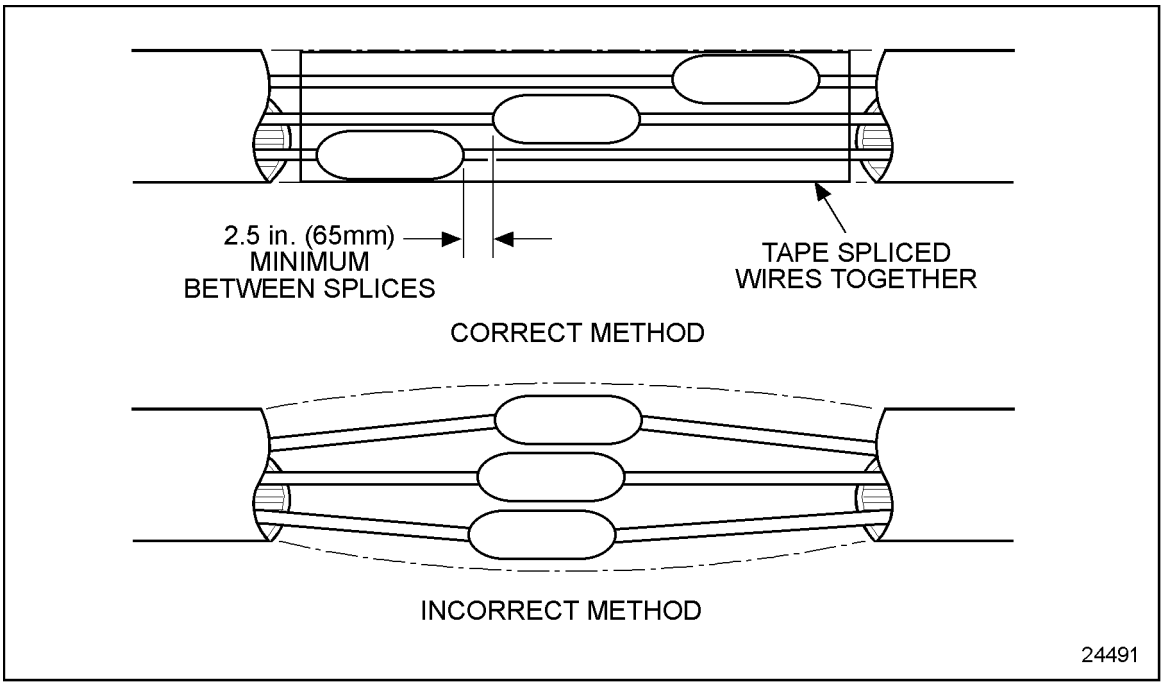


Figure 3-64 The Correct and Incorrect Method of Staggering Multiple Splices

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).

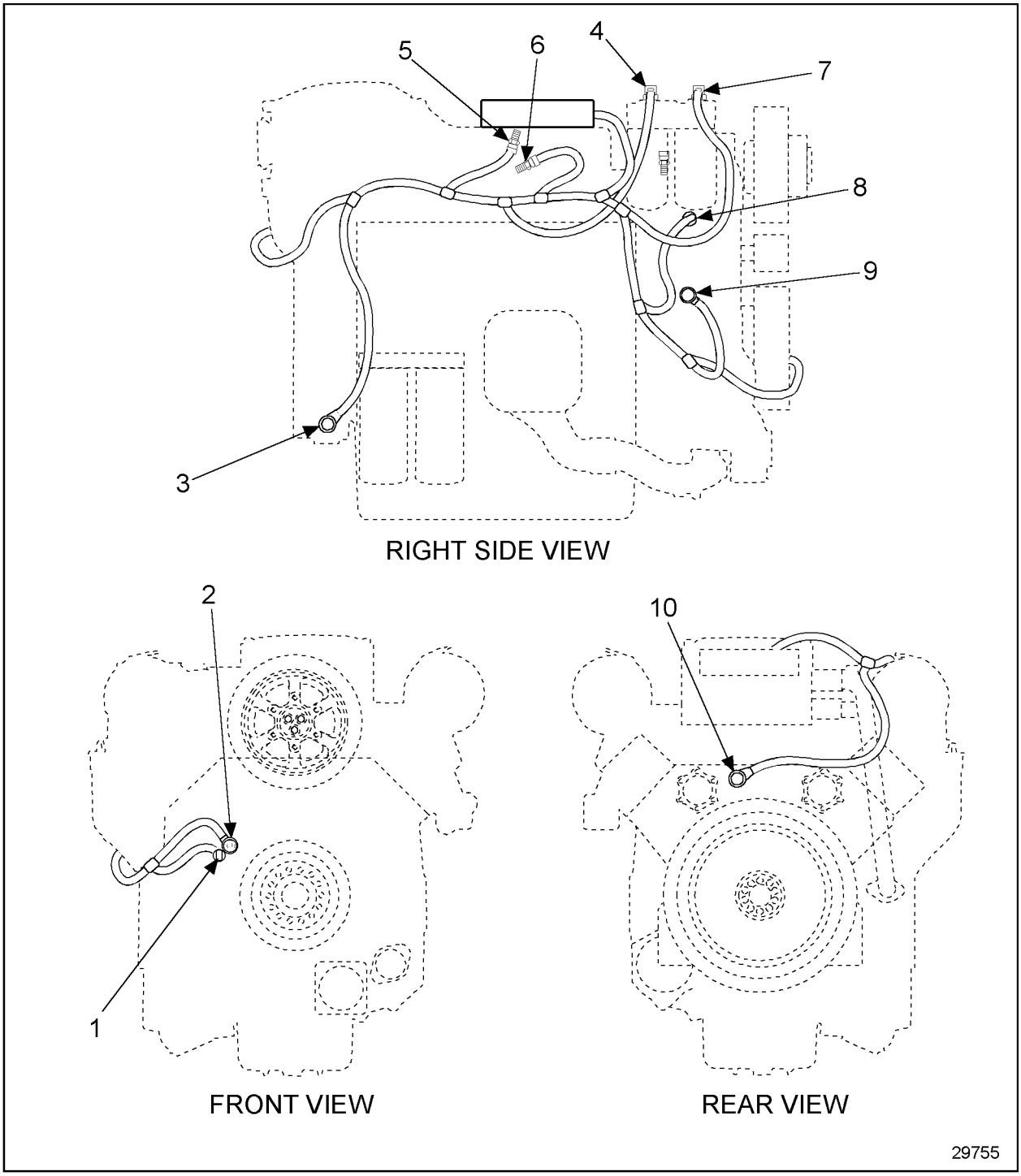
3.14.1 FACTORY-INSTALLED SENSORS

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

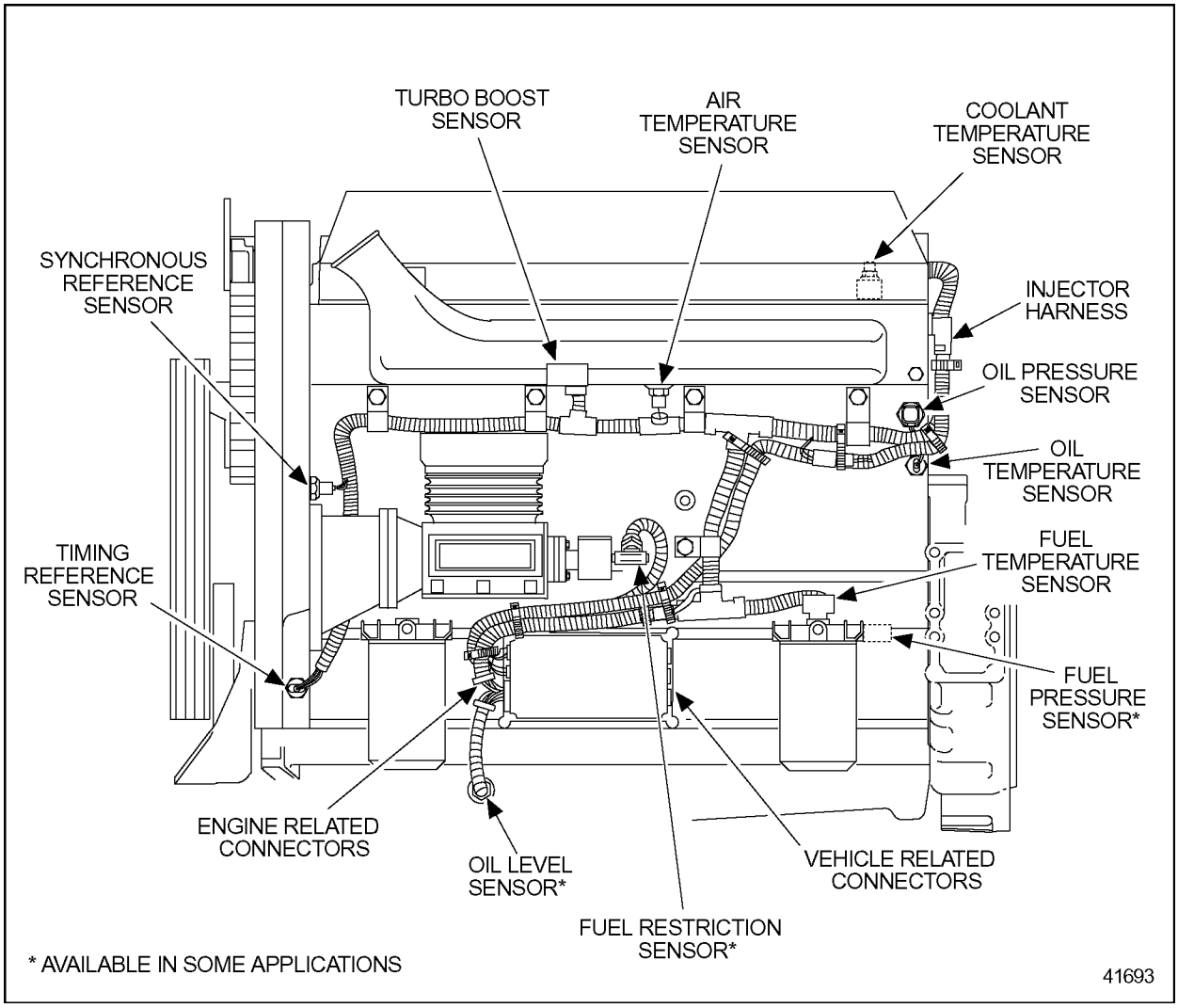
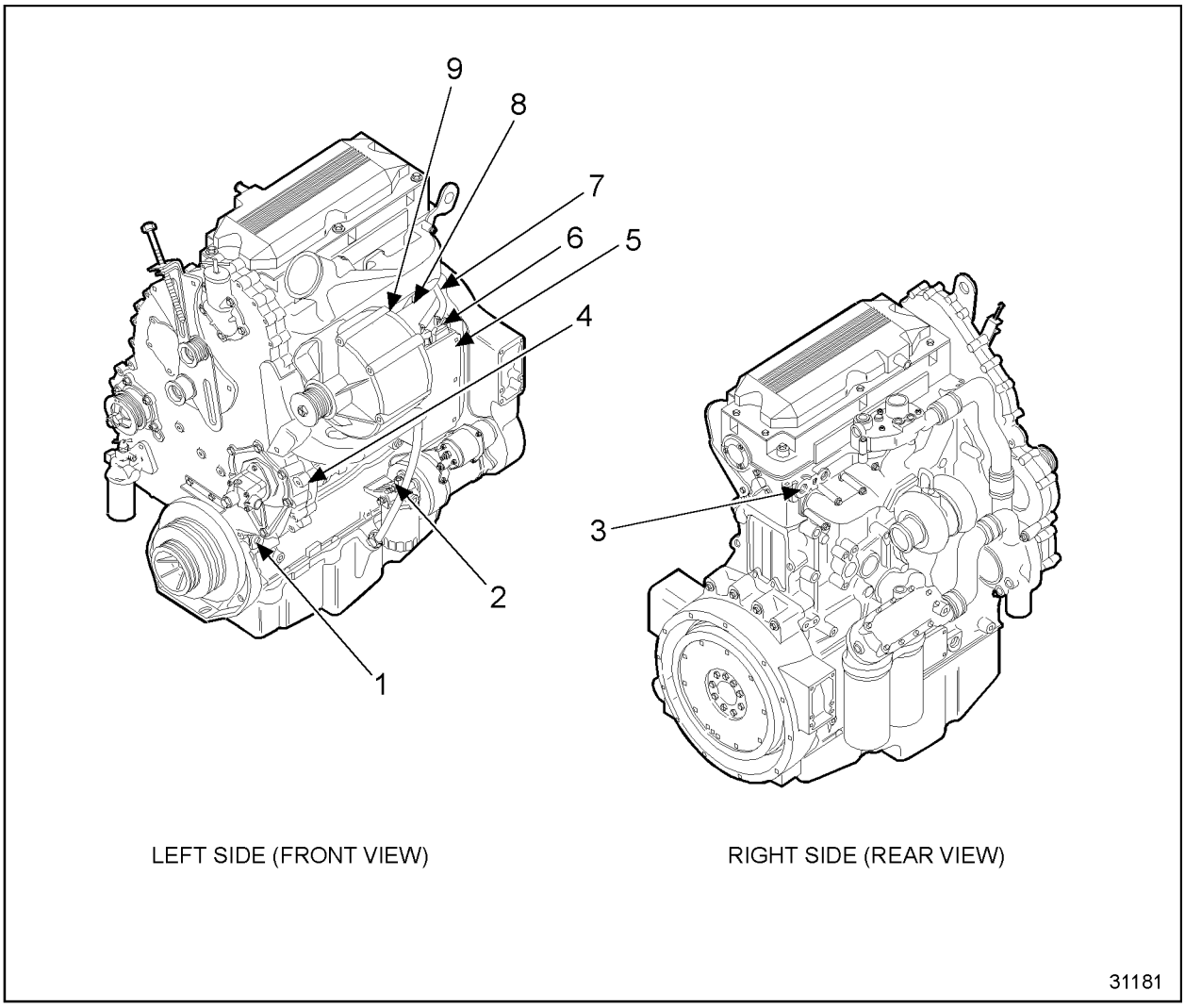
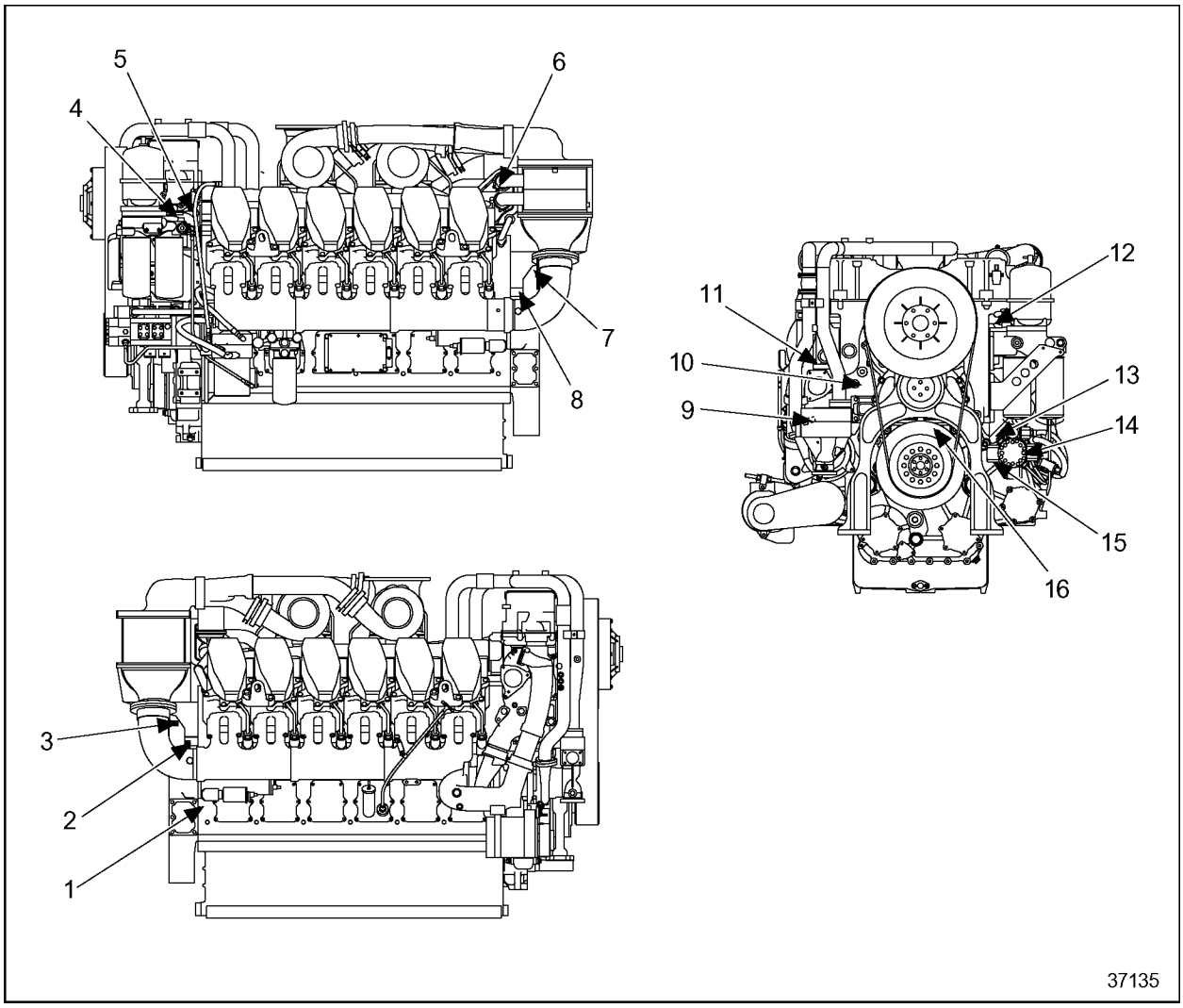


Figure 3-66 Engine Sensor Harness and Sensor Location - Series 60 Engine



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

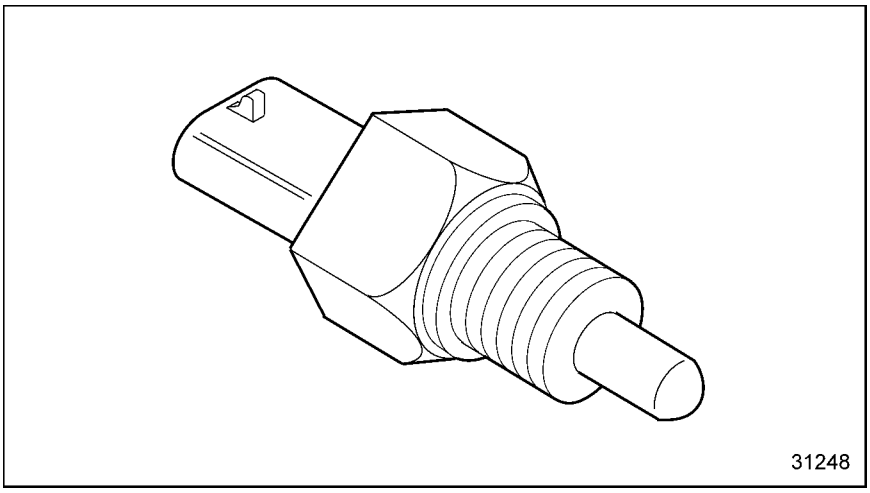


Figure 3-69 Air Temperature Sensor

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

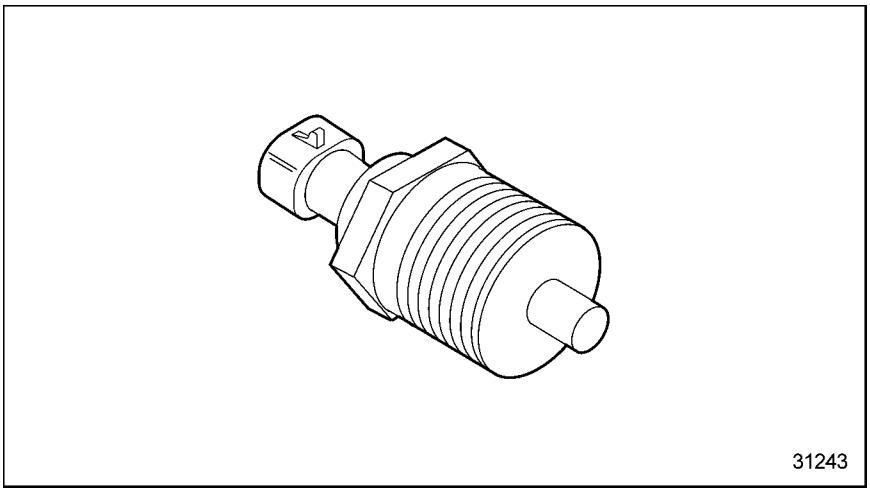


Figure 3-70 Charge Air Temperature Sensor - Series 2000 C & I Applications

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.

