

Application and Installation

DDEC® V

DETROIT DIESEL
CORPORATION



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Printed in U.S.A.

**CALIFORNIA
Proposition 65 Warning**

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

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DDEC V APPLICATION AND INSTALLATION MANUAL

ABSTRACT

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

The detail provided will facilitate the following:

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

The manual is arranged as follows:

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

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

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

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1 INTRODUCTION

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

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

1.1 FEATURES

DDEC V offers significant operating advantages. The following features can be tailored to achieve specific customer preferences:

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

1.2 ADVANTAGES

DDEC V offers these advantages over previous DDEC releases:

- Utilizes New Connectors for Improved Reliability and Harness Design
- More Input and Output Pins (up to 136 vs 81)
- More flexible inputs - 57 Analog channels vs 19 Analog + 12 Digital in DDEC IV. Up to 27 of these input channels can be configured as Digital inputs
- Frequency inputs: 6 vs 4
- Digital outputs: 19 (8 Hi, 11 Lo) vs 10 (2 Hi, 8 Lo)
- PWM outputs: 6 vs 4 (Lo side)
- Has full support for J1587 and J1939 Data Links

DDEC V offers end users significant operating advantages such as:

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

1.3 TYPICAL INSTALLATION

A typical installation includes:

- A fused ignition wire to the ECU
- An Engine Harness from the engine-mounted sensors and the fuel injection system to the ECU
- An OEM supplied Vehicle Interface Harness (VIH) connecting the remaining sensors, switches, throttle devices, and other components to the ECU, connecting the SAE J1939 ports to other vehicle systems, and supplying 12 or 24 volts to the ECU
- Display devices (lights, tachometer, etc.)

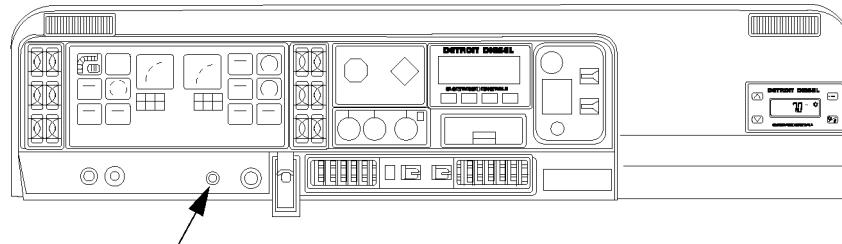
1.4 APPLICATION FLEXIBILITY

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

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

1.5 DIAGNOSTICS AND TOOLS

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

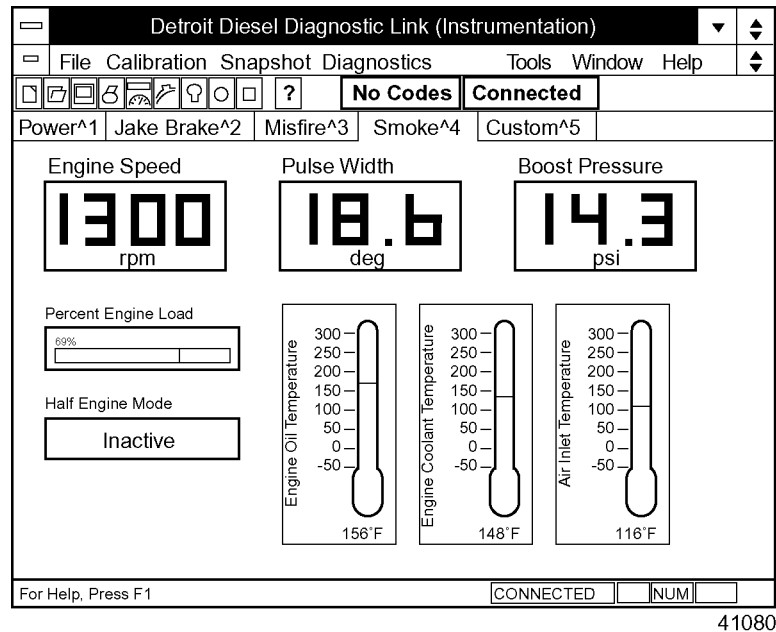


Diagnostic Request Switch

41079

The DDEC ECU provides engine control and monitoring as well as a stored summary of engine performance. Data can be extracted and analyzed with PC software products such as DDEC Reports, ProDriver Reports, and Detroit Diesel Data Summaries. All these products allow printing of comprehensive reports for managing vehicle operation.

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

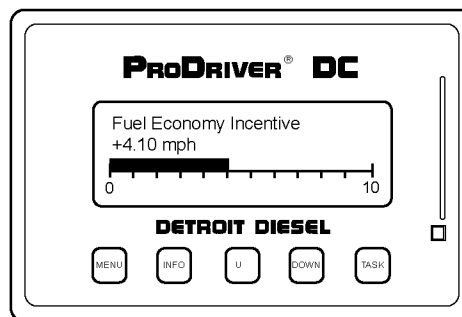


41080

1.6 ELECTRONIC DISPLAYS

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

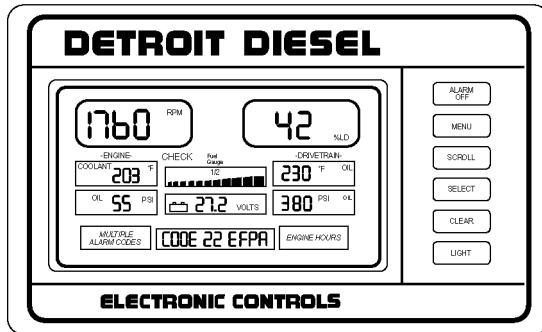
A panel-mounted ProDriver DC display shows operational data such as instantaneous fuel economy and idle time.



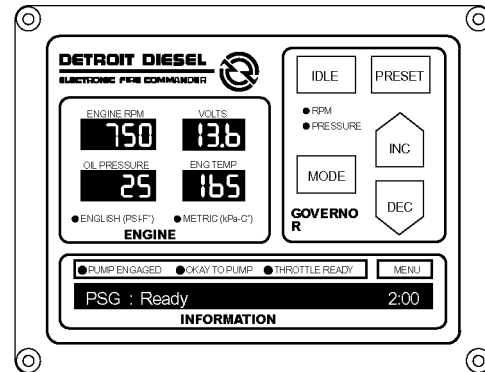
ProDriver DC

43772

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



ELECTRONIC DISPLAY MODULE



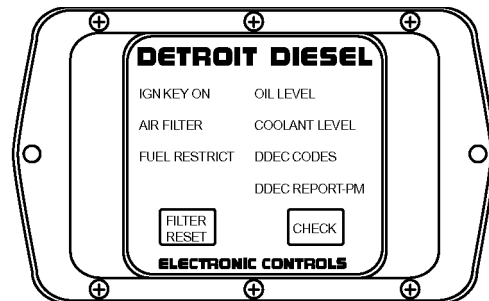
ELECTRONIC FIRE COMMANDER

41082

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



OPTIMIZED IDLE



MAINTENANCE ALERT SYSTEM

41083

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

1.7 THE BASICS

The ECU is the most important component of the DDEC system, as it controls the engine operation and acts as an interface with the other subsystems and devices, such as the SAE J1587 or J1939 data links.

In these roles, the ECU adjusts engine speed and torque by transmitting output signals to the injector solenoids and interacts with the other subsystems by:

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

The ECU adjusts engine speed and torque after:

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

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

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

The ECU also:

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

2 SAFETY PRECAUTIONS

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



WARNING:

PERSONAL INJURY

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

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

2.1 STANDS

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

2.2 GLASSES

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

2.3 WELDING

Consider the consequences of welding.

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

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

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

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

2.4 WORK PLACE

Organize your work area and keep it clean.

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

Eliminate the possibility of a fall by:

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

A fall could result in a serious injury.

After installation of the engine is complete:



WARNING:

PERSONAL INJURY

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

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

2.5 CLOTHING

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



WARNING:

PERSONAL INJURY

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

2.6 ELECTRIC TOOLS

Improper use of electrical equipment can cause severe injury.



WARNING:

ELECTRICAL SHOCK

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

Check power tools before using.

2.7 AIR

Use proper shielding to protect everyone in the work area.

 WARNING:

EYE INJURY

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

2.8 DIAGNOSTIC TOOLS

For mobile applications, the vehicle operator must maintain control of the vehicle while an assistant performs the diagnostic evaluations using a diagnostic tool.

 WARNING:

PERSONAL INJURY

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

2.9 FLUIDS AND PRESSURE

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

 WARNING:

PERSONAL INJURY

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

**WARNING:****HOT COOLANT**

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

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

2.10 BATTERIES

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

**WARNING:****Battery Explosion and Acid Burn**

To avoid injury from battery explosion or contact with battery acid, work in a well ventilated area, wear protective clothing, and avoid sparks or flames near the battery. If you come in contact with battery acid:

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

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

2.11 FIRE

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

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

Table 2-1 The Correct Type of Fire Extinguisher

2.12 PAINT

Mask off the Electronic Control Unit (ECU), Electronic Fire Commander(EFC) or Electronic Engine Commander (EEC) prior to applying any paint.

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

2.13 FLUROELASTOMER

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

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

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

2.14 OPTIMIZED IDLE

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



CAUTION:

UNEXPECTED ENGINE START

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

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3 HARDWARE AND WIRING

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3.4 VEHICLE INTERFACE HARNESS	3-15
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3.1 SUPPLIED HARDWARE

Original Equipment Manufacturer (OEM) supplied hardware and DDC supplied hardware is required to install DDEC V. 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
Vehicle Interface Harness (VIH) (refer to section 3.4)	Connects the vehicle functions and battery power (12/24 volts) and ground to the ECU and includes fuse(s) or circuit breaker(s). Also connects the ECU J1939 node to other vehicle systems.
Connector Shroud for VIH Connector (refer to section 3.2.1)	The shroud protects the connectors from dirt and direct spray and routes the wires in the correct orientation.
Throttle Input Device (refer to section 3.12)	An Accelerator Pedal (AP) with an Idle Validation Switch (required), hand throttle, or alternative throttle device
Ignition Switch (refer to section 3.4.2)	Switched 12 or 24 volt ignition source
Amber Warning Lamp (AWL) (refer to section 3.13.1)	A panel-mounted amber indicator light.
Red Stop Lamp (RSL) (refer to section 3.13.2)	A panel-mounted red indicator light.
Engine Coolant Level Sensor (ECL Sensor) (refer to section 3.11.20)	A radiator top tank- or remote surge tank-mounted sensor
Diagnostic Connector, Cab (DCC) (refer to section 3.7.3)	Cab-mounted diagnostic connector

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 Harness (refer to section 3.3)	Factory installed harness that facilitates the receipt of input and output signals, controlling the fuel injection process and engine speed. Harness is connected to DDC installed sensors, the injection unit and the ECU(s).
Electronic Control Unit (ECU) Refer to section 3.2.	Engine mounted ECU provides control logic for overall engine management.
Engine Sensors Refer to section 3.11.1.	Various engine mounted sensors for engine control.
Turbo Compressor In Temperature Sensor Refer to section 3.11.23.	Sensor to measure turbo compressor inlet temperature. MUST be installed by the OEM. Series 60 only.

Table 3-2 Minimum DDC-Supplied Hardware

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3.2 ELECTRONIC CONTROL UNIT

The engine-mounted Electronic Control Unit (ECU) (see Figure 3-1) includes control logic to provide overall engine management. The ECU 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.

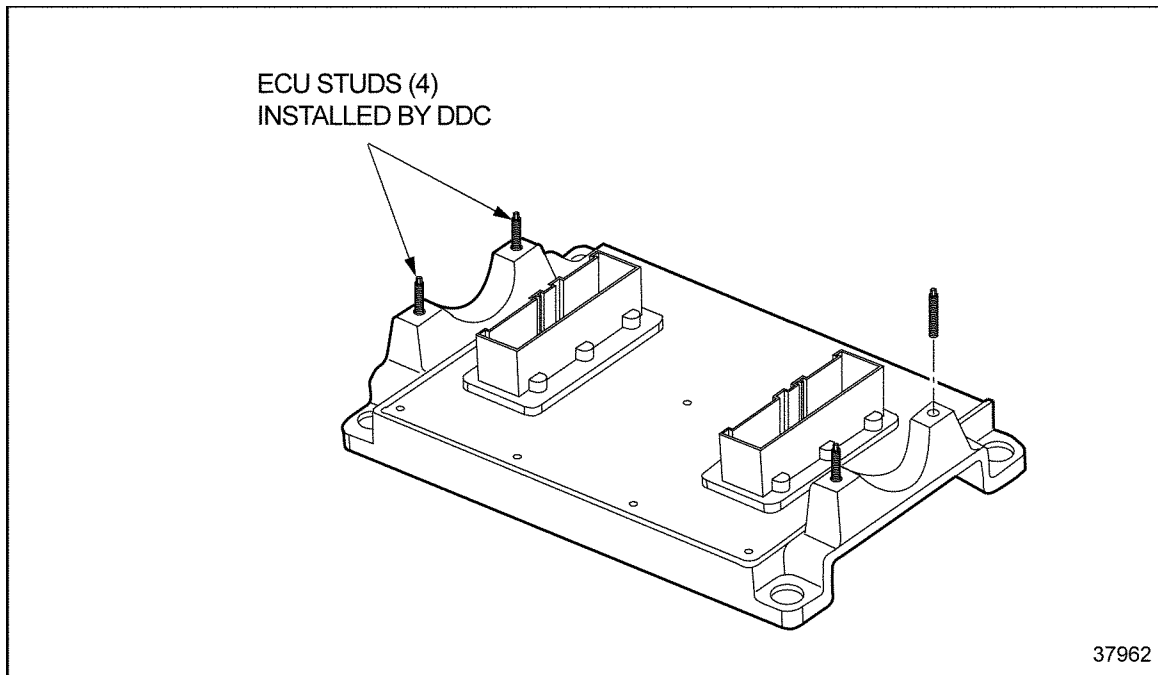


Figure 3-1 Electronic Control Unit

The DDEC V ECU has two 68-pin Tyco connectors - one for the engine and the other for the vehicle.

DDEC V supports three independent data links. There are two links on the Vehicle Interface Harness (VIH). One link is based on SAE J1708, and the second is SAE J1939. The other link, on the Engine Harness, is CAN based and will be used for proprietary communications such as multi-ECU applications and DDC factory programming.

The following warning label is found on the ECU (see Figure 3-2).

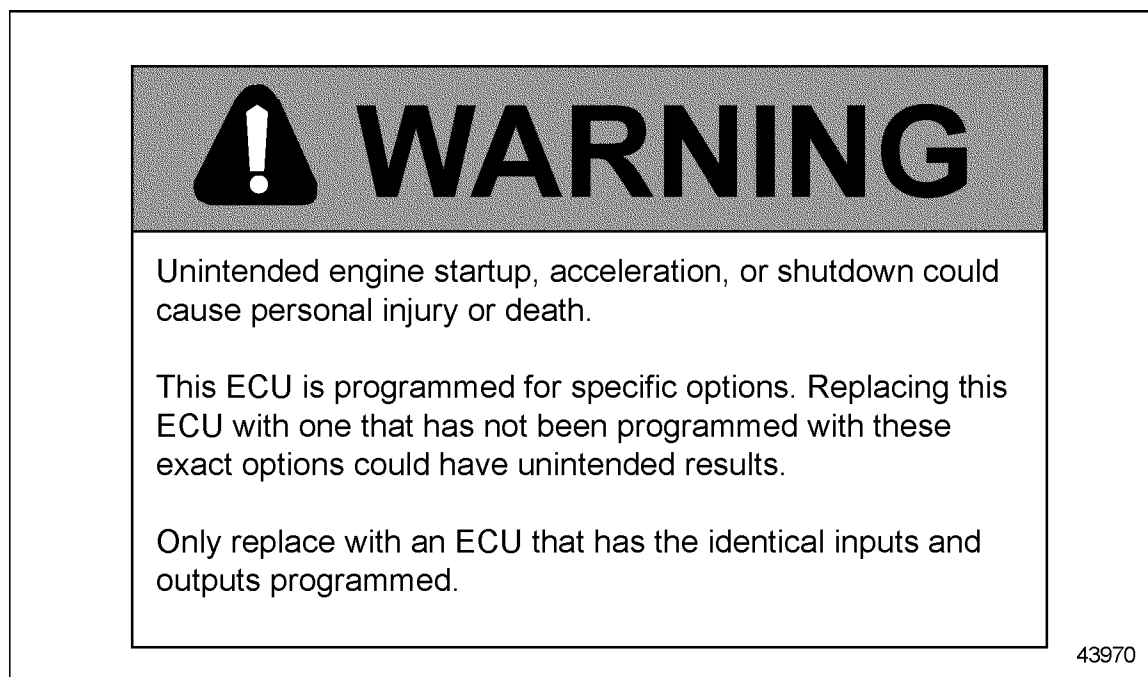


Figure 3-2 **ECU Warning Label**

Connector shrouds protect the two 68-pin Tyco connectors (see Figure 3-3).

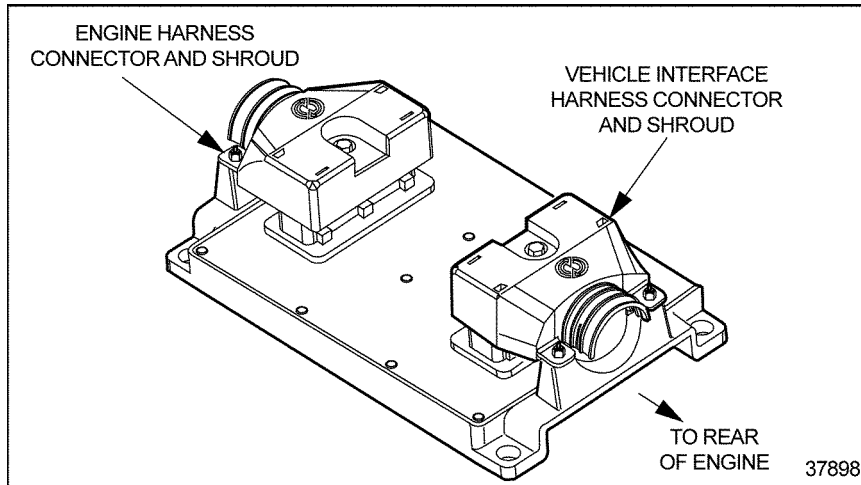


Figure 3-3 Electronic Control Unit with Connector Shrouds

The shrouds are fastened to the ECU studs with lock nuts.

See Figure 3-4 for the ECU outline and dimensions.

The DDEC V ECU has the same footprint as DDEC II, III, and IV.

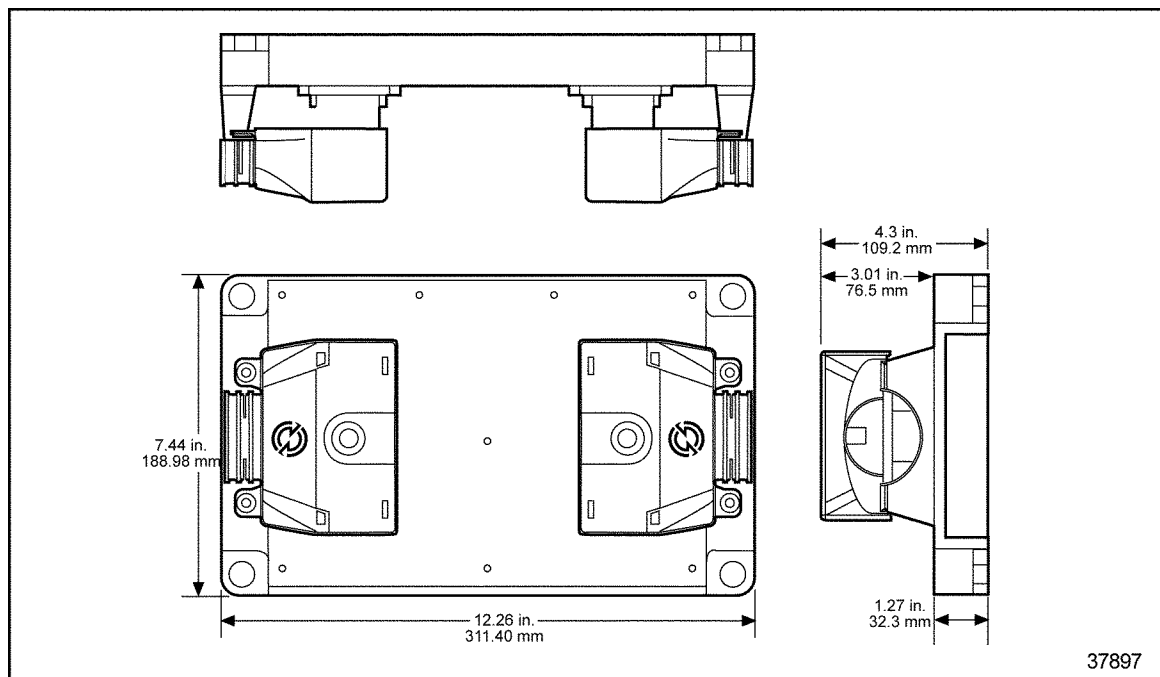


Figure 3-4 Dimensions of Electronic Control Unit with Connector Shrouds

3.2.1 CONNECTOR SHROUD

The shroud is used to protect the connectors from dirt and direct spray and to route the wires in the correct orientation. The shroud is designed for 25-30 mm conduit. The shroud is **REQUIRED**.

Different views of the connector shroud may be seen in the next illustration (see Figure 3-5).

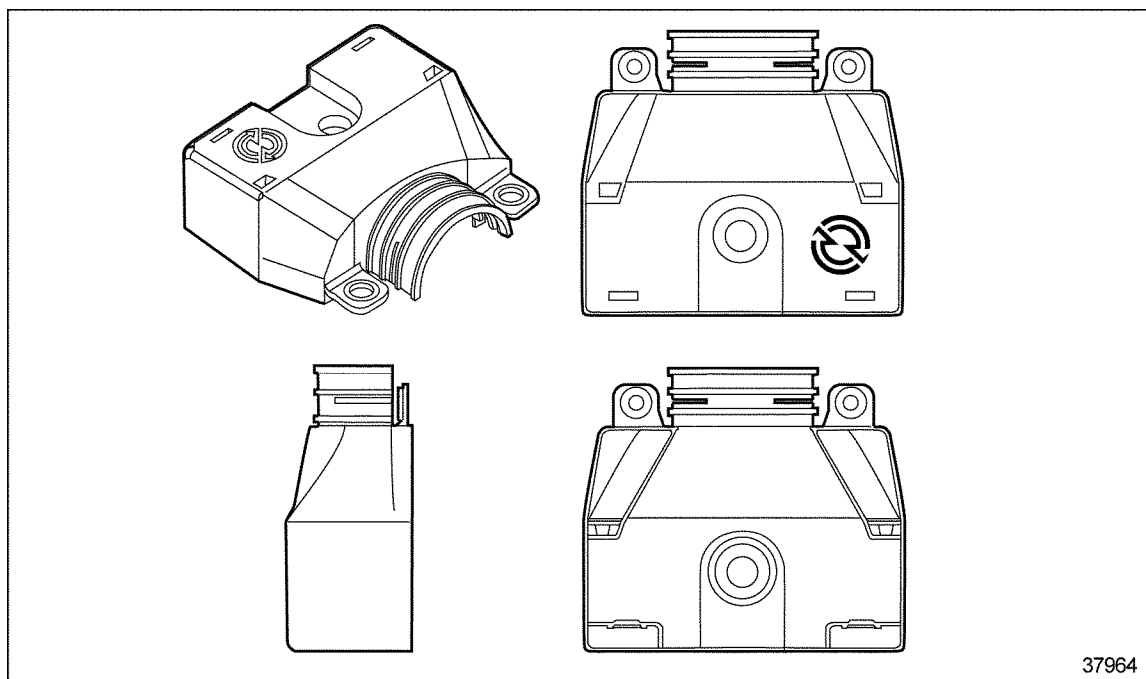


Figure 3-5 Electronic Control Unit Connector Shroud

Two lock nuts are required to attach the shroud to the ECU studs. The torque specification for the lock nuts is 30 in.·lb (3.4 N·m).

3.2.2 ECU PART NUMBERS

Part number for the DDEC V ECU is listed in Table 3-3.

Description	Part Number	Voltage	No. of Cylinders
DDEC V – ECU	23530802	12/24 Volts	6

Table 3-3 ECU Part Numbers

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

Description	DDC Part Number	Tyco Part Number
Vehicle Interface Harness Connector Assembly	23528252	776315-1
Engine Harness Connector Assembly	23528253	776315-2
Shroud	23532347	776501-1
Shroud Lock Nuts (M6x1.0 Nylon Insert Lock Nut Plated with Yellow Zinc)	23533607	—
ECU Stud	23533606	—
14 AWG Terminal (Large) (Terminal only)	23528272	776492-1
18 AWG Terminal (Standard) (Terminal only)	23528271	776326-4
14 AWG Terminal (Large) (crimped with 12 in. wire)	23528255	—
18 AWG Terminal (Standard) (crimped with 12 in. wire)	23528254	—
Cavity Plug	23528274	776364

Table 3-4 ECU Connector Part Numbers

3.2.3 ENVIRONMENTAL CONDITIONS

The following environmental conditions must be considered.

Temperature

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

Atmospheric Pressure

The engine-mounted ECU can withstand atmospheric pressures ranging from 62.0 to 120 kPa absolute that result from altitude and weather changes in the operating and non-operating conditions.

Water Intrusion

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

3.3 ENGINE HARNESS

The Engine Harness (EH) is installed at the factory and is delivered connected to all engine sensors, the fuel injection system and the ECU.

3.3.1 EH CONNECTOR AND TYPICAL REQUIRED FUNCTIONS

The EH 68-pin Tyco connector pinout for the Series 60® is listed in Table 3-5 and Table 3-6.

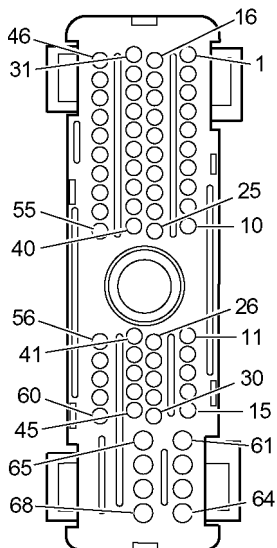
Pin	Wire Color	Signal Type	Function	Connector
E-1	Blk	PWM Output – Low Side	EGR Hydraulic Valve Control	 38483 Shroud Side of Connector
E-2	Wht	Analog Input – 1.5k Pull-up	Air Temp	
E-3	—	Analog Input – 51k Pull-down	Spare	
E-4	Blk	PWM Output – Low Side	VGT VPOD Control	
E-5	Yel	Analog Input – 1.5k Pull-up	Coolant Temp	
E-6	—	Analog Input – 51k Pull-down	Spare	
E-7	Tan	Analog Input – 1.5k Pull-up	Oil Temp	
E-8	—	PWM Output – Low Side	Spare	
E-9	Orn	Analog Input – 1.5k Pull-up	Fuel Temp	
E-10	—	Analog Input – 1.5k Pull-up	EGR Temp	
E-11	—	PWM Output – Low Side	Spare	
E-12	Gra	Sensor Supply #3	Sensor Supply	
E-13	—	Digital Output – Low Side	Spare	
E-14	Blk	Sensor Return #4	Sensor Return	
E-15	Blk	Sensor Return #3	Sensor Return	
E-16	Yel	Analog Input – 51k Pull-down	Fuel Restriction (MAS)	
E-17	Ppl	TRS (CKP) (-)	TRS (CKP) (-)	
E-18	Dk Grn	TRS (CKP) (+)	TRS (CKP) (+)	
E-19	Lt Blu	SRS (CMP) (+)	SRS (CMP) (+)	
E-20	Wht	SRS (CMP) (-)	SRS (CMP) (-)	
E-21	Dk Grn	Analog Input – 51k Pull-down	Oil Level (MAS)	
E-22	Dk Blu	Analog Input – 1.5k Pull-up	Turbo Compressor Out Temp	
E-23	—	Analog Input – 1.5k Pull-up	Spare	
E-24	—	Analog Input – 51k Pull-down	Spare	
E-25	—	Analog Input – 51k Pull-down	Spare	
E-26	Gra	Sensor Supply #4	Sensor Supply	
E-27	—	Analog Input – 1.5k Pull-up	Spare	
E-28	—	Ground Pin	Spare	
E-29	—	Ground Pin	Spare	
E-30	—	Ground Pin	Spare	
E-31	Brn	Analog Input – 51k Pull-down	Oil Pressure	
E-32	—	Frequency Input (+) — Aux 3	Spare	

Table 3-5 Series 60 Engine Harness Connector - Pins E-1 Through E-32

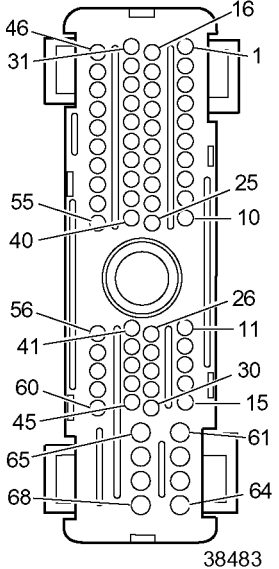
Pin	Wire Color	Signal Type	Function	Connector
E-33	—	Frequency Input (-) – Aux3	Spare	 38483 Shroud Side of Connector
E-34	Brn	Frequency Input (-) – Aux2	Turbo Speed Sensor (+)	
E-35	Blk	Frequency Input (+) – Aux2	Turbo Speed Sensor (-)	
E-36	—	Analog Input – 1.5k Pull-up	Spare	
E-37	Pnk	Analog Input – 51k Pull-down	Barometric Pressure	
E-38	—	Analog Input – 51k Pull-down	EGR Delta Pressure	
E-39	Lt Grn	Analog Input – 51k Pull-down	Turbo Boost	
E-40	Dk Blue	CAN2 (+)	CAN2 (+)	
E-41	—	Analog Input – 51k Pull-down	Spare	
E-42	Bk	Ground Pin	VGT VPOD Gnd	
E-43	Bk	Ground Pin	Spare	
E-44	—	Ground Pin	Spare	
E-45	—	Ground Pin	Spare	
E-46	Lt Grn	Digital Output – High Side	Switched Battery (+) – VGT	
E-47	—	Digital Output – High Side	Spare	
E-48	Red	Digital Output – High Side	Jake Med/High	
E-49	Orn	Digital Output – High Side	Jake Low	
E-50	—	Digital Output – High Side	Spare	
E-51	Yel	Digital Output – High Side	Switch Battery (+) — EGR	
E-52	Red	Digital Output – High Side	Spare	
E-53	—	Digital Output – High Side	Spare	
E-54	Pnk	CAN2 (-)	CAN2 (-)	
E-55	Blk	CAN2S	CAN2 Shield	
E-56	—	Analog Input – 51k Pull-down	Spare	
E-57	—	Analog Input – HWOLS	No Connection	
E-58	—	Analog Input – 1.5k Pull-up	Spare	
E-59	—	RTC BATT+	External RTC Battery (+)	
E-60	—	Ground Pin	Spare	
E-61	Wht	Injector High Common	S60 Common Cyl #1,2,3	
E-62	Wht	Injector High Common	S60 Common Cyl #4,5, 6	
E-63	Wht	Injector A – LO1	S60 Cylinder #1	
E-64	Wht	Injector A – LO2	S60 Cylinder #3	
E-65	Wht	Injector A – LO3	S60 Cylinder #2	
E-66	Wht	Injector B – LO1	S60 Cylinder #5	
E-67	Wht	Injector B – LO2	S60 Cylinder #6	
E-68	Wht	Injector B– LO3	S60 Cylinder #4	

Table 3-6 Series 60 Engine Harness Connector - Pins E-33 Through E-68

The EH 68-pin Tyco connector pinout for Series 60® non-road equipment is listed in Table 3-7 and Table 3-8.

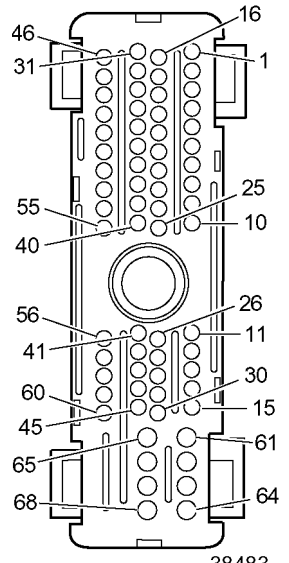
Pin	Wire Color	Signal Type	Function	Connector
E-1	—	PWM Output – Low Side	Spare	 38483 Shroud Side of Connector
E-2	Wht	Analog Input – 1.5k Pull-up	Air Temp	
E-3	—	Analog Input – 51k Pull-down	Spare	
E-4	—	PWM Output – Low Side	Spare	
E-5	Yel	Analog Input – 1.5k Pull-up	Coolant Temp	
E-6	—	Analog Input – 51k Pull-down	Spare	
E-7	Tan	Analog Input – 1.5k Pull-up	Oil Temp	
E-8	—	PWM Output – Low Side	Spare	
E-9	Orn	Analog Input – 1.5k Pull-up	Fuel Temp	
E-10	—	Analog Input – 1.5k Pull-up	Spare	
E-11	—	PWM Output – Low Side	Spare	
E-12	Gra	Sensor Supply #3	Sensor Supply	
E-13	—	Digital Output – Low Side	Spare	
E-14	Blk	Sensor Return #4	Sensor Return	
E-15	Blk	Sensor Return #3	Sensor Return	
E-16	Yel	Analog Input – 51k Pull-down	Spare	
E-17	Ppl	TRS (CKP) (-)	TRS (CKP) (-)	
E-18	Dk Grn	TRS (CKP) (+)	TRS (CKP) (+)	
E-19	Lt Blu	SRS (CMP) (+)	SRS (CMP) (+)	
E-20	Wht	SRS (CMP) (-)	SRS (CMP) (-)	
E-21	Dk Grn	Analog Input – 51k Pull-down	Spare	
E-22	—	Analog Input – 1.5k Pull-up	Spare	
E-23	—	Analog Input – 1.5k Pull-up	Spare	
E-24	—	Analog Input – 51k Pull-down	Spare	
E-25	—	Analog Input – 51k Pull-down	Spare	
E-26	Gra	Sensor Supply #4	Sensor Supply	
E-27	—	Analog Input – 1.5k Pull-up	Spare	
E-28	—	Ground Pin	Spare	
E-29	—	Ground Pin	Spare	
E-30	—	Ground Pin	Spare	
E-31	Brn	Analog Input – 51k Pull-down	Oil Pressure	
E-32	—	Frequency Input (+) — Aux 3	Spare	

Table 3-7 Series 60 Engine Harness Connector for Non-Road Equipment - Pins E-1 Through E-32

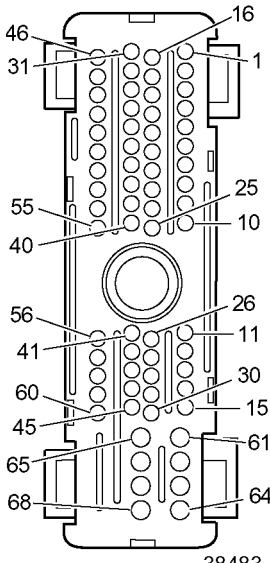
Pin	Wire Color	Signal Type	Function	Connector
E-33	—	Frequency Input (-) – Aux3	Spare	 38483 Shroud Side of Connector
E-34	—	Frequency Input (-) – Aux2	Spare	
E-35	—	Frequency Input (+) – Aux2	Spare	
E-36	—	Analog Input – 1.5k Pull-up	Spare	
E-37	Pnk	Analog Input – 51k Pull-down	Spare	
E-38	—	Analog Input – 51k Pull-down	Spare	
E-39	Lt Grn	Analog Input – 51k Pull-down	Turbo Boost	
E-40	Dk Blue	CAN2 (+)	CAN2 (+)	
E-41	—	Analog Input – 51k Pull-down	Spare	
E-42	—	Ground Pin	Spare	
E-43	Bk	Ground Pin	Spare	
E-44	—	Ground Pin	Spare	
E-45	—	Ground Pin	Spare	
E-46	—	Digital Output – High Side	Spare	
E-47	—	Digital Output – High Side	Spare	
E-48	Red	Digital Output – High Side	Jake Med/High	
E-49	Orn	Digital Output – High Side	Jake Low	
E-50	—	Digital Output – High Side	Spare	
E-51	Yel	Digital Output – High Side	Spare	
E-52	Red	Digital Output – High Side	Spare	
E-53	—	Digital Output – High Side	Spare	
E-54	Pnk	CAN2 (-)	CAN2 (-)	
E-55	Blk	CAN2S	CAN2 Shield	
E-56	—	Analog Input – 51k Pull-down	Spare	
E-57	—	Analog Input – HWOLS	No Connection	
E-58	—	Analog Input – 1.5k Pull-up	Spare	
E-59	—	RTC BATT+	External RTC Battery (+)	
E-60	—	Ground Pin	Spare	
E-61	Wht	Injector High Common	S60 Common Cyl #1,2,3	
E-62	Wht	Injector High Common	S60 Common Cyl #4,5, 6	
E-63	Wht	Injector A – LO1	S60 Cylinder #1	
E-64	Wht	Injector A – LO2	S60 Cylinder #3	
E-65	Wht	Injector A – LO3	S60 Cylinder #2	
E-66	Wht	Injector B – LO1	S60 Cylinder #5	
E-67	Wht	Injector B – LO2	S60 Cylinder #6	
E-68	Wht	Injector B– LO3	S60 Cylinder #4	

Table 3-8 Series 60 Engine Harness Connector for Non-Road Equipment Pins E-33 Through E-68

3.4 VEHICLE INTERFACE HARNESS

The OEM supplied Vehicle Interface Harness (VIH) connects the ECU to other vehicle systems as shown in the VIH illustration (see Figure 3-6). Refer to Appendix B for a harness schematic.