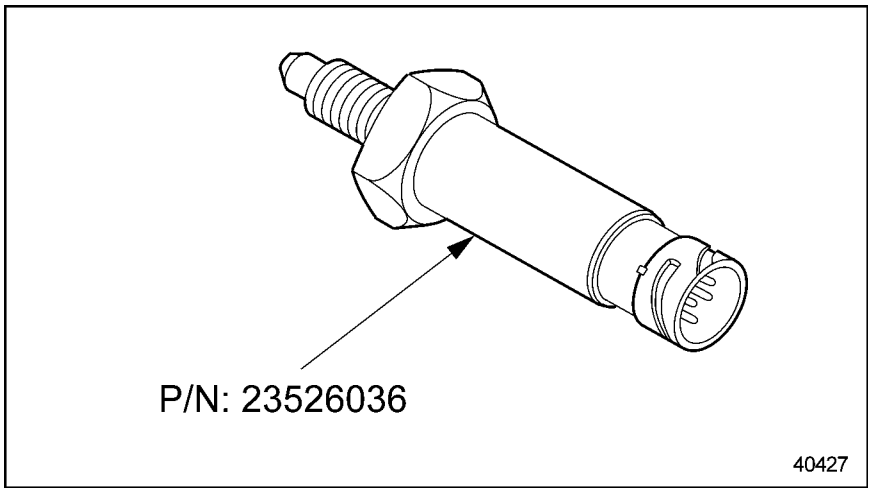


Figure 3-71 Common Rail Fuel Pressure Sensor - Series 4000

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.

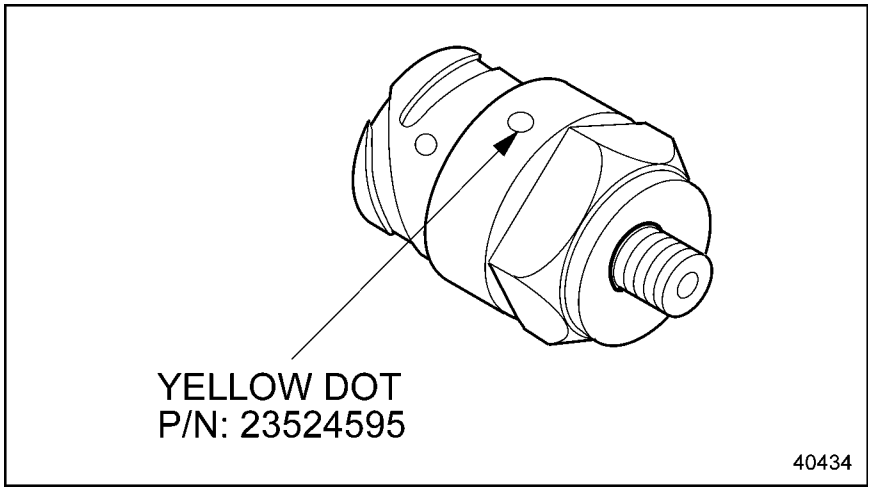


Figure 3-72 Coolant Pressure Sensor - Series 2000 and Series 4000

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.

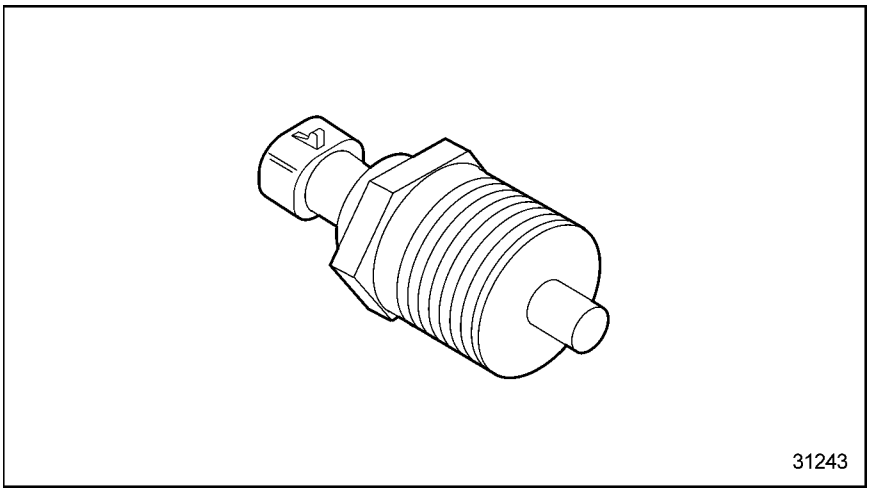


Figure 3-73 Coolant Temperature Sensor - Series 50 and Series 60

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.

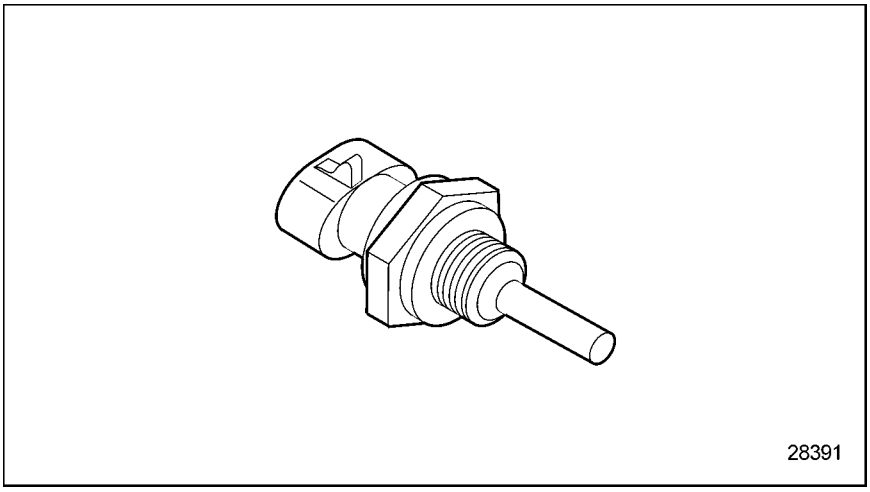


Figure 3-74 Series 2000 CTS , Series 4000 ICTS

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.

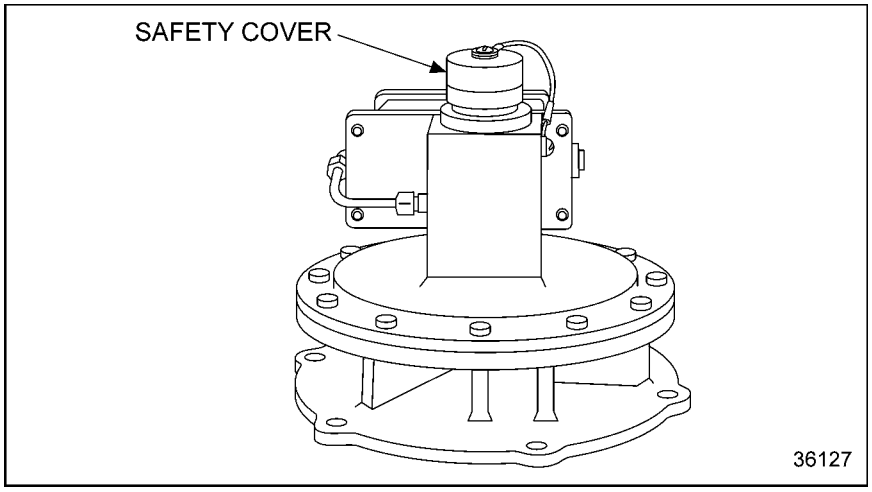


Figure 3-75 Crankcase Pressure Sensor - Series 149

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

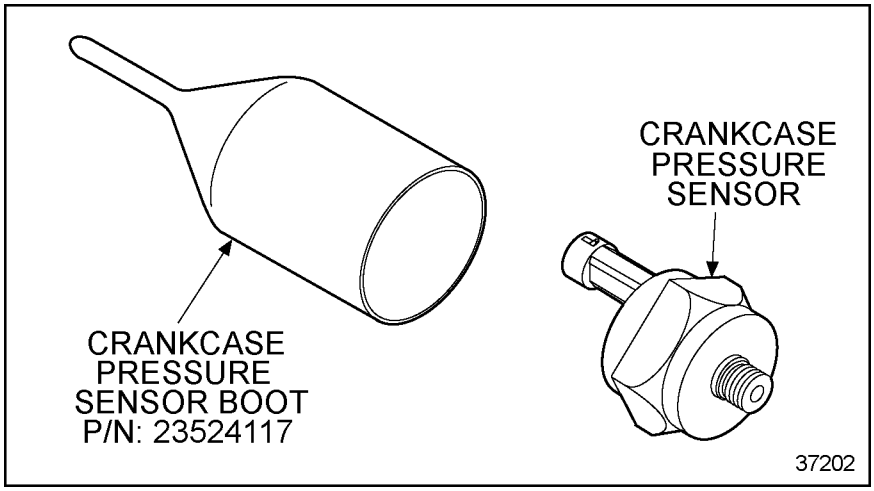


Figure 3-76 Crankcase Pressure Sensor - Series 4000

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).

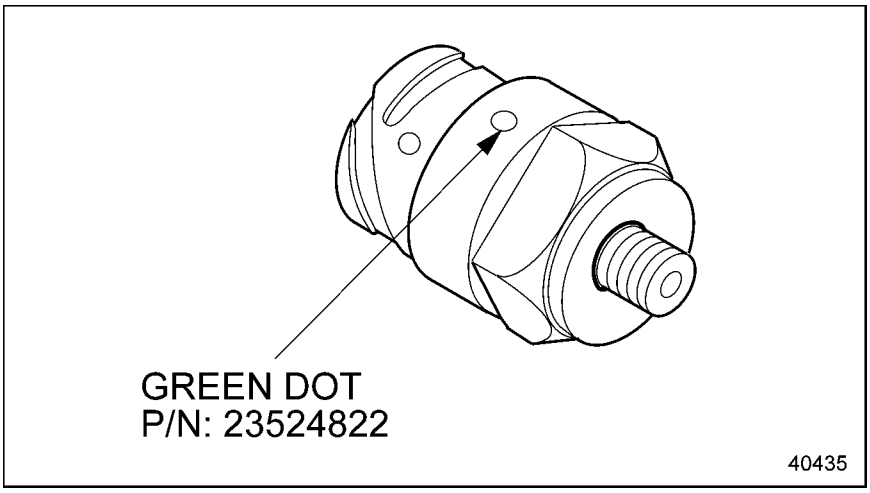


Figure 3-77 Fuel Pressure Sensor - Series 2000

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

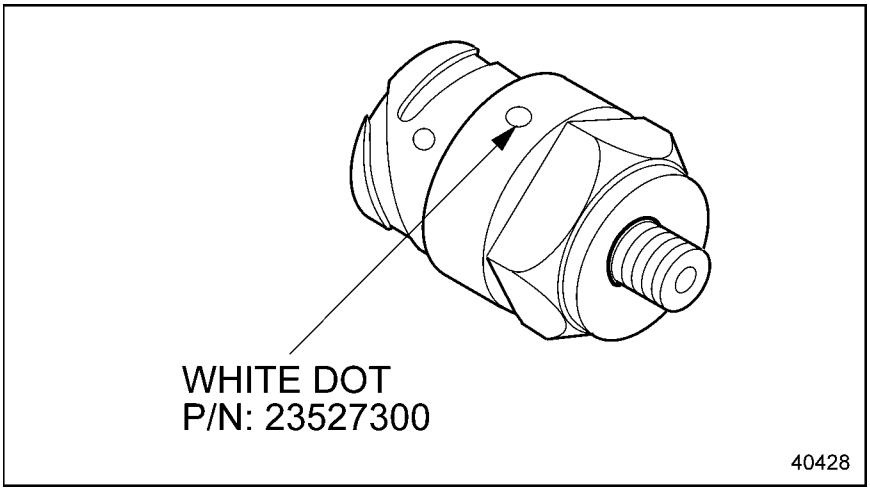


Figure 3-78 Fuel Pressure Sensor - Series 4000

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).

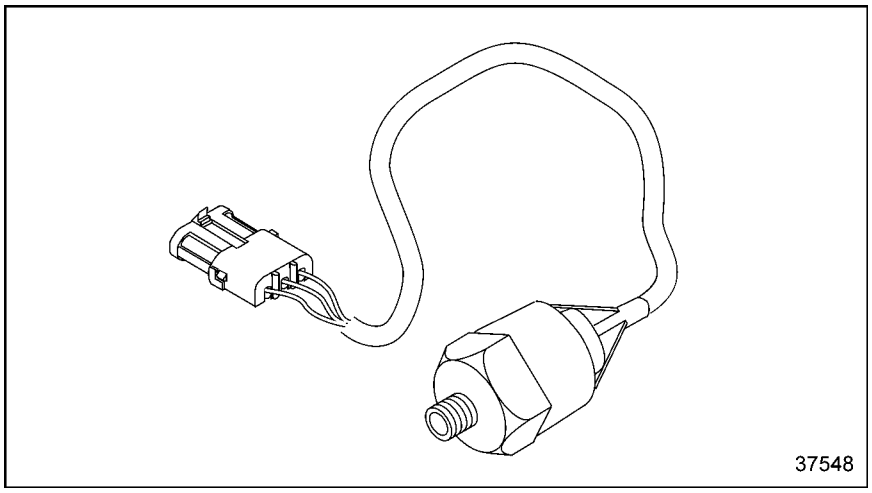


Figure 3-79 Fuel Restriction Sensor

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.

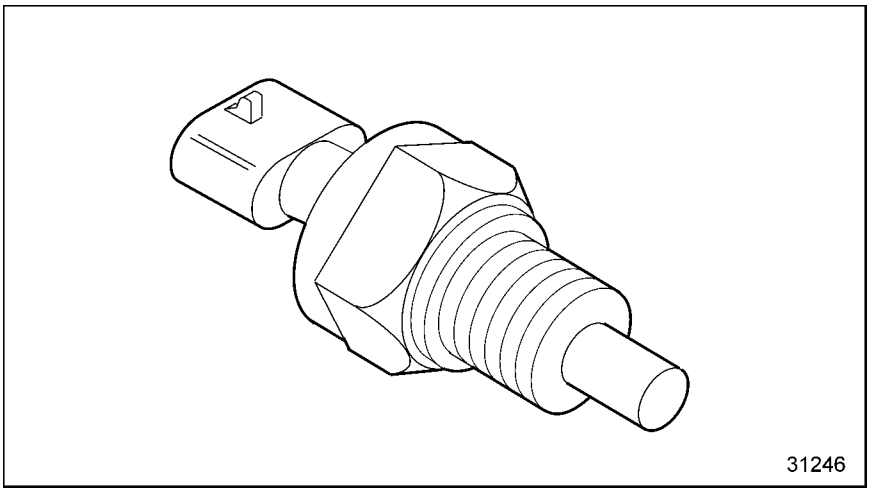


Figure 3-80 Fuel Temperature Sensor

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

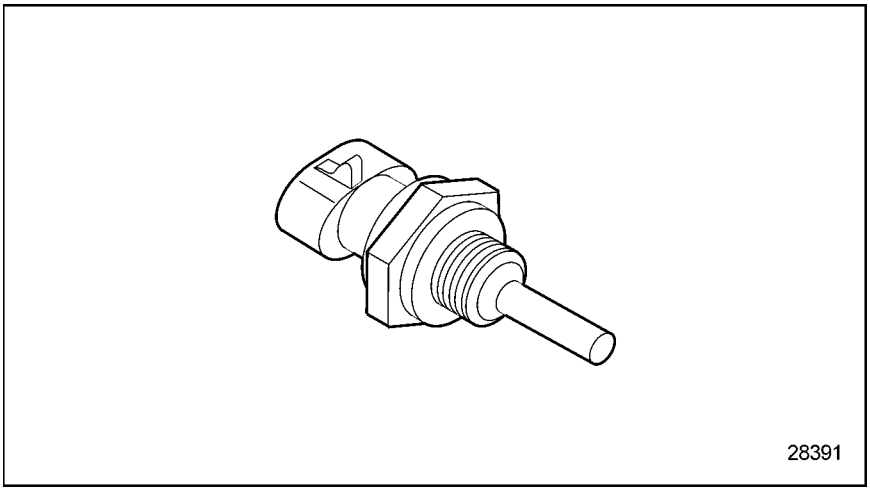


Figure 3-81 Fuel Temperature Sensor - Series 2000

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).

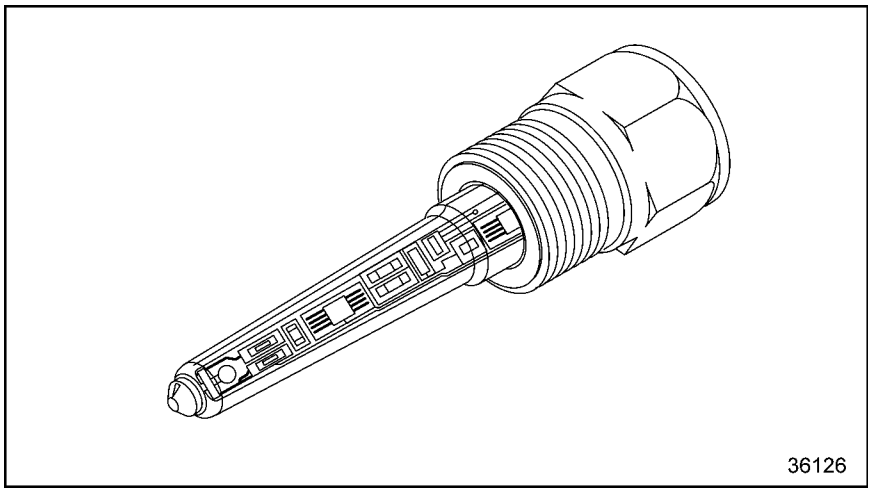


Figure 3-82 Oil Level Sensor

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).

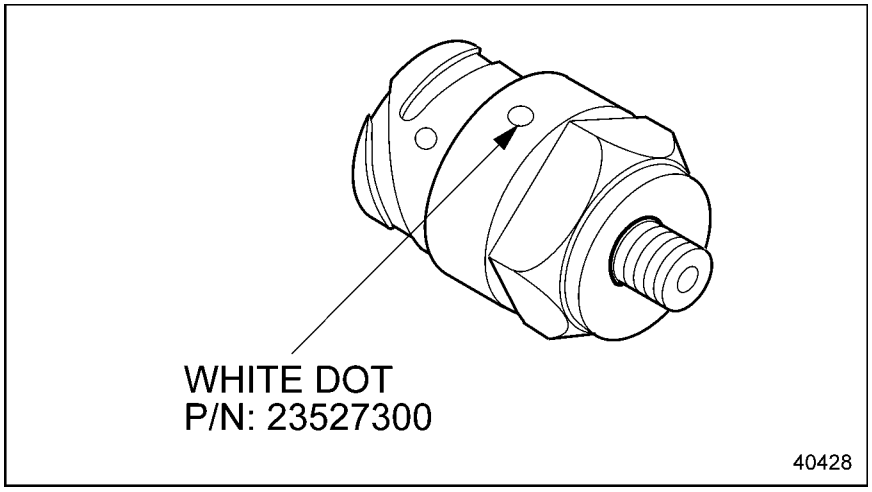


Figure 3-83 Oil Pressure Sensor - Series 2000 and Series 4000

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.

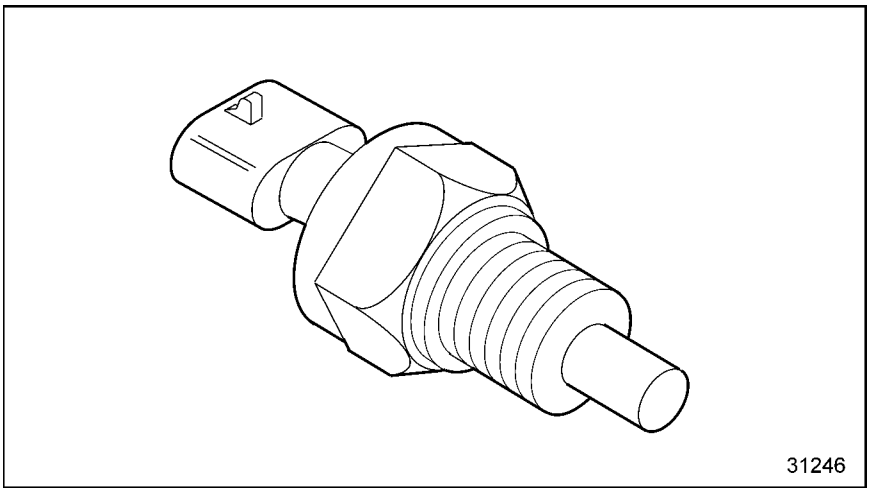


Figure 3-84 Oil Temperature Sensor

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

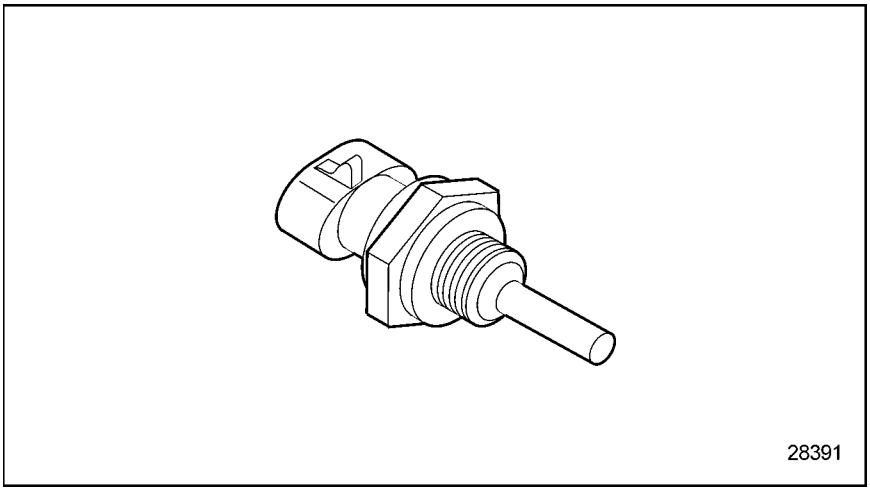


Figure 3-85 Oil Temperature Sensor - Series 2000 and Series 4000

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.

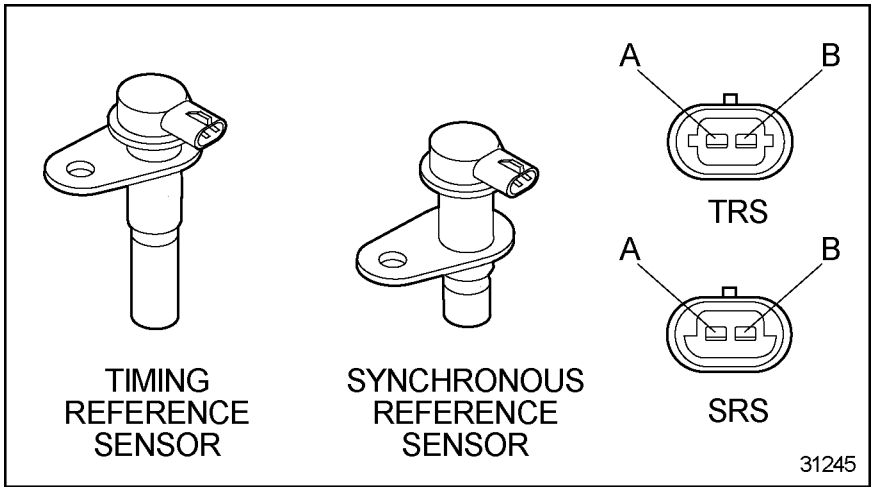


Figure 3-86 The SRS and TRS - Series 50, Series 60, and Series 2000 Engines

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

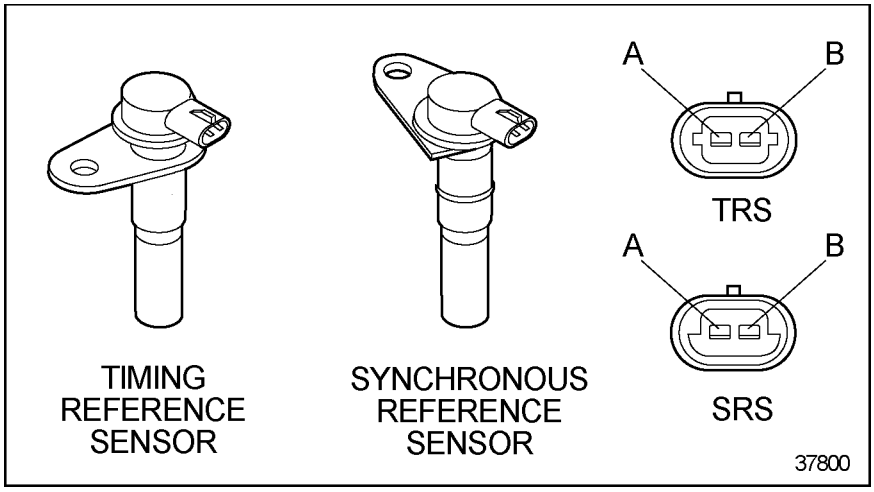


Figure 3-87 The SRS and TRS - Series 4000

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

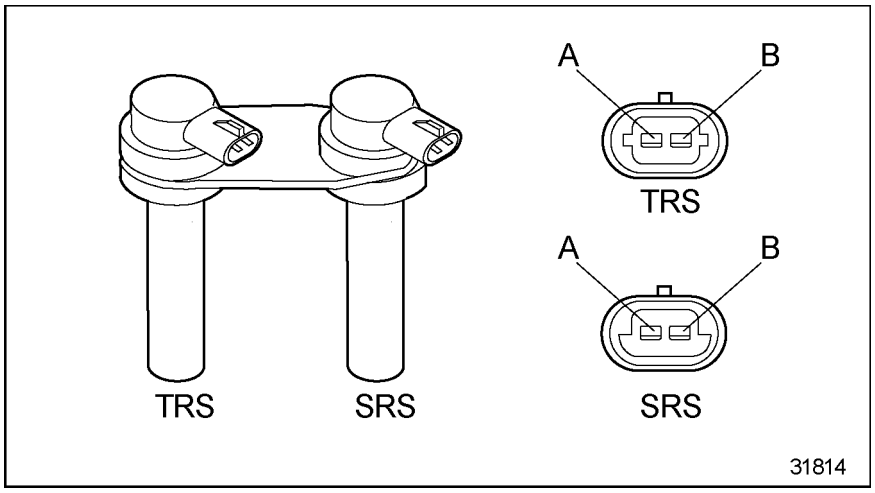


Figure 3-88 The SRS and TRS - Series 92 6/8V and Series 71 12V Engines

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

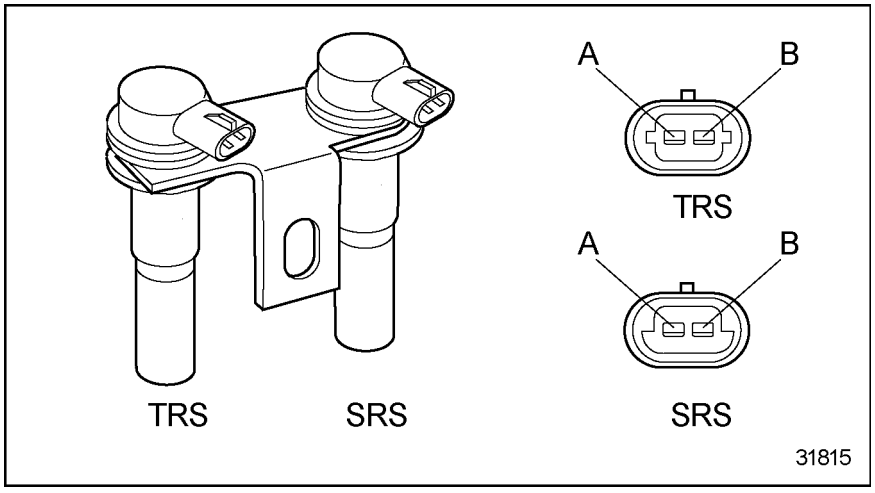


Figure 3-89 The SRS and TRS - Series 71 4/6V Engines

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

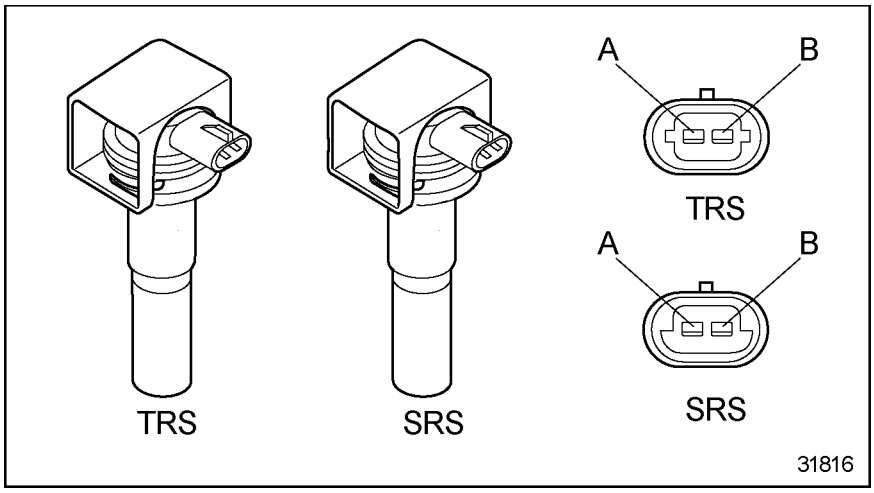


Figure 3-90 The SRS and TRS - Series 149, Series 92 12/16V Engines

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

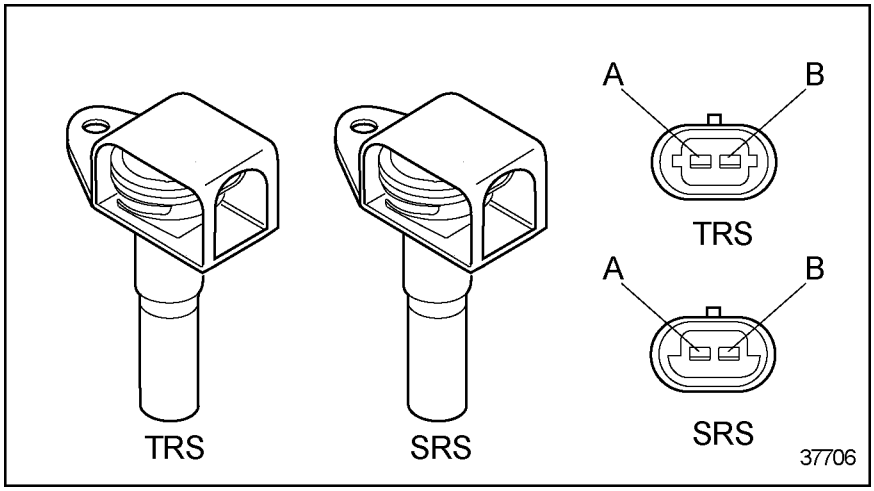


Figure 3-91 The SRS and TRS - Series 53 6V Engine

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.

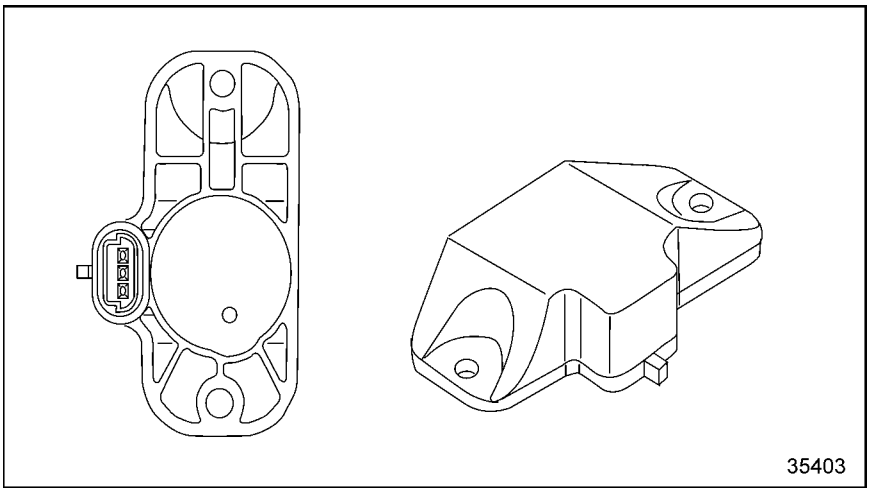


Figure 3-92 The Turbo Boost Sensor - On-highway Applications

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

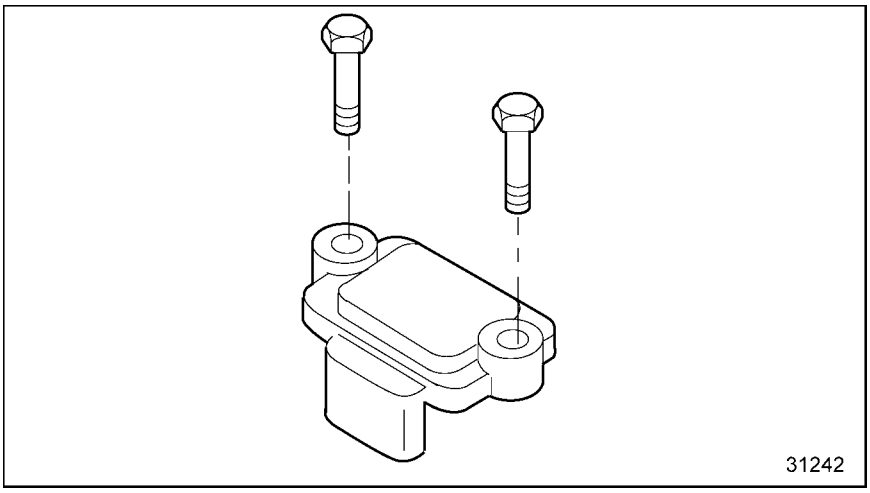


Figure 3-93 The Turbo Boost Sensor - Construction and Industrial Applications

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

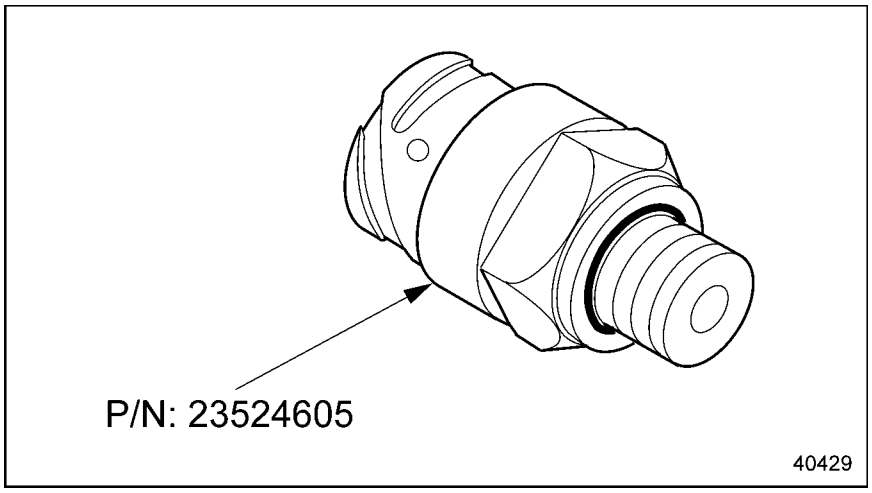


Figure 3-94 Turbo Boost Sensor - Series 2000 and Series 4000

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.

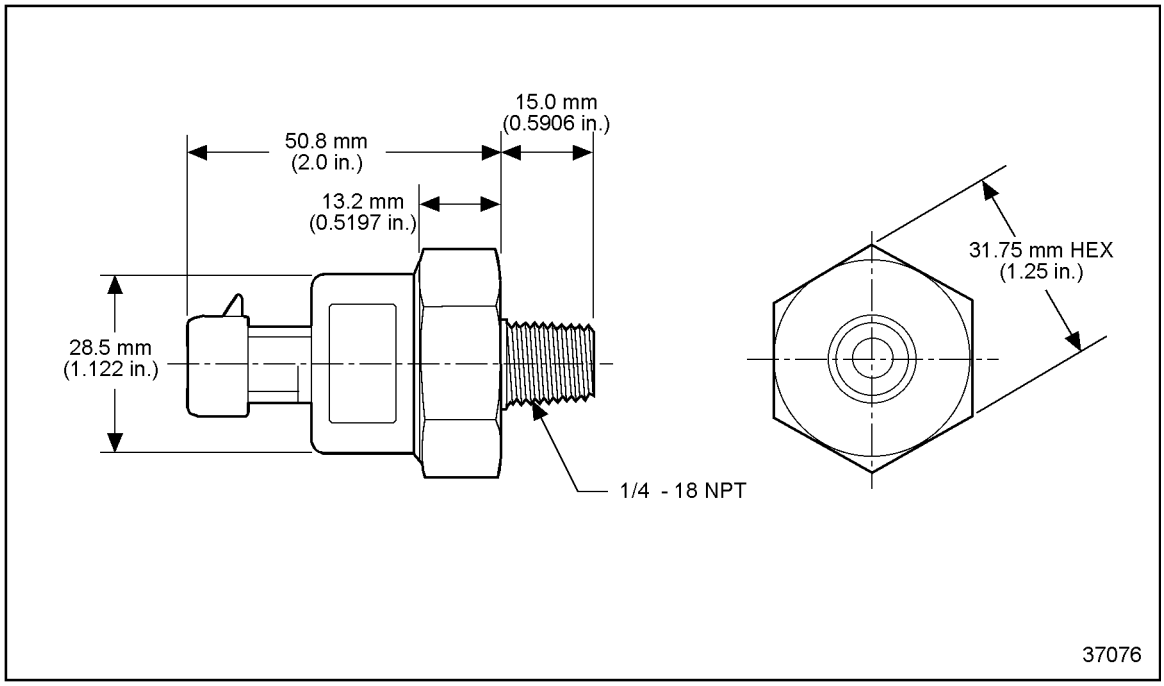
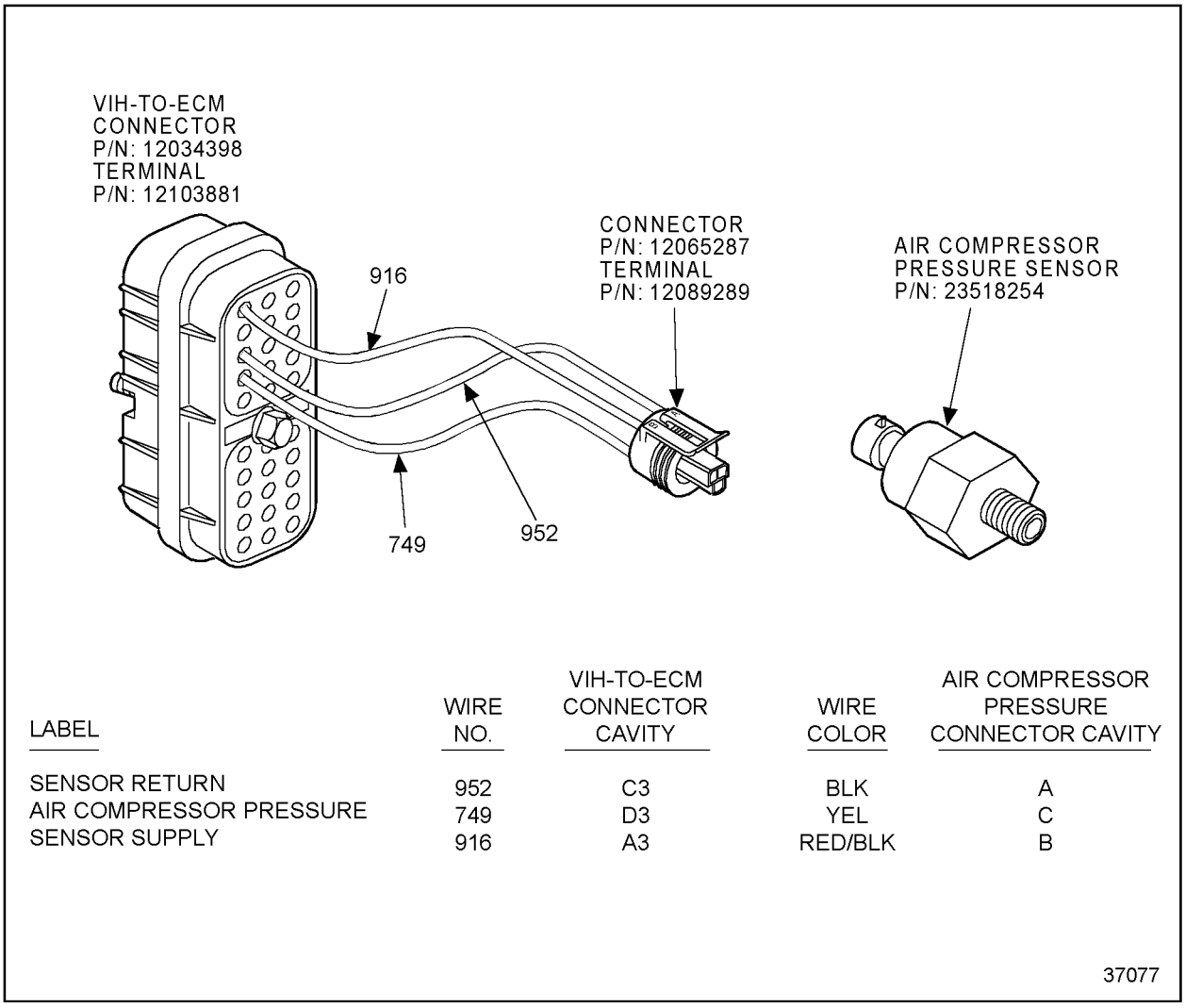


Figure 3-95 Air Compressor Pressure Sensor

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

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.