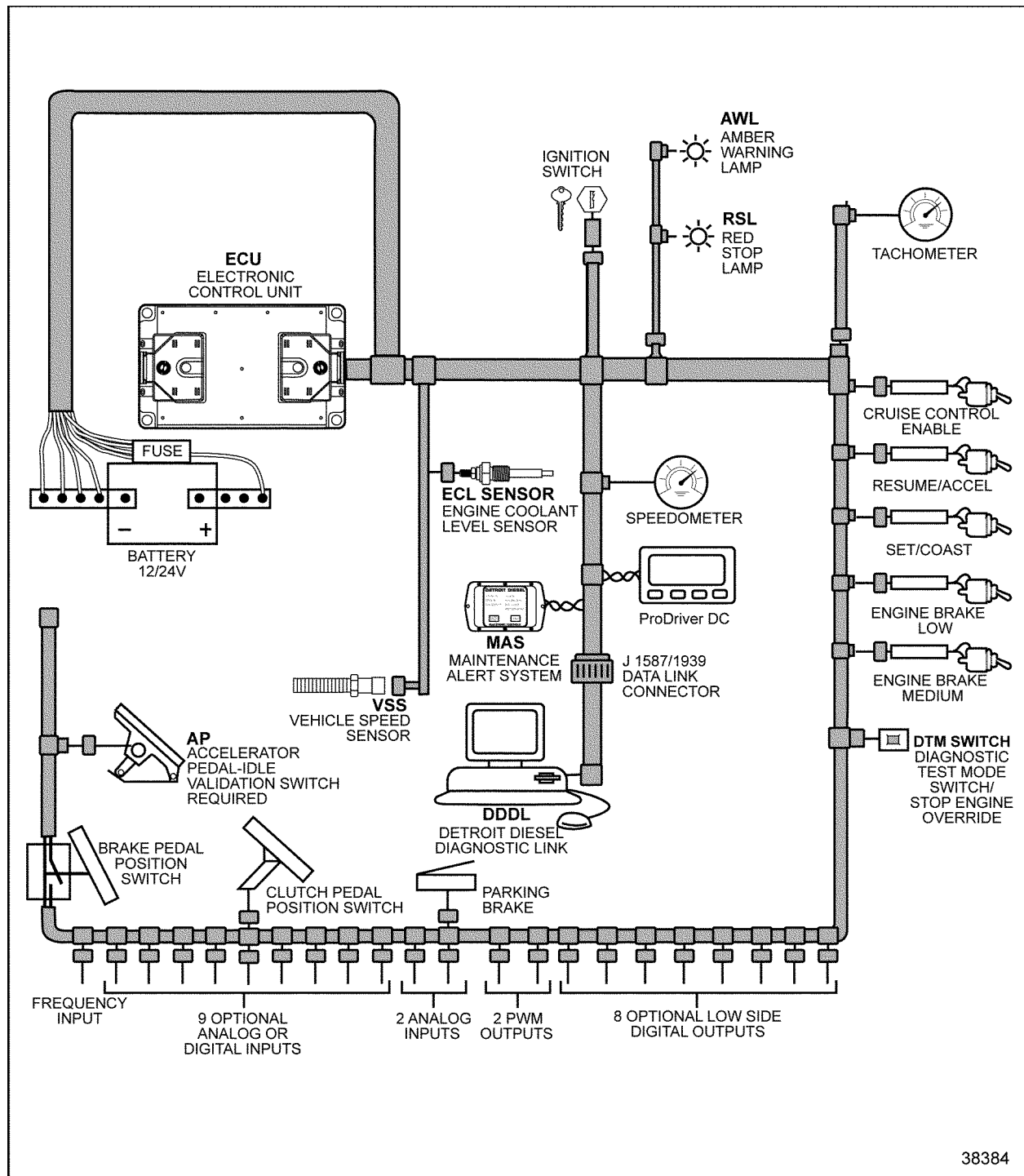


Figure 3-6 Typical On-highway Vehicle Interface Harness

3.4.1 VIH CONNECTOR AND TYPICAL REQUIRED FUNCTIONS

The VIH 68-pin Tyco connector pinout for the Series 60 is listed in Table 3-9 and Table 3-10.

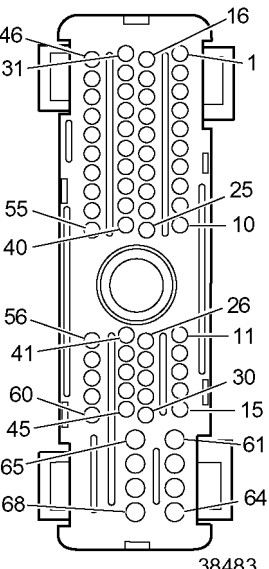
Pin	Wire Color	Signal Type	Function	Req/Typical	Connector
V-1	Dk Grn/Blk	Digital Output - Low Side	AWL	Required	 Shroud Side of Connector
V-2	Blk/Yel	Digital Output - Low Side	RSL	Required	
V-3	Wht/Dk Grn	Analog Input - 1.5k Pull-up	Service Brake Released	Required	
V-4	Blk/Lt Blu	Digital Output - Low Side	Fan Control #1	Typical: Fan	
V-5	Blk/Lt grn	Digital Output - Low Side	Top2 Shift Solenoid	Typical: Top2	
V-6	Blk/Orn	Digital Output - Low Side	Top2 Lockout Solenoid	Typical: Top2	
V-7	Blk/Wht	Digital Output - Low Side	Vehicle Power Shtdn	Typical	
V-8	Wht/Orn	Analog Input - 1.5k Pull-up	Resume/Accel	Typical: CC	
V-9	Ppl/Wht	Analog Input - 1.5k Pull-up	Cruise Enable	Typical: CC	
V-10	Lt Grn/Wht	Analog Input - 1.5k Pull-up	Clutch Released	Typical: CC	
V-11	Yel/Red	Sensor Supply #1	Sensor Supply #1	Required	
V-12	Wht/ Red	Sensor Supply #2	Sensor Supply #2	Required	
V-13	Lt Blu/Yel	Analog Input - 300k Pull-down	Throttle Position	Required	
V-14	Ppl/Yel	Analog Input - 300k Pull-down	VSG or No Function	Typical	
V-15	Pnk	Ignition	Ignition	Required	
V-16	Red/Wht	Analog Input - 1.5k Pull-up	Idle Validation	Required	
V-17	Lt Blu/ Orn	Frequency Input (+) VSS	Vehicle Speed (+)	Required	
V-18	Lt Blu/ Blk	Frequency Input (-) VSS	Vehicle Speed (-)	Required	
V-19	—	No Connection	No Connection	No Conn	
V-20	—	No Connection	No Connection	No Conn	
V-21	—	No Connection	No Connection	No Conn	
V-22	Yel/Lt Blu	Analog Input – 51k Pull-down	Air Filter Restriction	Typical: MAS	
V-23	Yel/Dk Grn	Analog Input - 1.5k Pull-up	Exhaust Temp (Bus/Coach)	Typical	
V-24	Dk Grn/Wht	Analog Input - 1.5k Pull-up	SEO/Diag Request	Required	
V-25	Grey/Wht	Analog Input - 1.5k Pull-up	A/C Status	Typical: Fan	
V-26	Yel/Lt Grn	Analog Input - 1.5k Pull-up	Engine Brake Disable	Typical	
V-27	Yel/Wht	Analog Input - 1.5k Pull-up	Turbo Compressor In Temp	Required	
V-28	—	No Connection	No Connection	No Conn	
V-29	Wht/Yel	Analog Input – 51k Pull-down	Exhaust Back Press or Water Pump Press or Air Compressor Press	Typical	
V-30	—	No Connection	No Connection	No Conn	
V-31	Tan	Frequency Output	Tachometer	Typical	

Table 3-9 Series 60 VIH Connector On-highway Trucks – Pins V-1 – V-31

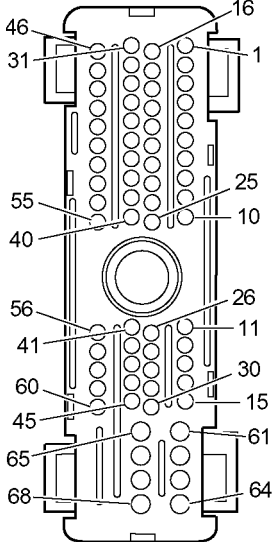
Pin	Wire Color	Signal Type	Function	Req/ Typical	Connector
V-32	Dk Blu/Orn	Frequency Input (+) Aux 1	Spare	—	 38483 Shroud Side of Connector
V-33	Dk Blu/Blk	Frequency Input (-) Aux 1	Spare	—	
V-34	—	No Connection	No Connection	No Conn	
V-35	—	No Connection	No Connection	No Conn	
V-36	—	No Connection	No Connection	No Conn	
V-37	Orn/Yel	Analog Input – 120k Pull-up	Add Coolant Level	Typical: MAS	
V-38	Lt Gr/Yel	Analog Input – 120k Pull-up	Coolant Level Shtdn	Req	
V-39	Lt Blu/Wht	Analog Input – 1.5k Pull-up	Engine Brake Low	Typical: Jake	
V-40	Orn/Blk	Digital Output – Low Side	OI Alarm	Typical: OI	
V-41	Dk Grn/Yel	Analog Input – 1.5k Pull-up	Aux Shtdn #1	—	
V-42	Grey/Yel	Analog Input – 1.5k Pull-up	OI Thermostat	Typical: OI	
V-43	Dk Blu/Red	J1939+	J1939+	Req	
V-44	Dk Blu/Yel	J1939S	J1939 Shield	Required	
V-45	—	No Connection	No Connection	No Conn	
V-46	Dk Grn/Brn	PWM Output - Low Side	Variable Speed Fan	—	
V-47	Wht/Lt Blu	Analog Input - 1.5k Pull-up	Set/Coast	Typical; CC	
V-48	Tan/ Yel	Analog Input - 1.5k Pull-up	Throttle Inhibit	Typical	
V-49	Pink/Wht	Analog Input - 1.5k Pull-up	Fan Control Override	Typical	
V-50	Tan/ Wht	Analog Input - 1.5k Pull-up	Park Brake	Typical	
V-51	Dk Blu/Wht	Analog Input - 1.5k Pull-up	Engine Brake Medium	Typical: Jake	
V-52	Dk Grn/Orn	PWM Output Low Side	Trans % Load	—	
V-53	Blk/Red	Digital Output - Low Side	Ether Start	—	
V-54	Blk/Pnk	Digital Output - Low Side	OI Starter	Typical: OI	
V-55	Lt Grn/Blk	Digital Output - Low Side	OI Active Lamp	Typical: OI	
V-56	Dk Grn/ Grey	J1587 (+)	J1587 (+)	Required	
V-57	Dk Grn	J1587(-)	J1587 (-)	Required	
V-58	Dk Blu	J1939 (-)	J1939 (-)	Required	
V-59	Dk Blu	Sensor Return #2	Sensor Return	Required	
V-60	Yel/ Blk	Sensor Return #1	Sensor Return	Required	
V-61	Red/Blk	Battery (+)	+12V / +24V	Required	
V-62	Red/ Lt Blu	Battery (+)	+12V / +24V	Required	
V-63	Brn/Blk	Battery (-)	Ground	Required	
V-64	Brn/ Lt Grn	Battery (-)	Ground	Required	
V-65	Red/ Lt Grn	Battery (+)	+12V / +24V	Required	
V-66	Red/ Pnk	Battery (+)	+12V / +24V	Required	
V-67	Brn/Wht	Battery (-)	Ground	Required	
V-68	Brn/Yel	Battery (-)	Ground	Required	

Table 3-10 Series 60 VIH Connector On-highway Trucks – Pins V-32 – V-68

The VIH 68-pin Tyco connector pinout for Series 60 Bus/Coach applications is listed in Table 3-11 and Table 3-12.

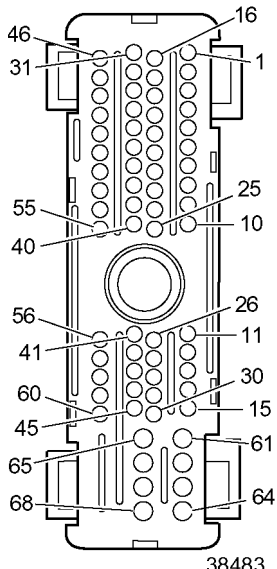
Pin	Wire Color	Signal Type	Function	Req/Typical	Connector
V-1	Dk Grn/Blk	Digital Output - Low Side	AWL	Required	 Shroud Side of Connector
V-2	Blk/Yel	Digital Output - Low Side	RSL	Required	
V-3	Wht/Dk Grn	Analog Input - 1.5k Pull-up	Service Brake Released	Required	
V-4	Blk/Lt Blu	Digital Output - Low Side	Fan Control #1	Typical: Fan	
V-5	Blk/Lt grn	Digital Output - Low Side	Fan Control #2	Typical: Fan	
V-6	Blk/Orn	Digital Output - Low Side	Decleration Lamp	Typical	
V-7	Blk/Wht	Digital Output - Low Side	Starter Lockout	Typical	
V-8	Wht/Orn	Analog Input - 1.5k Pull-up	Resume/Accel	Typical: CC	
V-9	Ppl/Wht	Analog Input - 1.5k Pull-up	Cruise Enable	Typical: CC	
V-10	Lt Grn/Wht	Analog Input - 1.5k Pull-up	Spare	—	
V-11	Yel/Red	Sensor Supply #1	Sensor Supply #1	Required	
V-12	Wht/ Red	Sensor Supply #2	Sensor Supply #2	Required	
V-13	Lt Blu/Yel	Analog Input - 300k Pull-down	Throttle Position	Required	
V-14	Ppl/Yel	Analog Input - 300k Pull-down	VSG or No Function	Typical	
V-15	Pnk	Ignition	Ignition	Required	
V-16	Red/Wht	Analog Input - 1.5k Pull-up	Idle Validation	Required	
V-17	Lt Blu/ Orn	Frequency Input (+) VSS	Vehicle Speed (+)	Required	
V-18	Lt Blu/ Blk	Frequency Input (-) VSS	Vehicle Speed (-)	Required	
V-19	—	No Connection	No Connection	No Conn	
V-20	—	No Connection	No Connection	No Conn	
V-21	—	No Connection	No Connection	No Conn	
V-22	Yel/Lt Blu	Analog Input – 51k Pull-down	Air Filter Restriction	Typical: MAS	
V-23	Yel/Dk Grn	Analog Input - 1.5k Pull-up	Exhaust Temp (Bus/Coach)	Typical	
V-24	Dk Grn/Wht	Analog Input - 1.5k Pull-up	SEO/Diag Request	Required	
V-25	Grey/Wht	Analog Input - 1.5k Pull-up	A/C Status	Typical: Fan	
V-26	Yel/Lt Grn	Analog Input - 1.5k Pull-up	Engine Brake Disable	Typical	
V-27	Yel/Wht	Analog Input - 1.5k Pull-up	Turbo Compressor In Temp	Required	
V-28	—	No Connection	No Connection	No Conn	
V-29	Wht/Yel	Analog Input – 51k Pull-down	Exhaust Back Pressure	Typical	
V-30	—	No Connection	No Connection	No Conn	
V-31	Tan	Frequency Output	Tachometer	Typical	

Table 3-11 Series 60 VIH Connector Bus/Coach – Pins V-1 – V-31

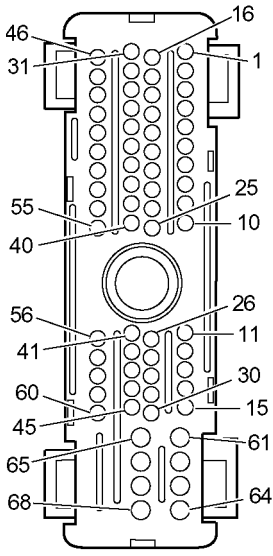
Pin	Wire Color	Signal Type	Function	Req/ Typical	Connector
V-32	Dk Blu/Orn	Frequency Input (+) Aux 1	Spare	—	 38483 Shroud Side of Connector
V-33	Dk Blu/Blk	Frequency Input (-) Aux 1	Spare	—	
V-34	—	No Connection	No Connection	No Conn	
V-35	—	No Connection	No Connection	No Conn	
V-36	—	No Connection	No Connection	No Conn	
V-37	Orn/Yel	Analog Input – 120k Pull-up	Add Coolant Level	Typical: MAS	
V-38	Lt Gr/Yel	Analog Input – 120k Pull-up	Coolant Level Shtdn	Req	
V-39	Lt Blu/Wht	Analog Input – 1.5k Pull-up	Engine Brake Low	Typical: Jake	
V-40	Orn/Blk	Digital Output – Low Side	Engine Brake Active	Typical	
V-41	Dk Grn/Yel	Analog Input – 1.5k Pull-up	Aux Shtdn #1	—	
V-42	Grey/Yel	Analog Input – 1.5k Pull-up	Alt Min VSG / Fast Idle	Typical	
V-43	Dk Blu/Red	J1939 (+)	J1939 (+)	Req	
V-44	Dk Blu/Yel	J1939S	J1939 Shield	Required	
V-45	—	No Connection	No Connection	No Conn	
V-46	Dk Grn/Brn	PWM Output - Low Side	Variable Speed Fan	—	
V-47	Wht/Lt Blu	Analog Input - 1.5k Pull-up	Set/Coast	Typical; CC	
V-48	Tan/ Yel	Analog Input - 1.5k Pull-up	Throttle Inhibit	Typical	
V-49	Pink/Wht	Analog Input - 1.5k Pull-up	Fan Control Override	Typical	
V-50	Tan/ Wht	Analog Input - 1.5k Pull-up	Park Brake	Typical	
V-51	Dk Blu/Wht	Analog Input - 1.5k Pull-up	Engine Brake Medium	Typical: Jake	
V-52	Dk Grn/Orn	PWM Output Low Side	Trans % Load	—	
V-53	Blk/Red	Digital Output - Low Side	Coolant Level Low Lamp	Typical	
V-54	Blk/Pnk	Digital Output - Low Side	No Connection	No Conn	
V-55	Lt Grn/Blk	Digital Output - Low Side	Cruise Active Lamp	Typical	
V-56	Dk Grn/ Grey	J1587 (+)	J1587 (+)	Required	
V-57	Dk Grn	J1587 (-)	J1587 (-)	Required	
V-58	Dk Blu	J1939 (-)	J1939 (-)	Required	
V-59	Dk Blu	Sensor Return #2	Sensor Return	Required	
V-60	Yel/ Blk	Sensor Return #1	Sensor Return	Required	
V-61	Red/Blk	Battery (+)	+12V / +24V	Required	
V-62	Red/ Lt Blu	Battery (+)	+12V / +24V	Required	
V-63	Brn/Blk	Battery (-)	Ground	Required	
V-64	Brn/ Lt Grn	Battery (-)	Ground	Required	
V-65	Red/ Lt Grn	Battery (+)	+12V / +24V	Required	
V-66	Red/ Pnk	Battery (+)	+12V / +24V	Required	
V-67	Brn/Wht	Battery (-)	Ground	Required	
V-68	Brn/Yel	Battery (-)	Ground	Required	

Table 3-12 Series 60 VIH Connector Bus/Coach – Pins V-32 – V-68

The VIH 68-pin Tyco connector pinout for Series 60 non-road equipment is listed in Table 3-13 and Table 3-14.

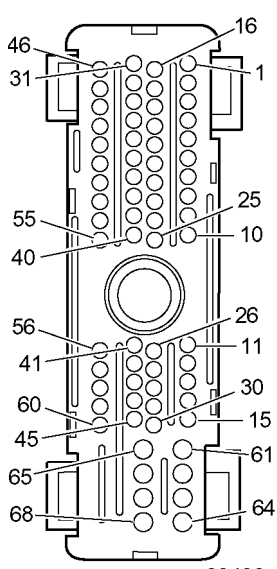
Pin	Wire Color	Signal Type	Function	Req/Typical	Connector
V-1	Dk Grn/Blk	Digital Output - Low Side	AWL	Required	 Shroud Side of Connector
V-2	Blk/Yel	Digital Output - Low Side	RSL	Required	
V-3	Wht/Dk Grn	Analog Input - 1.5k Pull-up	Service Brake Released	Required	
V-4	Blk/Lt Blu	Digital Output - Low Side	Fan Control #1	Typical: Fan	
V-5	Blk/Lt grn	Digital Output - Low Side	Fan Control #2	Typical: Fan	
V-6	Blk/Orn	Digital Output - Low Side	Spare	—	
V-7	Blk/Wht	Digital Output - Low Side	Starter Lockout	Typical	
V-8	Wht/Orn	Analog Input - 1.5k Pull-up	Resume/Accel	Typical: CC	
V-9	Ppl/Wht	Analog Input - 1.5k Pull-up	Cruise Enable	Typical: CC	
V-10	Lt Grn/Wht	Analog Input - 1.5k Pull-up	Spare	—	
V-11	Yel/Red	Sensor Supply #1	Sensor Supply #1	Required	
V-12	Wht/ Red	Sensor Supply #2	Sensor Supply #2	Required	
V-13	Lt Blu/Yel	Analog Input - 300k Pull-down	Throttle Position (ALSG)	Required	
V-14	Ppl/Yel	Analog Input - 300k Pull-down	VSG	Typical	
V-15	Pnk	Ignition	Ignition	Required	
V-16	Red/Wht	Analog Input - 1.5k Pull-up	Idle Validation	Required	
V-17	Lt Blu/ Orn	Frequency Input (+) VSS	Vehicle Speed (+)	Required	
V-18	Lt Blu/ Blk	Frequency Input (-) VSS	Vehicle Speed (-)	Required	
V-19	—	No Connection	No Connection	No Conn	
V-20	—	No Connection	No Connection	No Conn	
V-21	—	No Connection	No Connection	No Conn	
V-22	Yel/Lt Blu	Analog Input – 51k Pull-down	Air Filter Restriction	Typical: MAS	
V-23	Yel/Dk Grn	Analog Input - 1.5k Pull-up	Exhaust Temp	Typical	
V-24	Dk Grn/Wht	Analog Input - 1.5k Pull-up	SEO/Diag Request	Required	
V-25	Grey/Wht	Analog Input - 1.5k Pull-up	A/C Status	Typical: Fan	
V-26	Yel/Lt Grn	Analog Input - 1.5k Pull-up	Engine Brake Disable	Typical	
V-27	Yel/Wht	Analog Input - 1.5k Pull-up	Spare	—	
V-28	—	No Connection	No Connection	No Conn	
V-29	Wht/Yel	Analog Input – 51k Pull-down	Exhaust Back Pressure or Water Pump Pressure or Air Compressor Pressure	Typical	
V-30	—	No Connection	No Connection	No Conn	
V-31	Tan	Frequency Output	Tachometer	Typical	

Table 3-13 Series 60 VIH Connector Non-Road Equipment – Pins V-1 – V-31

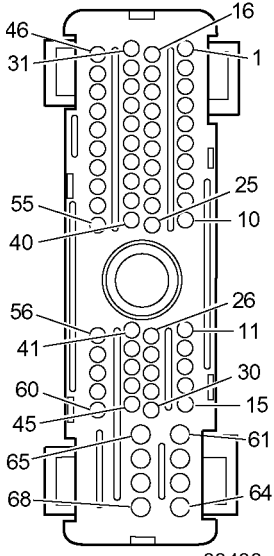
Pin	Wire Color	Signal Type	Function	Req/ Typical	Connector
V-32	Dk Blu/Orn	Frequency Input (+) Aux 1	Spare	—	
V-33	Dk Blu/Blk	Frequency Input (-) Aux 1	Spare	—	
V-34	—	No Connection	No Connection	No Conn	
V-35	—	No Connection	No Connection	No Conn	
V-36	—	No Connection	No Connection	No Conn	
V-37	Orn/Yel	Analog Input – 120k Pull-up	Add Coolant Level	Typical: MAS	
V-38	Lt Gr/Yel	Analog Input – 120k Pull-up	Coolant Level Shtdn	Req	
V-39	Lt Blu/Wht	Analog Input – 1.5k Pull-up	Engine Brake Low	Typical: Jake	
V-40	Orn/Blk	Digital Output – Low Side	Spare	—	
V-41	Dk Grn/Yel	Analog Input – 1.5k Pull-up	Aux Shtdn #1	—	
V-42	Grey/Yel	Analog Input – 1.5k Pull-up	Spare	—	
V-43	Dk Blu/Red	J1939 (+)	J1939 (+)	Req	
V-44	Dk Blu/Yel	J1939S	J1939 Shield	Required	
V-45	—	No Connection	No Connection	No Conn	
V-46	Dk Grn/Brn	PWM Output - Low Side	Variable Speed Fan	—	
V-47	Wht/Lt Blu	Analog Input - 1.5k Pull-up	Set/Coast	Typical; CC	
V-48	Tan/ Yel	Analog Input - 1.5k Pull-up	Throttle Inhibit	Typical	
V-49	Pink/Wht	Analog Input - 1.5k Pull-up	Fan Control Override	Typical	
V-50	Tan/ Wht	Analog Input - 1.5k Pull-up	Park Brake	Typical	
V-51	Dk Blu/Wht	Analog Input - 1.5k Pull-up	Engine Brake Medium	Typical: Jake	
V-52	Dk Grn/Orn	PWM Output Low Side	Trans % Load	—	
V-53	Blk/Red	Digital Output - Low Side	Coolant Level Low Lamp	Typical	
V-54	Blk/Pnk	Digital Output - Low Side	No Connection	No Conn	
V-55	Lt Grn/Blk	Digital Output - Low Side	Spare	—	
V-56	Dk Grn/ Grey	J1587 (+)	J1587 (+)	Required	
V-57	Dk Grn	J1587 (-)	J1587 (-)	Required	
V-58	Dk Blu	J1939 (-)	J1939 (-)	Required	
V-59	Dk Blu	Sensor Return #2	Sensor Return	Required	
V-60	Yel/ Blk	Sensor Return #1	Sensor Return	Required	
V-61	Red/Blk	Battery (+)	+12V / +24V	Required	
V-62	Red/ Lt Blu	Battery (+)	+12V / +24V	Required	
V-63	Brn/Blk	Battery (-)	Ground	Required	
V-64	Brn/ Lt Grn	Battery (-)	Ground	Required	
V-65	Red/ Lt Grn	Battery (+)	+12V / +24V	Required	
V-66	Red/ Pnk	Battery (+)	+12V / +24V	Required	
V-67	Brn/Wht	Battery (-)	Ground	Required	
V-68	Brn/Yel	Battery (-)	Ground	Required	

Table 3-14 Series 60 VIH Connector Non-Road Equipment – Pins V-32 – V-68

The 68-pin Tyco connector pinout for the Series 60 firetruck application is listed in Table 3-15 and Table 3-16.

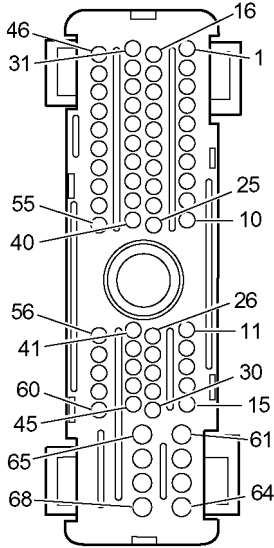
Pin	Wire Color	Signal Type	Function	Req/Typical	Connector
V-1	Dk Grn/Blk	Digital Output - Low Side	AWL	Required	 38483 Shroud Side of Connector
V-2	Blk/Yel	Digital Output - Low Side	RSL	Required	
V-3	Wht/Dk Grn	Analog Input - 1.5k Pull-up	Service Brake Released	Required	
V-4	Blk/Lt Blu	Digital Output - Low Side	Fan Control #1	Typical: Fan	
V-5	Blk/Lt grn	Digital Output - Low Side	Low DDEC Voltage	Typical	
V-6	Blk/Orn	Digital Output - Low Side	Spare	—	
V-7	Blk/Wht	Digital Output - Low Side	PSG Pressure Mode Lamp	Typical: PSG	
V-8	Wht/Orn	Analog Input - 1.5k Pull-up	Resume/Accel	Typical: PSG	
V-9	Ppl/Wht	Analog Input - 1.5k Pull-up	PSG Enable	Typical: PSG	
V-10	Lt Grn/Wht	Analog Input - 1.5k Pull-up	Spare	—	
V-11	Yel/Red	Sensor Supply #1	Sensor Supply #1	Required	
V-12	Wht/ Red	Sensor Supply #2	Sensor Supply #2	Required	
V-13	Lt Blu/Yel	Analog Input - 300k Pull-down	Throttle Position	Required	
V-14	Ppl/Yel	Analog Input - 300k Pull-down	VSG or No Function	Typical	
V-15	Pnk	Ignition	Ignition	Required	
V-16	Red/Wht	Analog Input - 1.5k Pull-up	Idle Validation	Required	
V-17	Lt Blu/ Orn	Frequency Input (+) VSS	Vehicle Speed (+)	Required	
V-18	Lt Blu/ Blk	Frequency Input (-) VSS	Vehicle Speed (-)	Required	
V-19	—	No Connection	No Connection	No Conn	
V-20	—	No Connection	No Connection	No Conn	
V-21	—	No Connection	No Connection	No Conn	
V-22	Yel/Lt Blu	Analog Input – 51k Pull-down	Air Filter Restriction	Typical: MAS	
V-23	Yel/Dk Grn	Analog Input - 1.5k Pull-up	Pressure / RPM Mode	Typical: PSG	
V-24	Dk Grn/Wht	Analog Input - 1.5k Pull-up	SEO/Diag Request	Required	
V-25	Grey/Wht	Analog Input - 1.5k Pull-up	A/C Status	Typical: Fan	
V-26	Yel/Lt Grn	Analog Input - 1.5k Pull-up	Engine Brake Disable	Typical	
V-27	Yel/Wht	Analog Input - 1.5k Pull-up	Turbo Compressor In Temp	Required	
V-28	—	No Connection	No Connection	No Conn	
V-29	Wht/Yel	Analog Input – 51k Pull-down	Water Pump Press	Typical	
V-30	—	No Connection	No Connection	No Conn	
V-31	Tan	Frequency Output	Tachometer	Typical	
V-32	Dk Blu/Orn	Frequency Input (+) Aux 1	Spare	—	
V-33	Dk Blu/Blk	Frequency Input (-) Aux 1	Spare	—	

Table 3-15 Series 60 VIH Connector Firetruck – Pins V-1 – V-33

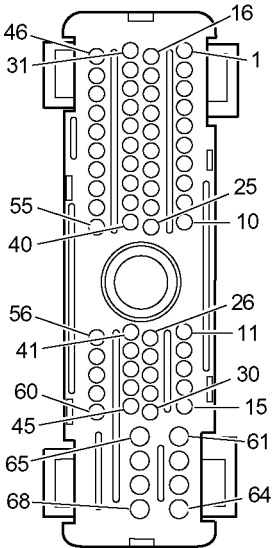
Pin	Wire Color	Signal Type	Function	Req/ Typical	Connector
V-34	—	No Connection	No Connection	No Conn	 38483 Shroud Side of Connector
V-35	—	No Connection	No Connection	No Conn	
V-36	—	No Connection	No Connection	No Conn	
V-37	Orn/Yel	Analog Input – 120k Pull-up	Add Coolant Level	Typical: MAS	
V-38	Lt Gr/Yel	Analog Input – 120k Pull-up	Coolant Level Shtdn	Req	
V-39	Lt Blu/Wht	Analog Input – 1.5k Pull-up	Engine Brake Low	Typical: Jake	
V-40	Orn/Blk	Digital Output – Low Side	Engine Brake Active	Typical	
V-41	Dk Grn/Yel	Analog Input – 1.5k Pull-up	Aux Shtdn #1	—	
V-42	Grey/Yel	Analog Input – 1.5k Pull-up	Alt Min VSG / Fast Idle	Typical	
V-43	Dk Blu/Red	J1939 (+)	J1939 (+)	Req	
V-44	Dk Blu/Yel	J1939S	J1939 Shield	Required	
V-45	—	No Connection	No Connection	No Conn	
V-46	Dk Grn/Brn	PWM Output - Low Side	Variable Speed Fan	—	
V-47	Wht/Lt Blu	Analog Input - 1.5k Pull-up	Set/Coast	Typical: PSG	
V-48	Tan/ Yel	Analog Input - 1.5k Pull-up	Throttle Inhibit	Typical	
V-49	Pink/Wht	Analog Input - 1.5k Pull-up	Fan Control Override	Typical	
V-50	Tan/ Wht	Analog Input - 1.5k Pull-up	Park Brake	Typical	
V-51	Dk Blu/Wht	Analog Input - 1.5k Pull-up	Engine Brake Medium	Typical: Jake	
V-52	Dk Grn/Orn	PWM Output Low Side	Trans % Load	—	
V-53	Blk/Red	Digital Output - Low Side	Coolant Level Low Lamp	Typical	
V-54	Blk/Pnk	Digital Output - Low Side	No Connection	No Conn	
V-55	Lt Grn/Blk	Digital Output - Low Side	Cruise/PSG Active Lamp	Typical	
V-56	Dk Grn/ Grey	J1587 (+)	J1587 (+)	Required	
V-57	Dk Grn	J1587 (-)	J1587 (-)	Required	
V-58	Dk Blu	J1939 (-)	J1939 (-)	Required	
V-59	Dk Blu	Sensor Return #2	Sensor Return	Required	
V-60	Yel/ Blk	Sensor Return #1	Sensor Return	Required	
V-61	Red/Blk	Battery (+)	+12V / +24V	Required	
V-62	Red/ Lt Blu	Battery (+)	+12V / +24V	Required	
V-63	Brn/Blk	Battery (-)	Ground	Required	
V-64	Brn/ Lt Grn	Battery (-)	Ground	Required	
V-65	Red/ Lt Grn	Battery (+)	+12V / +24V	Required	
V-66	Red/ Pnk	Battery (+)	+12V / +24V	Required	
V-67	Brn/Wht	Battery (-)	Ground	Required	
V-68	Brn/Yel	Battery (-)	Ground	Required	

Table 3-16 Series 60 VIH Connector Firetruck – Pins V-34 – V-68

3.4.2 VIH DESIGN GUIDELINES

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



Criteria: VIH Design

The 60 18 AWG terminals (pins V-1 through V-60) on the VIH 68-pin connector are designed to accept 16 or 18 AWG wire with Outer Diameter (OD) of 2.0-2.5 mm.

The eight 14 AWG (pins V-61 through V-68) on the VIH 68-pin connector are used for battery connections. These terminals are designed to accept 14 AWG wire with an OD of 2.50-3.18 mm.

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

Color code the wires as shown in the schematics. If the wires used are the same color, hot stamp the cavity number on the wires.

NOTE:

The Vehicle Speed Sensor (VSS) and the SAE J1708/J1587 Data Link circuits must be twisted pairs. The twists are a minimum of 12 turns per foot (305 mm) and are required to minimize electromagnetic field coupling. The maximum length for the SAE J1708/J1587 Data Link is 40 m (130 ft).

NOTE:

All output loads (PWM and digital outputs), ignition and ECU power must be powered from the same battery voltage source.

Pin functions for the VIH are listed in Table 3-17.

Function	Number of Pins
Analog Inputs	24 (18 can be used for Digital Inputs)
PWM Low-Side Output	2
Digital Low-Side Output	10
Frequency Input (two pins each)	4
Battery +	4
Battery -	4
Frequency Output (Tach)	1
SAE J1587 DATA LINK	2
SAE J1939 DATA LINK	3
Sensor Supply/Return	4
Ignition	1
Spare	9

Table 3-17 ECU Pin Functions

Frequency Inputs

The ECU has two frequency inputs on the VIH that can accept a variable reluctance sensor or open collector output device (i.e. Hall Effect sensor, transmission controller) signal types. Typical frequency input functions are: Vehicle Speed Sensor (VSS). Requirements for a variable reluctance signal interface are listed in Table 3-18.

Parameter	Range
Input Amplitude Range	800 mV - 100 V peak to peak
Input Frequency Range	1 to 3000 Hz

Table 3-18 Variable Reluctance Signal Interface

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.

The open collector signal is connected to the (+) input while the (-) input must remain an open circuit. The requirements for an open collector signal interface are listed in Table 3-19.

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

Table 3-19 Open Collector Signal Interface

Analog Inputs

The ECU has 24 analog inputs located on the VIH.

Analog inputs with a 1.5k Ω Pull-up to 5 volts internal to the ECU can be used for digital input functions.

These inputs are in low state by shorting to sensor return and placed in high state by opening.

Input Requirements for Analog Inputs Used as Digital Inputs:

High State: $4.0\text{ V} < E_{in} < \text{Battery (+)}$ with $I_{leakage} < 0.2\text{ mA}$.

Low State: $-2.0 < E_{in} < 1.0\text{ V}$ while $I_{source} < 5.0\text{ mA}$.

I_{source} : Capable of sourcing up to 5.0 mA.

NOTE:

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

Analog inputs must use the sensor supply and/or the sensor return circuit as listed in Table 3-20.

Cavity	Signal Type	Sensor Supply	Sensor Return
V-3	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)
V-8	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)
V-9	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)
V-10	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)
V-13	Analog Input - 300k Pull-down	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-14	Analog Input - 300k Pull-down	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-16	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)
V-22	Analog Input - 51k Pull-down	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-23	Analog Input - 1.5k Pull-up	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-24	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)
V-25	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)
V-26	Analog Input - 1.5k Pull-up	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-27	Analog Input - 1.5k Pull-up	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-29	Analog Input - 51k Pull-down	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-37	Analog Input - 120k Pull-up	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-38	Analog Input - 120k Pull-up	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-39	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)
V-41	Analog Input - 1.5k Pull-up	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-42	Analog Input - 1.5k Pull-up	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-47	Analog Input - 1.5k Pull-up	Sensor Supply 21 (V-12)	Sensor Return #2 (V-59)
V-48	Analog Input - 1.5k Pull-up	Sensor Supply #1 (V-11)	Sensor Return #1 (V-60)
V-49	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)
V-50	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)
V-51	Analog Input - 1.5k Pull-up	Sensor Supply #2 (V-12)	Sensor Return #2 (V-59)

Table 3-20 Analog Inputs and the Sensor Supply/Return Circuits

Pulse Width Modulated Output

There are two low-side PWM outputs on the VIH. These outputs are capable of providing 100 to 1000 Hz modulation between 0 and 100% duty cycle with a resolution of 0.10% duty cycle.

Output Characteristics:

Output On: E_{out} is less than 1.0 V with respect to ECU ground.
 (average) $I_{sink} = 3.0$ A
 Output On: E_{out} is less than 2.0 V with respect to ECU ground.
 (peak) $I_{sink} = 6.0$ A
 Output Off: $I_{leakage}$ (I_{sink}) is less than 700 μ A while $0 < E_{out} < V_{battery}$.

The outputs default to the off (open circuit) state until enabled by the software.

Load Drive Capability of Each PWM Output:

I_{sink} : Capable of sinking an average current of 3.0 A or less and peak current of 6.0 A or less.

Total Load Drive Capability of Both PWM Outputs:

$I_{sinkTotal}$: Capable of sinking an average current of 3.0 A or less and peak current of 6.0 A or less.

Frequency Output

The frequency output on the VIH typically provides an engine speed signal to a tachometer, gauge or another DDEC V ECU. The output frequency transfer function can be calibrated and is 12 pulses per RPM for a tachometer output. The output characteristics are listed in Table 3-21.

Parameter	Output
Frequency Range	10 to 2000 Hz
High State @ Max $I_{source} = 5.0$ mA	$4.0 < E_{out} < \text{Battery (+) V}$
Duty Cycle	50% $\pm$ 10%

Table 3-21 Frequency Output Characteristics

Digital Outputs

There are ten low-side digital outputs located on the VIH. The outputs default to off.

Low-Side Output Characteristics:

Output On: $E_{out} < 1.0 \text{ V}$ with respect to ECU ground.
 $I_{sink}(\text{max}) = 2.0 \text{ A}$.
 Output Off: $I_{leakage} < 210 \mu\text{A}$ while $0 < E_{out} < \text{Battery (+) V}$

Load Drive Capabilities of Each Low Side Digital Output:

Resistance: Capable of driving a resistance greater than or equal to 8Ω at 16.0 V.
 Capable of driving a resistance greater than or equal to 16Ω at 32.0 V.
 Inductance: Capable of connecting to an inductance less than or equal to 100 mH. If load is $>100 \text{ mH}$ then external clamping is required.
 I_{sink} : Capable of sinking less than or equal to 2.0 A.

Total Load Drive Capability of All Ten Low Side Digital Outputs:

$I_{sink\text{-Total}}$: Total current of all ten low-side digital outputs must be less than or equal to 10.0 A.

Ignition

The ignition source may be either 12 or 24 volts. The DDEC ignition must be an independent input sourced directly from the battery post via a weatherproof blade type fuse, circuit breaker, or equivalent. Ignition sinks a maximum of 10 mA. The ignition fuse rating must be sized for the loads utilized in the application; however, a rating between 5 and 10 amps is usually sufficient. Fuse holders for blade type fuses may be purchased from the DDC Parts Distribution Center. The fuse holder accepts a wire diameter with an OD of 2.89 - 3.65 mm. Part numbers are listed in Table 3-22.