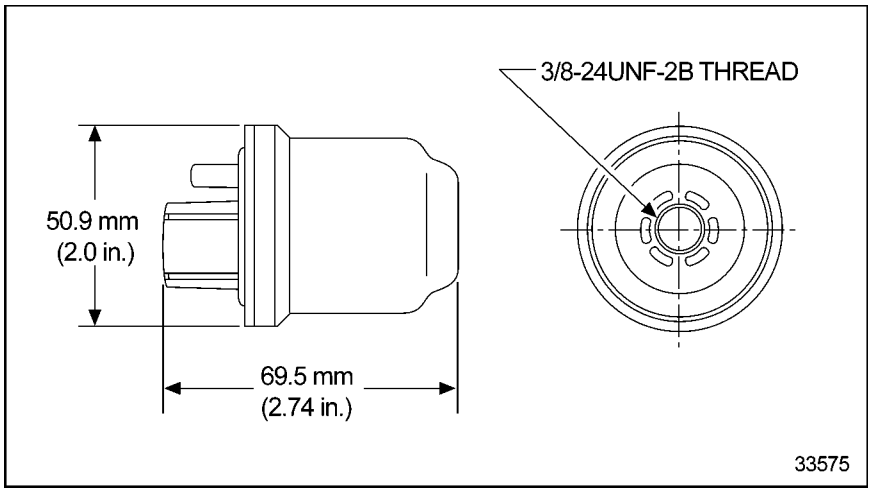
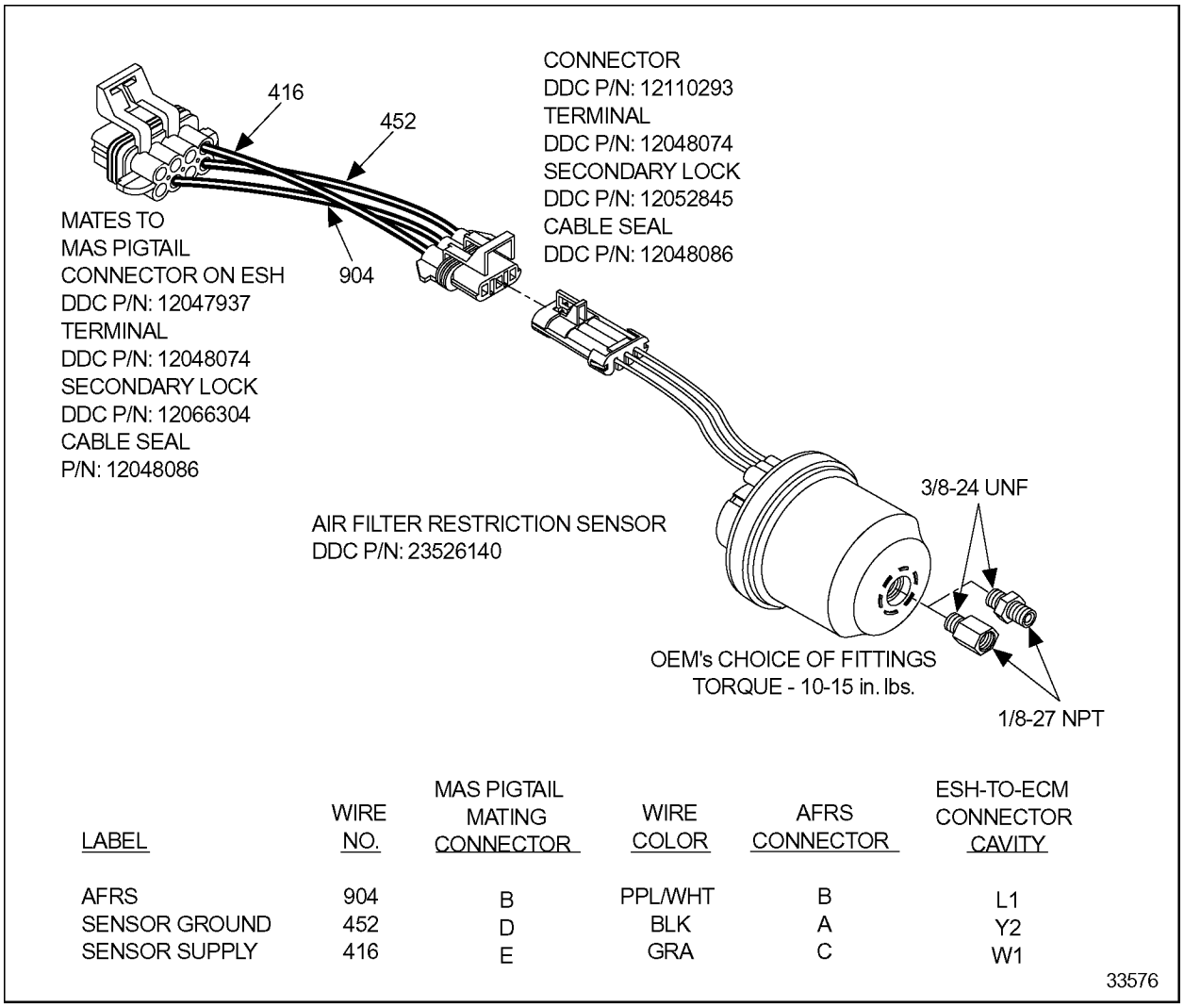


Figure 3-97 Air Filter Restriction Sensor

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

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.

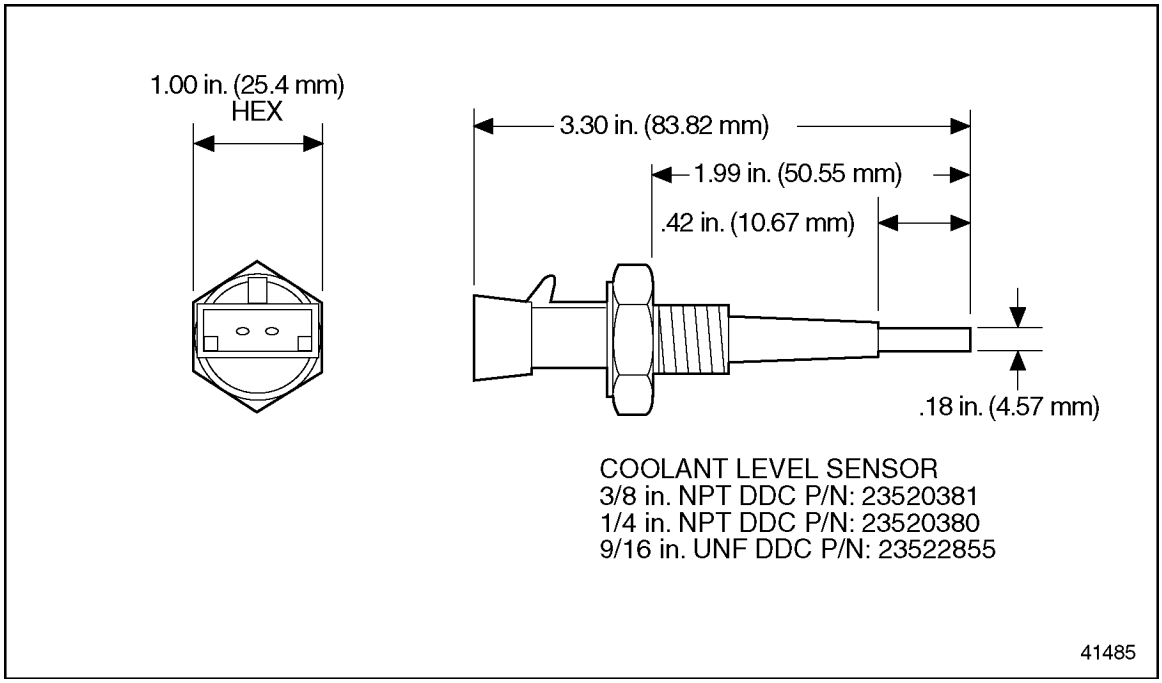


Figure 3-99 Coolant Level Sensor Specifications

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.

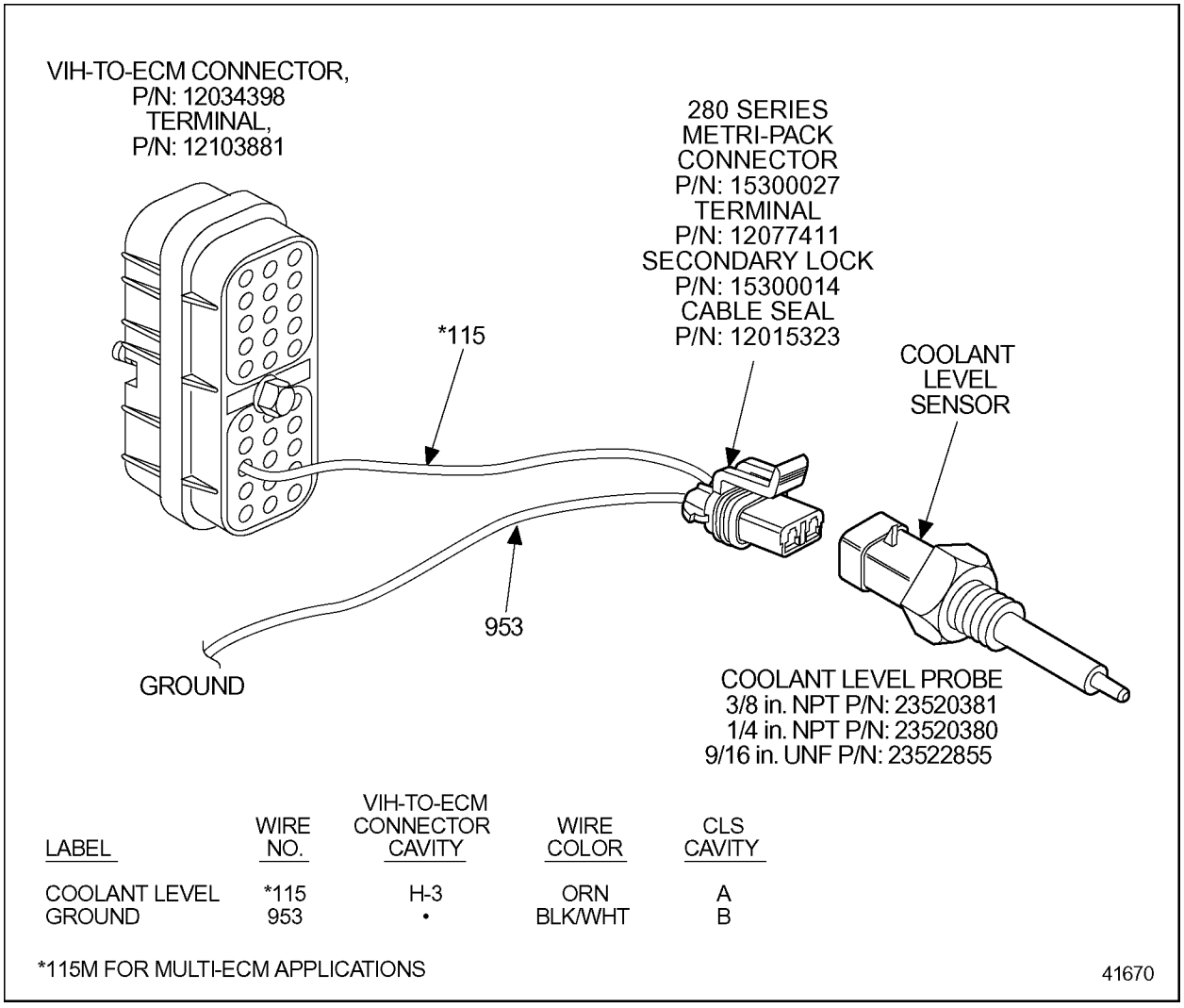


Figure 3-100 Coolant Level Sensor Installation

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.

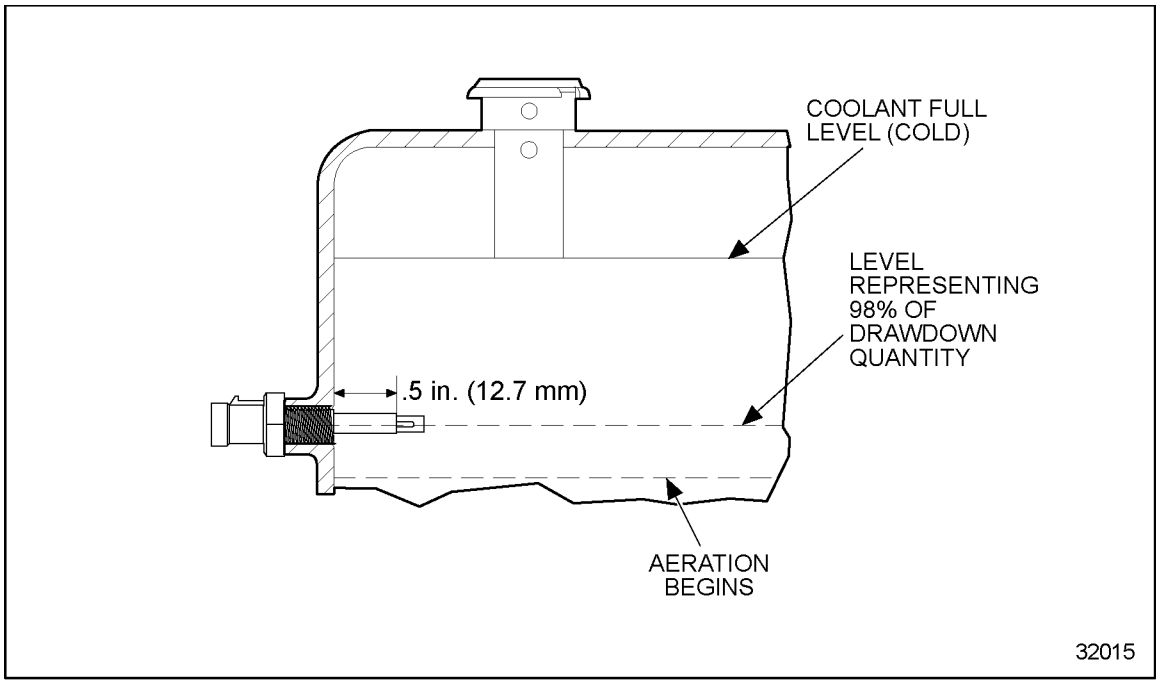


Figure 3-101 Coolant Level Sensor Location - Top of Radiator Tank

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).

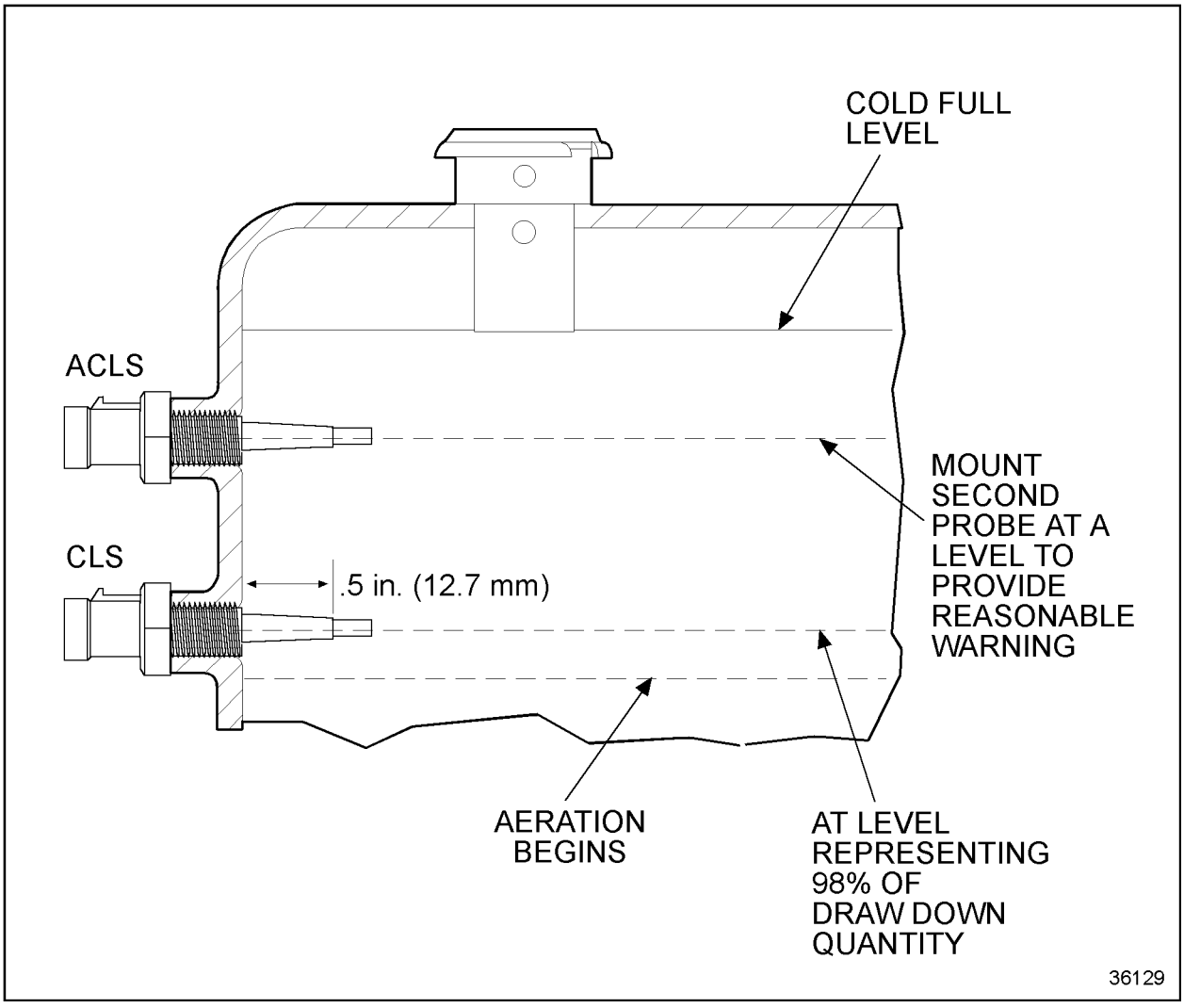
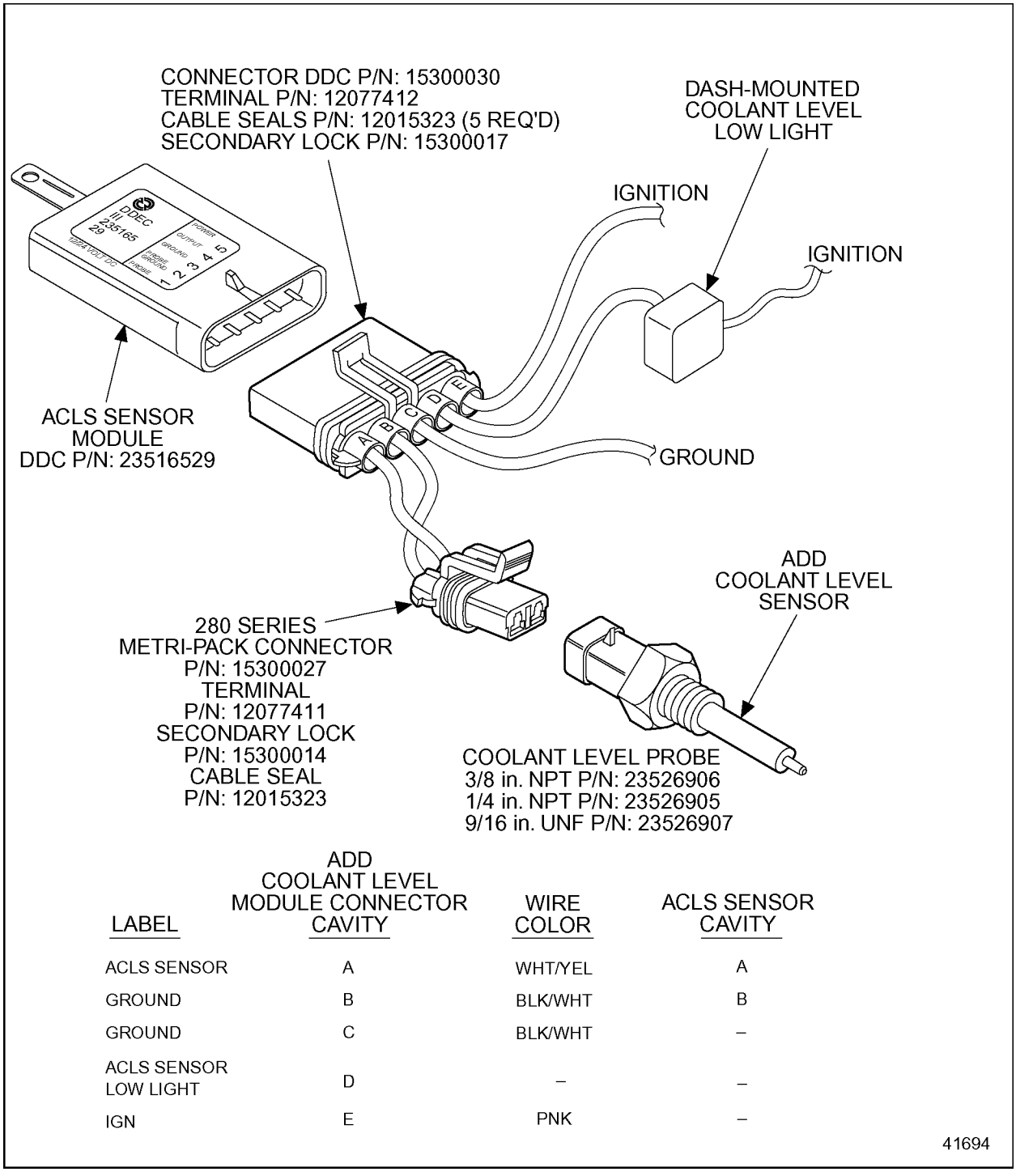


Figure 3-102 Add Coolant Level Sensor Location - Radiator Surge Tank

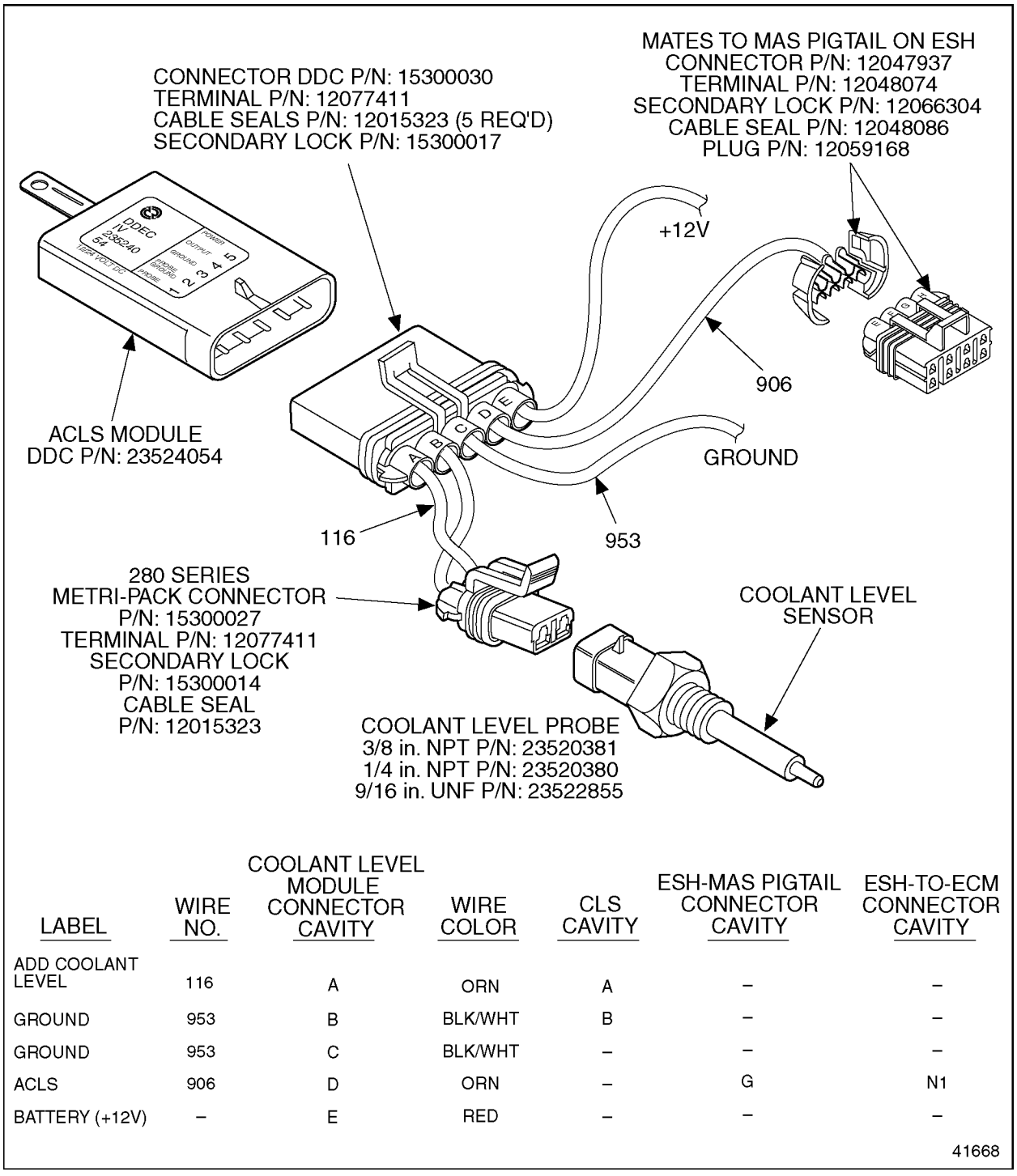
The ACLS probe is connected to a separate module. The module provides an output to drive an indicator light on the dash or can be used with the Maintenance Alert System. See Figure 3-103for the installation of a Coolant Level Low Light.



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	–

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.

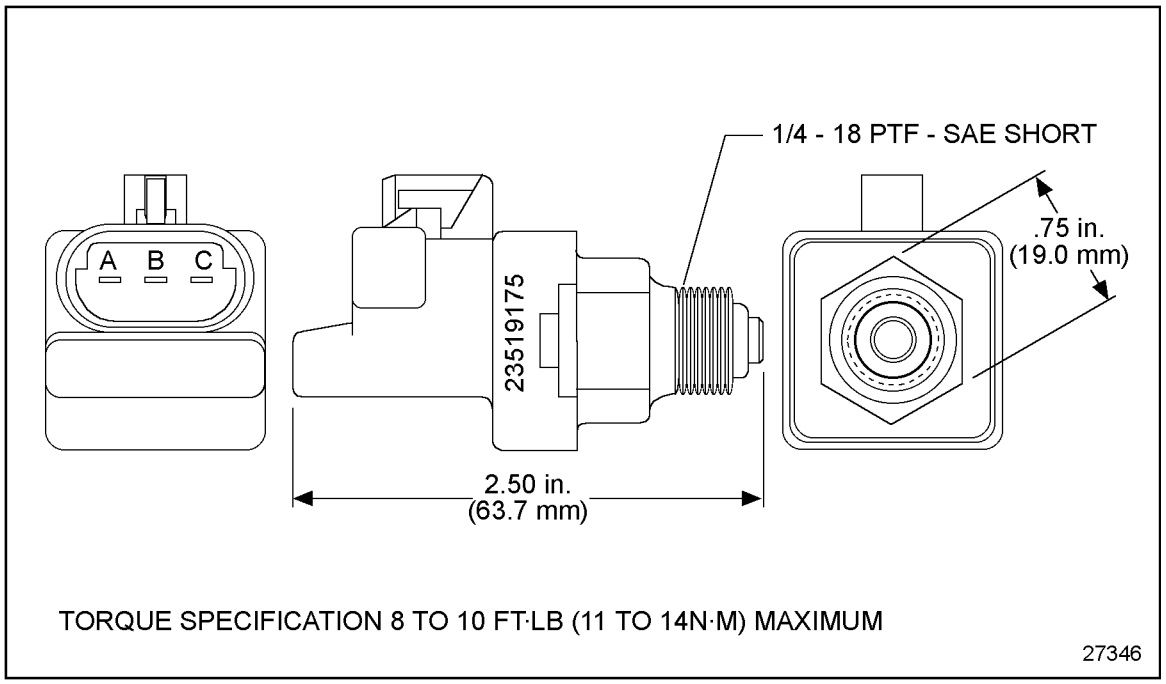


Figure 3-105 Optical Coolant Level Sensor Specifications

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.

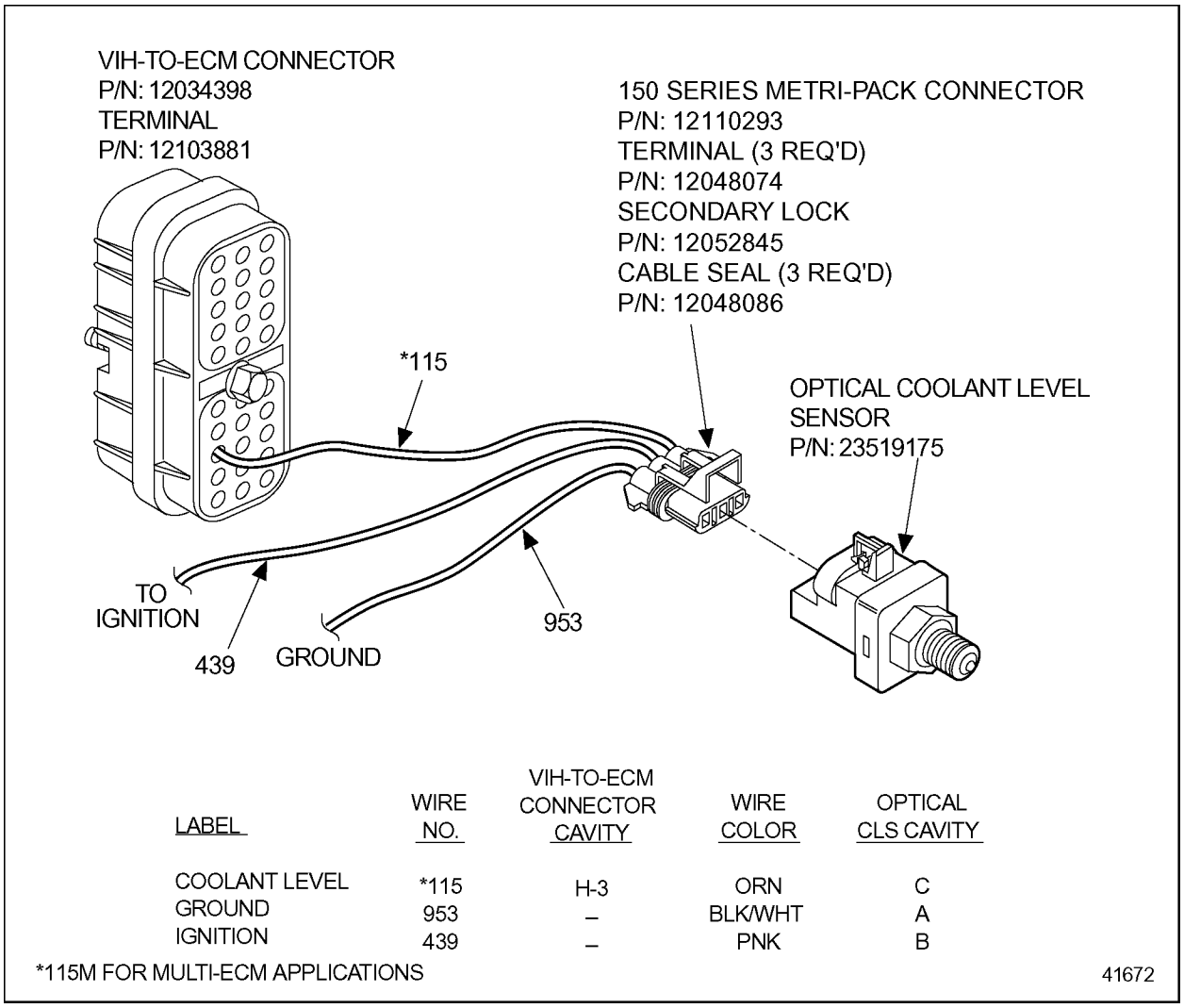


Figure 3-106 Optical Coolant Level Sensor Harness

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).

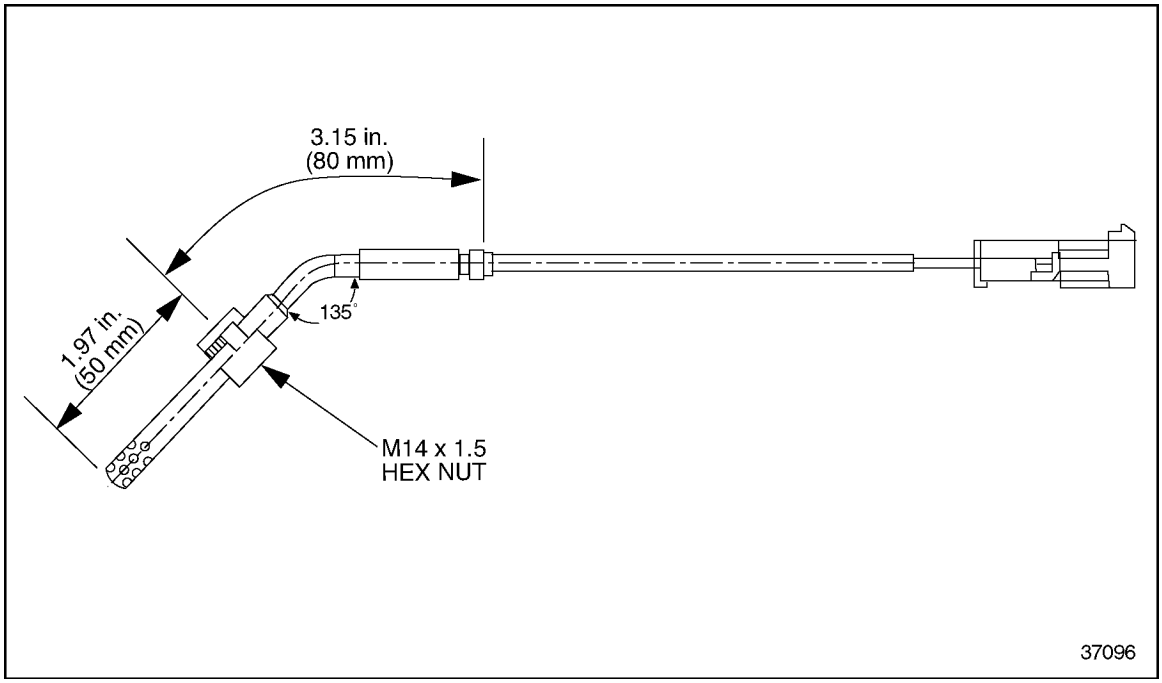


Figure 3-107 Exhaust Temperature Sensor

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.

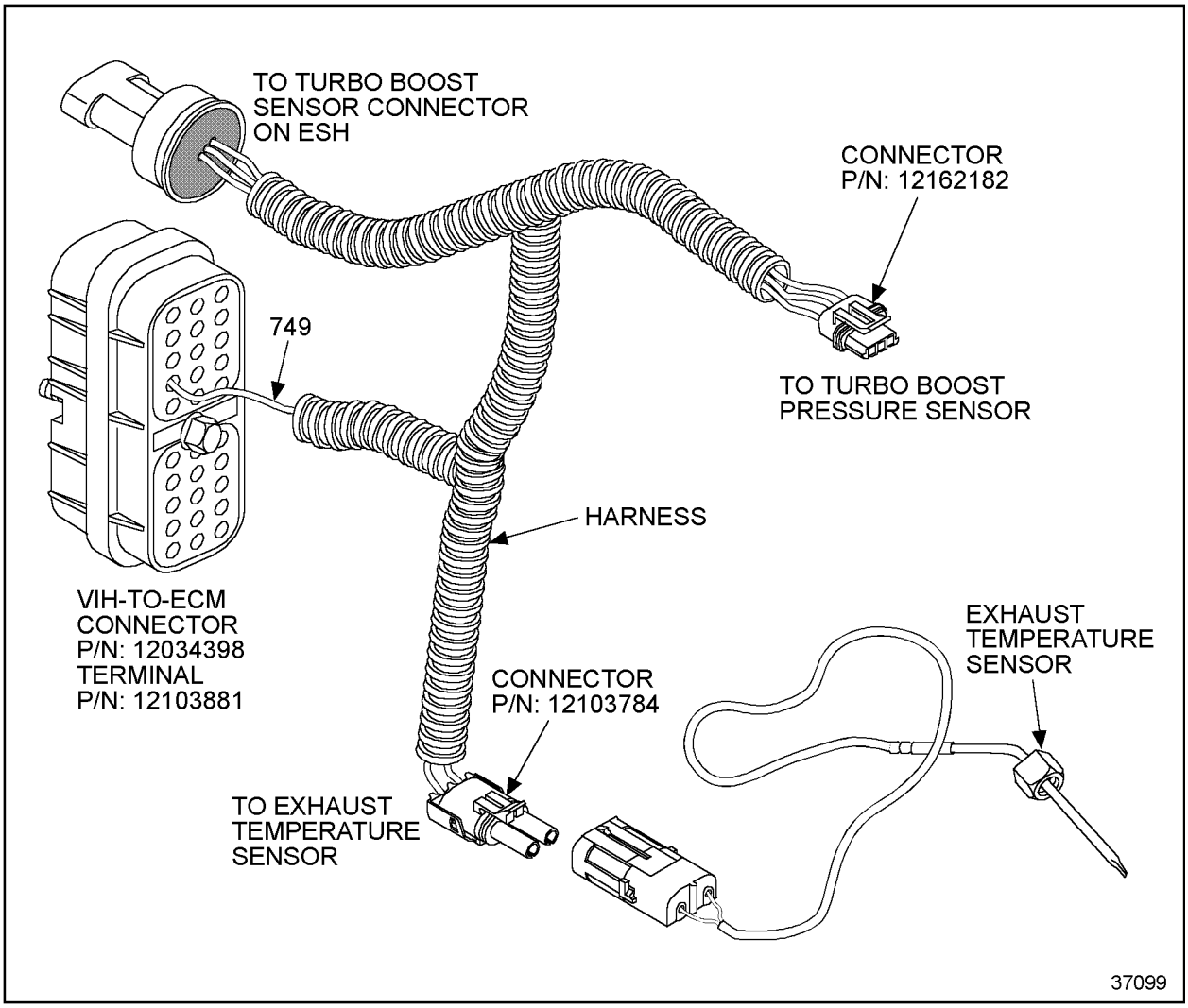


Figure 3-108 Exhaust Temperature Sensor Installation

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.