Part	Part Number
Fuse Holder	12033769
Cover	12033731
Terminals	12066614

Table 3-22 Fuse Holder Part Numbers

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

3.4.3 VIH POWER WIRING

The OEM-supplied VIH power wiring (see Figure 3-7) supplies either 12 or 24 volts to the ECU. The system must be sourced directly from the battery. The eight larger terminals (pins V-61 through V-68) on the VIH connector are used to supply power to the ECU. The terminals are designed to accept 14 AWG standard-wall wire with an OD of 2.5-3.18 mm.

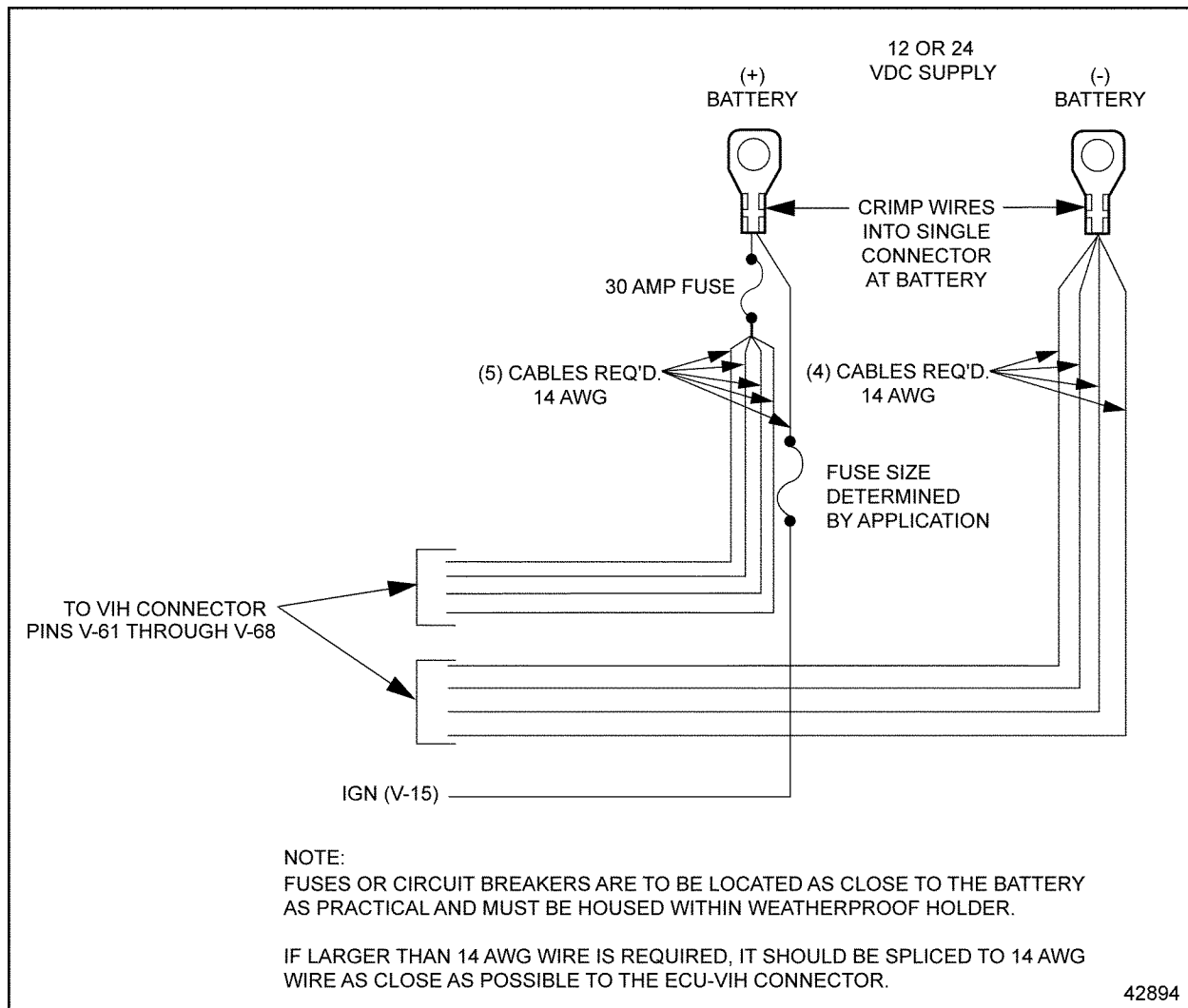


Figure 3-7 Power Wiring - Single-ECU, Single-Fuse

Power must be sourced directly from the battery. An electrically sound 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 VIH power wires. **Do not** use chassis ground.

NOTE:

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 VIH power wiring from other vehicle electrical systems. Other electrical system wires should ideally be at least three feet away from the VIH power wiring and should not be parallel to the VIH power wiring. This will eliminate coupling electromagnetic energy from other systems into the VIH power wiring.

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

If larger than 14 AWG wire is required, it should be spliced to 14 AWG wire as close as possible to the ECU VIH connector.

A 30 amp fuse must be used and installed as close to the battery as possible (see Figure 3-7).

The conductor must be annealed copper not aluminum and must comply with the industry standard, *SAE J1128 JAN 95 Low Tension Primary Cable*. Contact the Society of Automotive Engineers to obtain documents, refer to Appendix for their address.

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. Alternatively, wires may be hot stamped with the cavity number.

Wire Resistances

VIH power terminals require 14 AWG wire. The total resistance of the power harness cannot exceed 60 mΩ. The characteristics for Teflon coated and GXL type wire gauges are listed in Table 3-23.

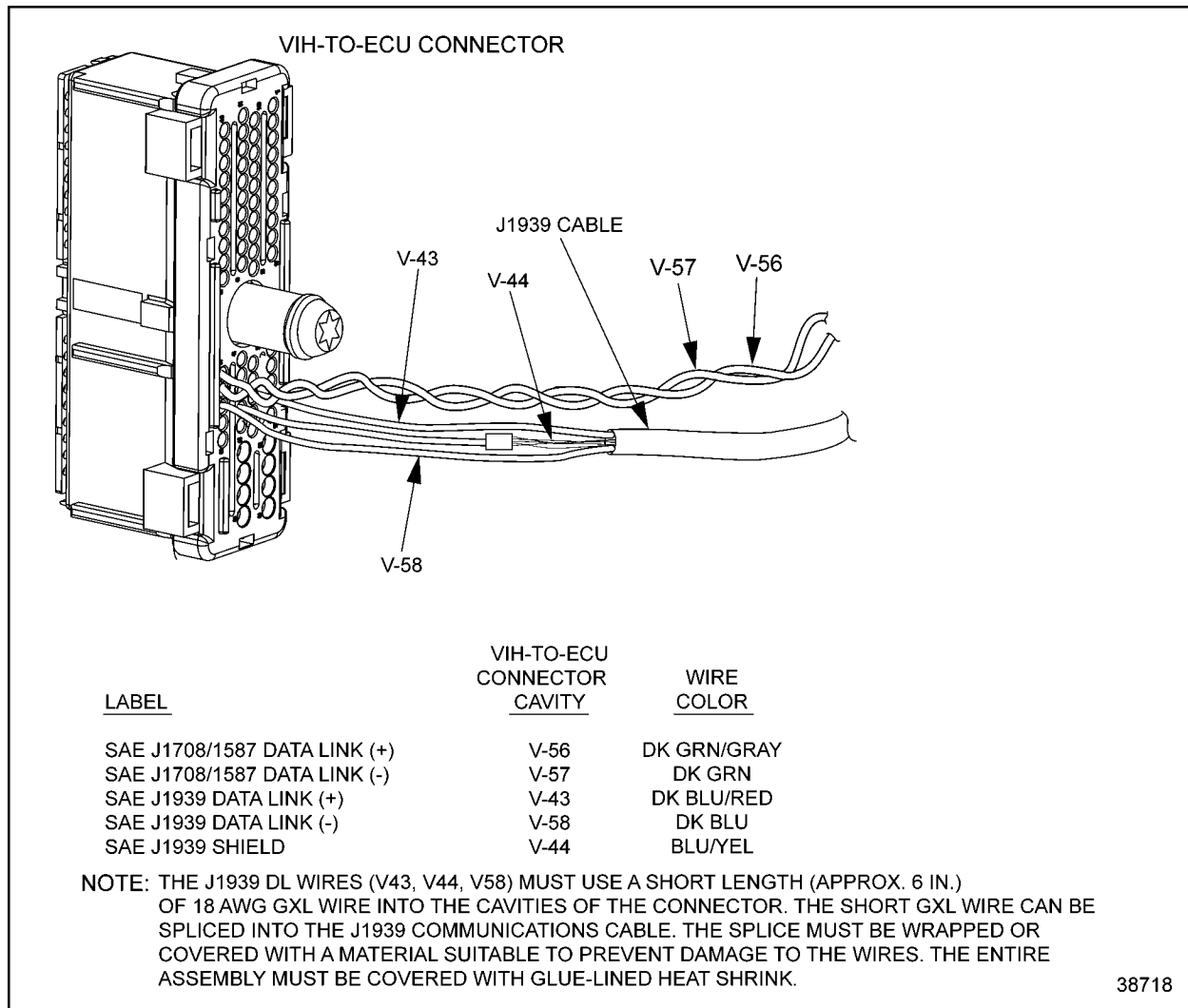
SAE Wire Gauge	Metric Gauge #	Area mm ²	Resistance mΩ/m	Resistance mΩ/ft @ 20°C	Resistance mΩ/ft @ 120°C	Diameter mm
16	1	1.129	15.300	4.66	6.50	0.72
14	2	1.859	9.290	2.83	3.94	1.18
12	3	2.929	5.900	1.80	2.50	1.86
10	5	4.663	3.720	1.13	1.58	2.97
8	8	7.277	2.400	0.73	1.02	4.63

Table 3-23 Wire Characteristics

Total power harness resistance is determined by shorting together the eight terminals in the ECU connector, and then measuring the resistance from the battery (+) to battery (-) terminal at the maximum operating temperature (105°C). Disconnect the harness from the batteries before measuring the resistance.

3.4.4 COMMUNICATION WIRING

SAE J1939 Data Link+, SAE J1939 Data Link-, and SAE J1939 Data Link Shield are used as the J1939 communication link. J1939 cable is required for the J1939 data link. Termination resistors are required per the SAE specification. Refer to SAE J1939-11 for specific requirements. SAE J1587 DL+ and SAE J1587 DL- are used for the SAE J1708/J1587 communication link. See Figure 3-8.



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Figure 3-8 Communication Wiring

The maximum length for the SAE J1939 Data Link is 130 ft (40 m).

The SAE J1587/J1708 Data Link must be twisted pairs. The twists are a minimum of 12 turns per foot (305 mm). The maximum length for the SAE J1587/J1708 Data Link is 130 ft (40 m).

The following SAE documents cover the SAE J1939 Data Link. Contact the Society of Automotive Engineers to obtain documents, refer to Appendix for their address.

<i>SAE J1939</i>	<i>Top Layer (Overview)</i>
<i>SAE J1939/11</i>	<i>Physical Layer</i>
<i>SAE J1939/21</i>	<i>Data Link Layer</i>
<i>SAE J1939/71</i>	<i>Application Layer</i>
<i>SAE J1939/01</i>	<i>Recommended Practice for Control and Communication Network for On-highway Equipment</i>
<i>SAE J1939/73</i>	<i>Application Layer Diagnostics</i>

The following SAE documents cover the SAE J1587/J1708 Data Link.

<i>SAE J1587</i>	<i>Electronic Data Interchange Between Microcomputer Systems in Heavy-duty Vehicle Applications</i>
<i>SAE J1708</i>	<i>Serial Data Communications Between Microcomputer Systems in Heavy-duty Vehicle Applications</i>

Contact the Society of Automotive Engineers to obtain documents, refer to Appendix F for their address.

For a list of supported messages, refer to Chapter 6, "Communications Protocols."

J1939 cable is available from the following vendors:

Belden Electronics Division

2200 U.S. 27 South
Richmond, IN 47374
Phone: 1-800-235-3361
www.belden.com

Tyco Electronics Corporation

Raychem Wire and Harnessing
300 Constitution Drive
Menlo Park, CA 94025
Phone: 1-800-926-2425
www.raychem.com

3.4.5 VIH INSTALLATION

The connector shroud is used to protect the connectors from dirt and direct spray, and to route the wires in the correct orientation. The shroud is designed for 25-30 mm conduit. The shroud is REQUIRED.

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



Criteria: VIH Installation

Provide maximum physical separation of the VIH from other vehicle electrical systems. Other electrical system wires 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.

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

The 68-pin VIH-to-ECU connector center screw must be torqued to 50 in·lb (5.6 N·m).

The shroud lock nuts must be torqued to 30 in·lb (3.4 N·m).

3.5 POWER SUPPLY

Normal operating voltage for DDEC V is 11-32 VDC.

NOTICE:
Operating the ECU over the voltage limits of 32 volts will cause damage to the ECU.

Operating the ECU between 6 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 ECU if the Power Harness is not properly fused.

3.5.1 AVERAGE CURRENT DRAW

The maximum average current draw is listed in Table 3-24. This information should be used to size the alternator.

System	Maximum Average Current Draw	
	Idle	Full Load/ Rated Speed
Injectors	2.0 A total	10.0 A total
Engine Loads (6 High-side Digital Outputs, 3 Low-side Digital Outputs, 4 Low-side PWM Outputs)	12.0 A total	12.0 A total
Vehicle Loads* (10 Low-side Digital Outputs, 2 PWM Outputs)	15.0 A total	15.0 A total

* Vehicle loads are controlled by the OEMs who can best determine the total maximum current draw for their installation.

Table 3-24 Maximum Average Current Draw

The current draw for a single-ECU configuration is listed in Table 3-25.

Configuration	Condition	Current*
Single-ECU	Ignition Off	25 mA
	Ignition On and Engine Stopped	500 mA

* Add up to 2.0 A to the current draw total for every digital output.

Table 3-25 Current Draw for Single-ECU Configuration

3.5.2 MAIN POWER SHUTDOWN

The main power supply shutdown schematic shows the DDC approved method for main power switch implementation. See Figure 3-9.

NOTE:

Disconnecting positive power is not sufficient to isolate the ECU for welding purposes.

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

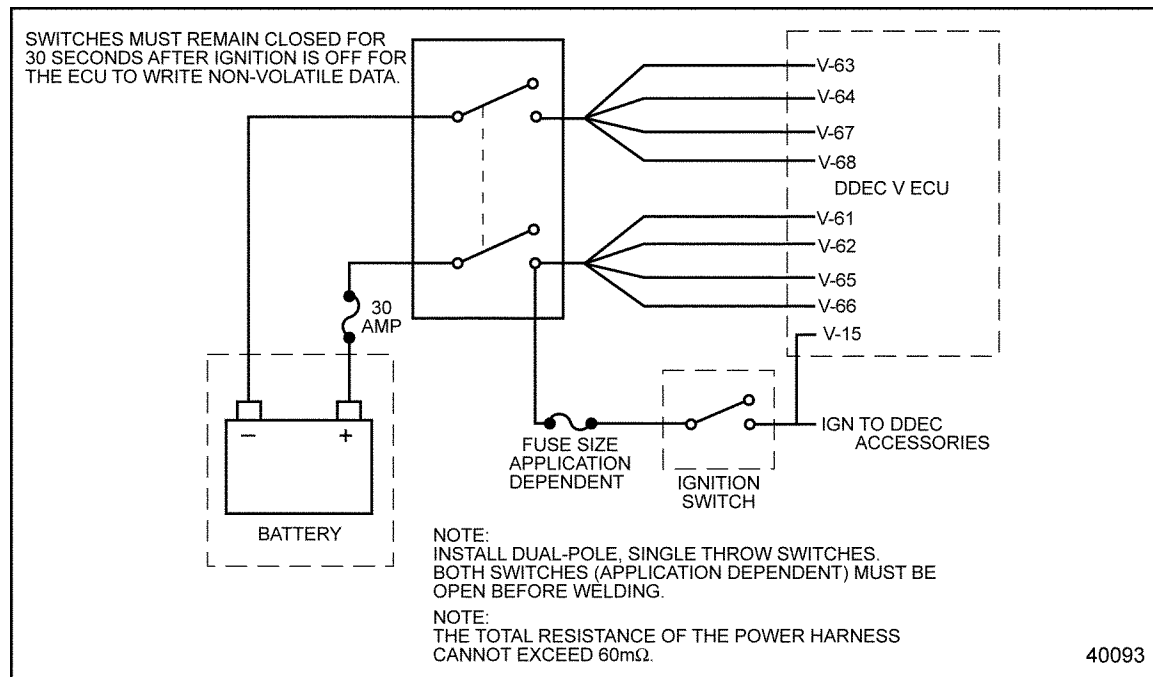


Figure 3-9 Main Power Supply Shutdown 12 or 24 Volt Systems

3.6 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 of 32 volts.



CAUTION:

FIRE

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 cause the circuit to overheat and burn.



CAUTION:

FIRE

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 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

Bussmann ATC-30 and Delphi Packard Electric Systems MaxiFuse 30 amp rated fuses or equivalent will satisfy these requirements. Acceptable blow times versus current and temperature derating characteristics are listed in Table 3-26 and Table 3-27.

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

Table 3-26 Fuse Current and Blow Time

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

Table 3-27 Fuse Temperature and Current

3.7 CONNECTORS

The DDEC V ECU has two 68-pin Tyco connectors - one for the engine and the other for the vehicle. Each connector has 60 18 AWG terminals and eight 14 AWG terminals (see Figure 3-10).

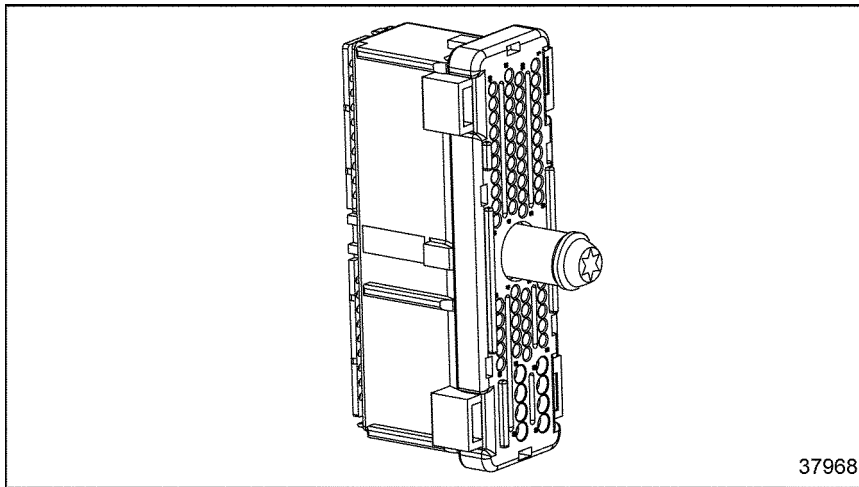


Figure 3-10 ECU 68-pin Tyco Connector

3.7.1 ECU VEHICLE INTERFACE HARNESS CONNECTOR

The VIH 68-pin Tyco connector pinout is listed in Table 3-28 and Table 3-29.

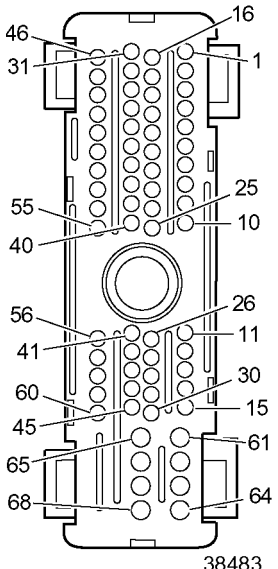
Pin	Wire Color	Signal Type	Function	Req/Typical	Connector
V-1	Dk Grn/Blk	Digital Output - Low Side	AWL	Required	 38483 Shroud Side of Connector
V-2	Blk/Yel	Digital Output - Low Side	RSL	Required	
V-3	Wht/Dk Grn	Analog Input - 1.5k Pull-up	Service Brake Released	Required	
V-4	Blk/Lt Blu	Digital Output - Low Side	Fan Control #1	Typical: Fan	
V-5	Blk/Lt grn	Digital Output - Low Side	Top2 Shift Solenoid	Typical: Top2	
V-6	Blk/Orn	Digital Output - Low Side	Top2 Lockout Solenoid	Typical: Top2	
V-7	Blk/Wht	Digital Output - Low Side	Vehicle Power Shtdn	Typical	
V-8	Wht/Orn	Analog Input - 1.5k Pull-up	Resume/Accel	Typical: CC	
V-9	Ppl/Wht	Analog Input - 1.5k Pull-up	Cruise Enable	Typical: CC	
V-10	Lt Grn/Wht	Analog Input - 1.5k Pull-up	Clutch Released	Typical: CC	
V-11	Yel/Red	Sensor Supply #1	Sensor Supply #1	Required	
V-12	Wht/ Red	Sensor Supply #2	Sensor Supply #2	Required	
V-13	Lt Blu/Yel	Analog Input - 300k Pull-down	Throttle Position	Required	
V-14	Ppl/Yel	Analog Input - 300k Pull-down	VSG or No Function	Typical	
V-15	Pnk	Ignition	Ignition	Required	
V-16	Red/Wht	Analog Input - 1.5k Pull-up	Idle Validation	Required	
V-17	Lt Blu/ Orn	Frequency Input (+) VSS	Vehicle Speed (+)	Required	
V-18	Lt Blu/ Blk	Frequency Input (-) VSS	Vehicle Speed (-)	Required	
V-19	—	No Connection	No Connection	No Conn	
V-20	—	No Connection	No Connection	No Conn	
V-21	—	No Connection	No Connection	No Conn	
V-22	Yel/Lt Blu	Analog Input – 51k Pull-down	Air Filter Restriction	Typical: MAS	
V-23	Yel/Dk Grn	Analog Input - 1.5k Pull-up	Exhaust Temp (Bus/Coach)	Typical	
V-24	Dk Grn/Wht	Analog Input - 1.5k Pull-up	SEO/Diag Request	Required	
V-25	Grey/Wht	Analog Input - 1.5k Pull-up	A/C Status	Typical: Fan	
V-26	Yel/Lt Grn	Analog Input - 1.5k Pull-up	Engine Brake Disable	—	
V-27	Yel/Wht	Analog Input - 1.5k Pull-up	Turbo Compressor In Temp	Required	
V-28	—	No Connection	No Connection	No Conn	
V-29	Wht/Yel	Analog Input – 51k Pull-down	Exhaust Back Press or Water Pump Press or Air Compressor Press	Typical	
V-30	—	No Connection	No Connection	No Conn	
V-31	Tan	Frequency Output	Tachometer	Typical	

Table 3-28 Series 60 VIH Connector - On-highway Truck – Pins V-1 – V-31

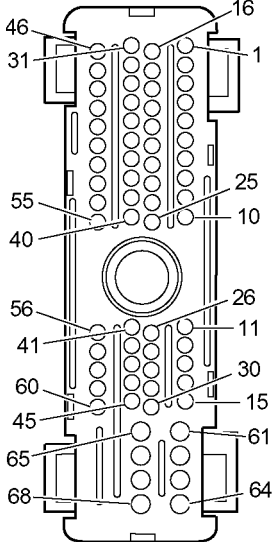
Pin	Wire Color	Signal Type	Function	Req/ Typical	Connector
V-32	Dk Blu/Orn	Frequency Input (+) Aux 1	Spare	—	 38483 Shroud Side of Connector
V-33	Dk Blu/Blk	Frequency Input (-) Aux 1	Spare	—	
V-34	—	No Connection	No Connection	No Conn	
V-35	—	No Connection	No Connection	No Conn	
V-36	—	No Connection	No Connection	No Conn	
V-37	Orn/Yel	Analog Input – 120k Pull-up	Add Coolant Level	Typical: MAS	
V-38	Lt Gr/Yel	Analog Input – 120k Pull-up	Coolant Level Shtdn	Req	
V-39	Lt Blu/Wht	Analog Input – 1.5k Pull-up	Engine Brake Low	Typical: Jake	
V-40	Orn/Blk	Digital Output – Low Side	OI Alarm	Typical: OI	
V-41	Dk Grn/Yel	Analog Input – 1.5k Pull-up	Aux Shtdn #1	—	
V-42	Grey/Yel	Analog Input – 1.5k Pull-up	OI Thermostat	Typical: OI	
V-43	Dk Blu/Red	J1939 (+)	J1939 (+)	Req	
V-44	Dk Blu/Yel	J1939S	J1939 Shield	Required	
V-45	—	No Connection	No Connection	No Conn	
V-46	Dk Grn/Brn	PWM Output - Low Side	Variable Speed Fan	—	
V-47	Wht/Lt Blu	Analog Input - 1.5k Pull-up	Set/Coast	Typical; CC	
V-48	Tan/ Yel	Analog Input - 1.5k Pull-up	Throttle Inhibit	—	
V-49	Pink/Wht	Analog Input - 1.5k Pull-up	Fan Control Override	Typical	
V-50	Tan/ Wht	Analog Input - 1.5k Pull-up	Park Brake	Typical	
V-51	Dk Blu/Wht	Analog Input - 1.5k Pull-up	Engine Brake Medium	Typical: Jake	
V-52	Dk Grn/Orn	PWM Output Low Side	Trans % Load	—	
V-53	Blk/Red	Digital Output - Low Side	Ether Start	—	
V-54	Blk/Pnk	Digital Output - Low Side	OI Starter	Typical: OI	
V-55	Lt Grn/Blk	Digital Output - Low Side	OI Active Lamp	Typical: OI	
V-56	Dk Grn/ Grey	J1587 (+)	J1587 (+)	Required	
V-57	Dk Grn	J1587 (-)	J1587 (-)	Required	
V-58	Dk Blu	J1939 (-)	J1939 (-)	Required	
V-59	Dk Blu	Sensor Return #2	Sensor Return	Required	
V-60	Yel/ Blk	Sensor Return #1	Sensor Return	Required	
V-61	Red/Blk	Battery (+)	+12V / +24V	Required	
V-62	Red/ Lt Blu	Battery (+)	+12V / +24V	Required	
V-63	Brn/Blk	Battery (-)	Ground	Required	
V-64	Brn/ Lt Grn	Battery (-)	Ground	Required	
V-65	Red/ Lt Grn	Battery (+)	+12V / +24V	Required	
V-66	Red/ Pnk	Battery (+)	+12V / +24V	Required	
V-67	Brn/Wht	Battery (-)	Ground	Required	
V-68	Brn/Yel	Battery (-)	Ground	Required	

Table 3-29 Series 60 VIH Connector - On-highway Truck - Pins V-32 — V-68

The VIH 68-pin Tyco connector pinout for Series 60 Bus/Coach applications is listed in Table 3-30 and Table 3-31.

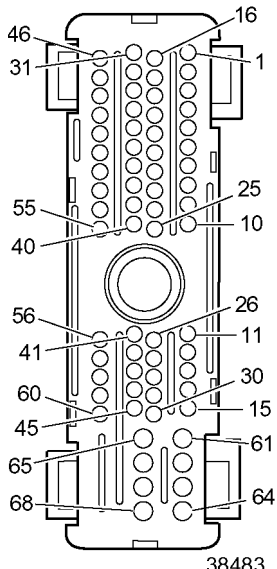
Pin	Wire Color	Signal Type	Function	Req/Typical	Connector
V-1	Dk Grn/Blk	Digital Output - Low Side	AWL	Required	 Shroud Side of Connector
V-2	Blk/Yel	Digital Output - Low Side	RSL	Required	
V-3	Wht/Dk Grn	Analog Input - 1.5k Pull-up	Service Brake Released	Required	
V-4	Blk/Lt Blu	Digital Output - Low Side	Fan Control #1	Typical: Fan	
V-5	Blk/Lt grn	Digital Output - Low Side	Fan Control #2	Typical: Fan	
V-6	Blk/Orn	Digital Output - Low Side	Decleration Lamp	Typical	
V-7	Blk/Wht	Digital Output - Low Side	Starter Lockout	Typical	
V-8	Wht/Orn	Analog Input - 1.5k Pull-up	Resume/Accel	Typical: CC	
V-9	Ppl/Wht	Analog Input - 1.5k Pull-up	Cruise Enable	Typical: CC	
V-10	Lt Grn/Wht	Analog Input - 1.5k Pull-up	Spare	—	
V-11	Yel/Red	Sensor Supply #1	Sensor Supply #1	Required	
V-12	Wht/ Red	Sensor Supply #2	Sensor Supply #2	Required	
V-13	Lt Blu/Yel	Analog Input - 300k Pull-down	Throttle Position	Required	
V-14	Ppl/Yel	Analog Input - 300k Pull-down	VSG or No Function	Typical	
V-15	Pnk	Ignition	Ignition	Required	
V-16	Red/Wht	Analog Input - 1.5k Pull-up	Idle Validation	Required	
V-17	Lt Blu/ Orn	Frequency Input (+) VSS	Vehicle Speed (+)	Required	
V-18	Lt Blu/ Blk	Frequency Input (-) VSS	Vehicle Speed (-)	Required	
V-19	—	No Connection	No Connection	No Conn	
V-20	—	No Connection	No Connection	No Conn	
V-21	—	No Connection	No Connection	No Conn	
V-22	Yel/Lt Blu	Analog Input – 51k Pull-down	Air Filter Restriction	Typical: MAS	
V-23	Yel/Dk Grn	Analog Input - 1.5k Pull-up	Exhaust Temp (Bus/Coach)	Typical	
V-24	Dk Grn/Wht	Analog Input - 1.5k Pull-up	SEO/Diag Request	Required	
V-25	Grey/Wht	Analog Input - 1.5k Pull-up	A/C Status	Typical: Fan	
V-26	Yel/Lt Grn	Analog Input - 1.5k Pull-up	Engine Brake Disable	Typical	
V-27	Yel/Wht	Analog Input - 1.5k Pull-up	Turbo Compressor In Temp	Required	
V-28	—	No Connection	No Connection	No Conn	
V-29	Wht/Yel	Analog Input – 51k Pull-down	Exhaust Back Pressure	Typical	
V-30	—	No Connection	No Connection	No Conn	
V-31	Tan	Frequency Output	Tachometer	Typical	

Table 3-30 Series 60 VIH Connector Bus/Coach – Pins V-1 – V-31

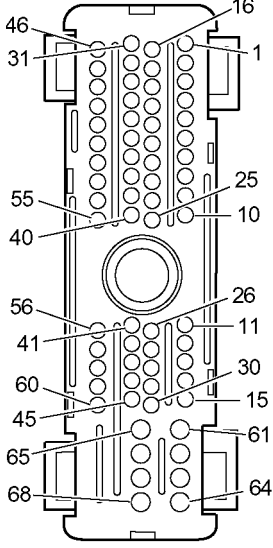
Pin	Wire Color	Signal Type	Function	Req/ Typical	Connector
V-32	Dk Blu/Orn	Frequency Input (+) Aux 1	Spare	—	 38483 Shroud Side of Connector
V-33	Dk Blu/Blk	Frequency Input (-) Aux 1	Spare	—	
V-34	—	No Connection	No Connection	No Conn	
V-35	—	No Connection	No Connection	No Conn	
V-36	—	No Connection	No Connection	No Conn	
V-37	Orn/Yel	Analog Input – 120k Pull-up	Add Coolant Level	Typical: MAS	
V-38	Lt Gr/Yel	Analog Input – 120k Pull-up	Coolant Level Shtdn	Req	
V-39	Lt Blu/Wht	Analog Input – 1.5k Pull-up	Engine Brake Low	Typical: Jake	
V-40	Orn/Blk	Digital Output – Low Side	Engine Brake Active	Typical	
V-41	Dk Grn/Yel	Analog Input – 1.5k Pull-up	Aux Shtdn #1	—	
V-42	Grey/Yel	Analog Input – 1.5k Pull-up	Alt Min VSG / Fast Idle	Typical	
V-43	Dk Blu/Red	J1939 (+)	J1939 (+)	Req	
V-44	Dk Blu/Yel	J1939S	J1939 Shield	Required	
V-45	—	No Connection	No Connection	No Conn	
V-46	Dk Grn/Brn	PWM Output - Low Side	Variable Speed Fan	—	
V-47	Wht/Lt Blu	Analog Input - 1.5k Pull-up	Set/Coast	Typical; CC	
V-48	Tan/ Yel	Analog Input - 1.5k Pull-up	Throttle Inhibit	Typical	
V-49	Pink/Wht	Analog Input - 1.5k Pull-up	Fan Control Override	Typical	
V-50	Tan/ Wht	Analog Input - 1.5k Pull-up	Park Brake	Typical	
V-51	Dk Blu/Wht	Analog Input - 1.5k Pull-up	Engine Brake Medium	Typical: Jake	
V-52	Dk Grn/Orn	PWM Output Low Side	Trans % Load	—	
V-53	Blk/Red	Digital Output - Low Side	Coolant Level Low Lamp	Typical	
V-54	Blk/Pnk	Digital Output - Low Side	No Connection	No Conn	
V-55	Lt Grn/Blk	Digital Output - Low Side	Cruise Active Lamp	Typical	
V-56	Dk Grn/ Grey	J1587 (+)	J1587 (+)	Required	
V-57	Dk Grn	J1587 (-)	J1587 (-)	Required	
V-58	Dk Blu	J1939 (-)	J1939 (-)	Required	
V-59	Dk Blu	Sensor Return #2	Sensor Return	Required	
V-60	Yel/ Blk	Sensor Return #1	Sensor Return	Required	
V-61	Red/Blk	Battery (+)	+12V / +24V	Required	
V-62	Red/ Lt Blu	Battery (+)	+12V / +24V	Required	
V-63	Brn/Blk	Battery (-)	Ground	Required	
V-64	Brn/ Lt Grn	Battery (-)	Ground	Required	
V-65	Red/ Lt Grn	Battery (+)	+12V / +24V	Required	
V-66	Red/ Pnk	Battery (+)	+12V / +24V	Required	
V-67	Brn/Wht	Battery (-)	Ground	Required	
V-68	Brn/Yel	Battery (-)	Ground	Required	

Table 3-31 Series 60 VIH Connector Bus/Coach – Pins V-32 – V-68

The VIH 68-pin Tyco connector pinout for Series 60 non-road equipment is listed in Table 3-32 and listed in Table 3-33.

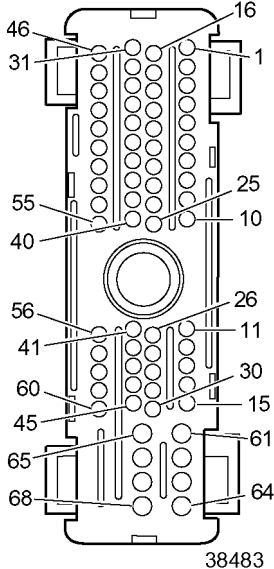
Pin	Wire Color	Signal Type	Function	Req/Typical	Connector
V-1	Dk Grn/Blk	Digital Output - Low Side	AWL	Required	 Shroud Side of Connector
V-2	Blk/Yel	Digital Output - Low Side	RSL	Required	
V-3	Wht/Dk Grn	Analog Input - 1.5k Pull-up	Service Brake Released	Required	
V-4	Blk/Lt Blu	Digital Output - Low Side	Fan Control #1	Typical: Fan	
V-5	Blk/Lt grn	Digital Output - Low Side	Fan Control #2	Typical: Fan	
V-6	Blk/Orn	Digital Output - Low Side	Spare	—	
V-7	Blk/Wht	Digital Output - Low Side	Starter Lockout	Typical	
V-8	Wht/Orn	Analog Input - 1.5k Pull-up	Resume/Accel	Typical: CC	
V-9	Ppl/Wht	Analog Input - 1.5k Pull-up	Cruise Enable	Typical: CC	
V-10	Lt Grn/Wht	Analog Input - 1.5k Pull-up	Spare	—	
V-11	Yel/Red	Sensor Supply #1	Sensor Supply #1	Required	
V-12	Wht/ Red	Sensor Supply #2	Sensor Supply #2	Required	
V-13	Lt Blu/Yel	Analog Input - 300k Pull-down	Throttle Position (ALSG)	Required	
V-14	Ppl/Yel	Analog Input - 300k Pull-down	VSG	Typical	
V-15	Pnk	Ignition	Ignition	Required	
V-16	Red/Wht	Analog Input - 1.5k Pull-up	Idle Validation	Required	
V-17	Lt Blu/ Orn	Frequency Input (+) VSS	Vehicle Speed (+)	Required	
V-18	Lt Blu/ Blk	Frequency Input (-) VSS	Vehicle Speed (-)	Required	
V-19	—	No Connection	No Connection	No Conn	
V-20	—	No Connection	No Connection	No Conn	
V-21	—	No Connection	No Connection	No Conn	
V-22	Yel/Lt Blu	Analog Input – 51k Pull-down	Air Filter Restriction	Typical: MAS	
V-23	Yel/Dk Grn	Analog Input - 1.5k Pull-up	Exhaust Temp	Typical	
V-24	Dk Grn/Wht	Analog Input - 1.5k Pull-up	SEO/Diag Request	Required	
V-25	Grey/Wht	Analog Input - 1.5k Pull-up	A/C Status	Typical: Fan	
V-26	Yel/Lt Grn	Analog Input - 1.5k Pull-up	Engine Brake Disable	Typical	
V-27	Yel/Wht	Analog Input - 1.5k Pull-up	Spare	—	
V-28	—	No Connection	No Connection	No Conn	
V-29	Wht/Yel	Analog Input – 51k Pull-down	Exhaust Back Pressure or Water Pump Pressure or Air Compressor Pressure	Typical	
V-30	—	No Connection	No Connection	No Conn	
V-31	Tan	Frequency Output	Tachometer	Typical	

Table 3-32 Series 60 VIH Connector Non-Road Equipment – Pins V-1 – V-31

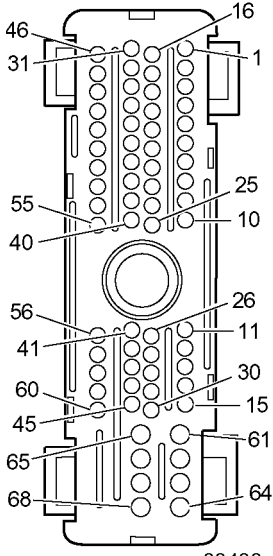
Pin	Wire Color	Signal Type	Function	Req/ Typical	Connector
V-32	Dk Blu/Orn	Frequency Input (+) Aux 1	Spare	—	 38483 Shroud Side of Connector
V-33	Dk Blu/Blk	Frequency Input (-) Aux 1	Spare	—	
V-34	—	No Connection	No Connection	No Conn	
V-35	—	No Connection	No Connection	No Conn	
V-36	—	No Connection	No Connection	No Conn	
V-37	Orn/Yel	Analog Input – 120k Pull-up	Add Coolant Level	Typical: MAS	
V-38	Lt Gr/Yel	Analog Input – 120k Pull-up	Coolant Level Shtdn	Req	
V-39	Lt Blu/Wht	Analog Input – 1.5k Pull-up	Engine Brake Low	Typical: Jake	
V-40	Orn/Blk	Digital Output – Low Side	Spare	—	
V-41	Dk Grn/Yel	Analog Input – 1.5k Pull-up	Aux Shtdn #1	—	
V-42	Grey/Yel	Analog Input – 1.5k Pull-up	Spare	—	
V-43	Dk Blu/Red	J1939 (+)	J1939 (+)	Req	
V-44	Dk Blu/Yel	J1939S	J1939 Shield	Required	
V-45	—	No Connection	No Connection	No Conn	
V-46	Dk Grn/Brn	PWM Output - Low Side	Variable Speed Fan	—	
V-47	Wht/Lt Blu	Analog Input - 1.5k Pull-up	Set/Coast	Typical; CC	
V-48	Tan/ Yel	Analog Input - 1.5k Pull-up	Throttle Inhibit	Typical	
V-49	Pink/Wht	Analog Input - 1.5k Pull-up	Fan Control Override	Typical	
V-50	Tan/ Wht	Analog Input - 1.5k Pull-up	Park Brake	Typical	
V-51	Dk Blu/Wht	Analog Input - 1.5k Pull-up	Engine Brake Medium	Typical: Jake	
V-52	Dk Grn/Orn	PWM Output Low Side	Trans % Load	—	
V-53	Blk/Red	Digital Output - Low Side	Coolant Level Low Lamp	Typical	
V-54	Blk/Pnk	Digital Output - Low Side	No Connection	No Conn	
V-55	Lt Grn/Blk	Digital Output - Low Side	Spare	—	
V-56	Dk Grn/ Grey	J1587 (+)	J1587 (+)	Required	
V-57	Dk Grn	J1587 (-)	J1587 (-)	Required	
V-58	Dk Blu	J1939 (-)	J1939 (-)	Required	
V-59	Dk Blu	Sensor Return #2	Sensor Return	Required	
V-60	Yel/ Blk	Sensor Return #1	Sensor Return	Required	
V-61	Red/Blk	Battery (+)	+12V / +24V	Required	
V-62	Red/ Lt Blu	Battery (+)	+12V / +24V	Required	
V-63	Brn/Blk	Battery (-)	Ground	Required	
V-64	Brn/ Lt Grn	Battery (-)	Ground	Required	
V-65	Red/ Lt Grn	Battery (+)	+12V / +24V	Required	
V-66	Red/ Pnk	Battery (+)	+12V / +24V	Required	
V-67	Brn/Wht	Battery (-)	Ground	Required	
V-68	Brn/Yel	Battery (-)	Ground	Required	

Table 3-33 Series 60 VIH Connector Non-Road Equipment – Pins V-32 – V-68

The 68-pin Tyco connector pinout for the Series 60 firetruck application is listed in Table 3-34 and Table 3-35.