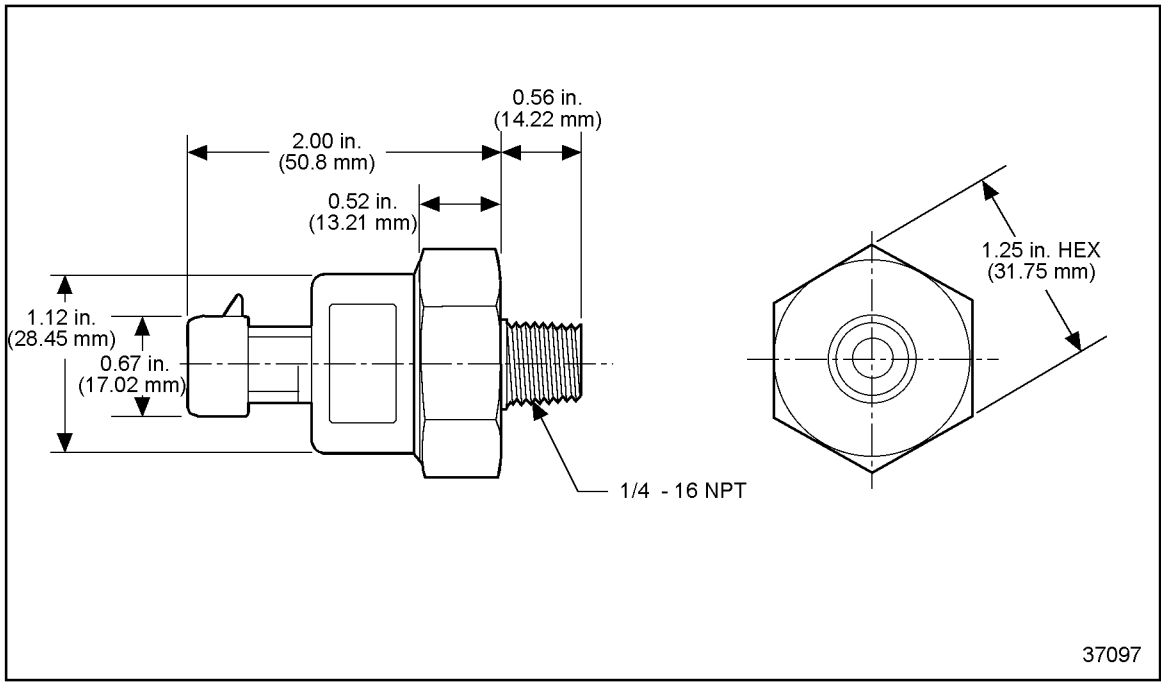


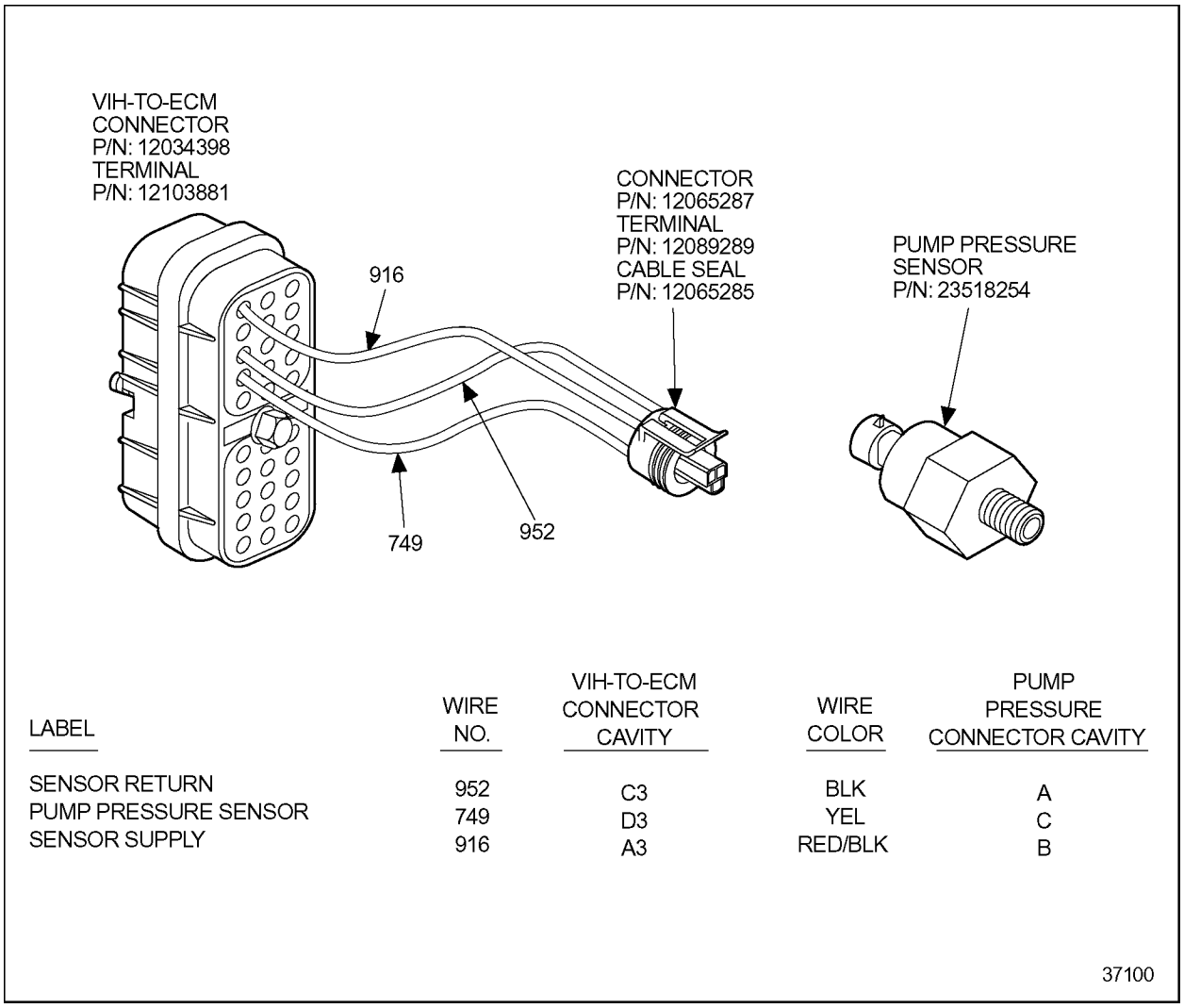
Figure 3-109 The Fire Truck Pump Pressure Sensor

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

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.

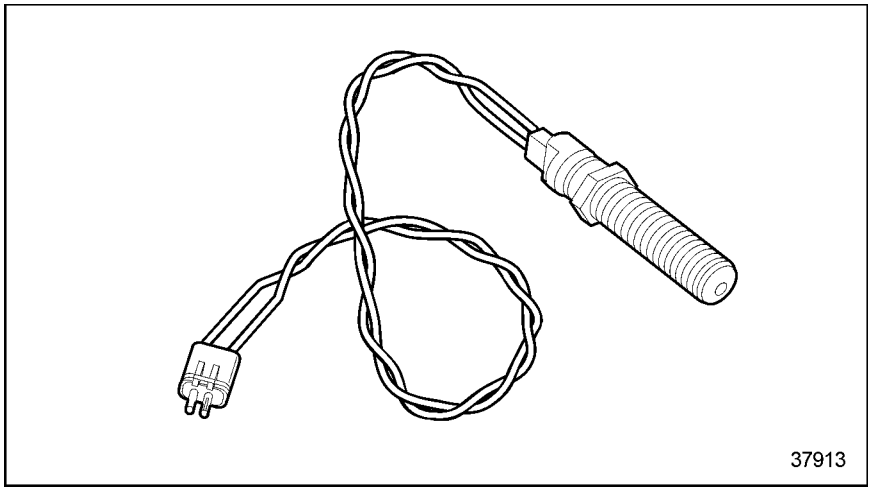


Figure 3-111 Vehicle Speed Sensor

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.

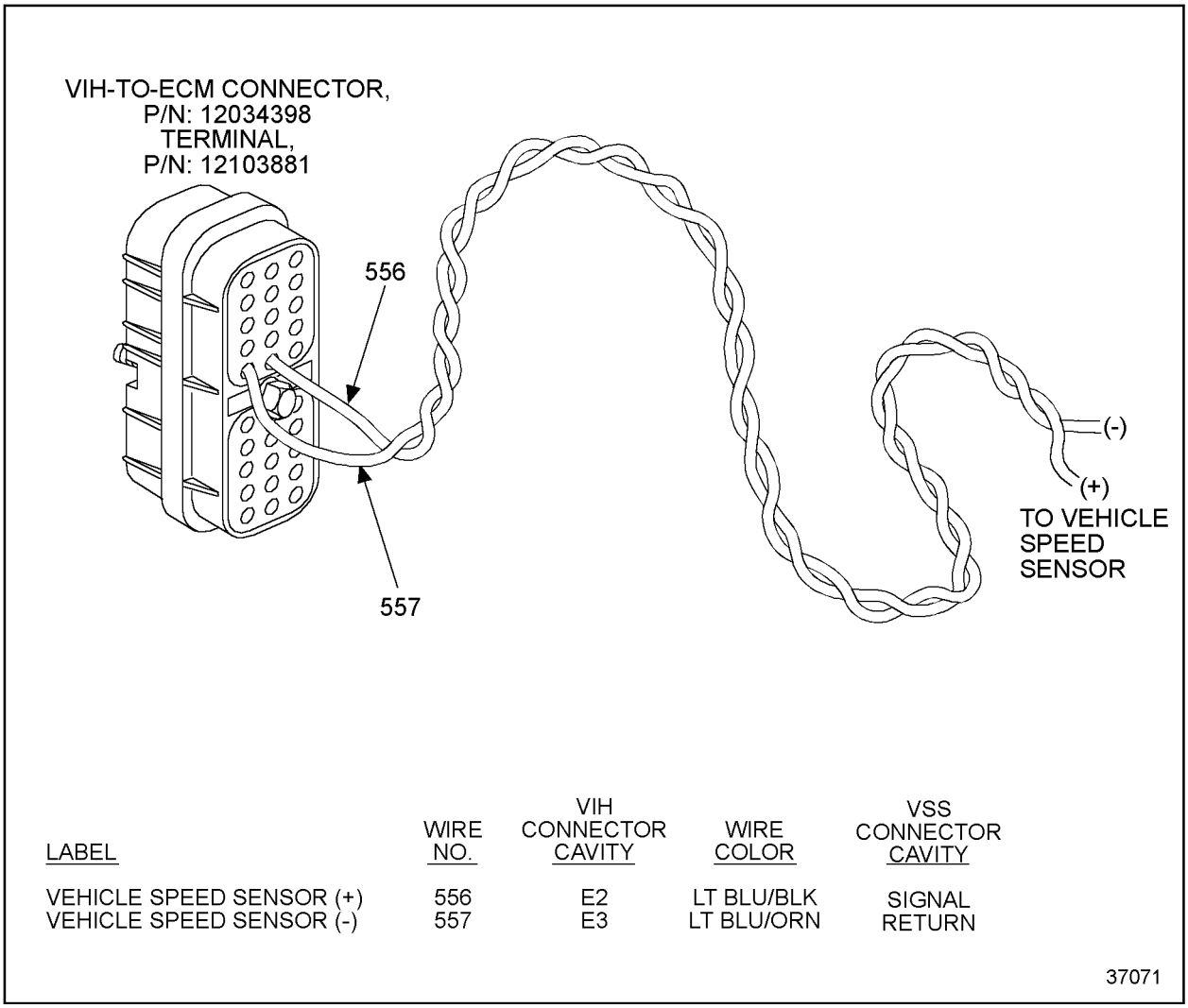


Figure 3-112 Magnetic Pickup Vehicle Speed Sensor Installation

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

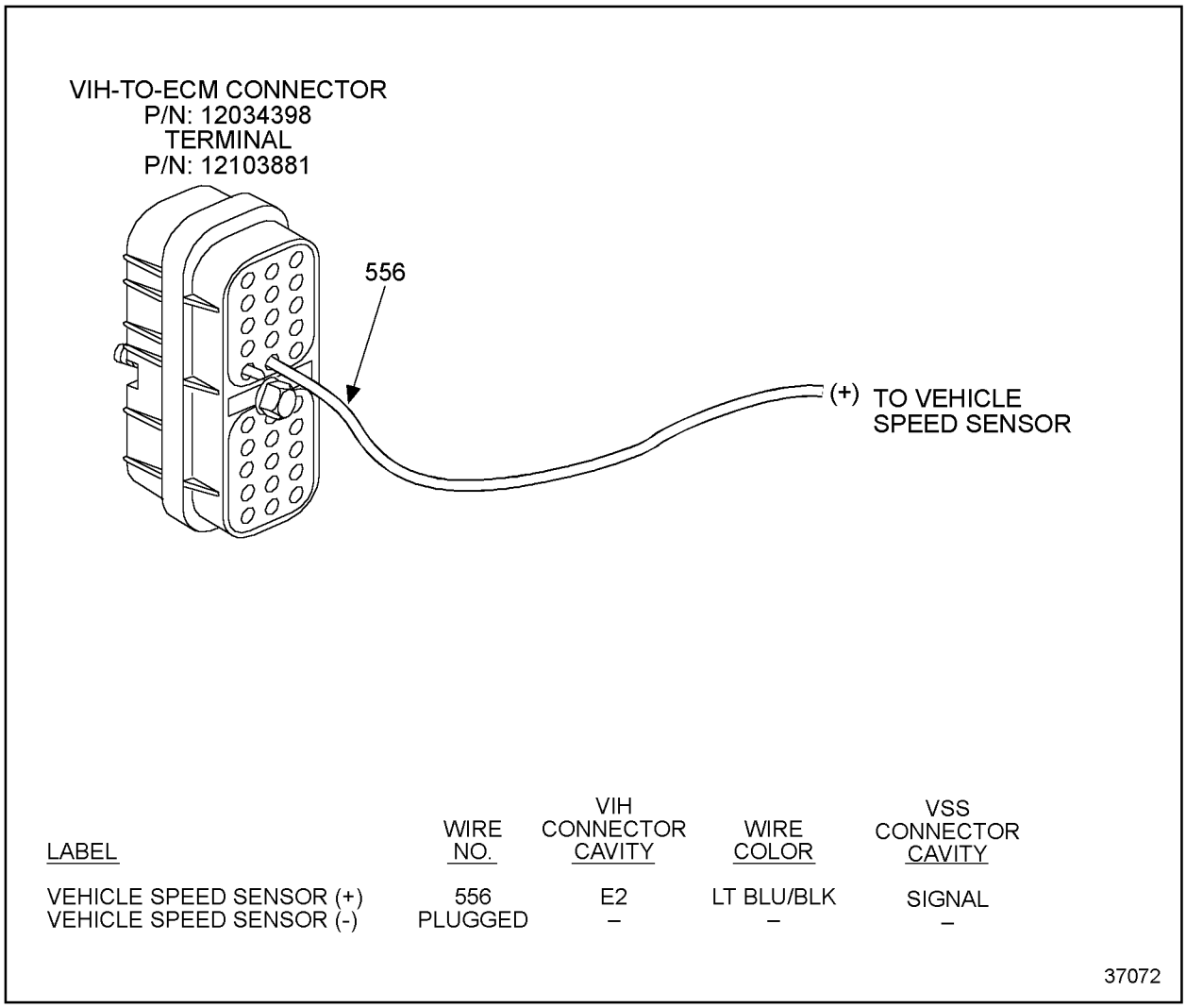
Wabash Technologies
1375 Swan Street
Huntington, Indiana 46750-0829
Tel: 219-356-8300
Fax: 219-356-3846

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	–	–	–

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.

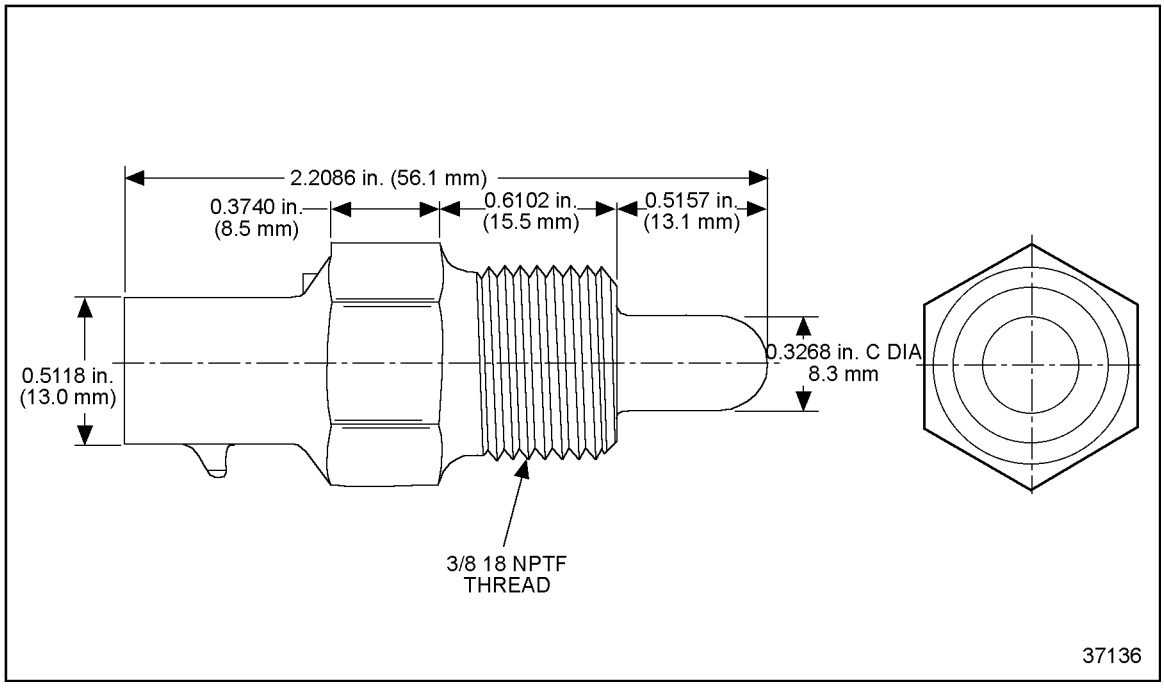


Figure 3-114 Ambient Air Temperature Sensor

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.

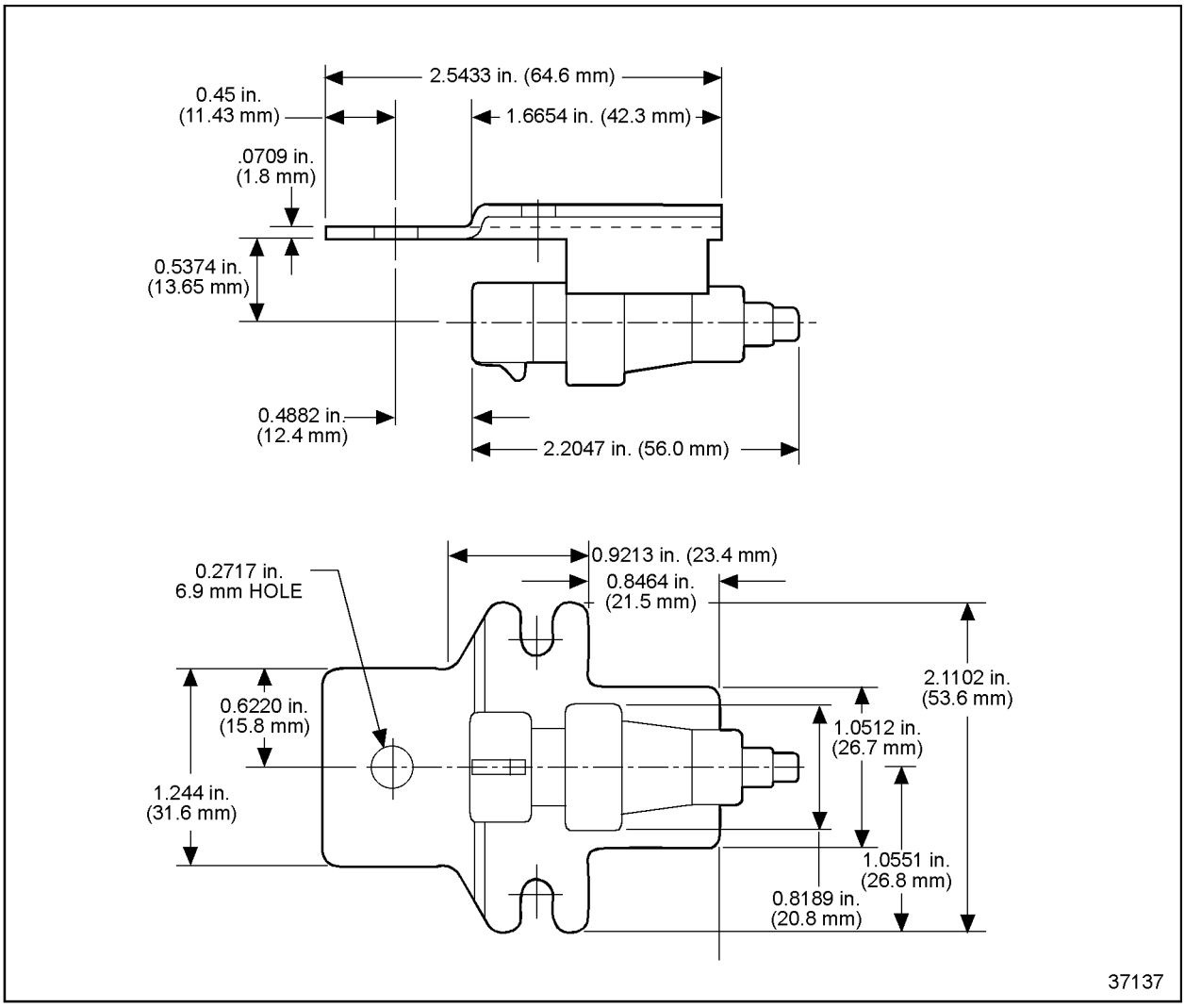


Figure 3-115 Ambient Air Temperature Sensor With Integrated Mounting Brackets

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.

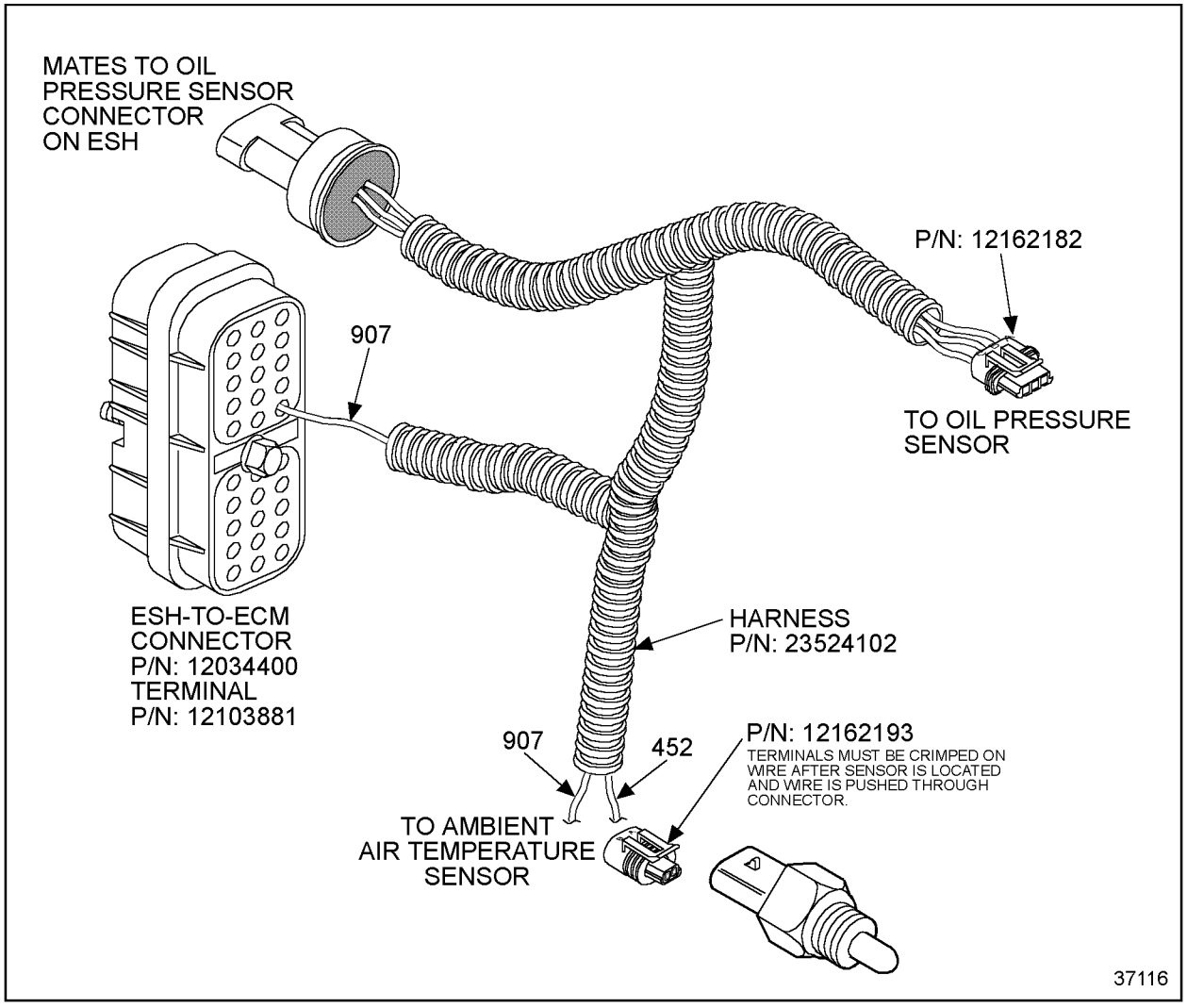


Figure 3-116 Ambient ATS Harness

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.

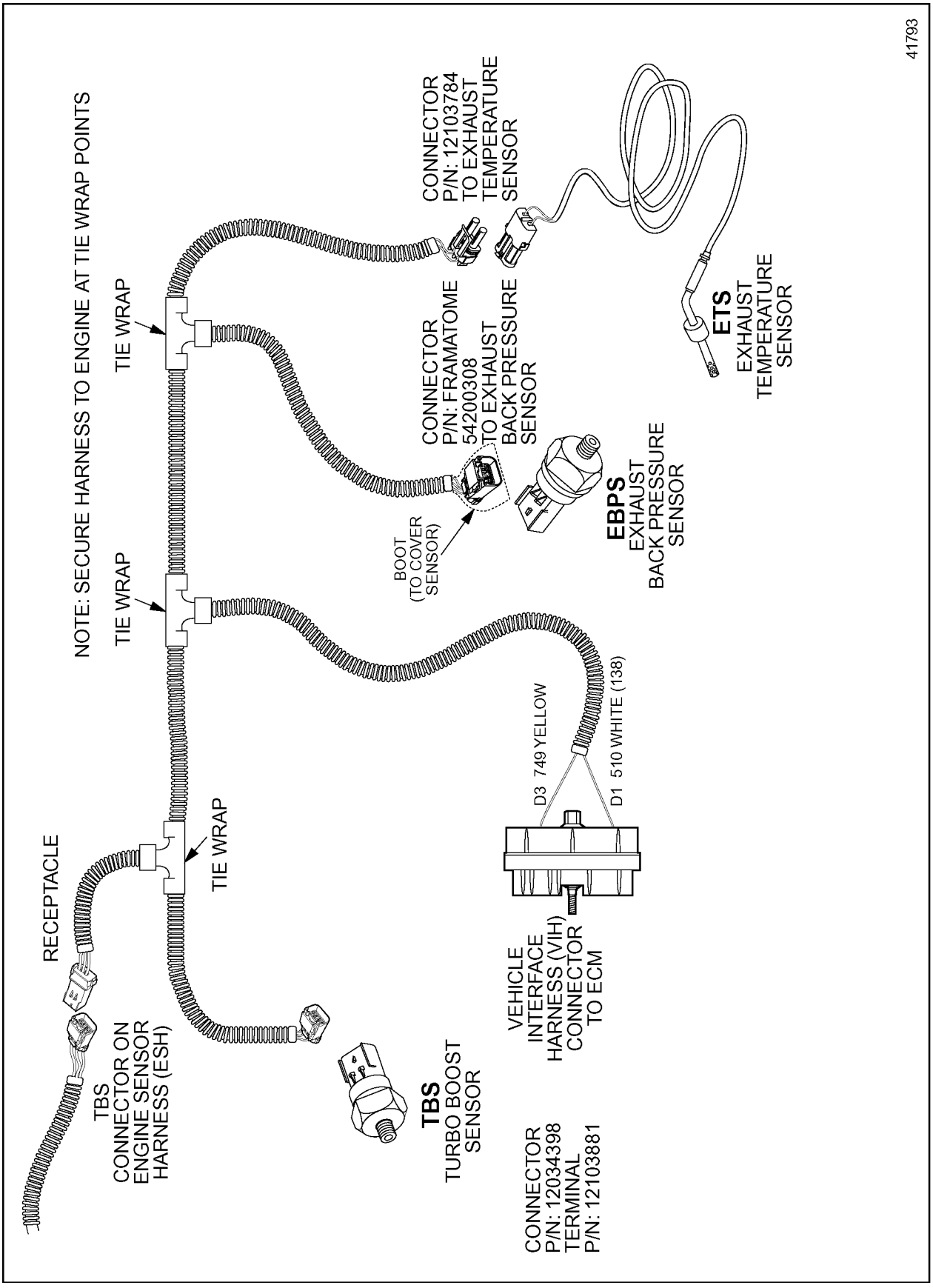


Figure 3-117 Exhaust Temperature and Pressure Sensor Harness

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.

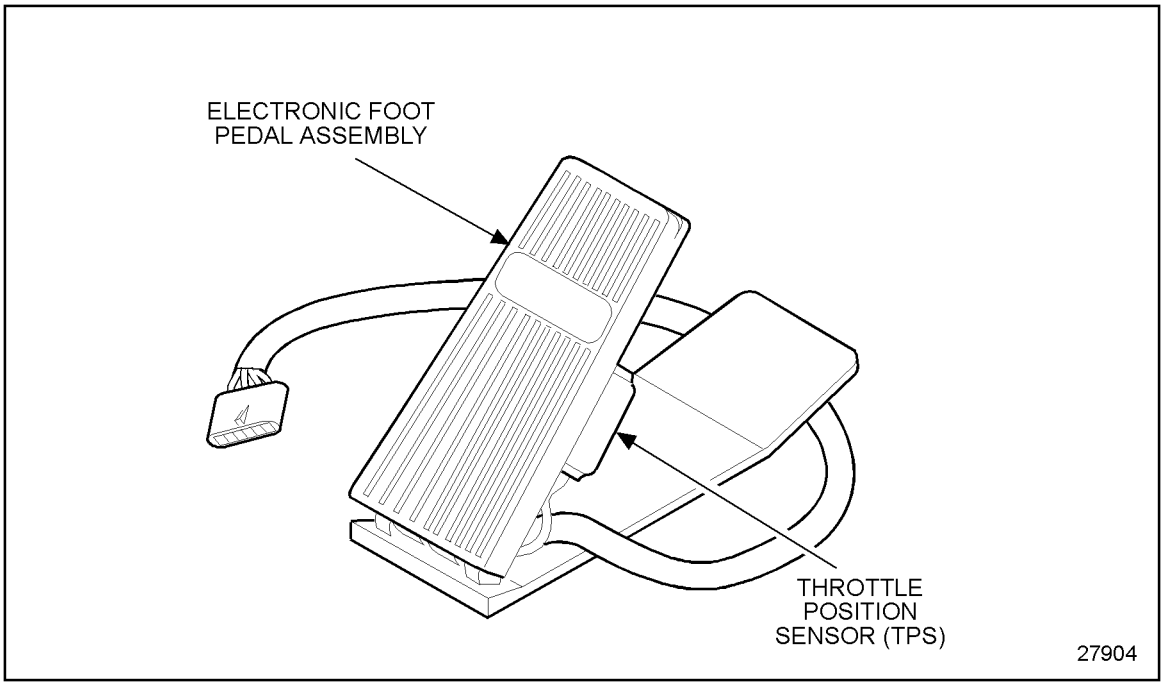

Figure 3-118 Typical EFPA Throttle Device (Shown with 6-pin Connector)

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.

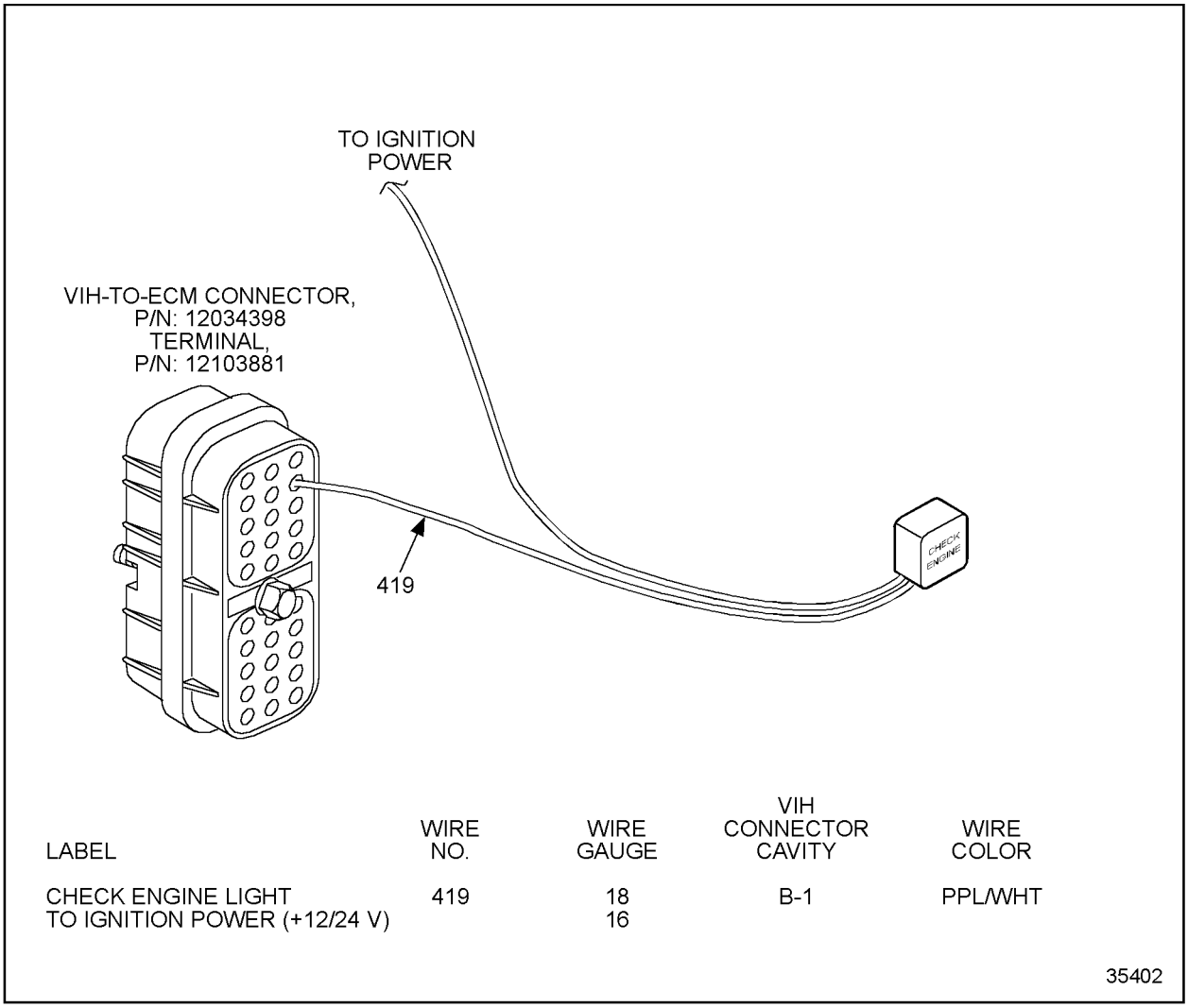
Check Engine Light Requirements and Guidelines

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.

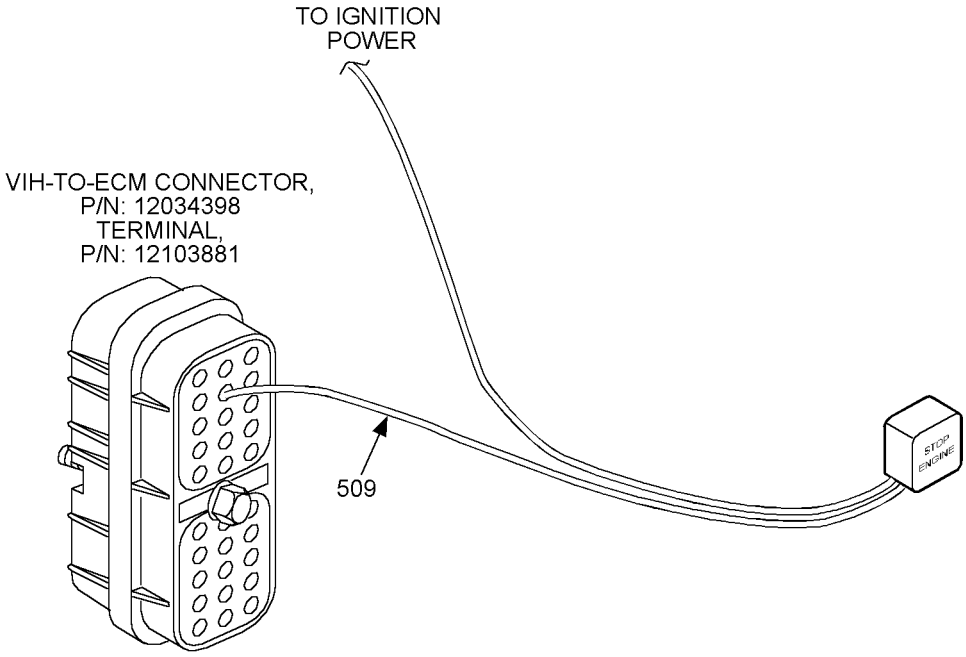
Stop Engine Light Requirements and Guidelines

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.

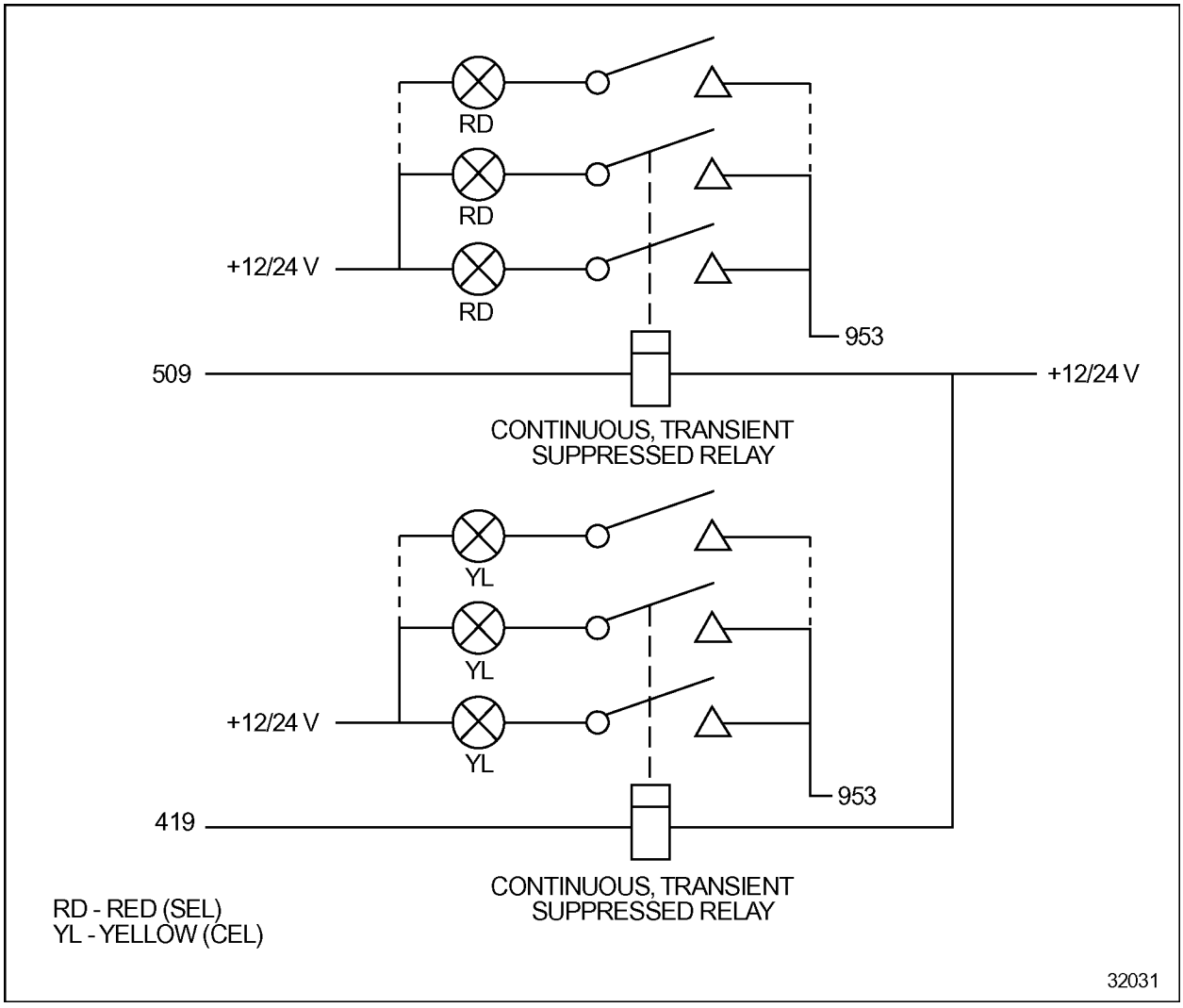


Figure 3-121 Multiple CEL/SEL Configuration - Single ECM Engine

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.

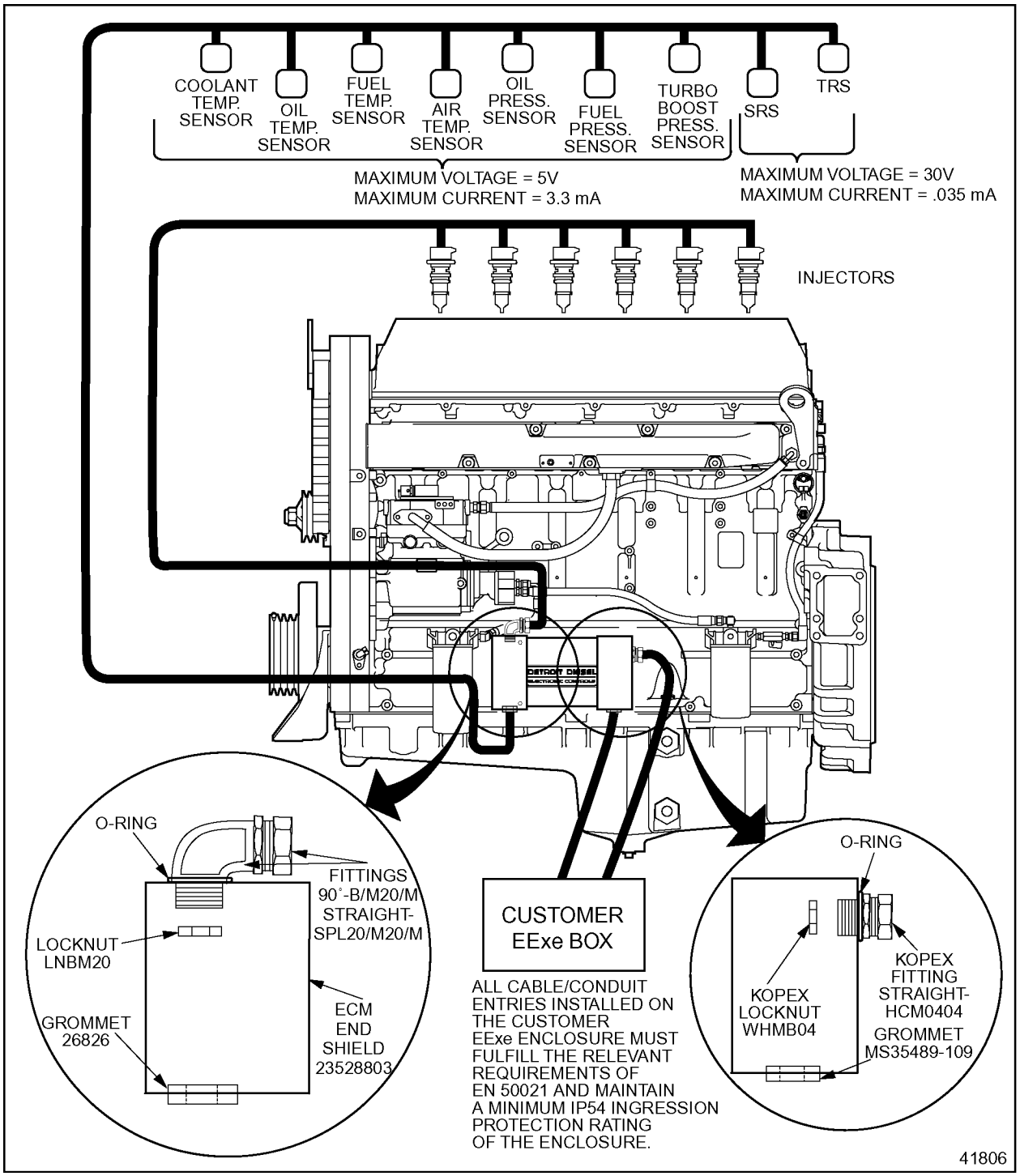

Figure 3-122 Series 50/Series 60 Engine-mounted ECM

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).