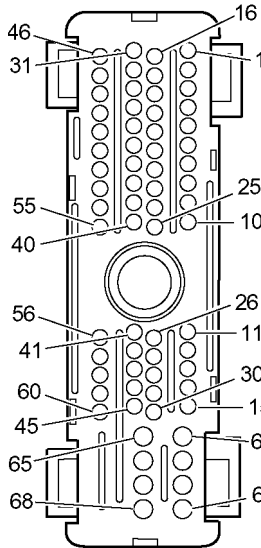
Pin	Wire Color	Signal Type	Function	Req/Typical	Connector
V-1	Dk Grn/Blk	Digital Output - Low Side	AWL	Required	 38483 Shroud Side of Connector
V-2	Blk/Yel	Digital Output - Low Side	RSL	Required	
V-3	Wht/Dk Grn	Analog Input - 1.5k Pull-up	Service Brake Released	Required	
V-4	Blk/Lt Blu	Digital Output - Low Side	Fan Control #1	Typical: Fan	
V-5	Blk/Lt grn	Digital Output - Low Side	Low DDEC Voltage	Typical	
V-6	Blk/Orn	Digital Output - Low Side	Deceleration Lamp	Typical	
V-7	Blk/Wht	Digital Output - Low Side	PSG Pressure Mode Lamp	Typical	
V-8	Wht/Orn	Analog Input - 1.5k Pull-up	Resume/Accel	Typical: PSG	
V-9	Ppl/Wht	Analog Input - 1.5k Pull-up	PSG Enable	Typical: PSG	
V-10	Lt Grn/Wht	Analog Input - 1.5k Pull-up	Spare	—	
V-11	Yel/Red	Sensor Supply #1	Sensor Supply #1	Required	
V-12	Wht/ Red	Sensor Supply #2	Sensor Supply #2	Required	
V-13	Lt Blu/Yel	Analog Input - 300k Pull-down	Throttle Position	Required	
V-14	Ppl/Yel	Analog Input - 300k Pull-down	VSG or No Function	Typical	
V-15	Pnk	Ignition	Ignition	Required	
V-16	Red/Wht	Analog Input - 1.5k Pull-up	Idle Validation	Required	
V-17	Lt Blu/ Orn	Frequency Input (+) VSS	Vehicle Speed (+)	Required	
V-18	Lt Blu/ Blk	Frequency Input (-) VSS	Vehicle Speed (-)	Required	
V-19	—	No Connection	No Connection	No Conn	
V-20	—	No Connection	No Connection	No Conn	
V-21	—	No Connection	No Connection	No Conn	
V-22	Yel/Lt Blu	Analog Input – 51k Pull-down	Air Filter Restriction	Typical: MAS	
V-23	Yel/Dk Grn	Analog Input - 1.5k Pull-up	Pressure / RPM Mode	Typical: PSG	
V-24	Dk Grn/Wht	Analog Input - 1.5k Pull-up	SEO/Diag Request	Required	
V-25	Grey/Wht	Analog Input - 1.5k Pull-up	A/C Status	Typical: Fan	
V-26	Yel/Lt Grn	Analog Input - 1.5k Pull-up	Engine Brake Disable	Typical	
V-27	Yel/Wht	Analog Input - 1.5k Pull-up	Turbo Compressor In Temp	Required	
V-28	—	No Connection	No Connection	No Conn	
V-29	Wht/Yel	Analog Input – 51k Pull-down	Water Pump Press	Typical	
V-30	—	No Connection	No Connection	No Conn	
V-31	Tan	Frequency Output	Tachometer	Typical	
V-32	Dk Blu/Orn	Frequency Input (+) Aux 1	Spare	—	
V-33	Dk Blu/Blk	Frequency Input (-) Aux 1	Spare	—	

Table 3-34 Series 60 VIH Connector Firetruck – Pins V-1 – V-33

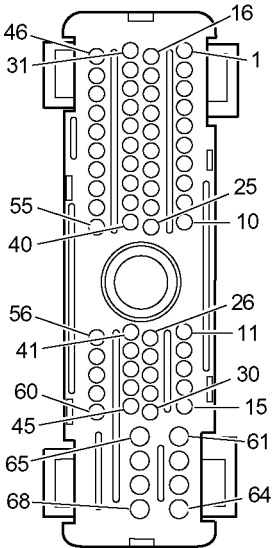
Pin	Wire Color	Signal Type	Function	Req/ Typical	Connector
V-34	—	No Connection	No Connection	No Conn	 38483 Shroud Side of Connector
V-35	—	No Connection	No Connection	No Conn	
V-36	—	No Connection	No Connection	No Conn	
V-37	Orn/Yel	Analog Input – 120k Pull-up	Add Coolant Level	Typical: MAS	
V-38	Lt Gr/Yel	Analog Input – 120k Pull-up	Coolant Level Shtdn	Req	
V-39	Lt Blu/Wht	Analog Input – 1.5k Pull-up	Engine Brake Low	Typical: Jake	
V-40	Orn/Blk	Digital Output – Low Side	Engine Brake Active	Typical	
V-41	Dk Grn/Yel	Analog Input – 1.5k Pull-up	Aux Shtdn #1	—	
V-42	Grey/Yel	Analog Input – 1.5k Pull-up	Alt Min VSG / Fast Idle	Typical	
V-43	Dk Blu/Red	J1939 (+)	J1939 (+)	Req	
V-44	Dk Blu/Yel	J1939S	J1939 Shield	Required	
V-45	—	No Connection	No Connection	No Conn	
V-46	Dk Grn/Brn	PWM Output - Low Side	Variable Speed Fan	—	
V-47	Wht/Lt Blu	Analog Input - 1.5k Pull-up	Set/Coast	Typical: PSG	
V-48	Tan/ Yel	Analog Input - 1.5k Pull-up	Throttle Inhibit	Typical	
V-49	Pink/Wht	Analog Input - 1.5k Pull-up	Fan Control Override	Typical	
V-50	Tan/ Wht	Analog Input - 1.5k Pull-up	Park Brake	Typical	
V-51	Dk Blu/Wht	Analog Input - 1.5k Pull-up	Engine Brake Medium	Typical: Jake	
V-52	Dk Grn/Orn	PWM Output Low Side	Trans % Load	—	
V-53	Blk/Red	Digital Output - Low Side	Coolant Level Low Lamp	Typical	
V-54	Blk/Pnk	Digital Output - Low Side	No Connection	No Conn	
V-55	Lt Grn/Blk	Digital Output - Low Side	Cruise/PSG Active Lamp	Typical	
V-56	Dk Grn/ Grey	J1587 (+)	J1587 (+)	Required	
V-57	Dk Grn	J1587 (-)	J1587 (-)	Required	
V-58	Dk Blu	J1939 (-)	J1939 (-)	Required	
V-59	Dk Blu	Sensor Return #2	Sensor Return	Required	
V-60	Yel/ Blk	Sensor Return #1	Sensor Return	Required	
V-61	Red/Blk	Battery (+)	+12V / +24V	Required	
V-62	Red/ Lt Blu	Battery (+)	+12V / +24V	Required	
V-63	Brn/Blk	Battery (-)	Ground	Required	
V-64	Brn/ Lt Grn	Battery (-)	Ground	Required	
V-65	Red/ Lt Grn	Battery (+)	+12V / +24V	Required	
V-66	Red/ Pnk	Battery (+)	+12V / +24V	Required	
V-67	Brn/Wht	Battery (-)	Ground	Required	
V-68	Brn/Yel	Battery (-)	Ground	Required	

Table 3-35 Series 60 VIH Connector Firetruck – Pins V-34 – V-68

The 68-pin VIH-to-ECU connector part numbers are listed in Table 3-36.

Description	DDC Part Number	Tyco Part Number
Vehicle Harness Connector Assembly	23528252	776315-1
Shroud	23532347	776501-1
Shroud Lock Nuts (M6–1.0 Nylon Insert Lock Nut Plated with Yellow Zinc)	23533607	—
ECU Stud	23533606	—
14 AWG Terminal (Large) (Terminal only)	23528272	776492-1
18 AWG Terminal (Standard) (Terminal only)	23528271	776326-4
14 AWG Terminal (Large) (crimped with 12 in. wire)	23528255	—
18 AWG Terminal (Standard) (crimped with 12 in. wire)	23528254	—
Cavity Plug	23528274	776364

Table 3-36 VIH-to-ECU Connector Part Numbers

The 68-pin connector center screw must be torqued to 50 in·lb (5.6 N·m)

The shroud is required to protect the connectors from dirt and direct spray and to route the wires in the correct orientation. The shroud lock nuts must be torqued to 30 in·lb (3.4 N·m).

If a replacement wire and/or terminal is required, the wires will arrive assembled with the terminals crimped on the wires (see Figure 3-11).

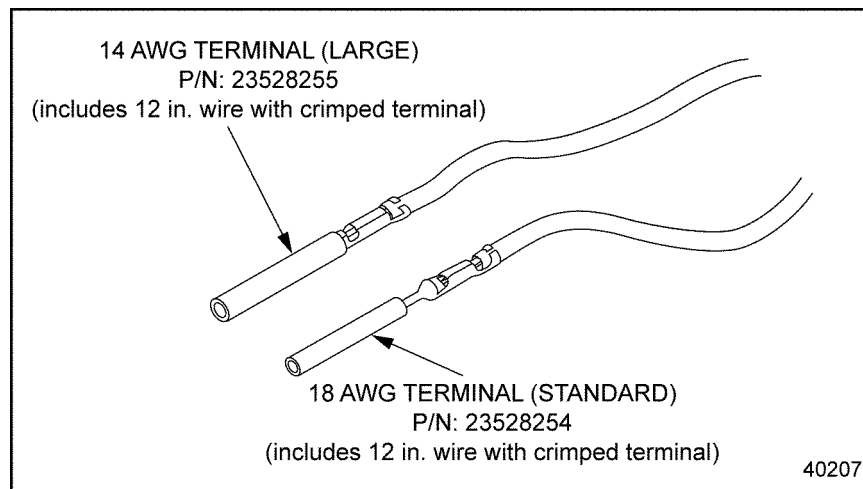


Figure 3-11 68-pin Connector Wires and Terminal

3.7.2 ECU ENGINE HARNESS CONNECTOR

The EH 68-pin Tyco connector pinout for the Series 60 is listed in Table 3-37 and listed in Table 3-38.

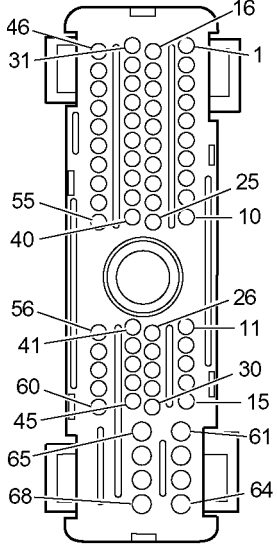
Pin	Wire Color	Signal Type	Function	Connector
E-1	Blk	PWM Output – Low Side	EGR Hydraulic Valve Control	 38483 Shroud Side of Connector
E-2	Wht	Analog Input – 1.5k Pull-up	Air Temp	
E-3	—	Analog Input – 51k Pull-down	Spare	
E-4	Blk	PWM Output – Low Side	VGT VPOD Control	
E-5	Yel	Analog Input – 1.5k Pull-up	Coolant Temp	
E-6	—	Analog Input – 51k Pull-down	Spare	
E-7	Tan	Analog Input – 1.5k Pull-up	Oil Temp	
E-8	—	PWM Output – Low Side	Spare	
E-9	Orn	Analog Input – 1.5k Pull-up	Fuel Temp	
E-10	—	Analog Input – 1.5k Pull-up	EGR Temp	
E-11	—	PWM Output – Low Side	Spare	
E-12	Gra	Sensor Supply #3	Sensor Supply	
E-13	—	Digital Output – Low Side	Spare	
E-14	Blk	Sensor Return #4	Sensor Return	
E-15	Blk	Sensor Return #3	Sensor Return	
E-16	Yel	Analog Input – 51k Pull-down	Fuel Restriction (MAS)	
E-17	Ppl	TRS (CKP) (-)	TRS (CKP) (-)	
E-18	Dk Grn	TRS (CKP) (+)	TRS (CKP) (+)	
E-19	Lt Blu	SRS (CMP) (+)	SRS (CMP) (+)	
E-20	Wht	SRS (CMP) (-)	SRS (CMP) (-)	
E-21	Dk Grn	Analog Input – 51k Pull-down	Oil Level (MAS)	
E-22	Dk Blu	Analog Input – 1.5k Pull-up	Turbo Compressor Out Temp	
E-23	—	Analog Input – 1.5k Pull-up	Spare	
E-24	—	Analog Input – 51k Pull-down	Spare	
E-25	—	Analog Input – 51k Pull-down	Spare	
E-26	Gra	Sensor Supply #4	Sensor Supply	
E-27	—	Analog Input – 1.5k Pull-up	Spare	
E-28	—	Ground Pin	Spare	
E-29	—	Ground Pin	Spare	
E-30	—	Ground Pin	Spare	
E-31	Brn	Analog Input – 51k Pull-down	Oil Pressure	
E-32	—	Frequency Input (+) — Aux 3	Spare	

Table 3-37 Series 60 Engine Harness Connector - Pins E-1 Through E-32

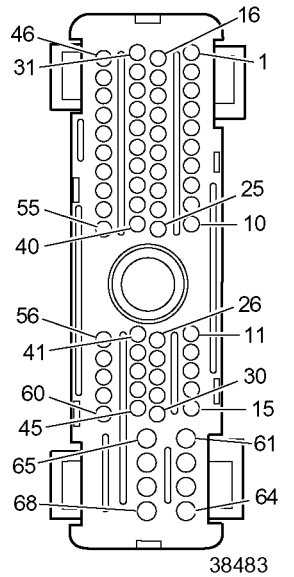
Pin	Wire Color	Signal Type	Function	Connector
E-33	—	Frequency Input (-) – Aux3	Spare	 Shroud Side of Connector
E-34	Brn	Frequency Input (-) – Aux2	Turbo Speed Sensor (+)	
E-35	Blk	Frequency Input (+) – Aux2	Turbo Speed Sensor (-)	
E-36	—	Analog Input – 1.5k Pull-up	Spare	
E-37	Pnk	Analog Input – 51k Pull-down	Barometric Pressure	
E-38	—	Analog Input – 51k Pull-down	EGR Delta Pressure	
E-39	Lt Grn	Analog Input – 51k Pull-down	Turbo Boost	
E-40	Dk Blue	CAN2 (+)	CAN2 (+)	
E-41	—	Analog Input – 51k Pull-down	Spare	
E-42	Blk	Ground Pin	VGT VPOD Gnd	
E-43	Blk	Ground Pin	Spare	
E-44	—	Ground Pin	Spare	
E-45	—	Ground Pin	Spare	
E-46	Lt Grn	Digital Output – High Side	Switched Battery (+) - VGT	
E-47	—	Digital Output – High Side	Spare	
E-48	Red	Digital Output – High Side	Jake Med/High	
E-49	Orn	Digital Output – High Side	Jake Low	
E-50	—	Digital Output – High Side	Spare	
E-51	Yel	Digital Output – High Side	Spare	
E-52	Red	Digital Output – High Side	Spare	
E-53	—	Digital Output – High Side	Spare	
E-54	Pnk	CAN2 (-)	CAN2 (-)	
E-55	Blk	CAN2S	CAN2 Shield	
E-56	—	Analog Input – 51k Pull-down	Spare	
E-57	—	Analog Input – HWOLS	No Connection	
E-58	—	Analog Input – 1.5k Pull-up	Spare	
E-59	—	RTC BATT+	External RTC Battery (+)	
E-60	—	Ground Pin	Spare	
E-61	Wht	Injector High Common	S60 Common Cyl #1,2,3	
E-62	Wht	Injector High Common	S60 Common Cyl #4,5, 6	
E-63	Wht	Injector A – LO1	S60 Cyl #1	
E-64	Wht	Injector A – LO2	S60 Cyl #3	
E-65	Wht	Injector A – LO3	S60 Cyl #2	
E-66	Wht	Injector B – LO1	S60 Cyl #5	
E-67	Wht	Injector B – LO2	S60 Cyl #6	
E-68	Wht	Injector B– LO3	S60 cyl #4	

Table 3-38 Series 60 Engine Harness Connector - Pins E-33 Through E-68

The 68-pin connector part numbers are listed in Table 3-39.

Description	DDC Part Number	Tyco Part Number
Engine Harness Connector Assembly	23528253	776315-2
Shroud	23532347	776501-1
Shroud Lock Nuts (M6–1.0 Nylon Insert Lock Nut Plated with Yellow Zinc)	23533607	—
ECU Stud	23533606	—
14 AWG Terminal (Large) (Terminal only)	23528272	776492-1
18 AWG Terminal (Standard) (Terminal only)	23528271	776326-4
14 AWG Terminal (Large) (crimped with 12 in. wire)	23528255	—
18 AWG Terminal (Standard) (crimped with 12 in. wire)	23528254	—
Cavity Plug	23528274	776364

Table 3-39 EH-to-ECU Connector Part Numbers

The 68-pin connector center screw must be torqued to 50 in·lb (5.6 N·m)

The shroud is required to protect the connectors from dirt and direct spray and to route the wires in the correct orientation. The shroud lock nuts must be torqued to 30 in·lb (3.4 N·m).

If a replacement wire and/or terminal is required, the wires will arrive assembled with the terminals crimped on the wires (see Figure 3-12).

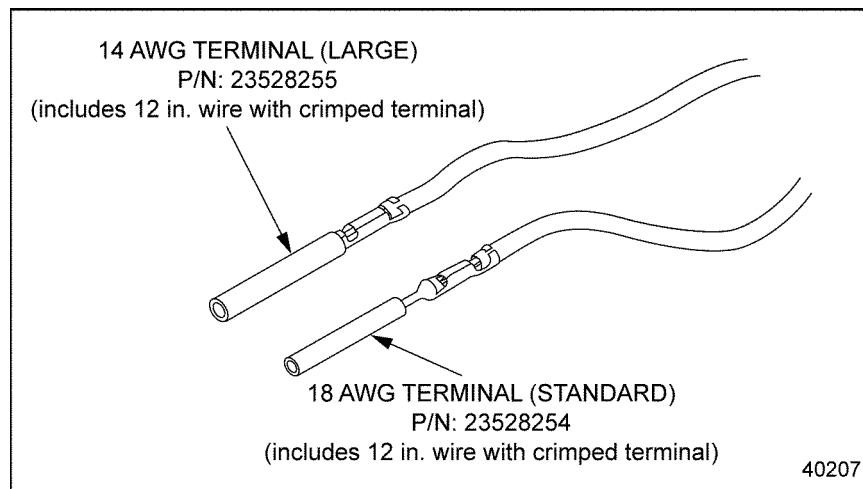


Figure 3-12 68 Pin Connector Wires and Terminals

3.7.3 DATA LINK CONNECTOR

The SAE J1708/J1587 nine-pin data link connector is required. DDC recommends that the OEM-supplied Data Link Connector be conveniently positioned in a well protected location facilitating subsequent DDDL usage (i.e., reprogramming, diagnostics, etc.).

The components listed in Table 3-40 are required to incorporate a SAE J1939/J1587 Data Link in a VIH for diagnostic and reprogramming devices.

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	114017
Seven (7) Terminals	23507132	0460-202-16141

Table 3-40 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 3-13).

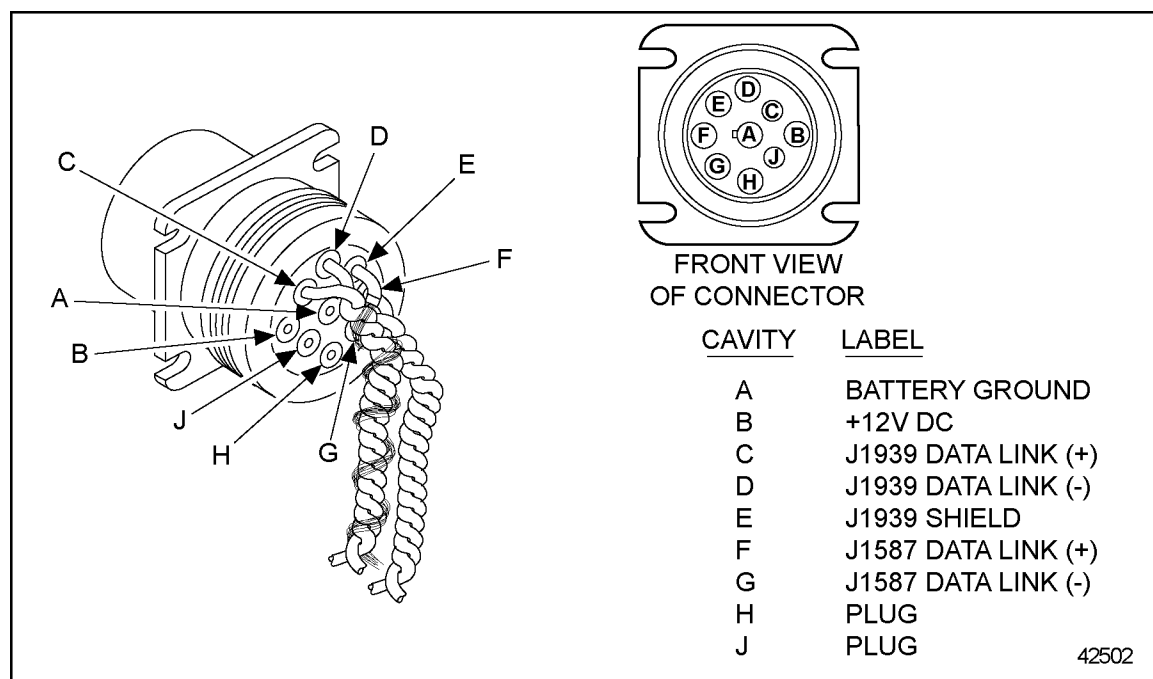


Figure 3-13 Wiring for 9-pin Data Link Connector

The maximum length for the SAE J1939 Data Link is 130 ft (40 m).

The SAE J1587/J1708 Data Link must be twisted pairs. The twists are a minimum of 12 turns per foot (305 mm). The maximum length for the SAE J1587/J1708 Data Link is 130 ft (40 m).

3.7.4 FCI CONNECTORS

An FCI connector for the Turbo Compressor In Temperature Sensor is the OEM responsibility. FCI connectors are available from:

FCI Automotive

Telephone: 1-800-303-3577 or 734-728-2100

NTI, LLC

300 Randall Street, Suite B

Greer SC 29651

Telephone: 864-877-4800

Fax: 864-877-2997

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3.8 WIRES AND WIRING

This section contains recommendations and requirements for the VIH and EH connectors and wiring.

3.8.1 GENERAL WIRE RECOMMENDATIONS

Detroit Diesel Corporation recommends color coding or hot stamping of wires.

NOTE:

Color code the wires as shown in the schematics. If the wires used are the same color, hot stamp the cavity number on the wires.

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.

NOTICE:
Insulation must be free of nicks.

Tape, conduit, loom or a combination thereof must be used to protect the wires. Refer to sections 3.9 and 3.10. All wires must be annealed copper wire (not aluminum). All wires must comply with *SAE J1128 JAN 95 Low Tension Primary Cable*. Contact the Society of Automotive Engineers to obtain documents, refer to Appendix for their address.

3.8.2 ECU CONNECTOR WIRE INTO SHROUD INSTALLATION

The following procedures for using tape, ties, and conduit must be followed to ensure proper placement of the shroud over the ECU connectors:

1. Use heavy electrical tape where wires exit conduit into the shroud (see Figure 3-14, A).

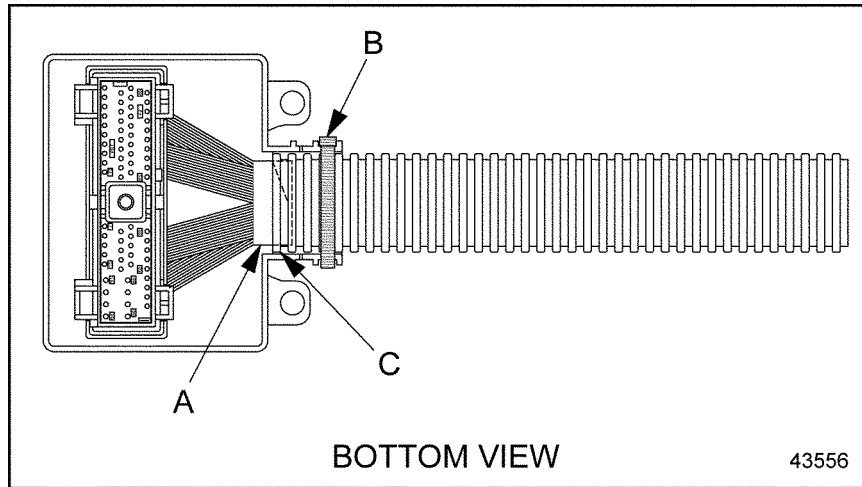


Figure 3-14 Bottom View of Shroud, ECU Connector and Conduit

2. Use a tie strap to secure the shroud to the conduit and connector (see Figure 3-14, B).
3. Check that the conduit extends past the innermost ring on the shroud inlet. The conduit **must** extend this far (see Figure 3-14, C).

4. The two locking tabs in the shroud furthest from the wire inlet must be securely latched into the connector. The two tabs closest to the wire inlet should be snapped over the connector tabs (see Figure 3-15).

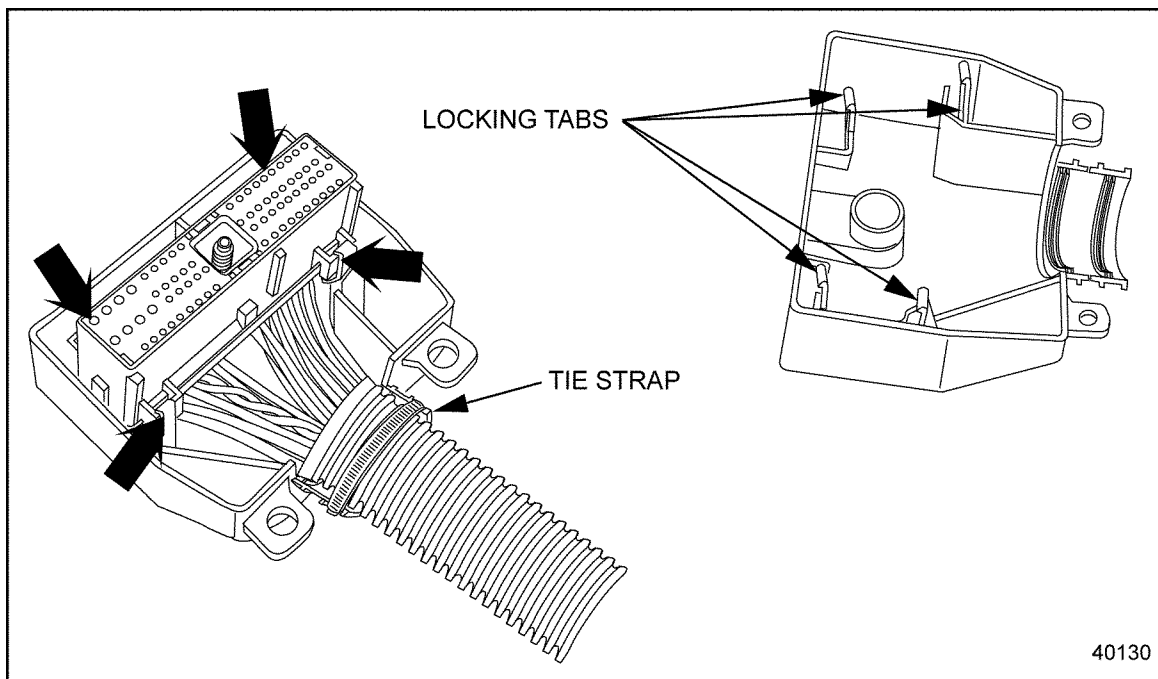


Figure 3-15 Shroud Tabs

5. Ensure that the wires are not pinched between the connector and any of the shroud's protrusions during assembly (see Figure 3-16, D).

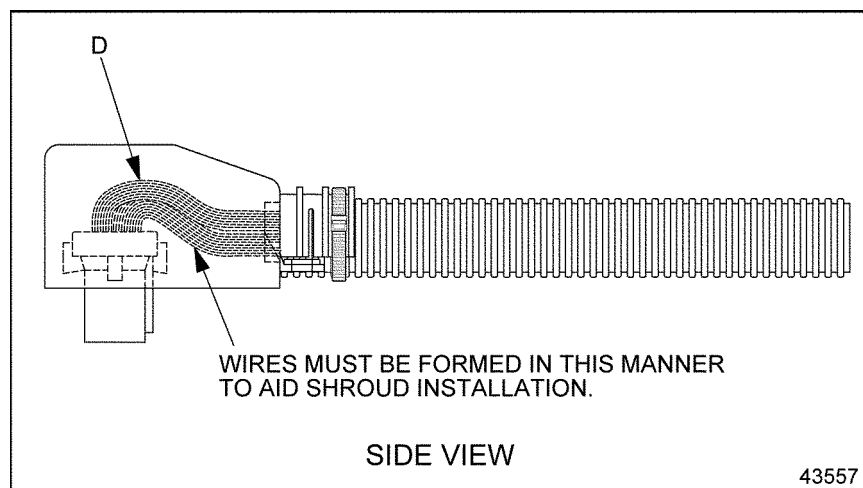


Figure 3-16 Side View of Shroud, ECU Connector and Conduit

3.8.3 TERMINAL INSTALLATION AND REMOVAL

The method of terminal installation and removal varies, depending on the terminal/connector design. No other terminals are to be removed or installed on the Engine Harness.

Wire and Terminal Installation - Tyco ECU Connector

To install the wires and terminals into the Tyco connector:

1. Remove the Terminal Position Assurance (TPA) from the connector using a jewelers (small) screwdriver (see Figure 3-18).
2. Push the terminal into the cavity until it clicks.
3. Replace the TPA.
4. Secure the harness in the shroud neck with two tie wraps (see Figure 3-17).

NOTE:

The conduit must cover the harness wires in the neck of the shroud.

Wire and Terminal Removal - Tyco ECU Connector

Use a jewelers (small) screwdriver as your extraction tool. To remove the terminals from the connector body:

1. Cut the tie wraps holding the harness in the neck of the shroud.
2. Remove the connector from the shroud by pushing the four locking tabs (arrows) back from the connector. Use the screwdriver to push back the tabs closest to the shroud wall (see Figure 3-17).

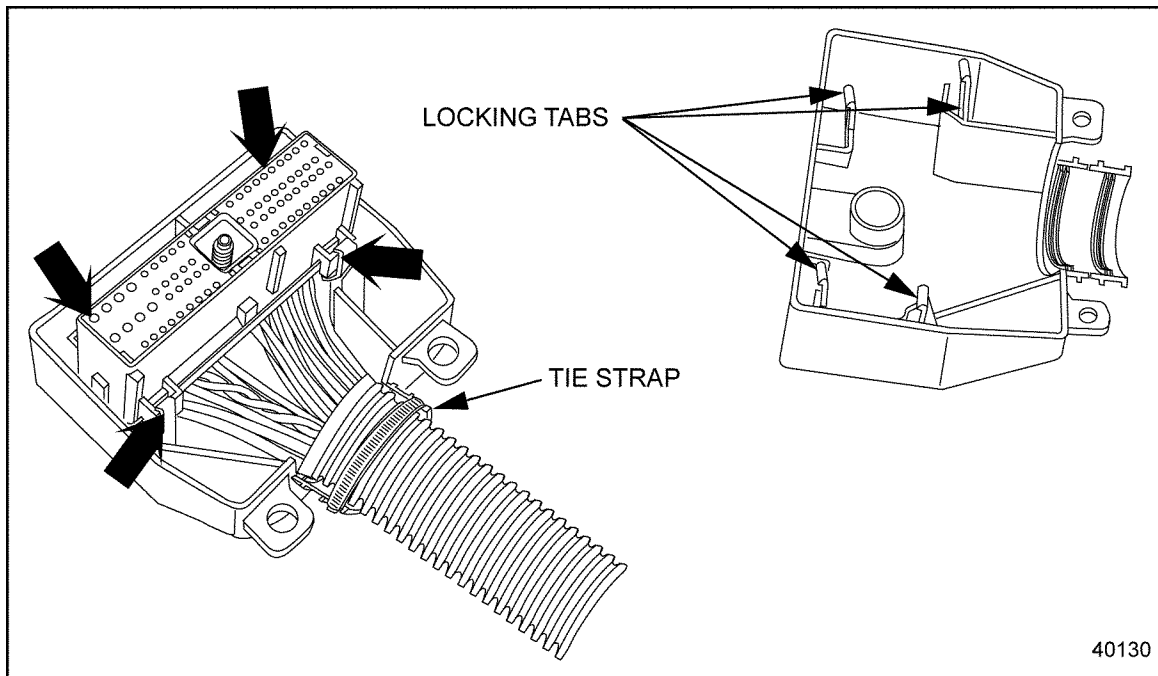


Figure 3-17 Tyco Connector and Locking Tabs

3. Remove the Terminal Position Assurance from the connector with the screwdriver (see Figure 3-18).

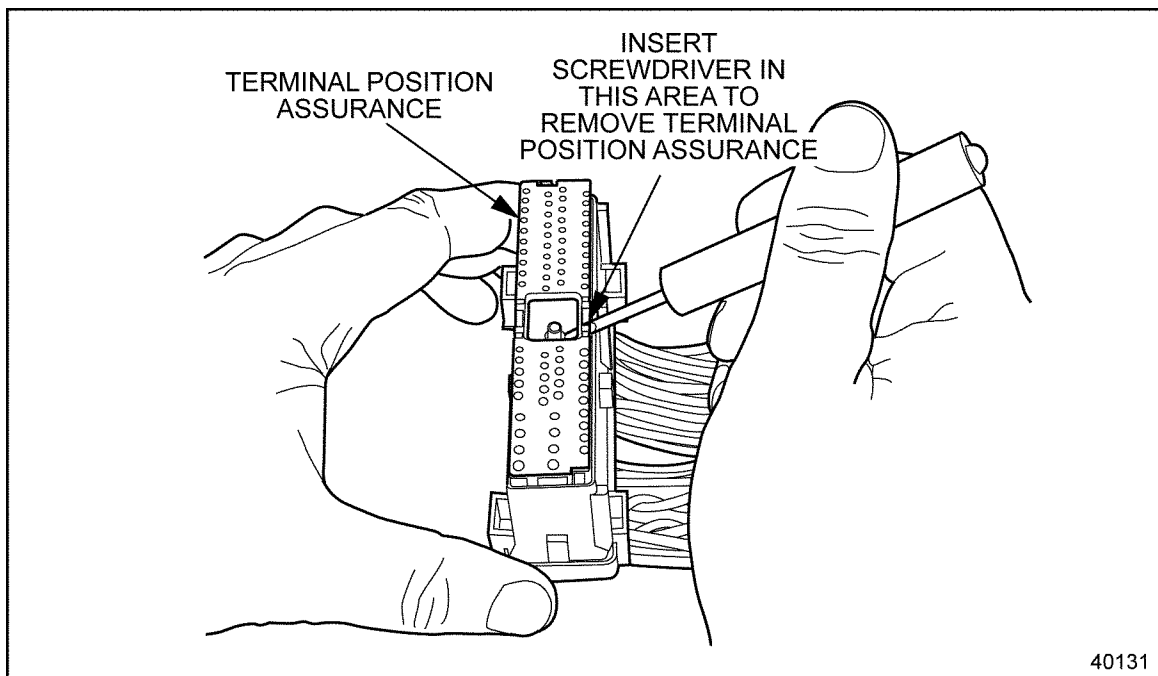


Figure 3-18 Removing the Terminal Position Assurance

4. Use the screwdriver to gently pry back the tab holding the terminal you wish to remove (see Figure 3-19).

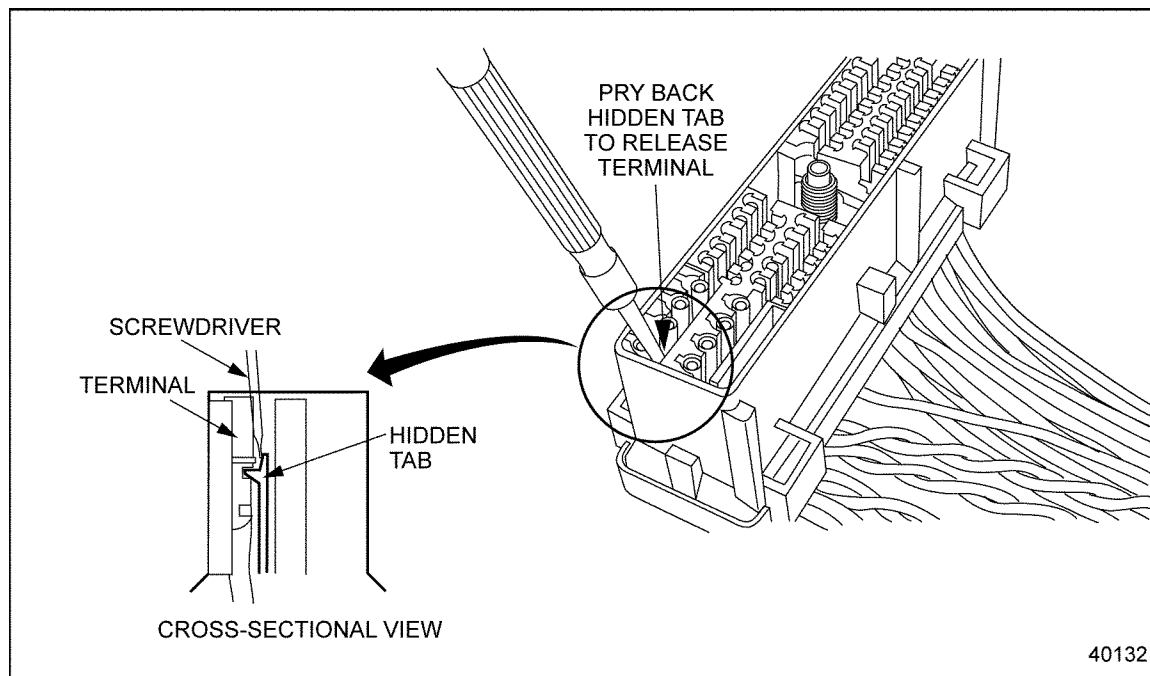


Figure 3-19 Removing the Terminal

5. While holding the tab back, carefully pull the wire and terminal out of the connector.

Deutsch Terminal Installation Guidelines

Deutsch connectors have wire seals molded into the connector. These connectors are push-to-seat connectors with cylindrical terminals.