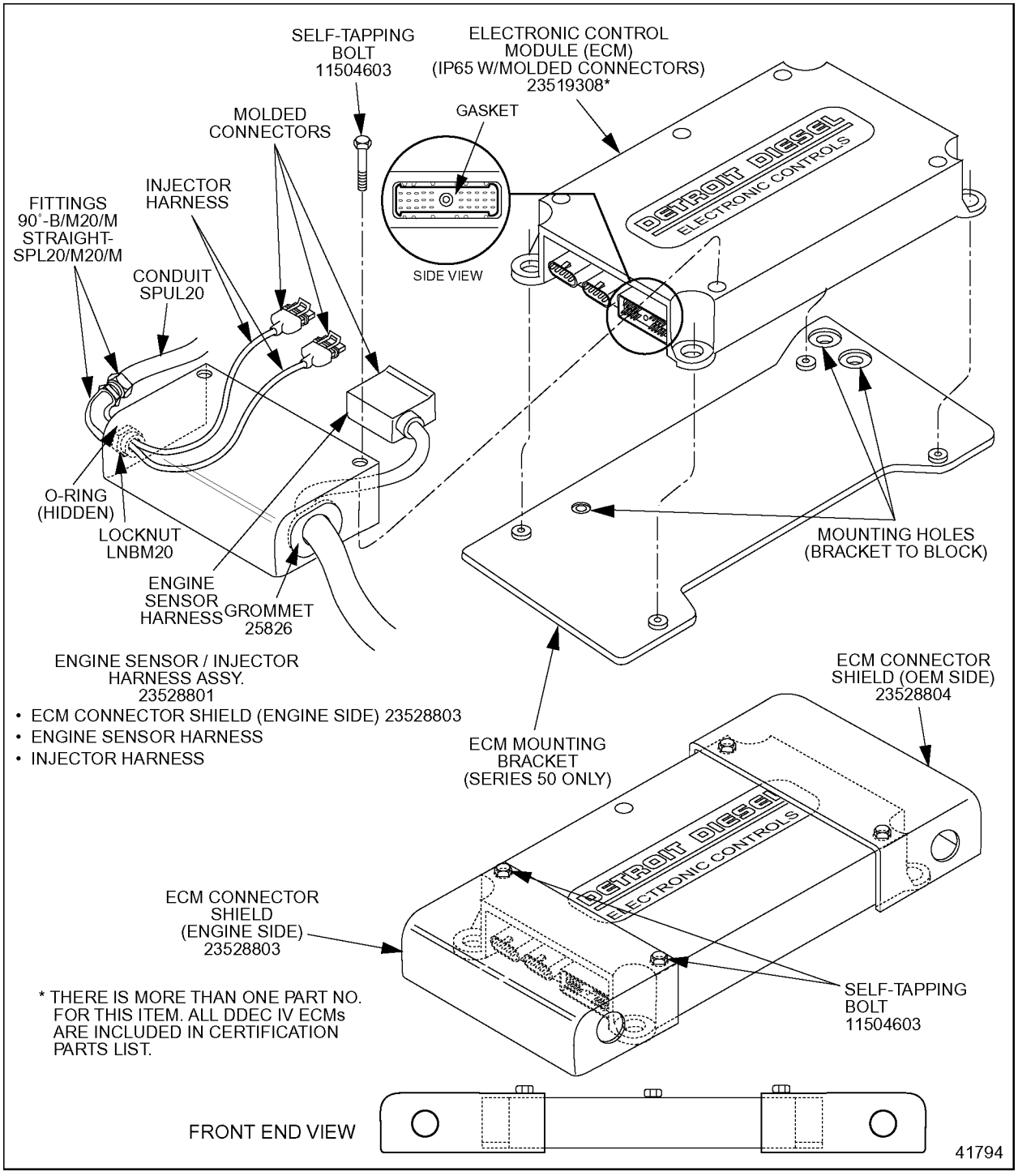

Figure 3-123 Series 50/Series 60 Engine Side Connectors, Cables, and Shield

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).

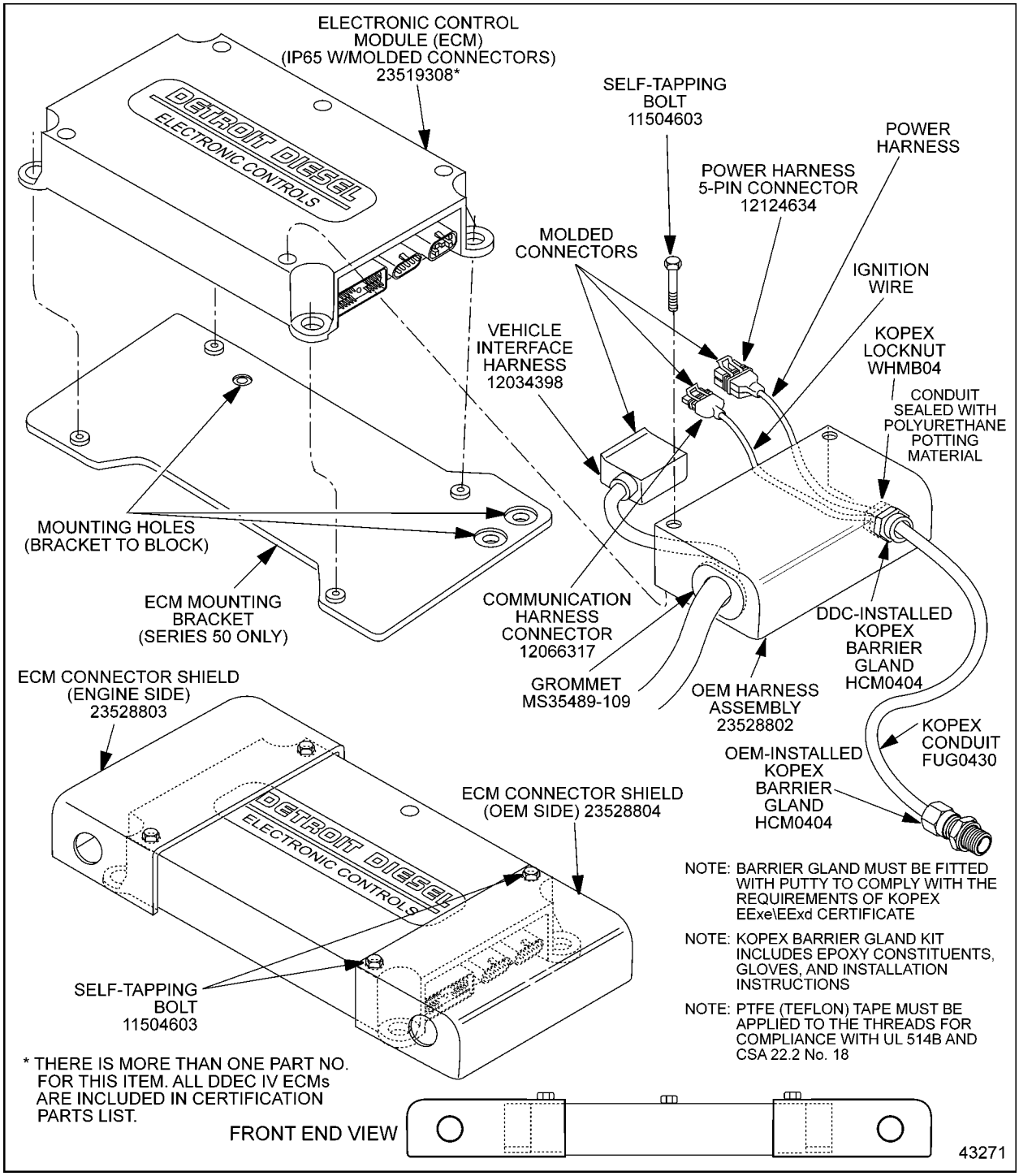

Figure 3-124 Series 50/Series 60 OEM Side Connectors, Cables, and Shield

The harness assembly is intended to be connected to the ECM connectors, cables, and shield 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.

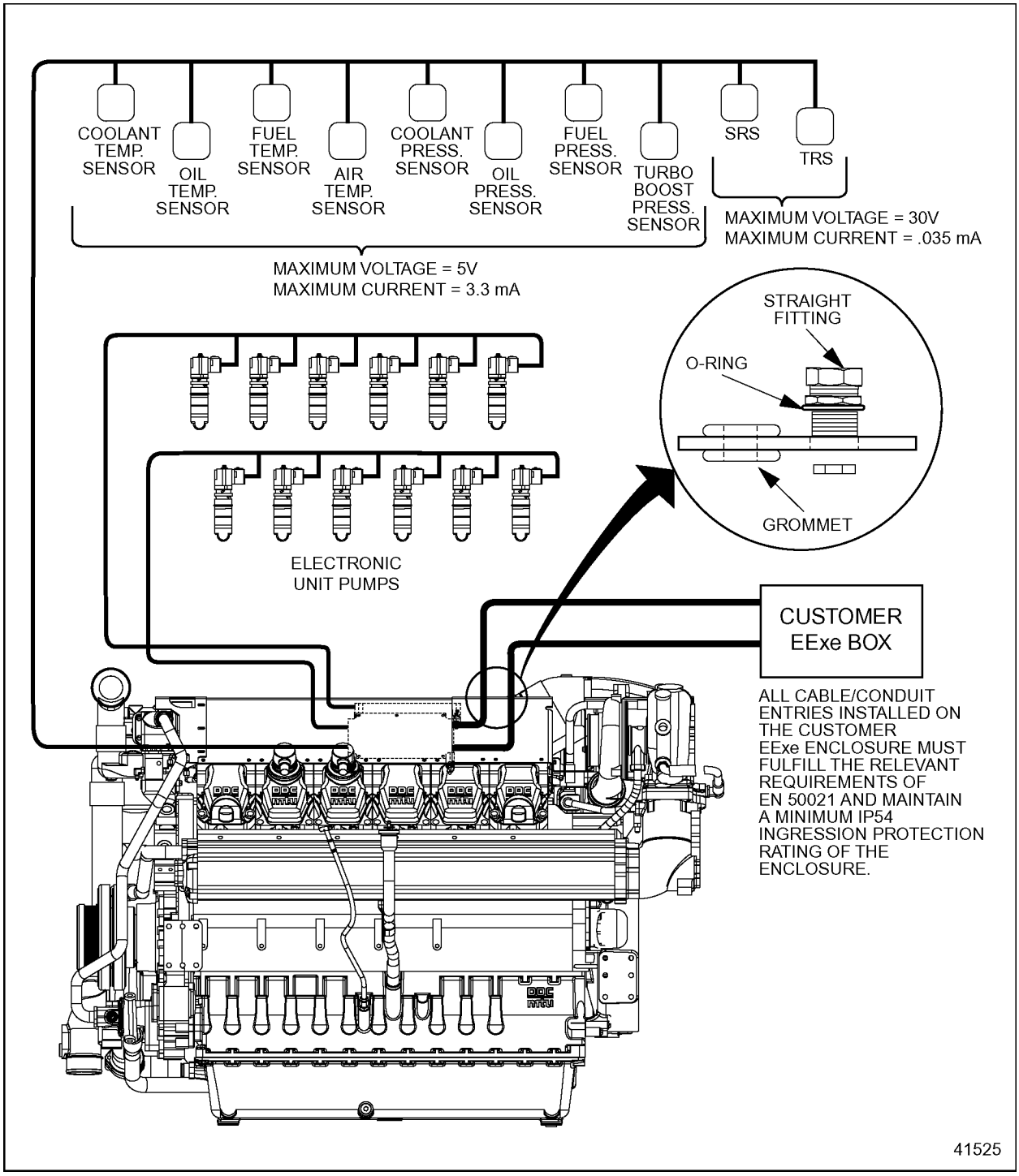

Figure 3-125 Series 2000 Engine-mounted ECMs

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).

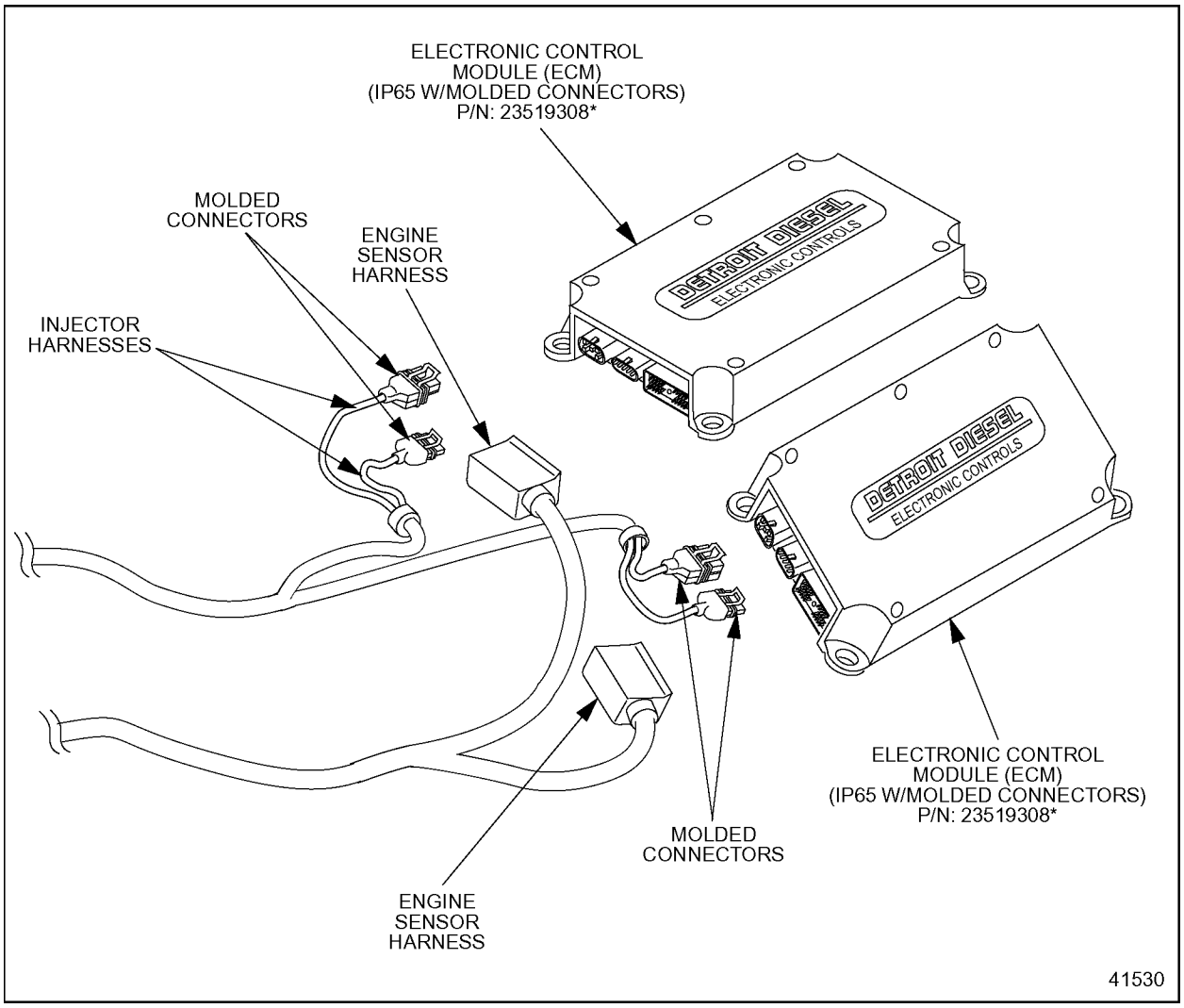

Figure 3-126 Series 2000 Engine Side Connectors and Cables

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).

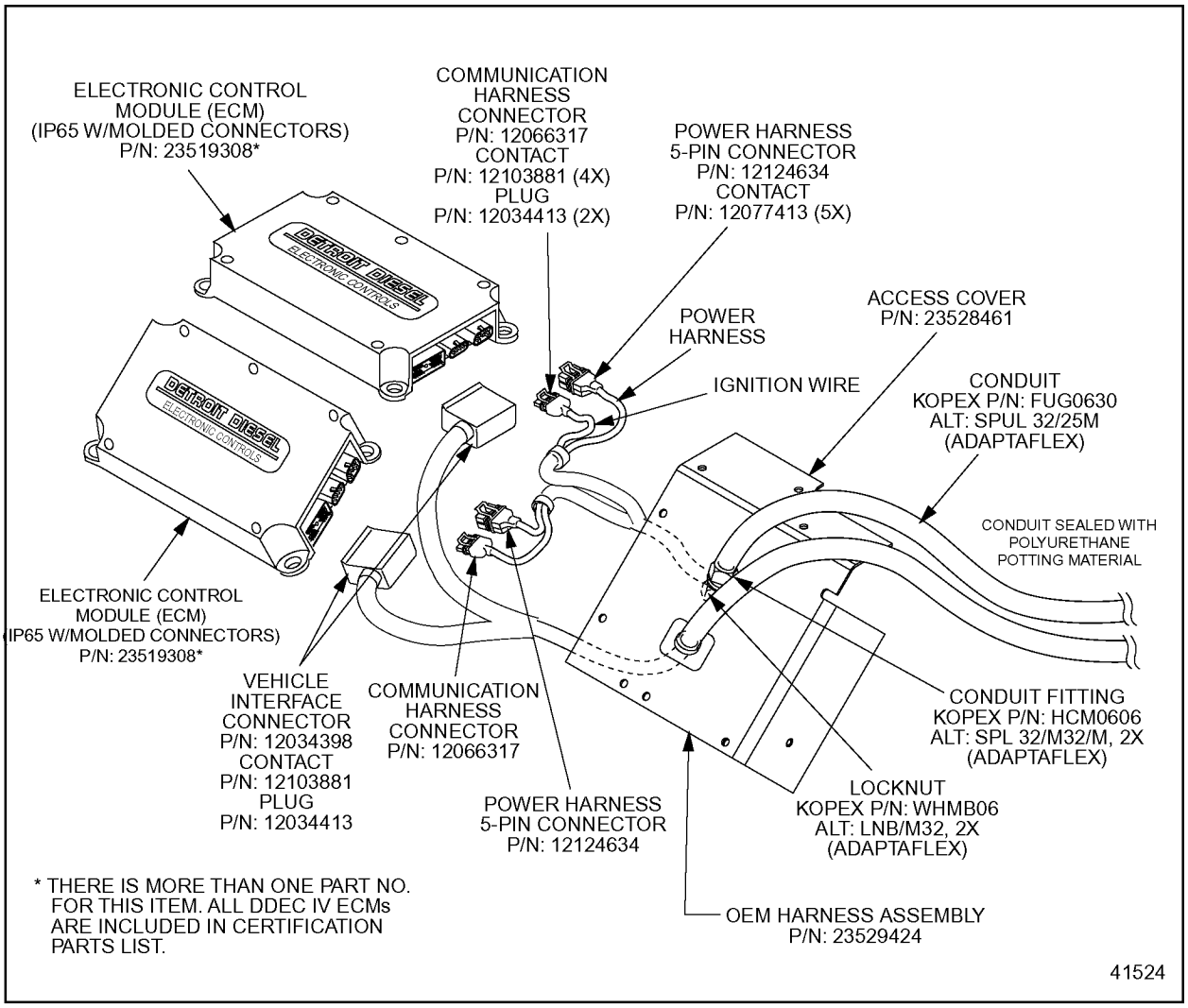

Figure 3-127 Series 2000 Equipment Side Connectors and Cables

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.