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 1/4 in. (6 mm) of insulation from the wire.
2. Remove the lock clip, raise the wire gage selector, and rotate the knob to the number matching the gauge wire that is being used.
3. Lower the selector and insert the lock clip.
4. Position the terminal so that the crimp barrel is 1/32 of an inch above the four indenters. See Figure 3-20. Crimp the wire.

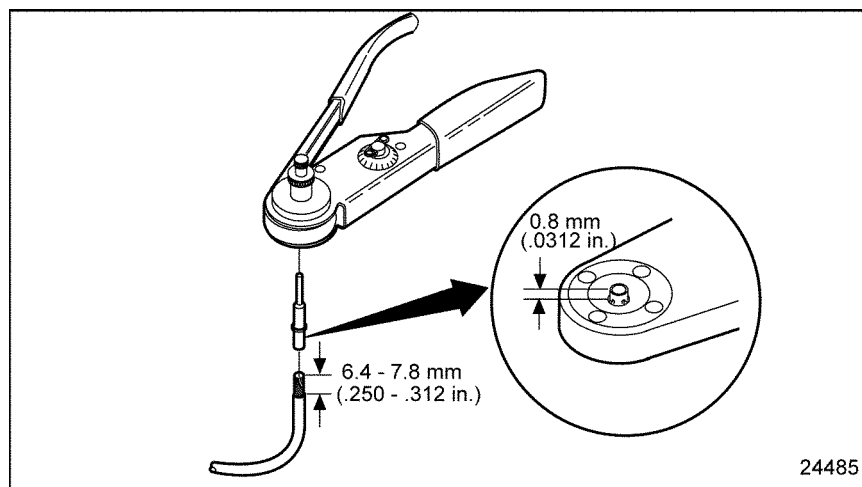


Figure 3-20 **Setting Wire Gage Selector and Positioning the Terminal**

5. Grasp the terminal approximately one inch behind the terminal crimp barrel. Hold the connector with the rear grommet facing you. See Figure 3-21.

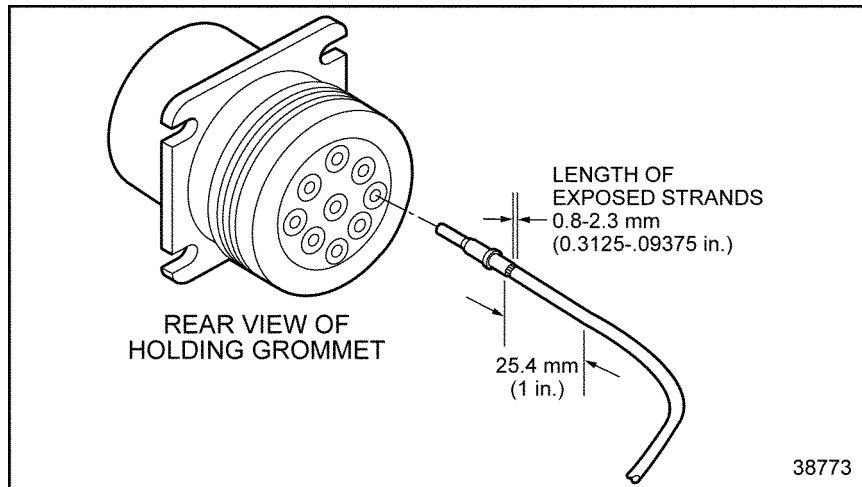


Figure 3-21 Pushing Terminal Into Grommet

6. Push the terminal into the grommet until a positive stop is felt. See Figure 3-21. A slight tug will confirm that it is properly locked into place. See Figure 3-22.

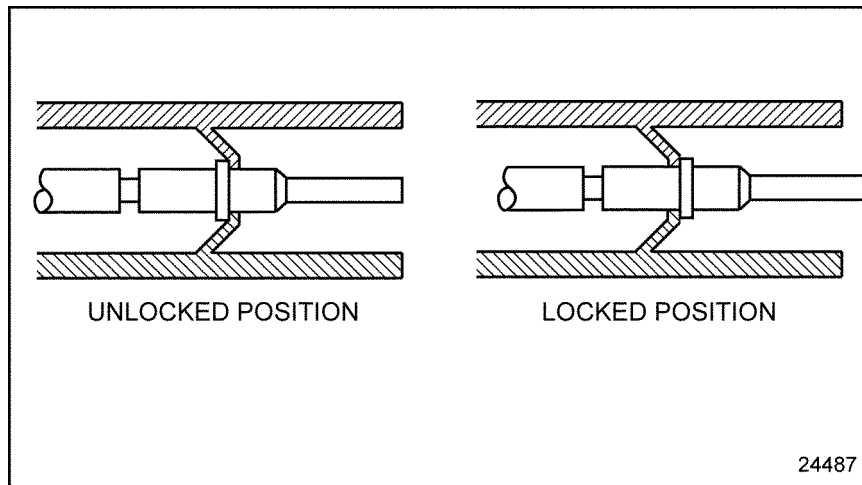


Figure 3-22 Locking Terminal Into Connector

Deutsch Terminal Removal

The appropriate size removal tool should be used when removing wires from connectors. The proper removal tools are listed in Table 3-41.

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

Table 3-41 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 wire of the terminal to be removed. See Figure 3-23.

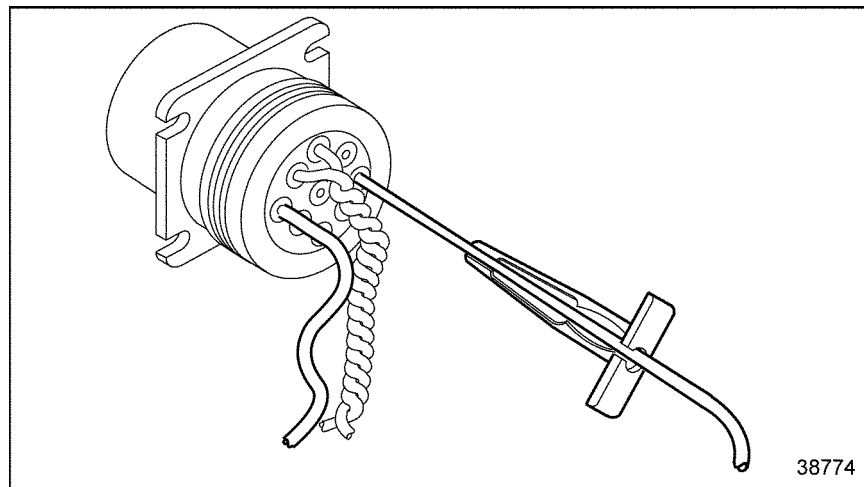


Figure 3-23 Removal Tool Position

2. Slide the tool along the wire into the insert cavity until it engages and resistance is felt. Do not twist or insert tool at an angle. See Figure 3-24.

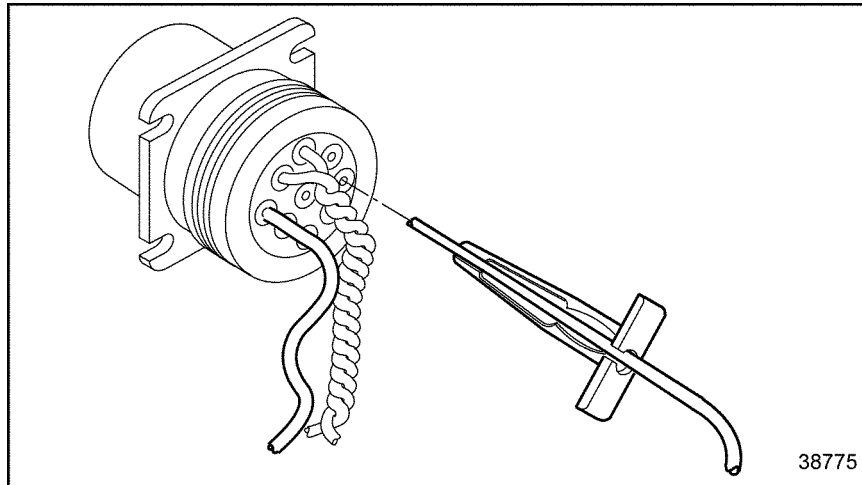


Figure 3-24 Removal Tool Insertion

3. Pull terminal wire assembly out of the connector. Keep reverse tension on the wire and forward tension on the tool.

3.8.4 FCI APEX TERMINAL INSTALLATION AND REMOVAL

The following sections cover FCI APEX male and female terminal installation and removal.

FCI Apex Male Terminal Installation

Install the FCI APEX male terminal as follows:

1. Determine if the connector is new or used.
 - [a] If the connector is new, the red Terminal Assurance Position (TPA) is in an unlocked position so go to step 2.
 - [b] If the connector is used, pull the TPA out (see Figure 3-25).
2. Insert the crimped terminal into the connector until it clicks (see Figure 3-25). The orientation of the terminal is not critical.

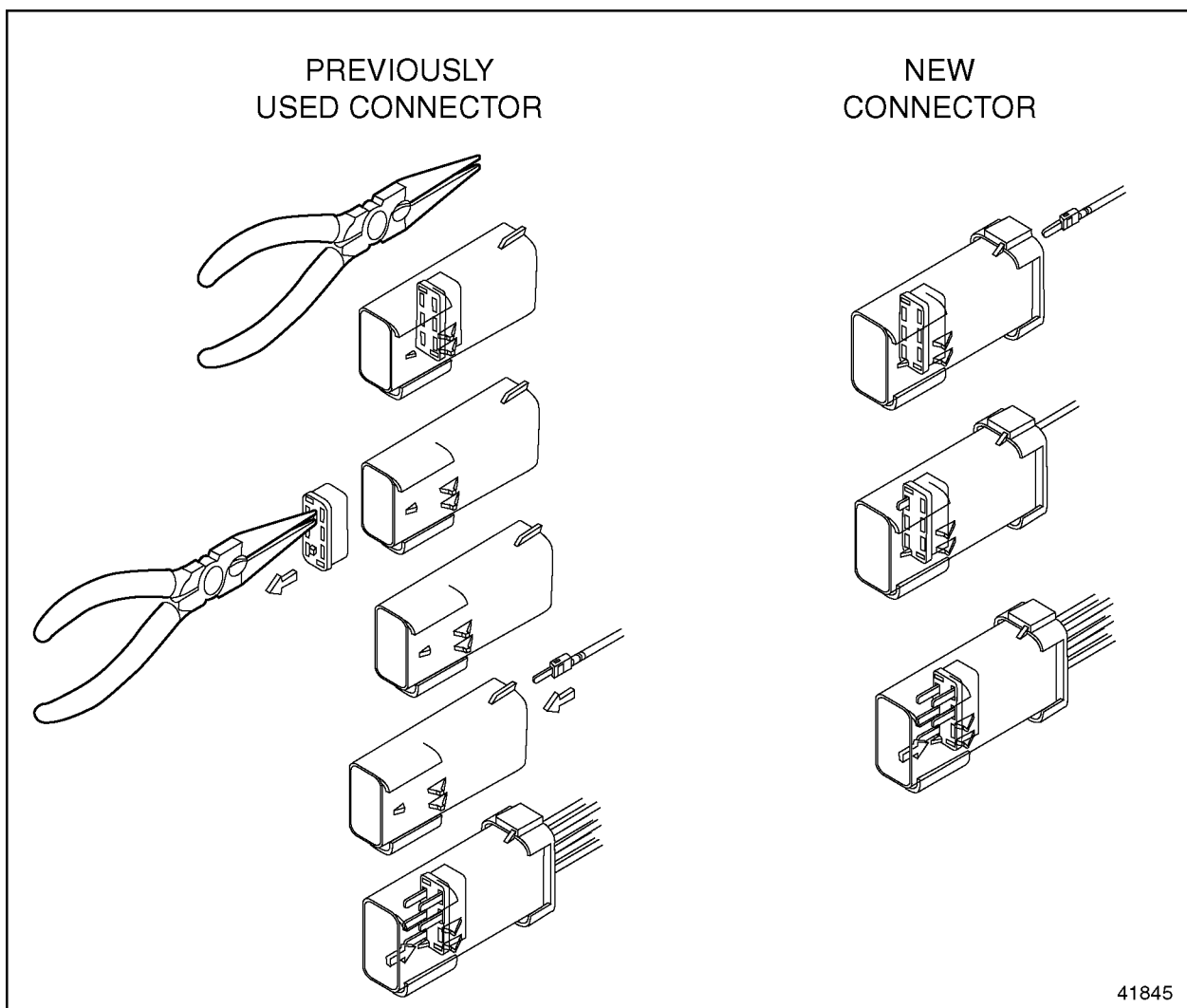


Figure 3-25 Installing the FCI Male Terminal

3. Push the TPA into the locked (fully seated) position.

NOTE:

The TPAs will self lock when the connectors are mated.

FCI Apex Male Terminal Removal

Remove the terminal as follows:

1. Using pliers pull out the red Terminal Position Assurance (TPA) (see Figure 3-26).

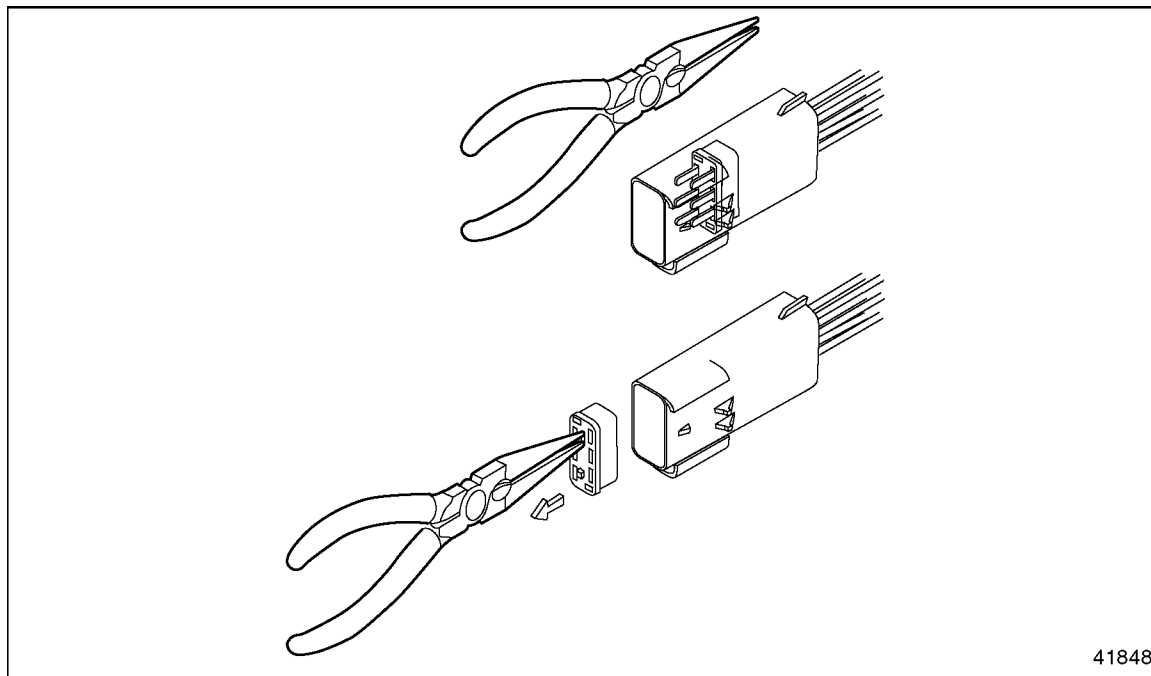


Figure 3-26 **Removing the Terminal**

2. Using a FCI APEX repair tool (P/N: 54900002) or a #2 jeweler's screwdriver, press back the terminal locking tang (see Figure 3-27).

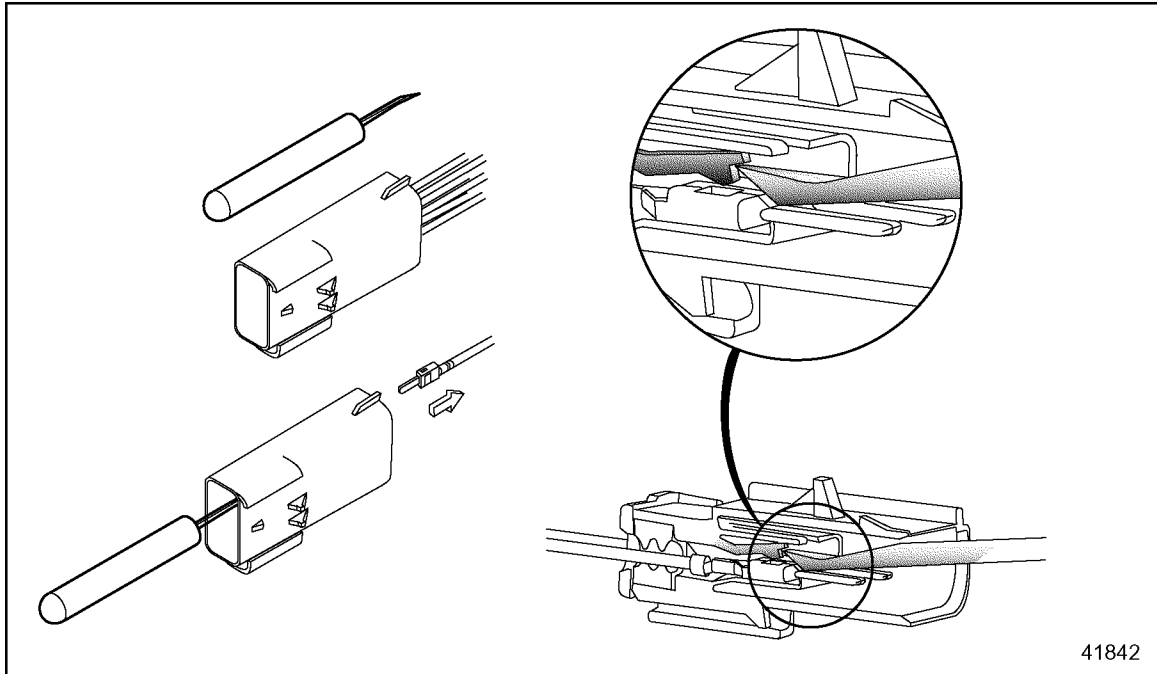


Figure 3-27 Pressing the Locking Tang

3. Pull the cable back through the connector (see Figure 3-26).

FCI Apex Female Terminal Installation

Install the terminal as follows:

1. Determine if the connector is new or used.
 - [a] If the connector is new, the blue Terminal Assurance Position (TPA) is in an unlocked position so go to 2.
 - [b] If the connector is used, pull the TPA out (see Figure 3-28).
2. Insert the crimped terminal into the connector until it clicks (see Figure 3-28).

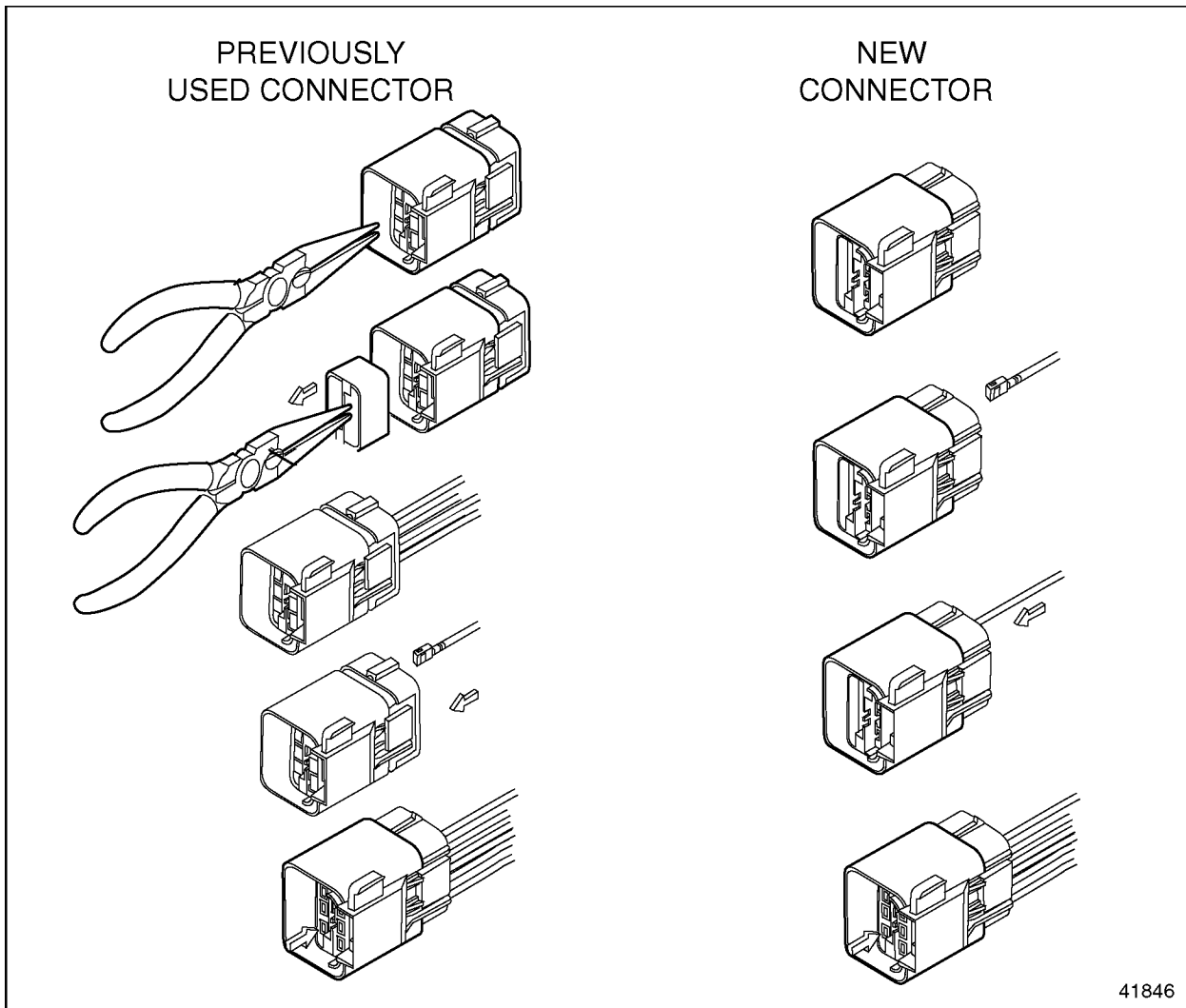


Figure 3-28 Installing the Terminal

3. Push the TPA into the locked (fully seated) position.

NOTE:

The TPAs will self lock when the connectors are mated.

FCI Apex Female Terminal Removal

Remove the terminal as follows:

1. Using pliers pull out the blue Terminal Position Assurance (TPA) that is located inside the connector (see Figure 3-29).

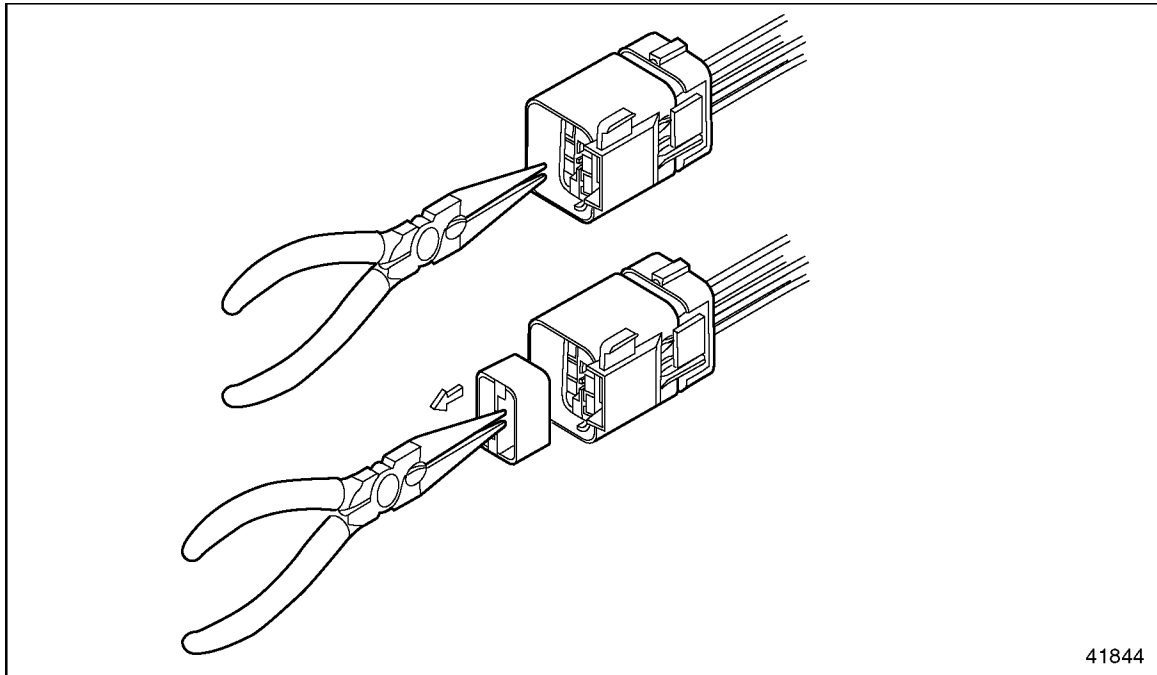


Figure 3-29 **Removing the Terminal**

2. Using a FCI APEX repair tool (P/N: 54900002) or a #2 jeweler's screwdriver, press back the terminal locking tang (see Figure 3-30).

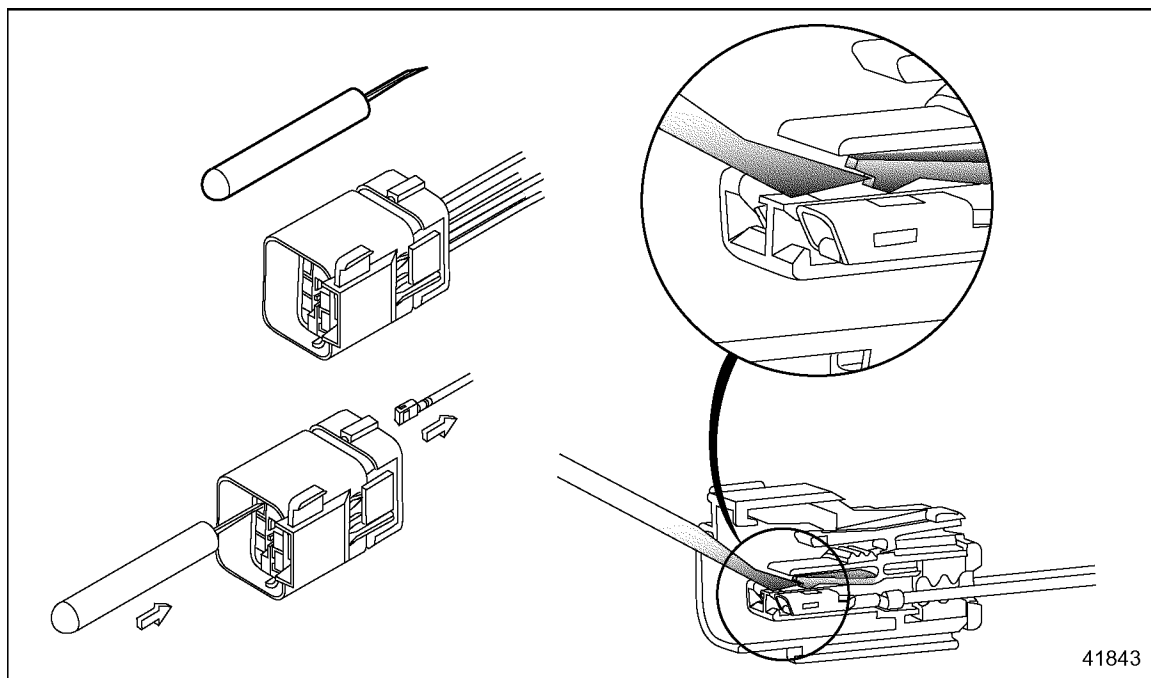


Figure 3-30 Pressing the Locking Tang

3. Pull the cable back through the connector (see Figure 3-29).

3.8.5 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 3-42.

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 3-42 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 3-31.

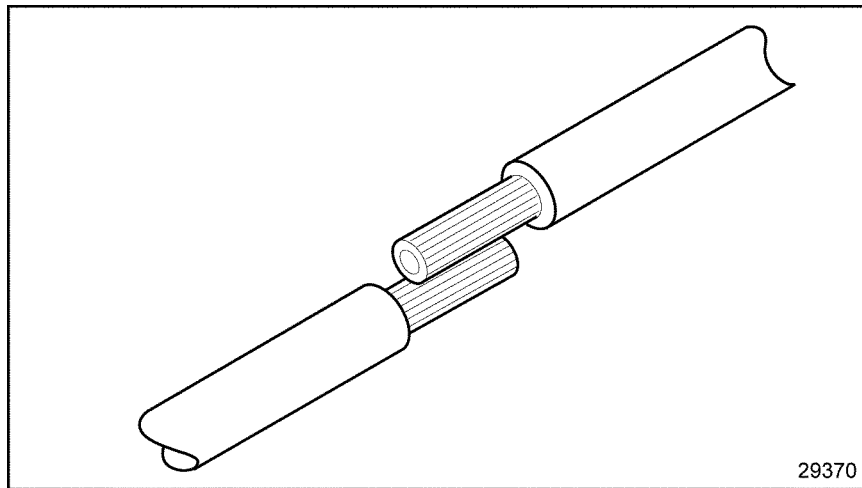


Figure 3-31 **Positioning the Leads**

2. Secure the leads with a commercially available clip and hand tool. See Figure 3-32.

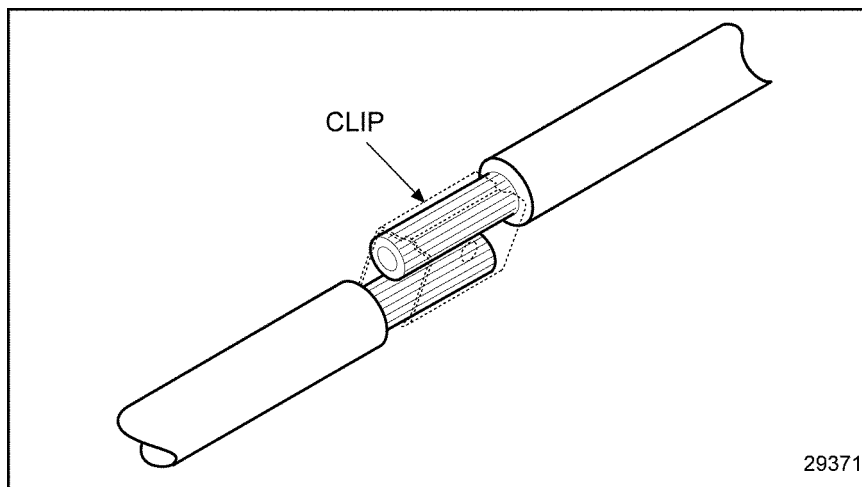


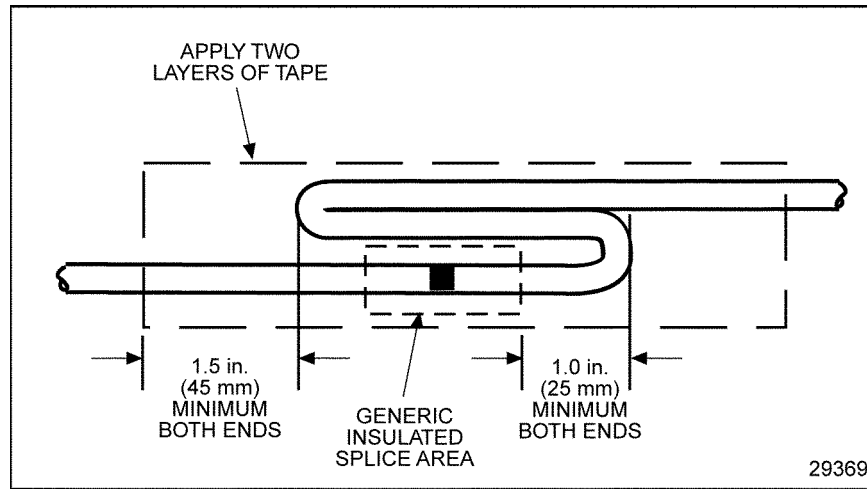
Figure 3-32 **Securing the Leads With a Clip**

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 3-43 must be met.

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

Table 3-43 Applied Load Criteria for Terminals

5. Shrink wrap.
6. Loop the lead back over the spliced joint and tape. See Figure 3-33.

**Figure 3-33 Recommended Strain Relief of Spliced Joint**

Splicing and Repairing Straight Leads-Alternate Method 1

The tools required are listed in Table 3-44.

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

Table 3-44 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 3-34, A).
4. Insert the other wire into the splice clip until it butts against the clip stop (see Figure 3-34, 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 3-45 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 3-45 Applied Load Criteria for Terminals

7. Shrink the splice clip insulative casing with a heat gun to seal the splice (see Figure 3-34, C).
8. Loop the lead back over the spliced joint and tape. See Figure 3-33.

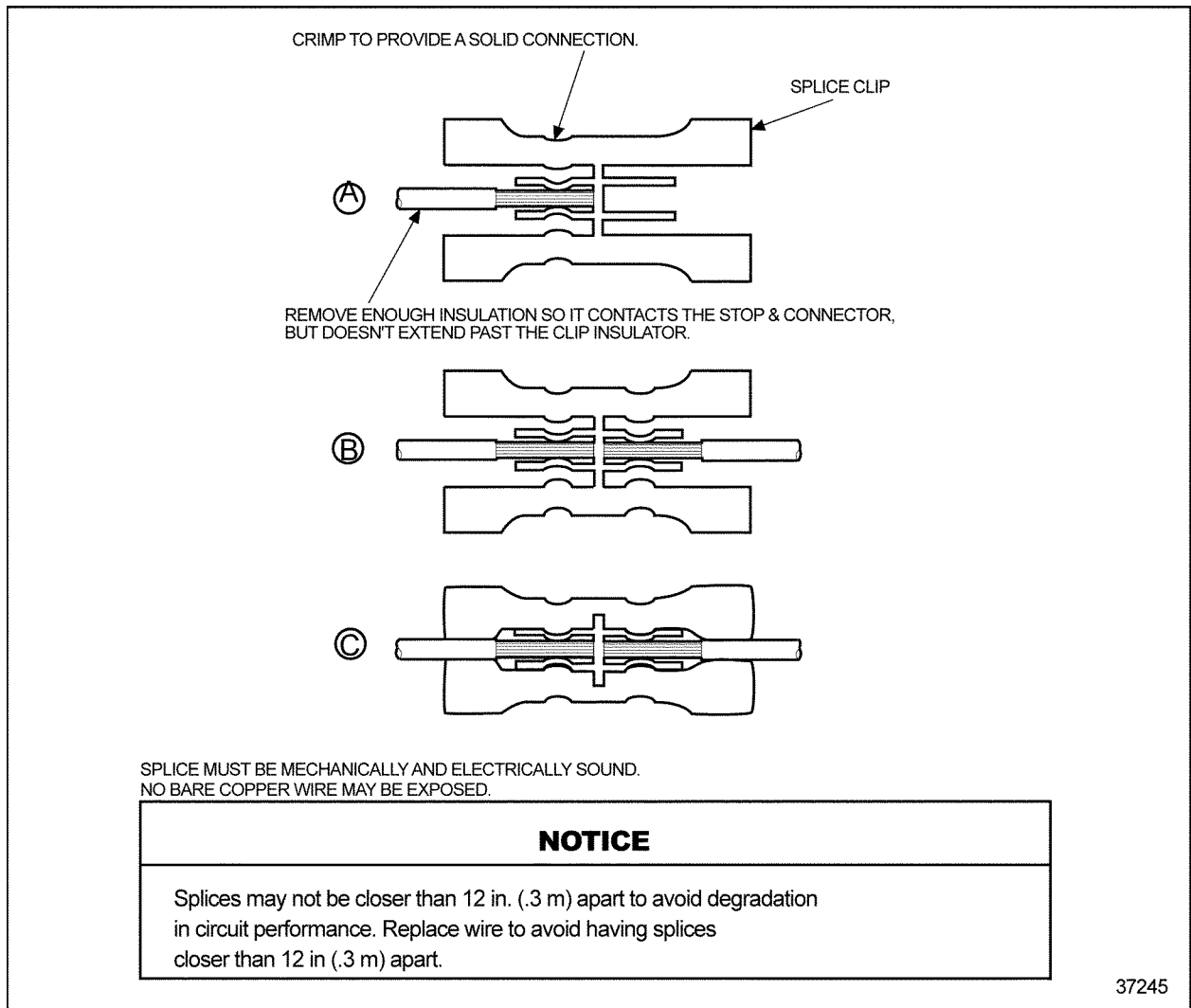


Figure 3-34 Splicing Straight Leads - Alternate Method 1

Splicing and Repairing Straight Leads - Alternate Method 2

This method is not allowed or recommended for power, ignition, or injector circuits. The tools required are listed in Table 3-46.

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

Table 3-46 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 ¼ in. (6 mm) on both sides (see Figure 3-35, A).
4. Insert one wire into splice clip until it butts against the splice clip. Stop and crimp (see Figure 3-35, 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 3-35, B).

NOTICE:

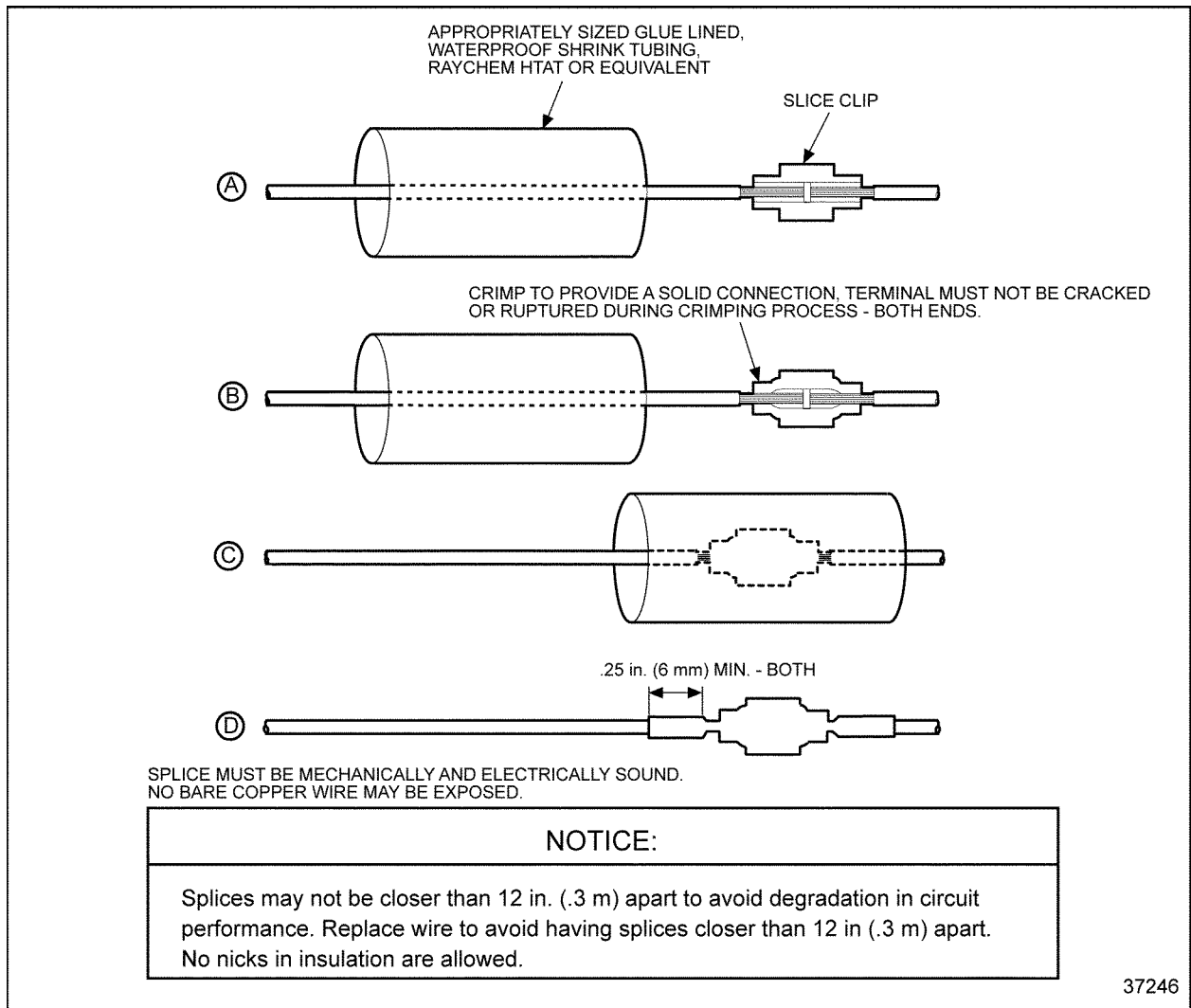
Any terminal that is cracked or ruptured is unacceptable as malfunctions may occur.

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 3-35, C).
8. Shrink tubing with a heat gun to seal the splice (see Figure 3-35, 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 3-33.



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Figure 3-35 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

www.alphawire.com

Tyco Electronics Corporation

Raychem Cable Identification and Protection

300 Constitution Drive

Menlo Park, CA 94025

Phone: 1-800-926-2425

www.raychem.com

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 3-36) so there is at least a 2.5 in. (65 mm) separation between splices.

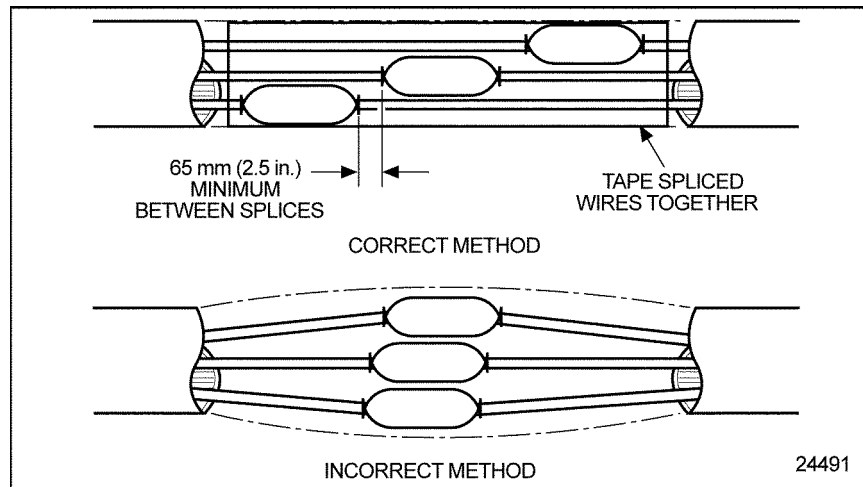


Figure 3-36 The Correct and Incorrect Method of Staggering Multiple Splices

NOTICE:

A minimum of two layers of heat shrink tubing extending 0.25 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 3.10.

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3.9 CONDUIT AND LOOM

Conduit must be used to protect the harness wires and wire 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
 - 3.0 in. (75 mm) for multiple connectors/devices
- All wire 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 J562 APR86 Nonmetallic Loom (A)** 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.

Contact the Society of Automotive Engineers to obtain documents, refer to Appendix for their address.

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3.10 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 3.9). Be sure to firmly secure the start and finish ends of tape.

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



Criteria: Tape

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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3.11 SENSORS

The DDEC V system is designed to operate with several types of sensors as listed in Table 3-47.

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.
Switch	Used to signal coolant level, inlet air restriction, and oil level.
Magnetic Pick-up	Used to sense vehicle speed, accumulate trip distance, and enable several vehicle features.

Table 3-47 Sensor Types

The sensors integrated into the Engine Harness are factory-installed (refer to section 3.11.1). The sensors integrated into the Vehicle Interface Harness are installed by the OEM (refer to section 3.11.16).

Starting with DDEC V, DDC has begun using the nomenclature found in SAE J2403 which is industry standard. The previously used names and the SAE J2403 names are listed in Table 3-48.

Old/New	Old/New
ACLS/AECL Sensor	Add Coolant Level Sensor/Add Engine Coolant Level Sensor
AFRS/AFR Sensor	Air Filter Restriction Sensor
ATS/IAT Sensor	Air Temperature Sensor/Intake Air Temperature Sensor
CEL/AWL	Check Engine Light/Amber Warning Lamp
CLS/ECL Sensor	Coolant Level Sensor/Engine Coolant Level Sensor
CPS/ECP Sensor	Coolant Pressure Sensor/Engine Coolant Pressure Sensor
CTS/ECT Sensor	Coolant Temperature Sensor/Engine Coolant Temperature Sensor
ECM/ECU	Electronic Control Module/Electronic Control Unit
EFPA/AP	Electronic Foot Pedal Assembly/Accelerator Pedal
ESH/EH	Engine Sensor Harness/Engine Harness
ETS/ET Sensor	Exhaust Temperature Sensor
FRS/Fuel Restriction Sensor	Fuel Restriction Sensor
FTS/SFT Sensor	Fuel Temperature Sensor/Supply Fuel Temperature Sensor
LSG/ALSG	Limiting Speed Governor/Automotive Limiting Speed Governor
OLS/EOL Sensor	Oil Level Sensor/Engine Oil Level Sensor
OPS/EOP Sensor	Oil Pressure Sensor/Engine Oil Pressure Sensor
OTS/EOT Sensor	Oil Temperature Sensor/Engine Oil Temperature Sensor
SEL/RSL	Stop Engine Light/Red Stop Light
SRS/CMP	Synchronous Reference Sensor/Camshaft Position Sensor
TBS/IMP Sensor	Turbo Boost Sensor/Intake Manifold Pressure Sensor
TPS/AP Sensor	Throttle Position Sensor/Accelerator Pedal Sensor
TRS/CKP	Timing Reference Sensor/Crankshaft Position Sensor

Table 3-48 Old and New Terminology

3.11.1 FACTORY-INSTALLED SENSORS

The sensors integrated into the factory-installed Engine Harness are listed in Table 3-49.

Sensor	Function
Barometric Pressure Sensor (Baro Sensor)	Senses barometric pressure. Refer to section 3.11.2.
EGR Delta Pressure Sensor	Senses EGR pressure for EGR control. Refer to section 3.11.3.
EGR Temperature Sensor	Senses EGR temperature for EGR control. Refer to section 3.11.4.
Engine Coolant Temperature Sensor (ECT Sensor)	Senses coolant temperature for functions such as engine protection, fan control and engine fueling. Refer to section 3.11.5.
Engine Oil Level (EOL Sensor)	Detects oil level at four quarts low. Used in the Maintenance Alert System.
Engine Oil Pressure Sensor (EOP Sensor)	Senses gallery oil pressure for functions such as engine protection. Refer to section 3.11.7.
Engine Oil Temperature Sensor (EOT Sensor)	Senses oil temperature for functions such as reducing variation in fuel injection and fan control. Refer to section 3.11.8.
Fuel Restriction Sensor	Detects fuel restriction for replacement of fuel filter. Used in Maintenance Alert System.
Intake Air Temperature Sensor (IAT Sensor)	Senses air temperature for functions such as fan control and engine fueling. Refer to section 3.11.10.
Intake Manifold Pressure Sensor (IMP Sensor)	Senses turbo boost for functions such as smoke control and engine protection. Refer to section 3.11.11.
Synchronous Reference Sensor (SRS or CMP)	Indicates a specific cylinder in the firing order. Refer to section 3.11.12.
Supply Fuel Temperature Sensor (SFT Sensor)	Senses fuel temperature for functions such as engine fueling. Refer to section 3.11.13.
Timing Reference Sensor (TRS or CKP)	Senses crankshaft position and engine speed for functions such as fuel control strategy. Refer to section 3.11.12.
Turbo Compressor Temperature Out Sensor	Senses turbo out air temperature. Refer to section 3.11.14.
Turbo Speed Sensor (TSS)	Senses turbo speed for overspeed conditions. Refer to section 3.11.15.

Table 3-49 Function of Factory-installed Sensors

3.11.2 BAROMETRIC PRESSURE SENSOR

The Barometric Pressure Sensor (see Figure 3-37) senses barometric pressure for EGR control.

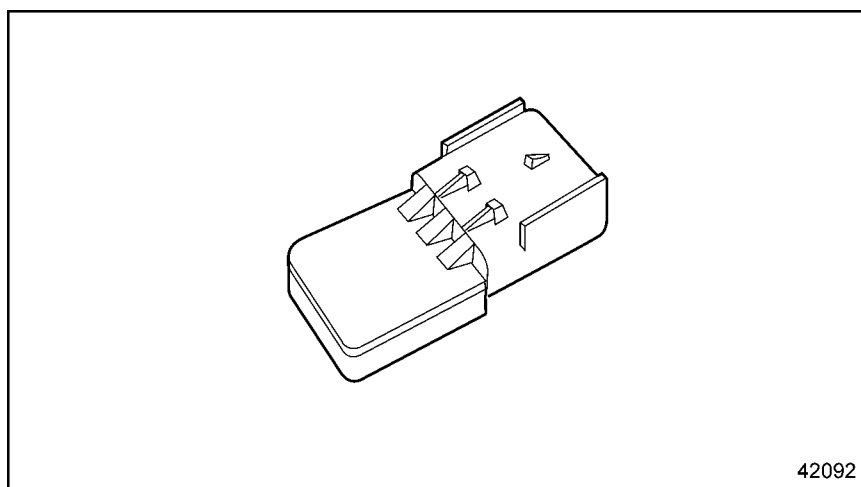


Figure 3-37 Barometric Pressure Sensor — Series 60

3.11.3 EGR DELTA PRESSURE SENSOR

The EGR Delta Pressure Sensor (EGR Delta P) senses EGR pressure for EGR control. See Figure 3-38.

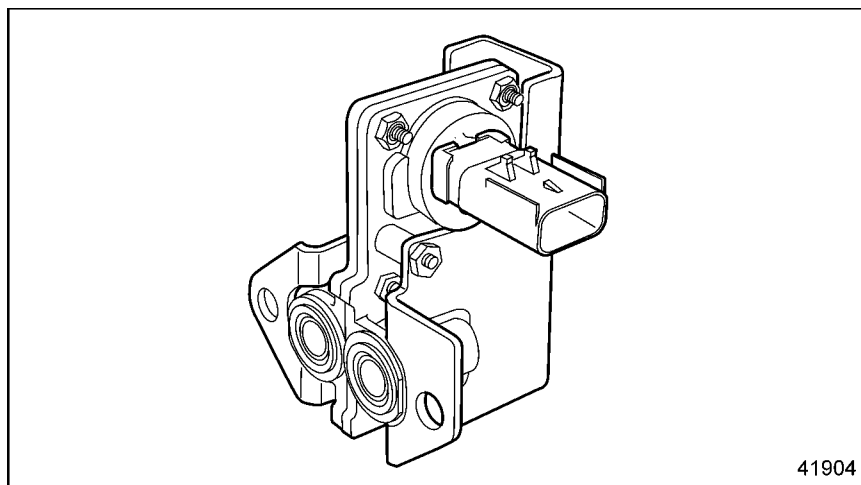


Figure 3-38 EGR Delta Pressure Sensor – Series 60

3.11.4 EGR TEMPERATURE SENSOR

The EGR Temperature Sensor senses EGR temperature for EGR control. See Figure 3-39.

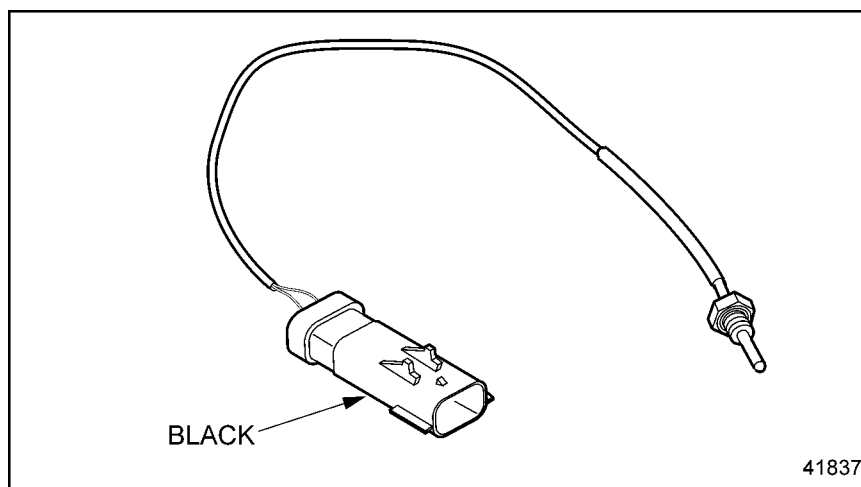


Figure 3-39 EGR Temperature Sensor – Series 60

3.11.5 ENGINE COOLANT TEMPERATURE SENSOR

The ECT Sensor is a thermistor type sensor that has a variable resistance, when exposed to different temperatures. The ECT Sensor senses coolant temperature. See Figure 3-40 for the ECT Sensor for the Series 60.

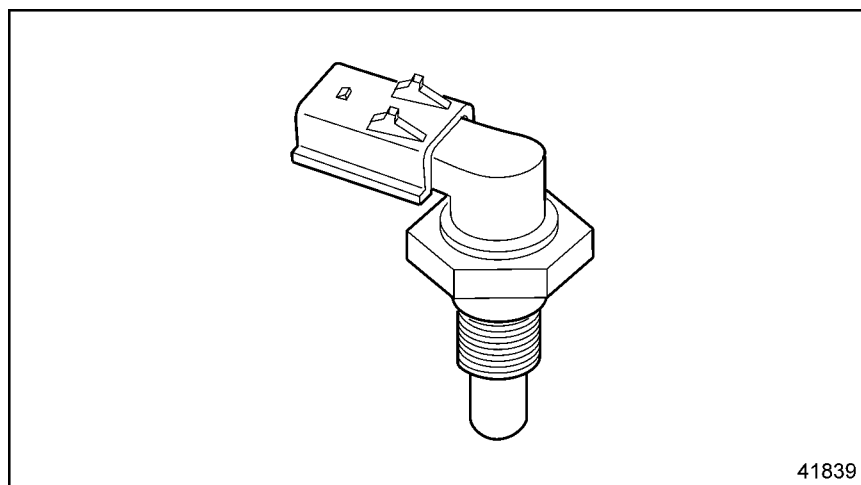


Figure 3-40 Engine Coolant Temperature Sensor — Series 60

3.11.6 ENGINE OIL LEVEL SENSOR

The EOL Sensor (see Figure 3-41) is factory installed at DDC and is incorporated into the DDC Engine Harness for applications which have the Maintenance Alert system (MAS).

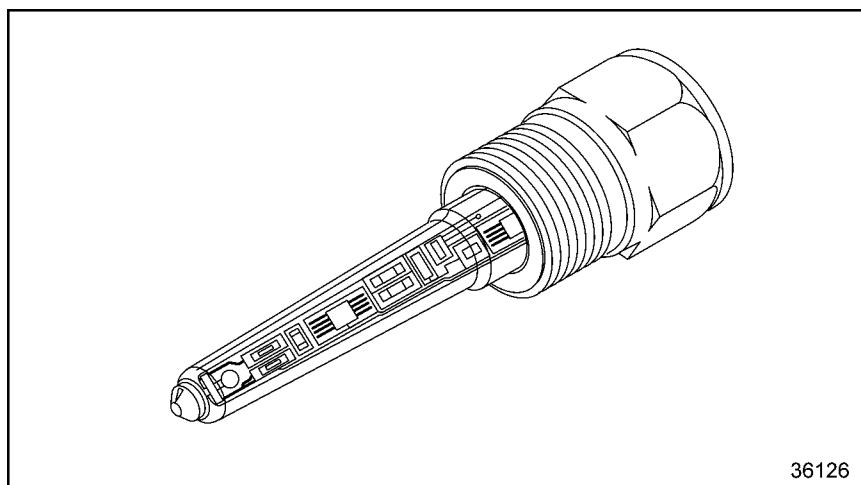


Figure 3-41 Engine Oil Level Sensor — Series 60

3.11.7 ENGINE OIL PRESSURE SENSOR

The EOP Sensor is a variable capacitance sensor that produces a linear analog signal, indicating engine oil pressure.

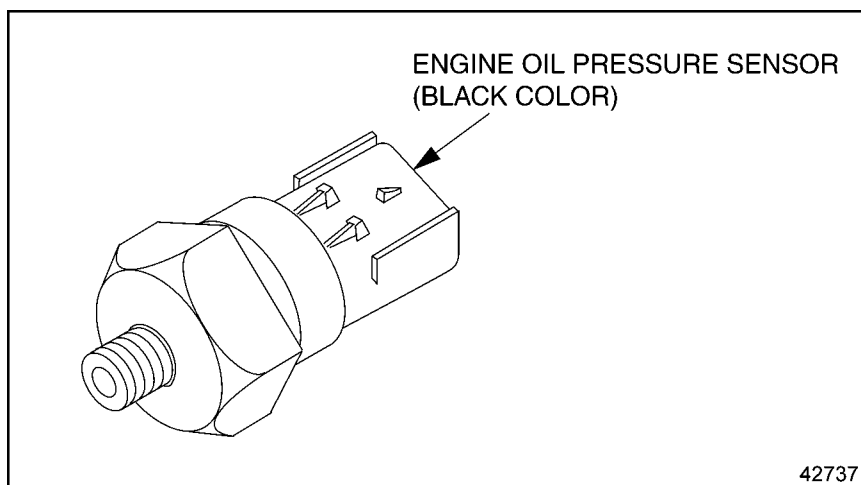


Figure 3-42 Engine Oil Pressure Sensor — Series 60

3.11.8 ENGINE OIL TEMPERATURE SENSOR

The EOT Sensor (Figure 3-43) is a thermistor type sensor that has a variable resistance, when exposed to different temperatures.

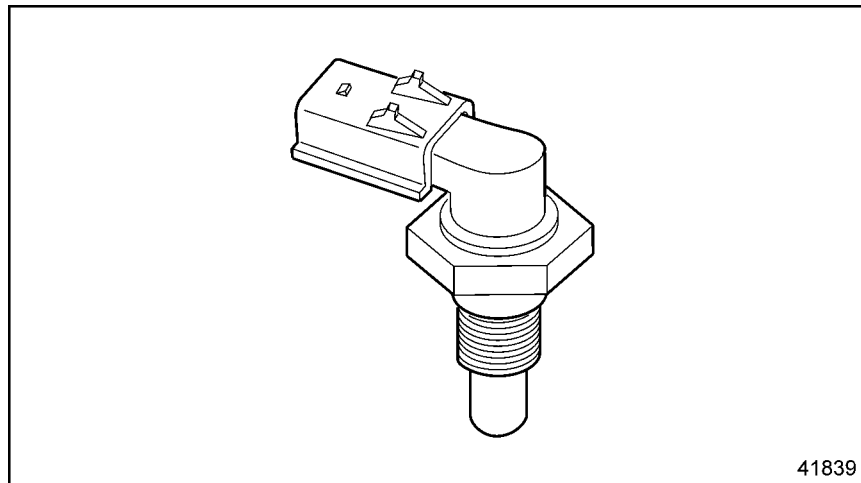


Figure 3-43 Engine Oil Temperature Sensor — Series 60

The ECU uses the EOT Sensor signal to determine the quantity and timing of fuel required to optimize starting over a range of temperatures. The EOT Sensor 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.

3.11.9 FUEL RESTRICTION SENSOR

The Fuel Restriction Sensor (see Figure 3-44) monitors the condition of the fuel filter. The sensor is factory installed at DDC for applications which have the Maintenance Alert System (MAS).

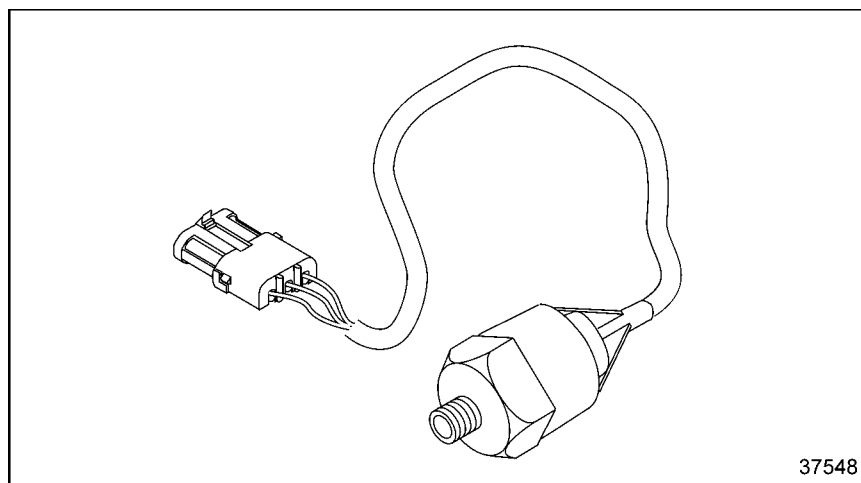


Figure 3-44 Fuel Restriction Sensor — Series 60

3.11.10 INTAKE AIR TEMPERATURE SENSOR

The IAT Sensor (see Figure 3-45) is a thermistor type sensor that has a variable resistance, when exposed to different temperatures. The IAT Sensor 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.

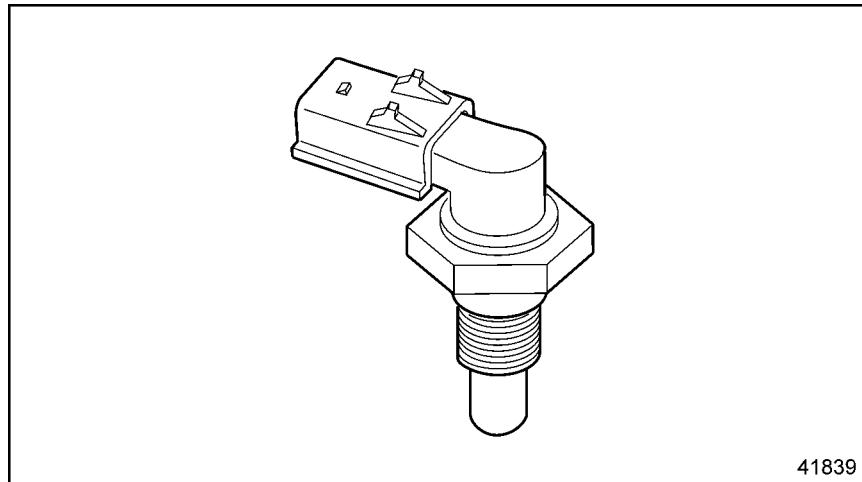


Figure 3-45 Intake Air Temperature Sensor — Series 60

3.11.11 INTAKE MANIFOLD PRESSURE SENSOR

The IMP Sensor provides data to the ECU for use in engine fueling (smoke control). See Figure 3-46 for the sensor used in on-highway applications.

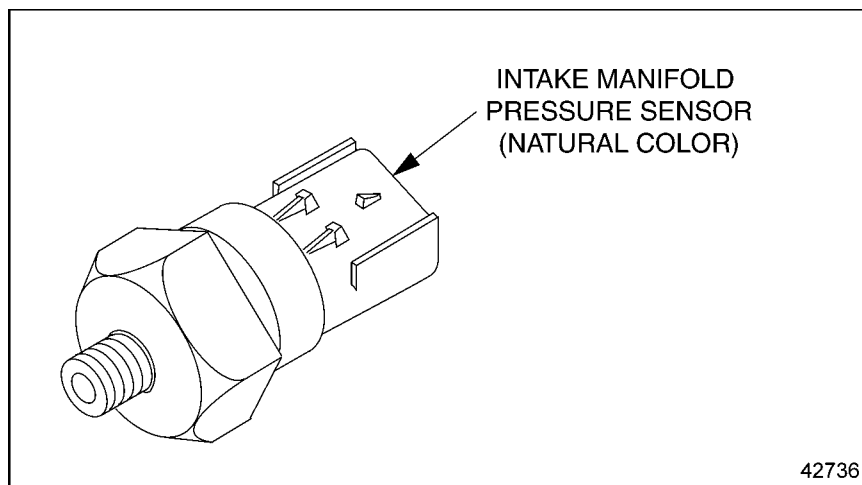


Figure 3-46 The Intake Manifold Pressure Sensor — Series 60

3.11.12 SYNCHRONOUS AND TIMING REFERENCE SENSORS

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

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

See Figure 3-47 for the Series 60 engine TRS and SRS.

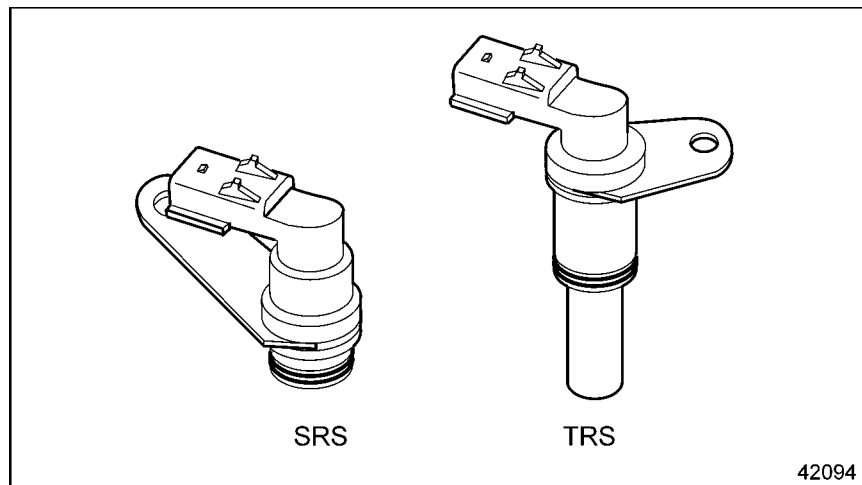


Figure 3-47 SRS and TRS — Series 60

3.11.13 SUPPLY FUEL TEMPERATURE SENSOR

The SFT Sensor (see Figure 3-48) is a thermistor type sensor that has a variable resistance, when exposed to different temperatures. The EFT Sensor measures fuel temperatures necessary for fuel consumption calculations and fuel input compensation.

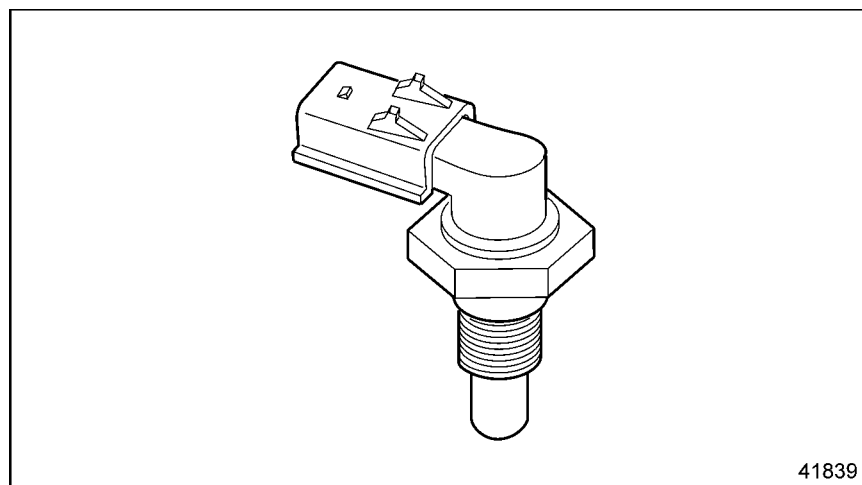


Figure 3-48 Supply Fuel Temperature Sensor — Series 60

3.11.14 TURBO COMPRESSOR TEMPERATURE OUT SENSOR

The Turbo Compressor Temperature Out Sensor senses turbo out air temperature. See Figure 3-49 for the sensor used with the Series 60 engine.

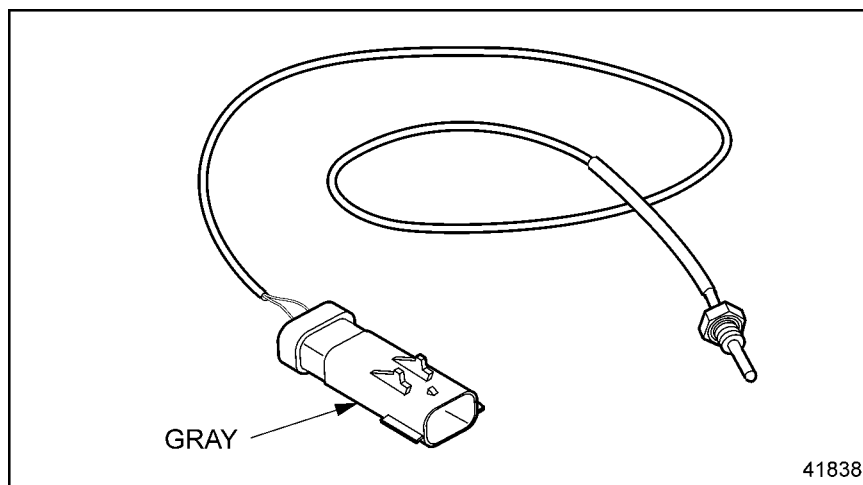


Figure 3-49 Turbo Compressor Temperature Out Sensor — Series 60

3.11.15 TURBO SPEED SENSOR

The Turbo Speed Sensor (TSS) senses turbo speed for overspeed conditions. See Figure 3-50.

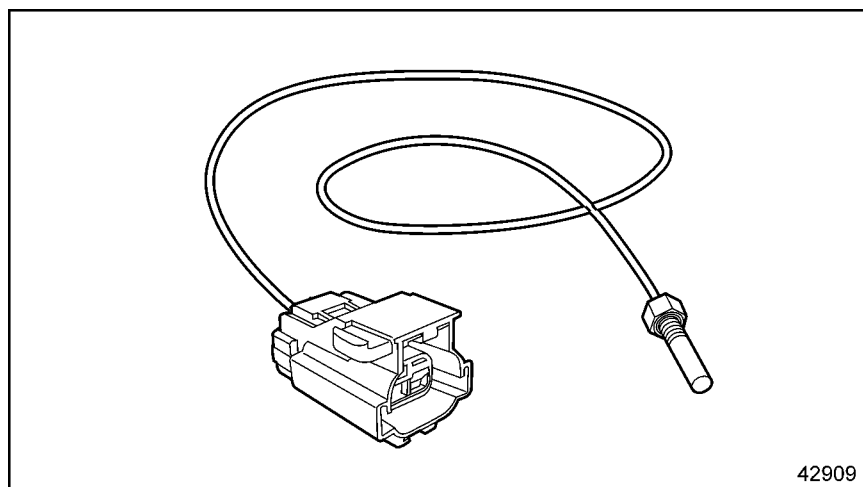


Figure 3-50 Turbo Speed Sensor — Series 60

3.11.16 OEM-INSTALLED SENSORS

Starting with DDEC V, DDC has begun using the nomenclature found in SAE J2403 which is industry standard. The previously used names and the SAE J2403 names are listed in Table 3-50.

Old/New	Old/New
ACLS/AECL Sensor	Add Coolant Level Sensor/Add Engine Coolant Level Sensor
AFRS/AFR Sensor	Air Filter Restriction Sensor
CLS/ECL Sensor	Coolant Level Sensor/Engine Coolant Level Sensor
TPS/AP Sensor	Throttle Position Sensor/Accelerator Pedal Sensor

Table 3-50 Old and New Terminology

The OEM is responsible for installing the sensors listed in Table 3-51.

Sensor	Part Number	Function
Accelerator Pedal Sensor (AP Sensor)	—	Senses operator's input to the ECU for throttle input. Refer to section 3.11.17.
Add Engine Coolant Level Sensor (AECL Sensor)	23526905 23526906 23526907	Senses coolant level for engine maintenance. Refer to section 3.11.21.
Air Filter Restriction Sensor (AFR Sensor)	23523756	Senses the condition of the air inlet filter for engine maintenance. Refer to section 3.11.18.
Ambient Air Temperature Sensor (AAT Sensor)	23518328	Senses ambient air temperature specifically for the Ambient Air Temperature Override Disable feature or for OI. Refer to section 3.11.19.
Engine Coolant Level Sensor (ECL Sensor)	23526905 23526906 23526907	Senses coolant level for engine protection. Refer to section 3.11.20.
Fire Truck Pump Pressure Sensor *	23520795	Senses water pump pressure to maintain a constant fire truck pump pressure. Refer to section 3.11.22.
Turbo Compressor In Temperature Sensor	23527831	Senses the temperature of the turbo compressor inlet. Refer to section 3.11.23. Series 60 only.
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 3.11.24.

* Available in some applications

Table 3-51 Function and Guidelines for OEM-installed Sensors

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

NOTE:

The OEM harness must be securely fastened every 6 in. It is required that the harness be fastened within 6 in. of the sensor.

3.11.17 ACCELERATOR PEDAL SENSOR

The Accelerator Pedal contains the AP Sensor which converts the operator's hand throttle and/or foot pedal input into a signal for the ECU. Refer to section 3.12.1 for additional information on the Accelerator Pedal.

3.11.18 AIR FILTER RESTRICTION SENSOR

The AFR Sensor (see Figure 3-51) has two indicator points, the first indicates the air filter has approximately 50% life left, the second indicates that the filter is plugged. This sensor is only used with the Maintenance Alert System.

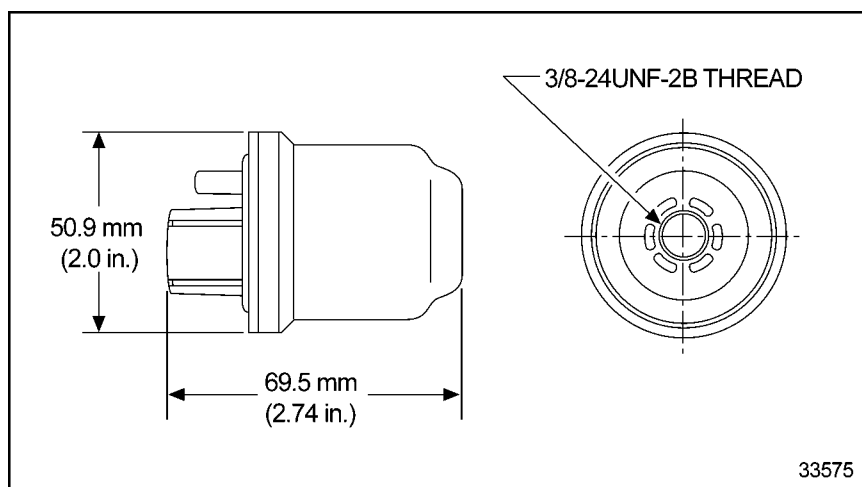


Figure 3-51 Air Filter Restriction Sensor

The AFR Sensor is mounted downstream of the air filter and upstream of the turbocharger. The AFR Sensor must be in a straight section of pipe or where the OEM mechanical unit is normally mounted. This sensor must be enabled with the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

The AFR Sensor must be wired as shown (see Figure 3-52).

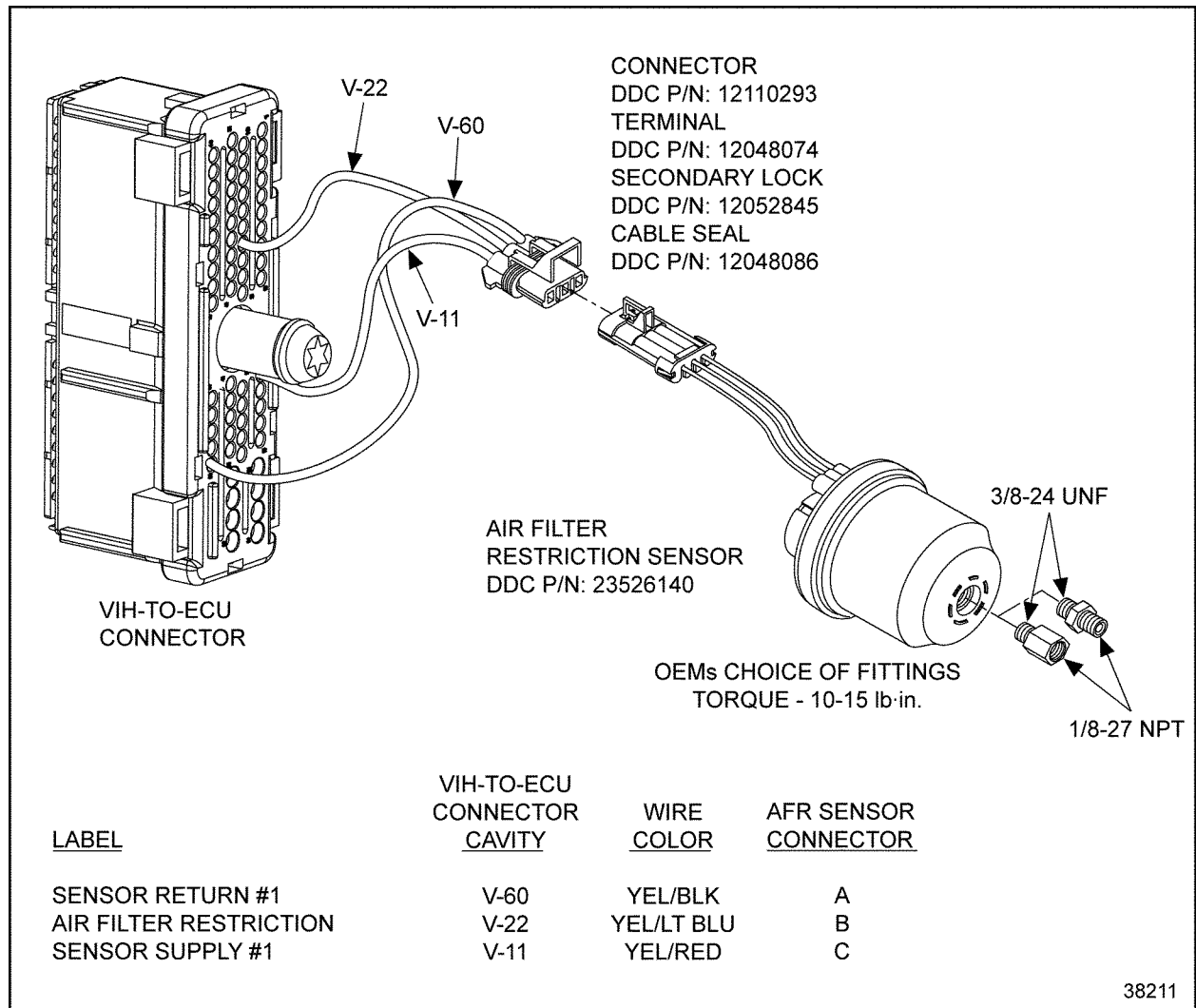


Figure 3-52 Air Filter Restriction Wiring Diagram

3.11.19 AMBIENT AIR TEMPERATURE SENSOR

The AAT Sensor 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 AAT Sensor (see Figure 3-53) is used with the Idle Shutdown Timer, specifically for the Ambient Air Temperature Override Disable feature or for Optimized Idle. For additional information on these features refer to Chapter 5.

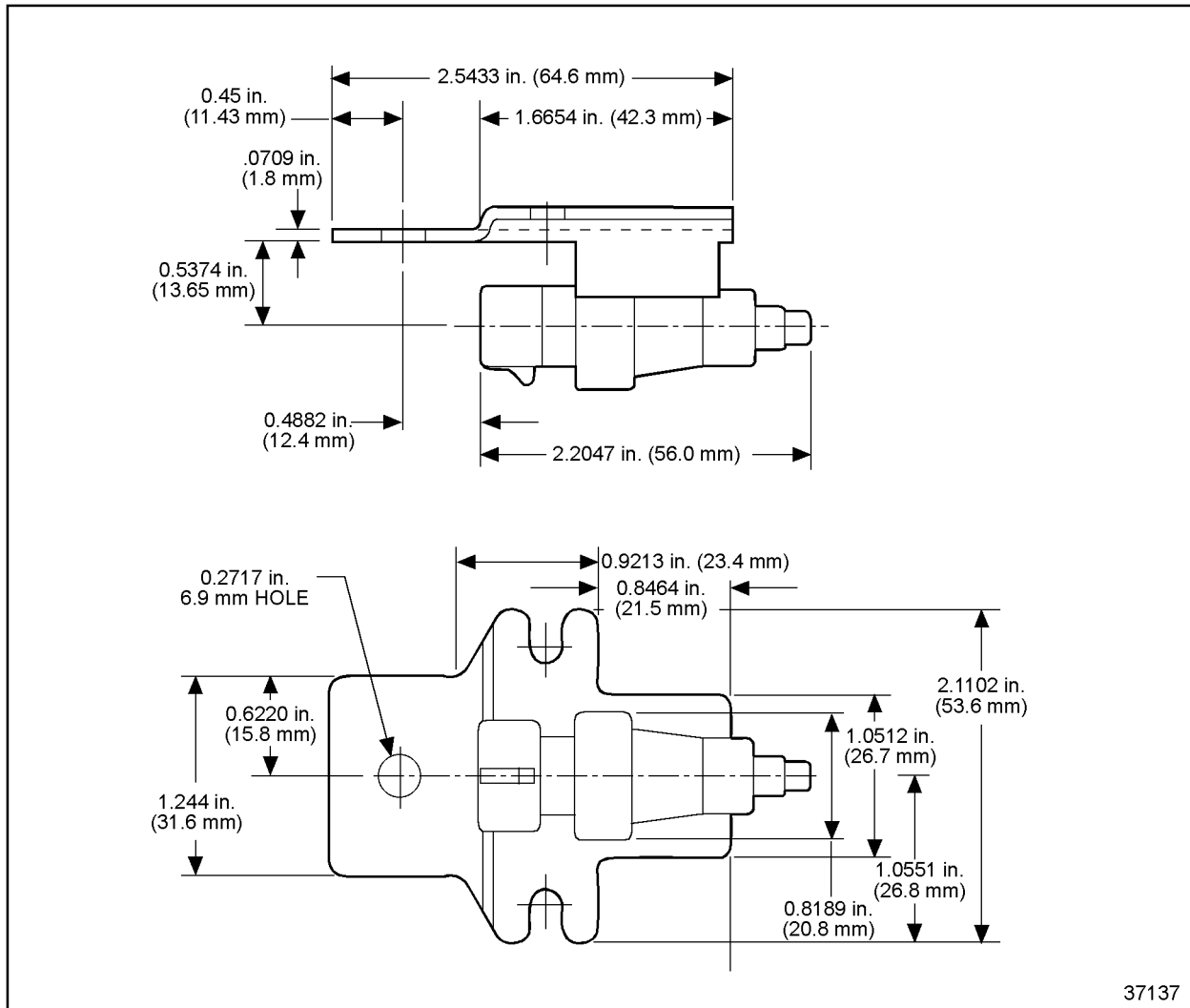


Figure 3-53 Ambient Air Temperatures Sensor Dimensions

Ambient Air Temperature Sensor Installation

Install the AAT Senaor 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. See Figure 3-54 for AAT Sensor installation.

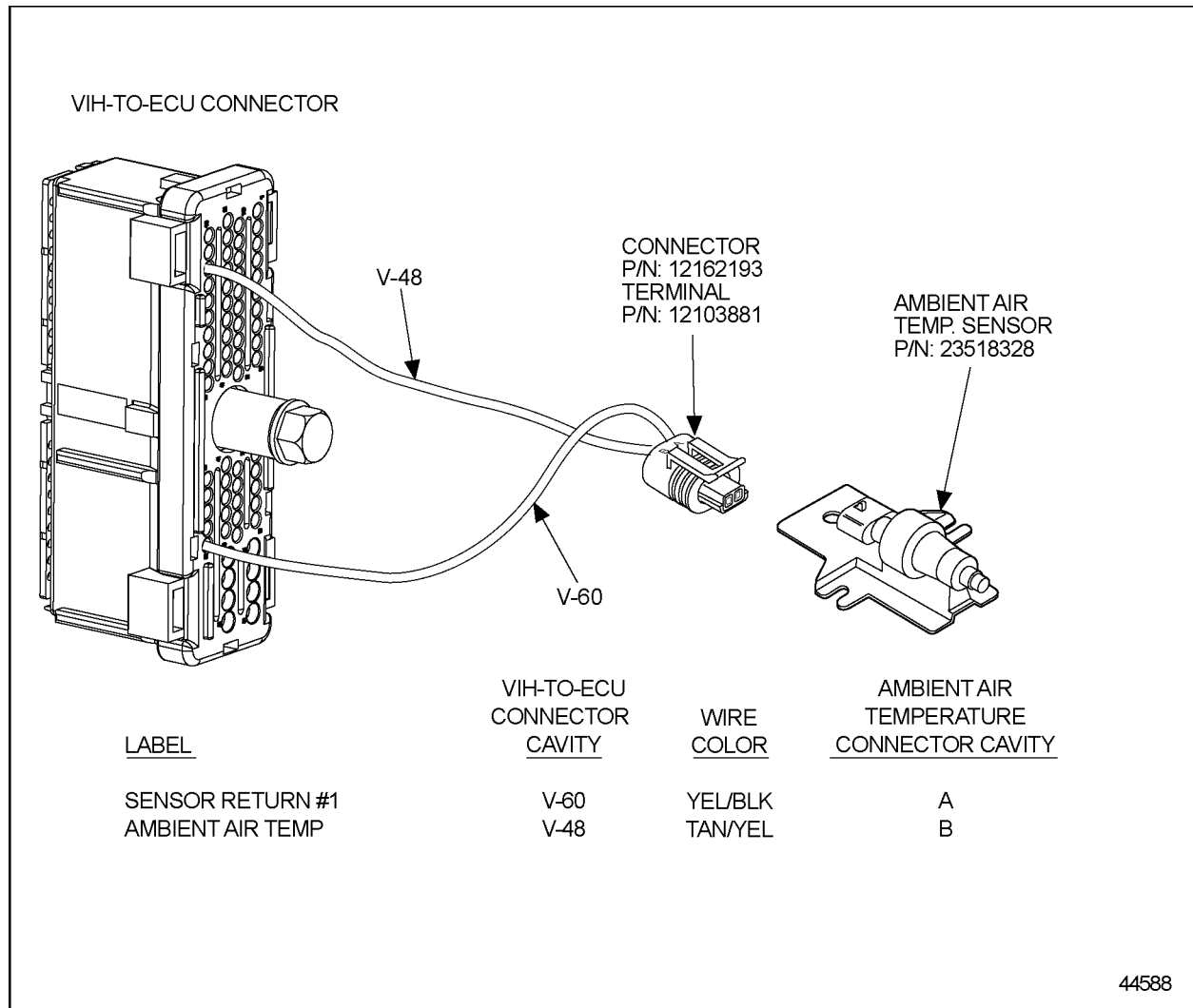


Figure 3-54 Ambient Air Temperature Sensor Installation

3.11.20 ENGINE COOLANT LEVEL SENSOR

The ECL Sensor is required for DDEC V 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 engine coolant level sensors may be used but may require the use of a signal interface.

The main component of the ECL Sensor consists of a conductivity probe, which connects to the ECU (see Figure 3-55).

NOTICE:

The probe has an operational temperature range of -40 to 257°F (-40 to 125°C). Exposure to temperatures beyond this range may result in unacceptable component life, or degraded sensor accuracy.

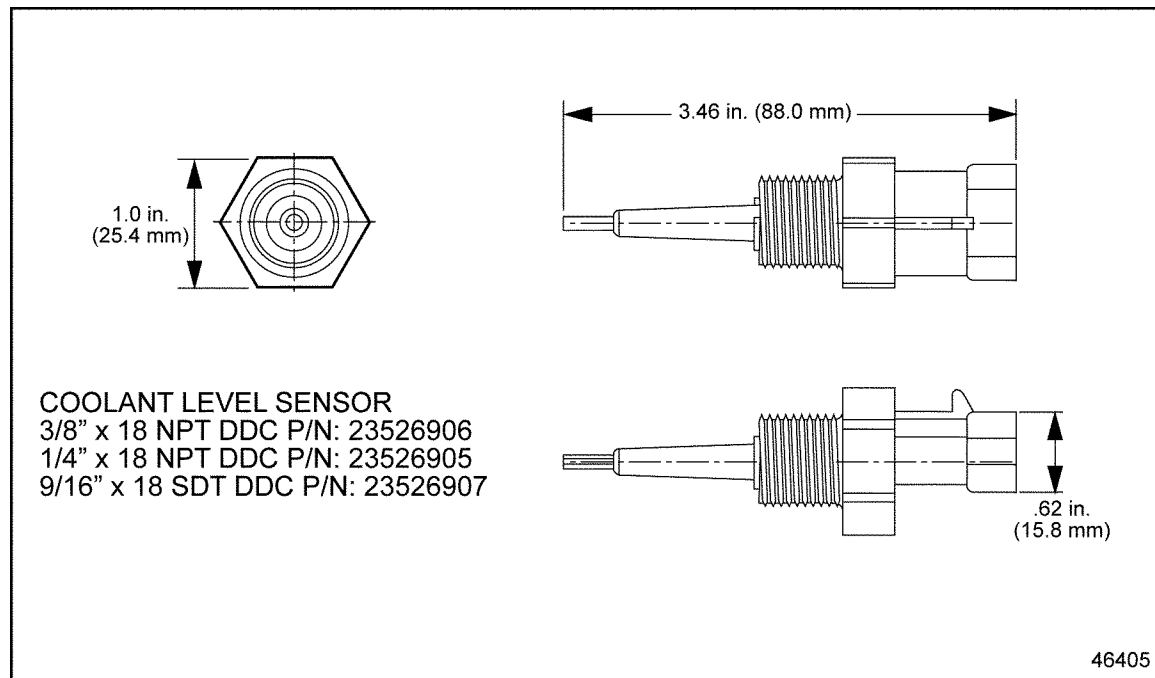


Figure 3-55 Engine Coolant Level Sensor Specifications

The connector listed in Table 3-52 is 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 3-52 Metri-Pack 280 Connectors and Part Numbers

The OEM must connect the ECL Sensor probe as shown in the next illustration (see Figure 3-56). Polarity of the ground and signal must be correct for proper operation.

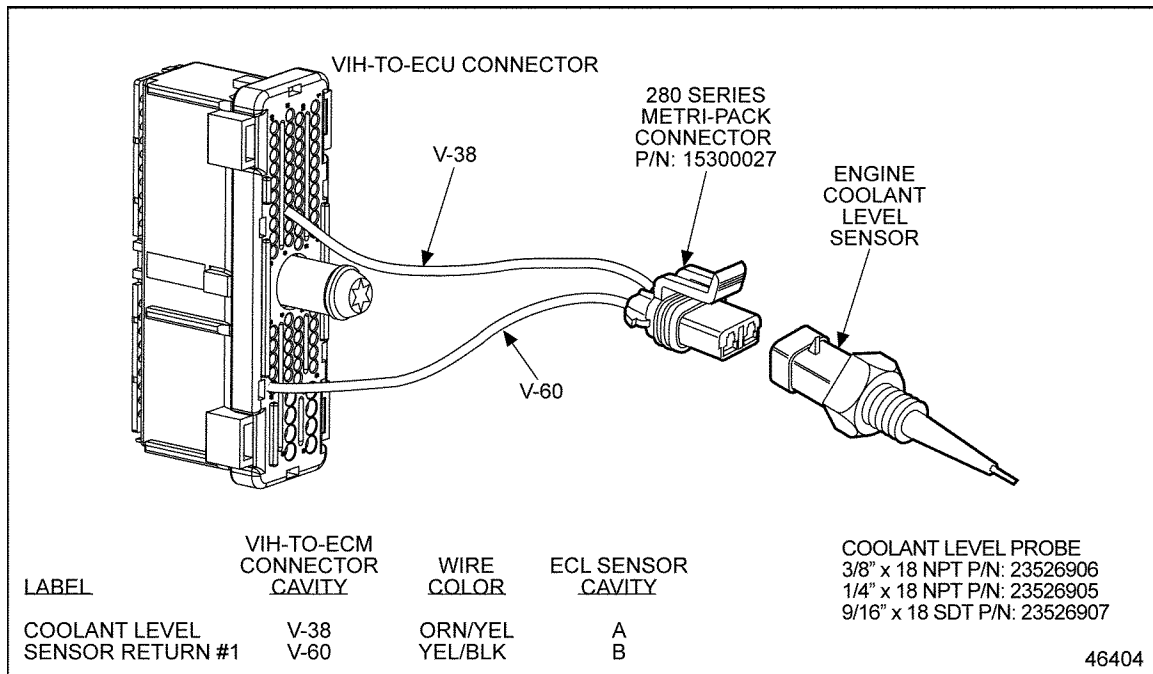


Figure 3-56 Engine Coolant Level Sensor Installation

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 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 1/2 in. or more past the inside wall of the tank. See Figure 3-57.

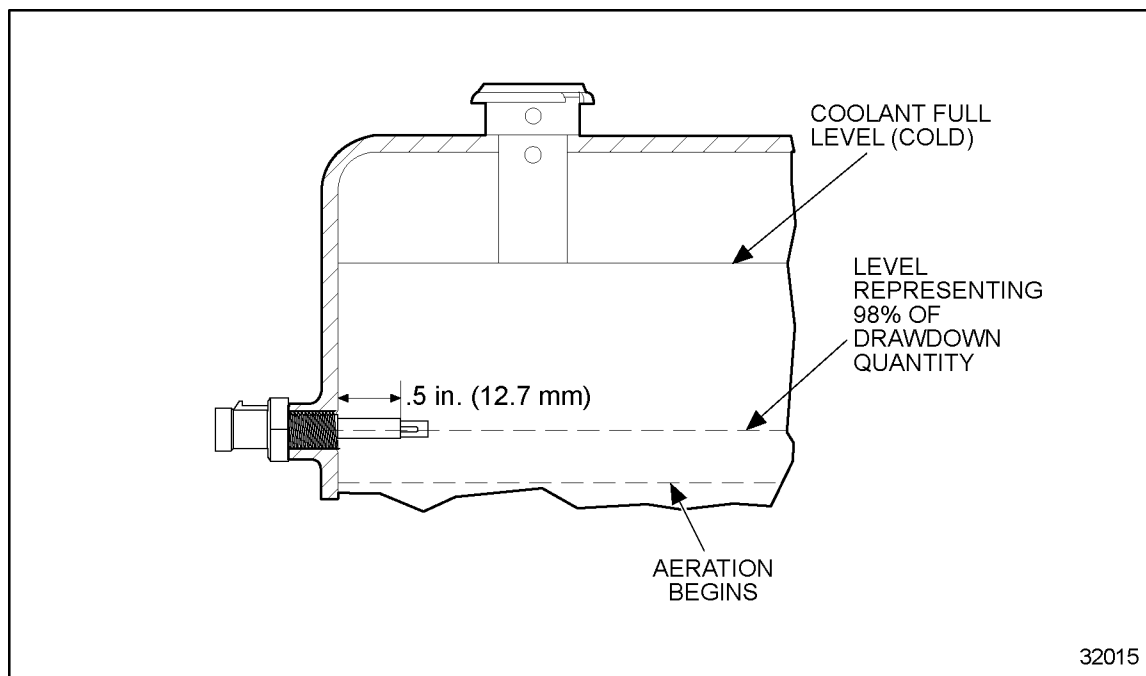


Figure 3-57 Engine Coolant Level Sensor Location - Top of Radiator Tank

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 ECL Sensor components are OEM supplied hardware and can be purchased as kits or individual components, depending on OEM requirements.

The following kits listed in Table 3-53 and Table 3-54 provide all the necessary hardware for proper installation of the ECL Sensor. Kits are available through the DDC parts distribution network.

Component	Part Number
ECL Sensor	23526905
Metri-Pack Connector Kit	15300027
Metri-Pack Terminals	12077411
Secondary Lock	15300014
Wire Seal	12015323
Terminal	12103881

Table 3-53 ECL Sensor Installation Kit 1/4 in. NPTF P/N: 23515397

Component	Part Number
ECL Sensor	23526906
Metri-Pack Connector Kit	15300027
Metri-Pack Terminals	12077411
Secondary Lock	15300014
Wire Seal	12015323
Terminal	12103881

Table 3-54 ECL Sensor Installation Kit 3/8 in. NPTF P/N: 23515398

3.11.21 ADD ENGINE COOLANT LEVEL SENSOR

The AECL Sensor 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) ECL Sensor is located (see Figure 3-58).

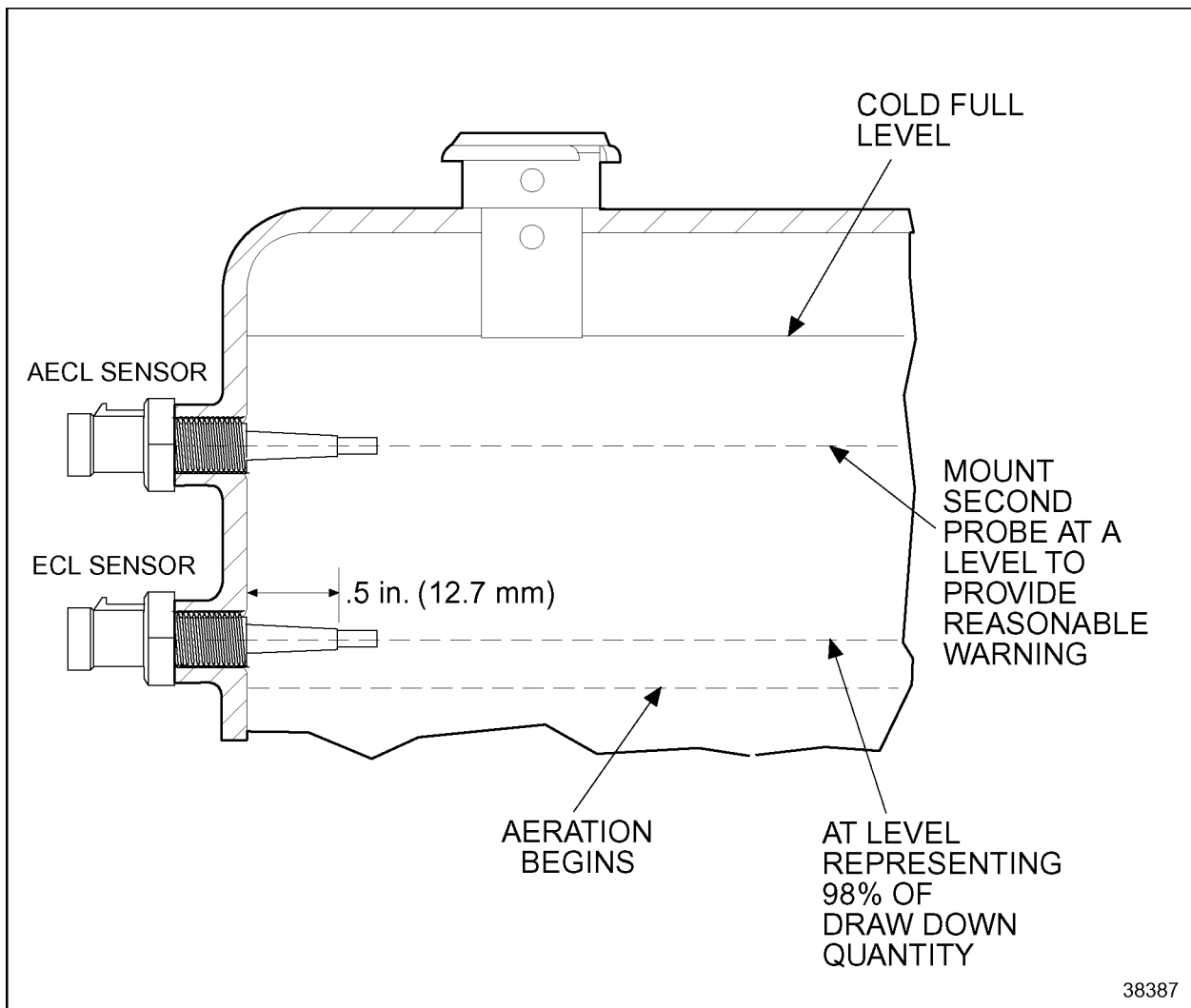


Figure 3-58 Add Engine Coolant Level Sensor Location - Radiator Surge Tank

The AECL Sensor probe is connected to a separate module when used for a Coolant Level Low Lamp. The module provides an output to drive an indicator light on the dash. See Figure 3-59 for the installation of a Coolant Level Low Lamp.

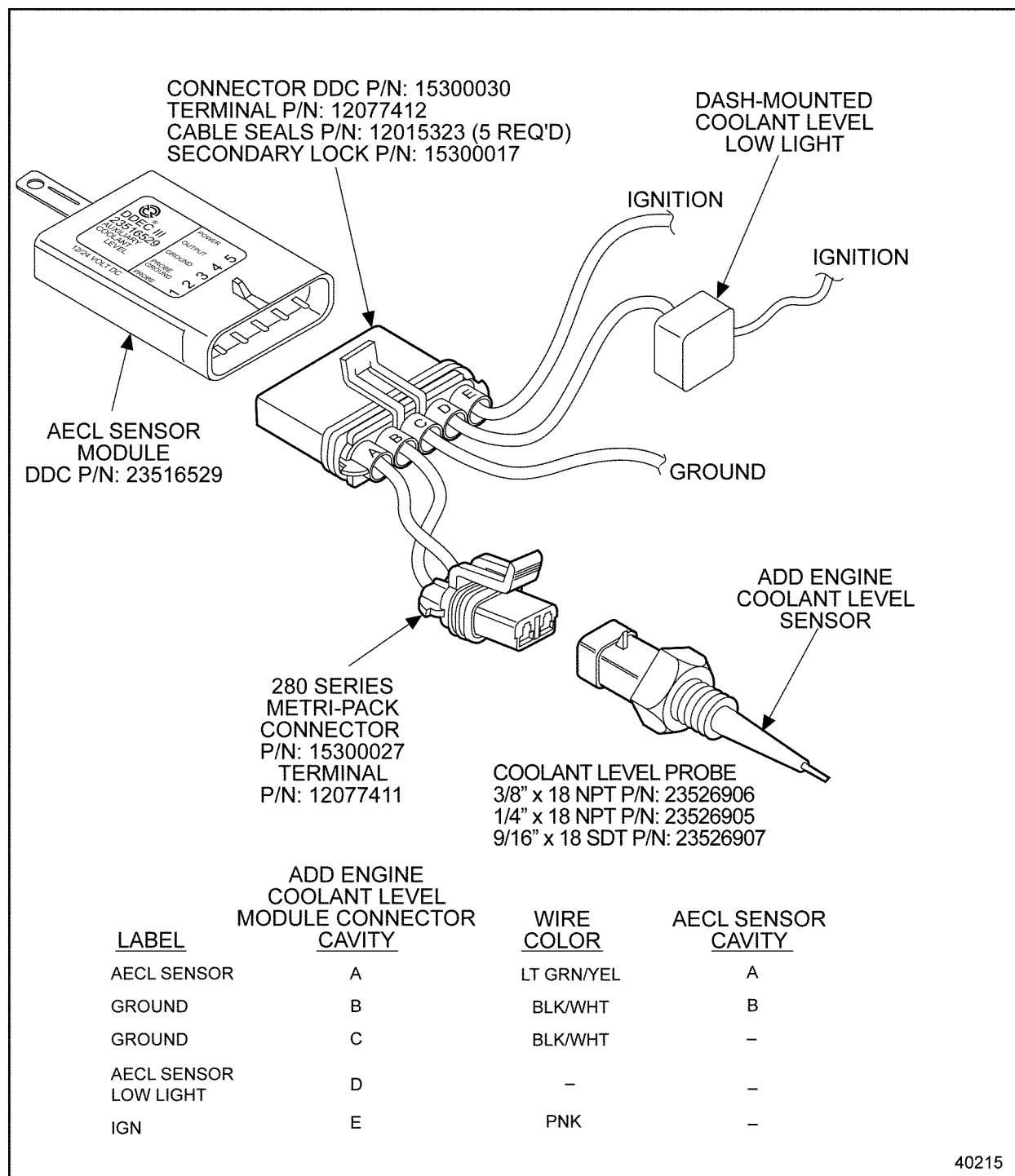


Figure 3-59 Add Engine Coolant Level Sensor with Dash-mounted Lamp Installation

DDC recommends this installation for the AECL Sensor (see Figure 3-60).

This sensor must be enabled with VEPS or the DDEC Reprogramming System.

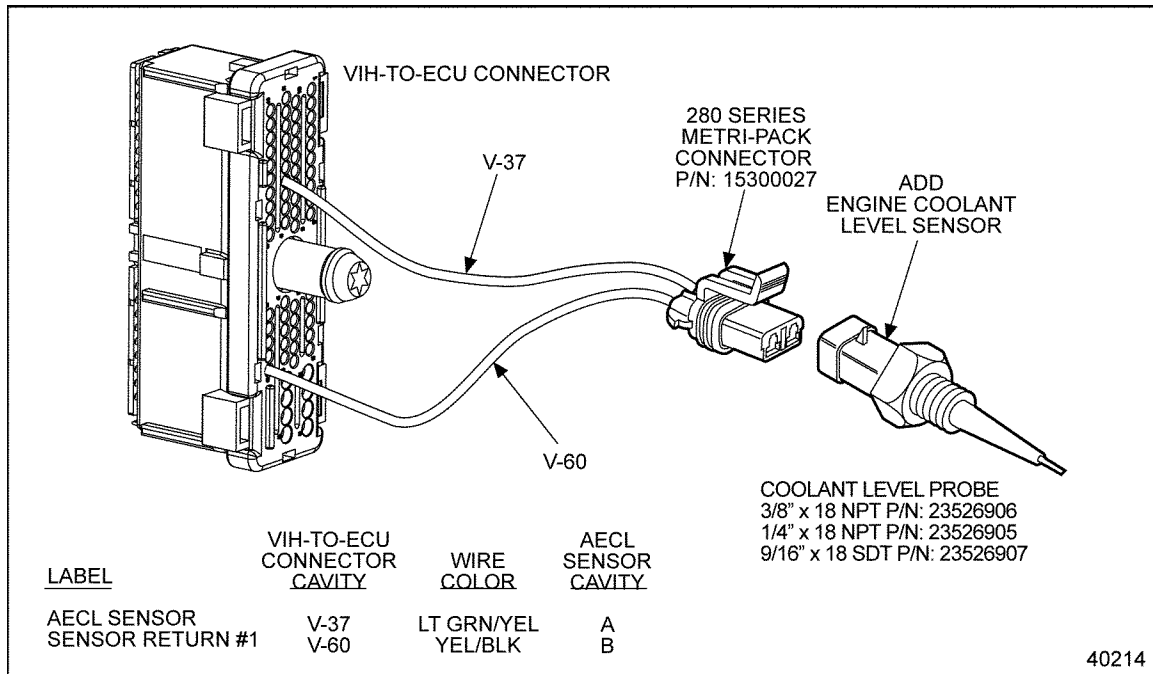


Figure 3-60 Add Engine Coolant Level Sensor Installation

3.11.22 FIRE TRUCK PUMP PRESSURE SENSOR

The Fire Truck Pump Pressure Sensor is used with the Pressure Sensor Governor. It provides a fire truck pump pressure signal to the ECU, which modulates engine fueling to maintain a constant fire truck pump pressure. See Figure 3-61. The Pressure Sensor is capable of reading up to 400 PSIA and is located in the water pump discharge manifold.

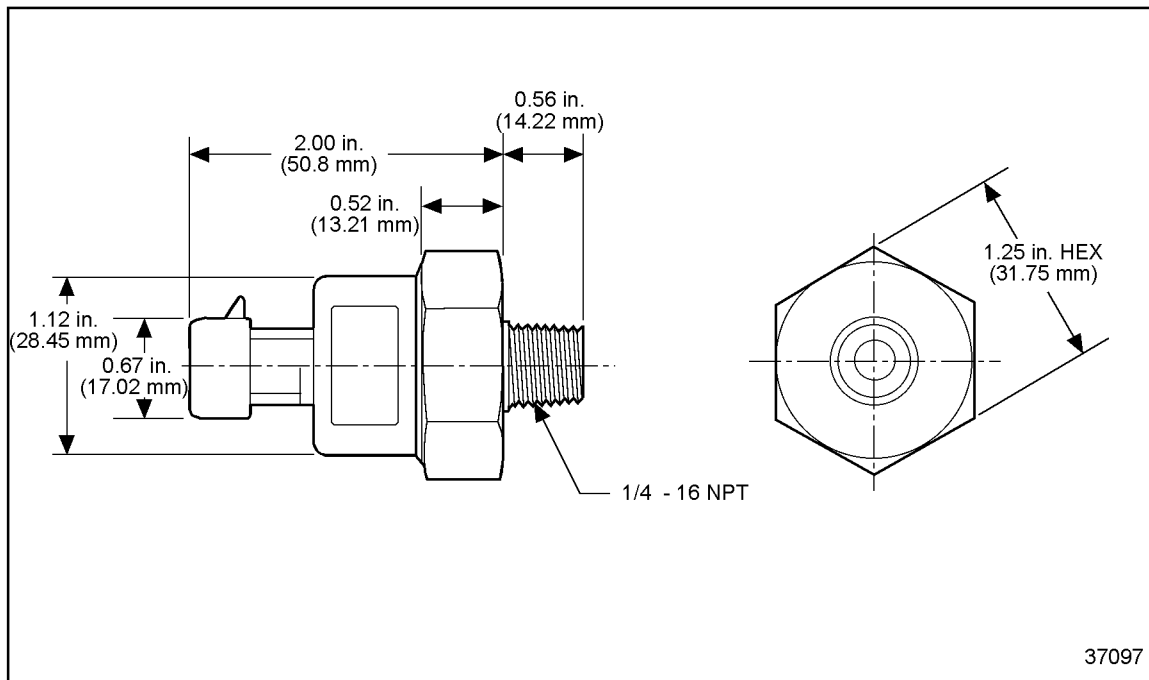


Figure 3-61 The Fire Truck Pump Pressure Sensor

The Fire Truck Pump Pressure Sensor connector, listed in Table 3-55, is a Metri-Pack 150 series pull-to-seat connector.

Fire Truck Pressure Sensor	
Connector	P/N: 12065287
Terminal	P/N: 12089289
Seal	In Connector

Table 3-55 Fire Truck Pump Pressure Sensor Connector

DDC recommends this installation for the Fire Truck Pump Pressure Sensor (see Figure 3-62).

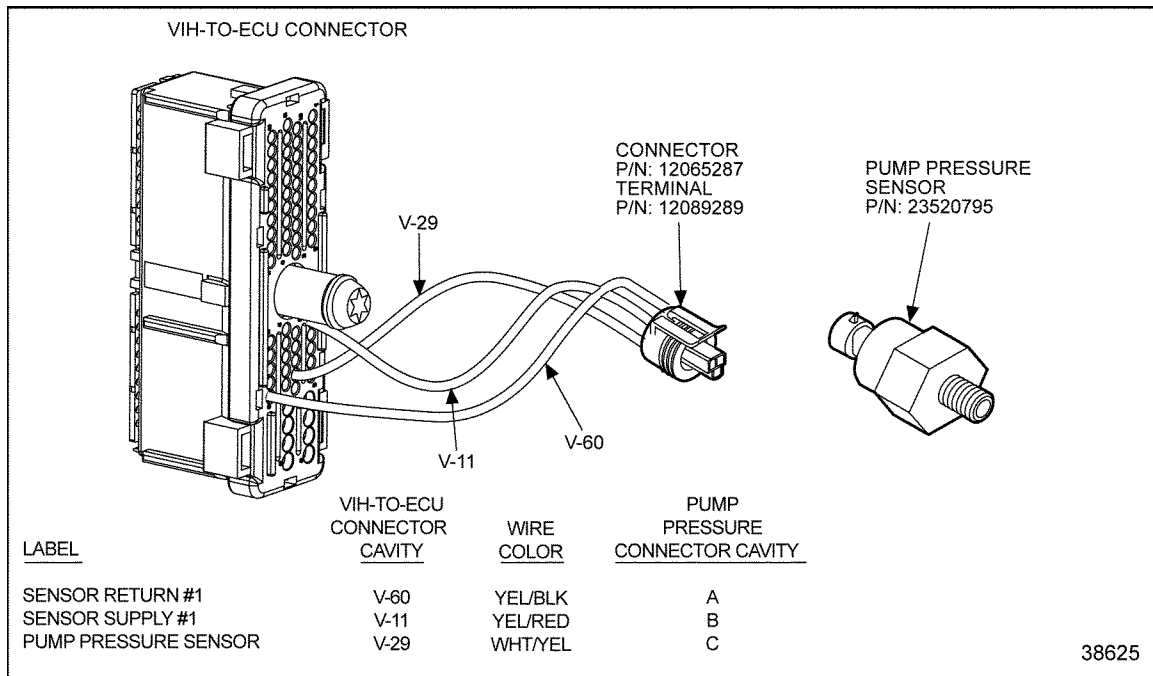


Figure 3-62 Fire Truck Pump Pressure Sensor Installation

3.11.23 TURBO COMPRESSOR IN TEMPERATURE SENSOR

The Turbo Compressor In Temperature Sensor (TCI Sensor) produces a signal representing the temperature of the turbo compressor inlet. See Figure 3-63.

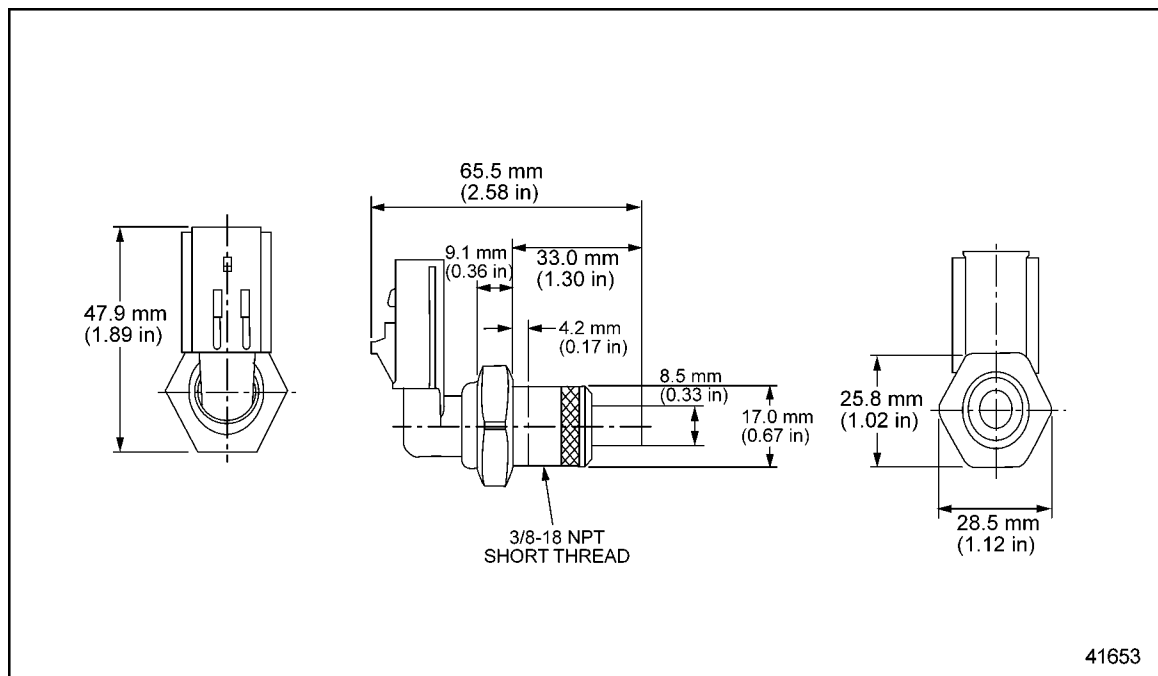


Figure 3-63 Turbo Compressor In Temperature Sensor

This sensor is required for the Series 60.

The maximum vibration for the sensor is 5 g. The sensor must be torqued between 10 ft lb and 20 ft lb. The harness must be fastened within 6 in of the sensor. The maximum operating temperature for this sensor is 248°F (120°C).

Install the Turbo Compressor In Temperature Sensor in the filtered air side of the air filter canister. Otherwise it must be mounted between the air cleaner and the turbocharger compressor inlet. See Figure 3-64.

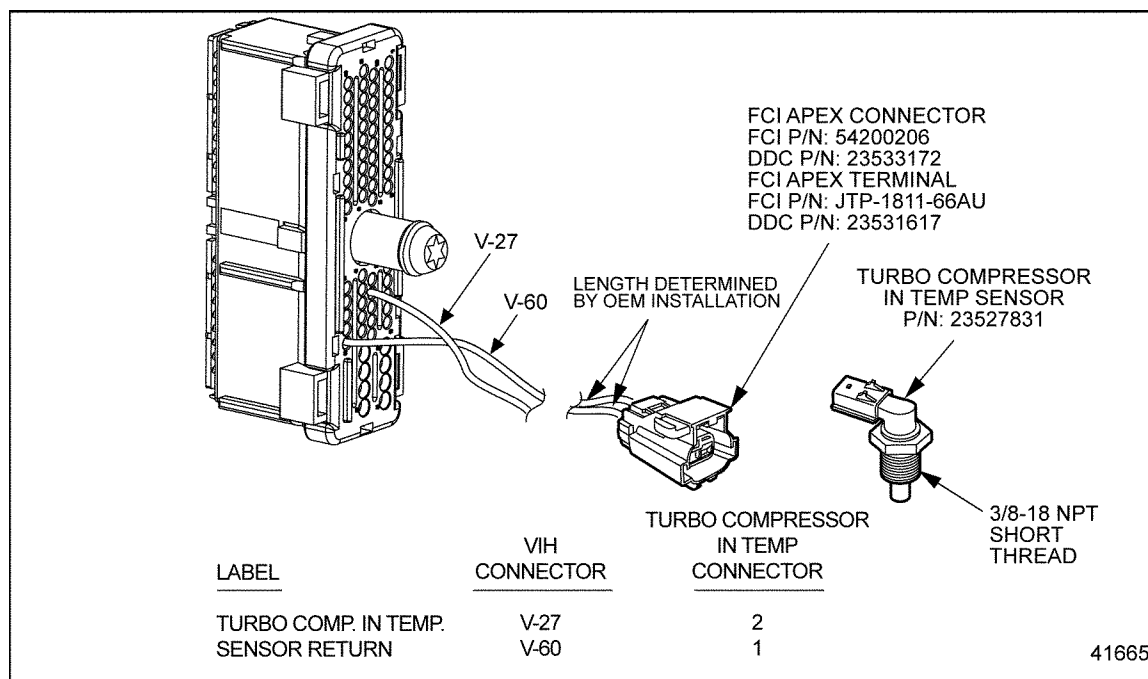


Figure 3-64 Turbo Compressor In Temperature Sensor Installation

FCI connectors are available from the following:

FCI Automotive

Telephone: 1-800-303-3577 or 734-728-2100

NTI, LLC

300 Randall Street, Suite B

Greer SC 29651

Telephone: 864-877-4800

Fax: 864-877-2997

3.11.24 VEHICLE SPEED SENSOR

The DDEC ECU can calculate vehicle speed providing that the ECU is properly programmed and interfaced with a Vehicle Speed Sensor (VSS) that meets DDC requirements. The VSS (see Figure 3-65) provides a vehicle speed signal for use in Cruise Control and Vehicle Speed Limiting. The VSS signal type can be changed with the VEPS, or DRS.

NOTE:

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

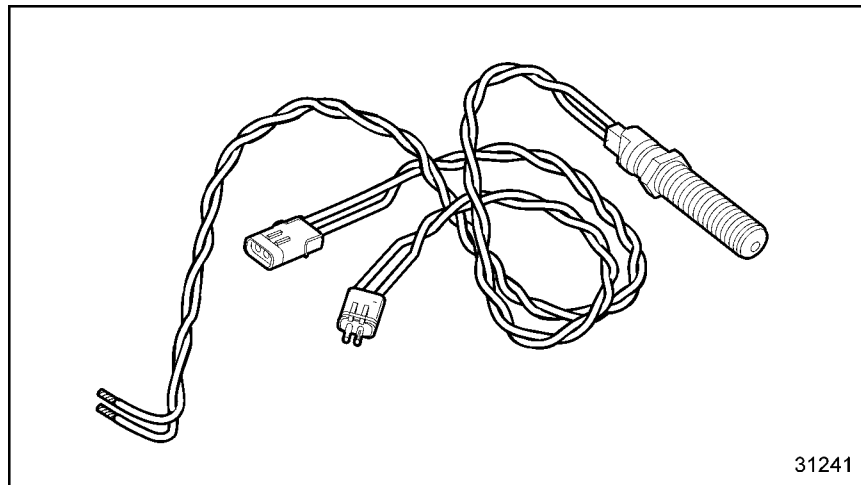


Figure 3-65 Vehicle Speed Sensor

To obtain accurate vehicle mileage, the parameters listed in Table 3-56 must be programmed with DDDL, VEPS or DRS.

Parameter	Description	Choice / Display
Enable Vehicle Speed Sensor	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 Size	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 3-56 Vehicle Speed Sensor Parameters

Magnetic Pickup

The magnetic pickup requirements are listed in Table 3-57. Magnetic Pickup size is determined by installation requirements. Both cavity V-17 and V-18 must be used.

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

Table 3-57 Magnetic Pickup Vehicle Speed Sensor Requirements

See Figure 3-66 for the installation of magnetic pickup VSS.

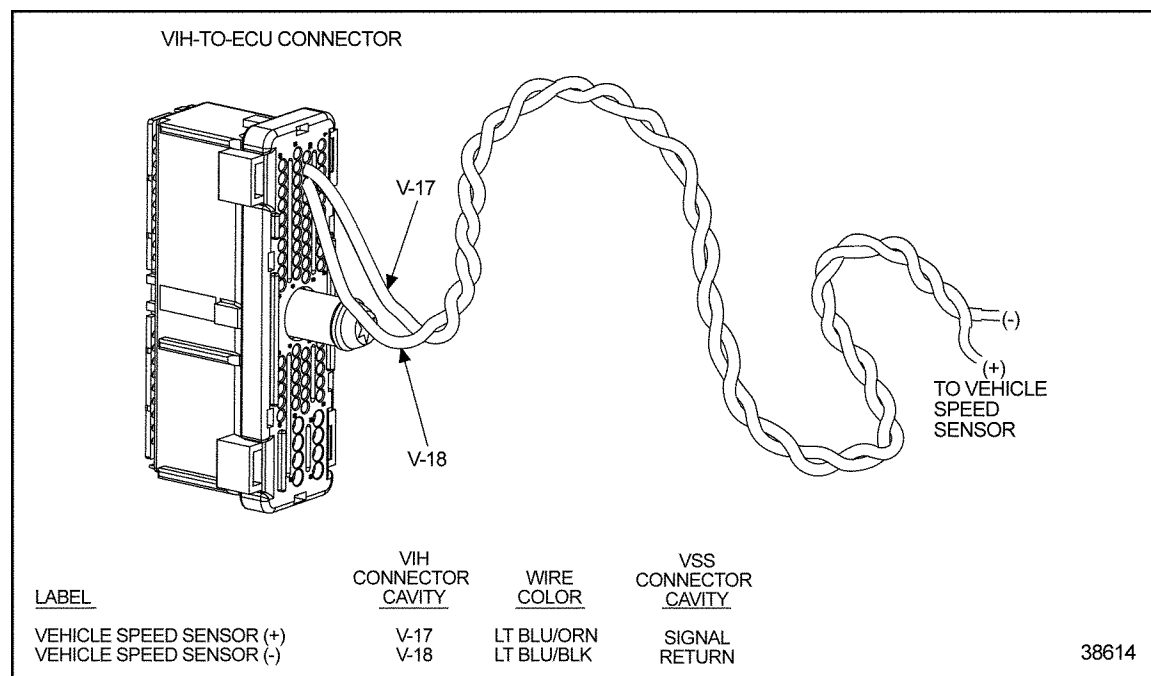


Figure 3-66 Magnetic Pickup Vehicle Speed Sensor Installation

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

Wabash Technologies

1375 Swan Street
Huntington, Indiana
46750-0829
Tel: 260-356-8300
www.wabashtech.com

Airpax Instruments

Phillips Technologies
150 Knotter Drive
Cheshire, Connecticut 06410
Tel: 800-643-0643

Invensys Electro Corporation

1845 57th Street
Sarasota, Florida 34231
Tel: 1-800-446-5762
Fax: 941-355-3120
www.electrocorp.com

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 VDC 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 3-67 for open collector VSS installation.

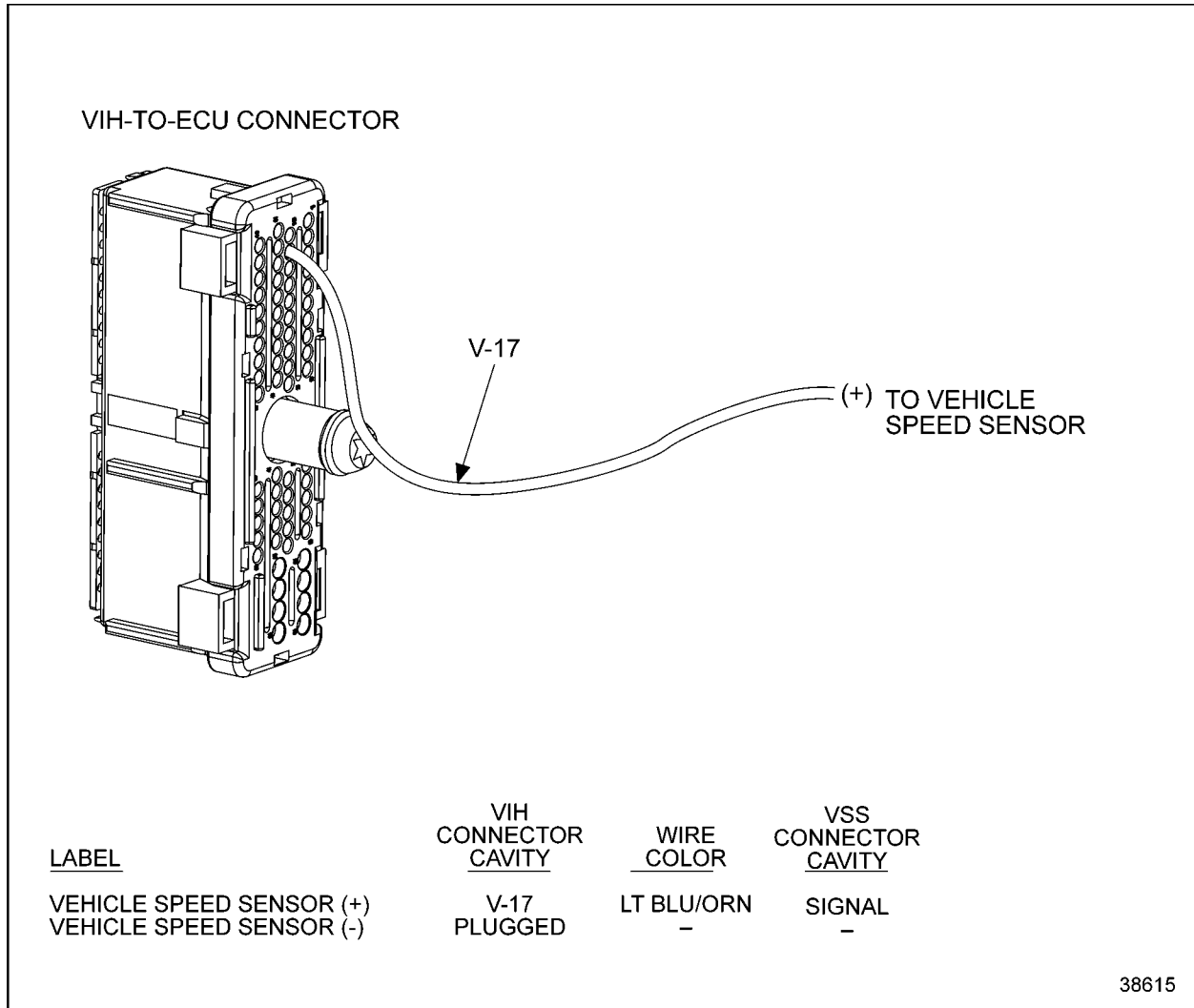


Figure 3-67 Open Collector Vehicle Speed Sensor Installation

The open collector requirements are listed in Table 3-58. Only cavity V-17 is used. Cavity V-18 must be empty.

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

Table 3-58 Open Collector Vehicle Speed Sensor Requirements

SAE J1939 Data Link

A VSS wired to the ECU is not required if the transmission output shaft speed message is being transmitted over the SAE J1939 Data Link. To obtain accurate vehicle mileage, the parameters listed in Table 3-59 must be programmed with DDDL, VEPS, or DRS. The VSS type will automatically be set to SAE J1939 when the appropriate transmission type is selected (tran type = 16).

Parameter	Description	Choice / Display
Tire Size	Vehicle tire revolutions per mile.	100 to 999
Axle Ratio	Indicates the rear axle ratio of the vehicle.	2.00 to 19.99

Table 3-59 Vehicle Speed Sensor 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 incorrect. This indicates that there is a problem with the sensor on the transmission or the transmission controller. 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 will log a VSS fault. The engine speed in all gears will be limited for the duration of the ignition cycle to the engine speed at vehicle speed limit in top gear. Refer to section 5.30 for more information on VSS Anti-tamper.

3.11.25 AFTERMARKET INSTALLED SENSORS

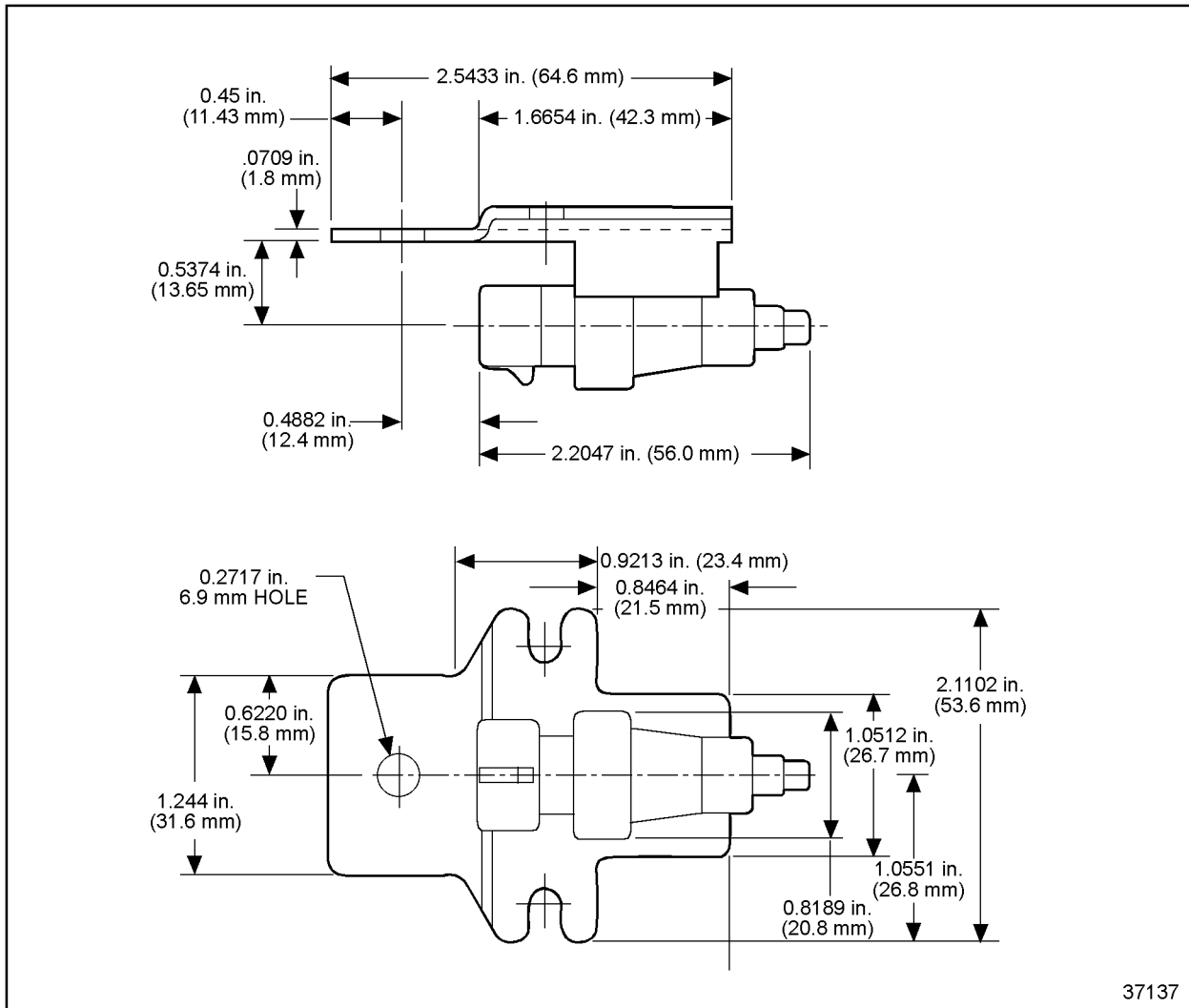
Sensors that can be installed aftermarket are listed in Table 3-60.

Sensor	Part Number	Function
Ambient Air Temperature Sensor (AAT Sensor)	23518328	Senses ambient air temperature specifically for the Ambient Air Temperature Override Disable feature or for OI. Refer to section 3.11.26.

Table 3-60 Aftermarket Installed Sensor

3.11.26 AMBIENT AIR TEMPERATURE SENSOR

The AAT Sensor 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 AAT Sensor (see Figure 3-68) is used with the Idle Shutdown Timer, specifically for the Ambient Air Temperature Override Disable feature or for Optimized Idle. For additional information on these features refer to Chapter 5.



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Figure 3-68 Ambient Air Temperatures Sensor Dimensions

Install the AAT Senaor 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.

An aftermarket kit P/N: 23534278 is available as listed in Table 3-61.

Description	Part Number	Quantity
Harness, Ambient Air Temp	23534225	1
Sensor Ambient Air Temp (with Bracket)	23518328	1
Connector – Air Temp Sensor	12162193	1
Terminal, Female	12103881	4
18SP583 – Installation Instructions	18SP583	1

Table 3-61 Ambient Air Temp Kit P/N: 23534278

Ambient Air Temp Sensor Kit Installation

Install the kit as follows:

1. Unplug the connector from the Intake Manifold Pressure Sensor (IMP Sensor).
2. Take the ambient AAT Sensor harness and plug the IMP Sensor connector into the IMP Sensor. Plug the IMP Sensor (from the Engine Harness) into the 3-pin connector (IMP Sensor connector mate) on the AAT Sensor harness.
3. Route the harness along the Engine Harness towards the ECU 68-pin connector.
4. Remove the Vehicle Interface Harness 68-pin connector from the ECU.
5. Insert lead into the connector cavity V-48 and reinstall the 68-pin connector. See Figure 3-69.

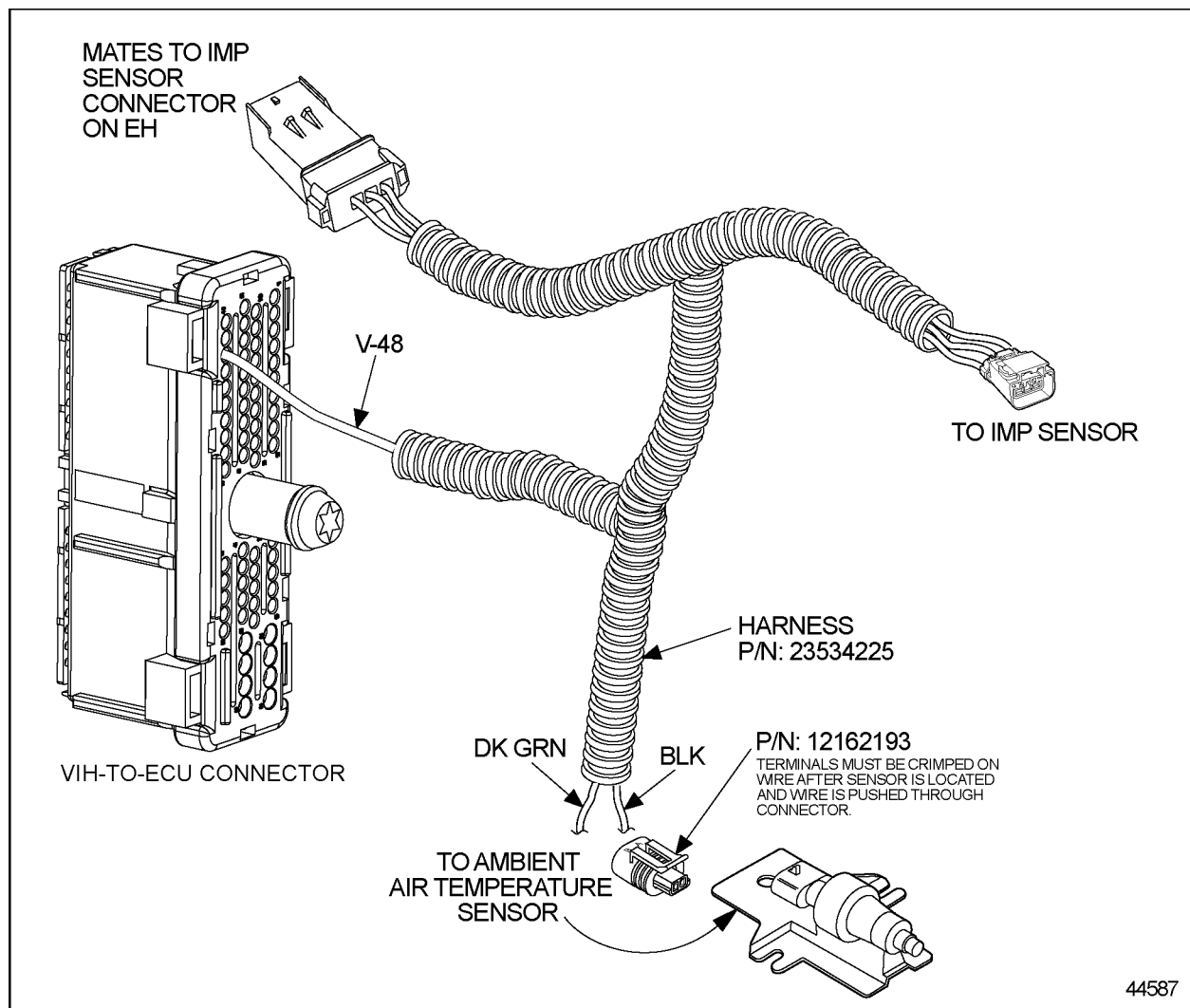


Figure 3-69 Ambient Air Temperature Sensor Harness

6. Route the body of the harness to the desired location for the AAT Sensor. Remove any excess harness material and discard.
7. Install the black lead (circuit E-15) into cavity "A" of AAT Sensor connector (P/N: 12162193) and the green lead (circuit V-48) into cavity "B." Crimp the terminals (P/N: 12103881) on each lead using tool J 35123. Insert the terminals into the connector.
8. Secure the sensor to the desired location and plug in the AAT Sensor connector.

NOTE:

Preferred mounting location for the sensor is on the front bumper away from any heat sources.

9. Secure the harness to adjacent components with wire ties.
10. Sensor must be enabled with a Distributor Reprogramming Station. Choose DDEC V Ambient Air Temperature Sensor.

3.12 THROTTLE DEVICES

Starting with DDEC V, DDC has begun using the nomenclature found in SAE J2403 which is industry standard. The previously used names and the SAE J2403 names are listed in Table 3-62.

Old/New	Old/New
EFPA/AP	Electronic Foot Pedal Assembly/Accelerator Pedal
LSG/ALSG	Limiting Speed Governor/Automotive Limiting Speed Governor
TPS/AP Sensor	Throttle Position Sensor/Accelerator Pedal Sensor

Table 3-62 Old and New Terminology

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

- ☐ Hand throttle
- ☐ Accelerator Pedal Assembly (AP)
- ☐ Cruise Control switches
- ☐ Fast Idle Switch
- ☐ 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 Automotive Limiting Speed Governor (ALSG) for torque control
- ☐ The Variable Speed Governor (VSG) for speed control

3.12.1 ACCELERATOR PEDAL ASSEMBLY

The AP contains the Accelerator Pedal Sensor (AP Sensor) and the Idle Validation Switch which converts the operator's hand throttle and/or foot pedal input into a signal for the ECU. The AP and the AP Sensor are shown in Figure 3-70.

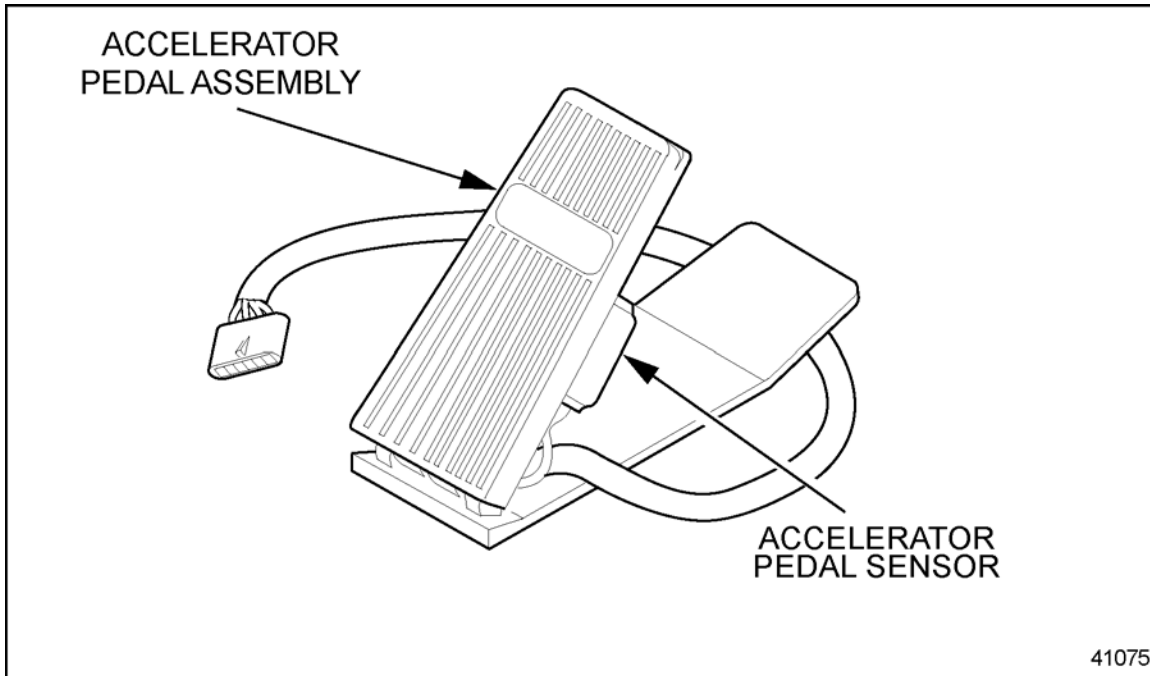


Figure 3-70 Typical AP Throttle Device (Shown with 6-pin Connector)

The AP sends the ECU an input signal which controls engine power on the ALSG, proportional to the foot pedal position. This assembly is also referred to as the Accelerator Pedal Sensor assembly.

NOTE:

An Accelerator Pedal with an Idle Validation Switch is required.

The system fault detection diagnostics will return the engine to idle speed in the event of a sensor or associated wiring malfunction. An idle validation switch provides redundancy to assure that the engine will be at idle in the event of an in-range malfunction.

The AP can be used with either or both ALSG and VSG.

3.12.2 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 5.25.2 .

3.12.3 HAND THROTTLE

A hand throttle (potentiometer) may be used to control engine speed on the VSG between the minimum VSG speed and maximum VSG speed. The total resistance must be between 1 k Ω and 10 k Ω . For more information on the hand throttle, refer to section 5.25.2 .

3.12.4 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 5.25.2 .

3.12.5 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 5.25.2.

3.12.6 FREQUENCY INPUT

A frequency input can be used to control the VSG. This frequency is connected to a frequency input. Frequency speed control offers better resolution than analog throttles. For more information on frequency input, refer to section 5.25.2 .

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3.13 LIGHTS

Starting with DDEC V, DDC has begun using the nomenclature found in SAE J2403 which is industry standard. The previously used names and the SAE J2403 names are listed in Table 3-63.

Old/New	Old/New
CEL/AWL	Check Engine Light/Amber Warning Lamp
SEL/RSL	Stop Engine Light/Red Stop Light

Table 3-63 Old and New Terminology

The instrument panel warning lights, the Amber Warning Lamp (AWL) and the Red Stop Lamp (RSL), are supplied by the OEM. The functionality of each lamp along with the wiring requirements are covered separately in the following sections.

3.13.1 AMBER WARNING LAMP

The AWL is controlled by the DDEC ECU. The AWL 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 AWL flashes:

- ☐ When the Diagnostic Request Switch is used to activate the AWL 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

AWL and Maintenance Intervals

AWL is active with the DDEC Reports Periodic Maintenance intervals. If a maintenance interval is within a specified percentage of expiration (default is 20%), the AWL 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.

AWL and PasSmart

AWL is active with PasSmart. When the Passing Speed Duration time expires, the Amber Warning Lamp on the dashboard will begin to flash one minute prior to ramping the Vehicle Limit Speed (VLS) back down to the normal VLS limit. The rampdown event always takes 5 seconds regardless of the Passing Speed Increment programmed into the ECU. The rampdown alert can be distinguished from an engine fault warning in that the AWL 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 Amber Warning Lamp goes from constant illumination to flashing one minute before the VLS limit ramps down. At the end of the passing event when PasSmart is deactivated, the Amber Warning Lamp will return to constant illumination if the engine fault is still active.

AWL and the Maintenance Alert System

AWL activity with the Maintenance Alert System (MAS) is set with DDDL, the Vehicle Electronic Programming System (VEPS), or the DDEC Reprogramming System (DRS). The four options for using the AWL with MAS are:

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

Amber Warning Lamp Requirements and Guidelines

The following requirements and guidelines apply to the AWL:

- ☐ The AWL must be supplied by the OEM.
- ☐ A 12 or 24 volt light of less than 2 A (DC) is required depending on the ignition source. Digital output circuits are designed to sink no more than 2 A (DC) current. A low-side digital output sinks 210 μ A when OFF.
- ☐ The AWL 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 AWL lamp.

Wiring Requirements

The AWL is connected to pin V-1 in the VIH connector.

See Figure 3-71 for the recommended AWL wiring.

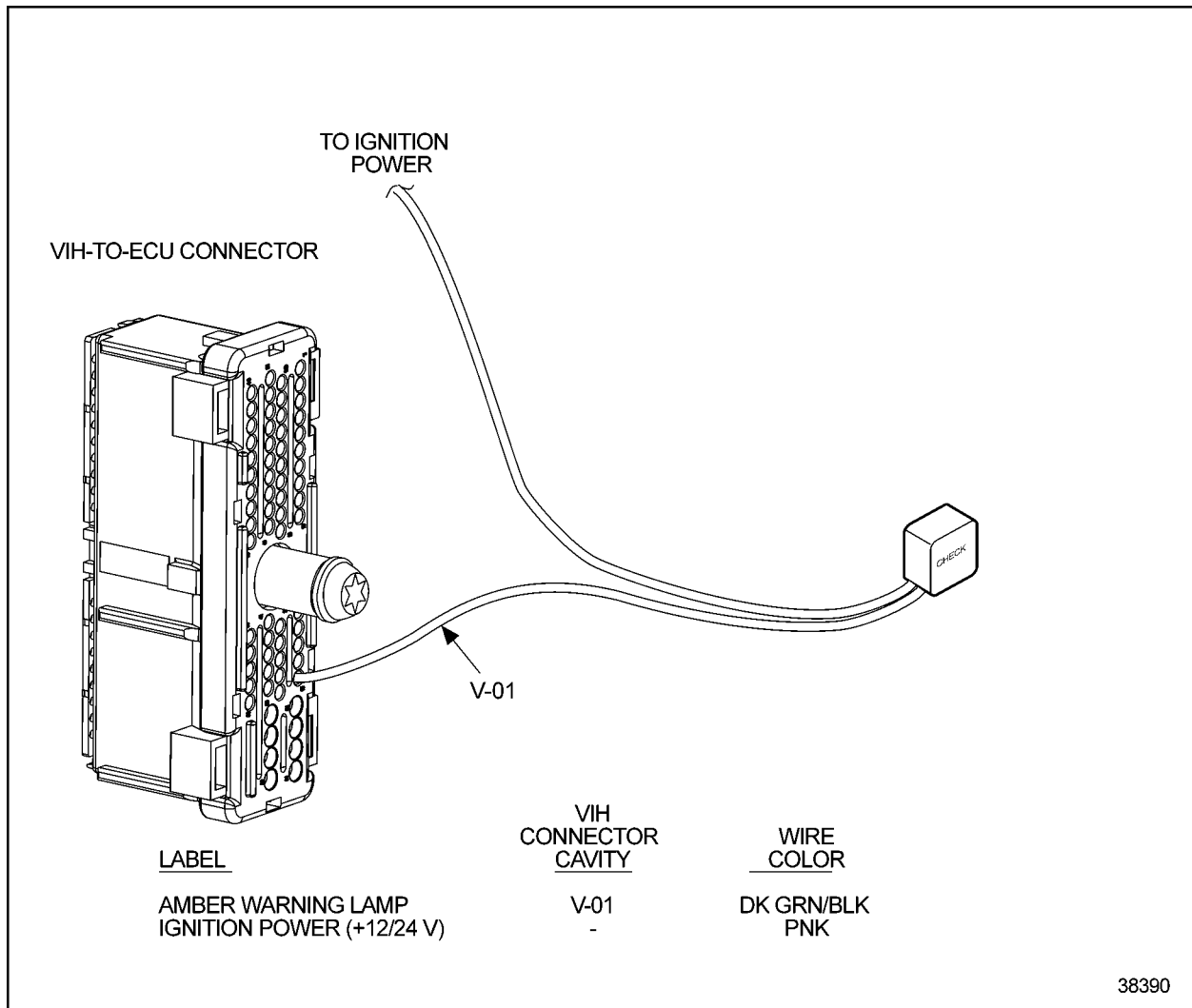


Figure 3-71 Amber Warning Lamp Wiring

3.13.2 RED STOP LAMP

The RSL is controlled by the DDEC ECU. The RSL remains ON:

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

The RSL flashes:

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

RSL activity with the MAS is set with DDDL, the Vehicle Electronic Programming System (VEPS), or the DDEC Reprogramming System (DRS). The two options for using the RSL with MAS are:

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

Red Stop Lamp Requirements and Guidelines

The following requirements and guidelines apply to the RSL:

- The RSL must be incorporated into the VIH by the OEM.
- A 12 or 24 volt light of less than 2 A (DC) is required depending on the ignition source. Digital output circuits are designed to sink no more than 2 A (DC) current. A low-side digital output sinks 210 μ A when OFF.
- The RSL 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 RSL lamp.

Red Stop Lamp Wiring

The RSL is connected to pin V-2 in the VIH connector.

See Figure 3-72 for the recommended RSL wiring.

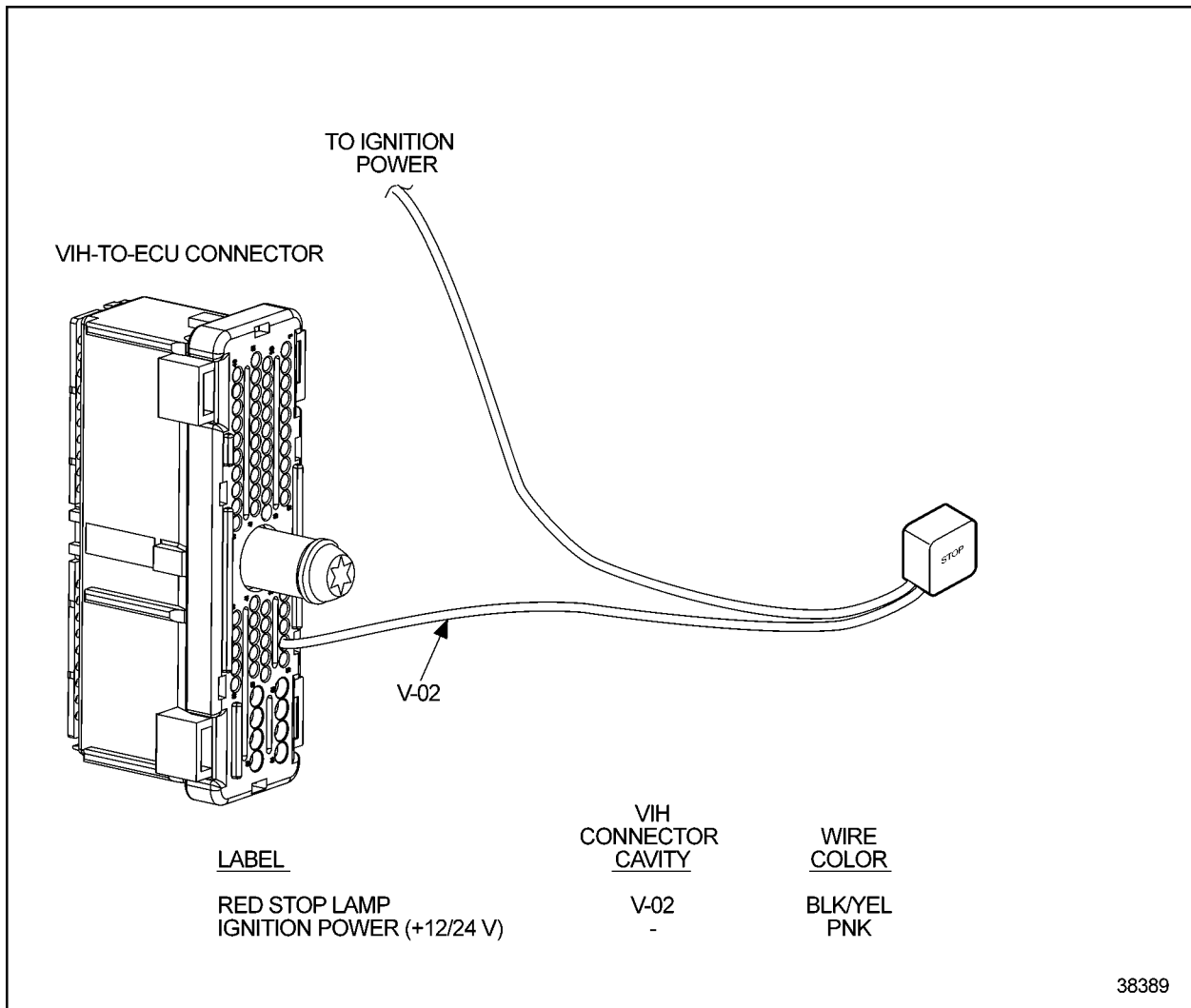


Figure 3-72 Red Stop Lamp Wiring

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4 INPUTS AND OUTPUTS

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4.2 DIGITAL OUTPUTS	4-27
4.3 PWM OUTPUTS	4-49

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4.1 DIGITAL AND ANALOG INPUTS

DDEC V has 24 input ports located on the VIH, 18 of these can be used for digital inputs. The Application Code System (ACS) sets the default function number for each of the 24 ports. These inputs can be configured for various analog or digital functions as identified by the config ID. These functions can be ordered at the time of engine order, configured by Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS). Some features are further customized by programming the ECU with Detroit Diesel Diagnostic Link® (DDDL), VEPS, or DRS. DDEC does not detect broken or shorted wires on switched digital input functions. Pins V-13 (throttle position) and V-14 (VSG) are dedicated pins and cannot be programmed for any other function.

Digital input functions are activated when the digital input wire is switched to sensor return, see Figure 4-1. The input function can be controlled by either a switch or an OEM interlock depending on the function. Digital input functions can be wired to inputs that have a 1.5 kΩ pull-up resistor.

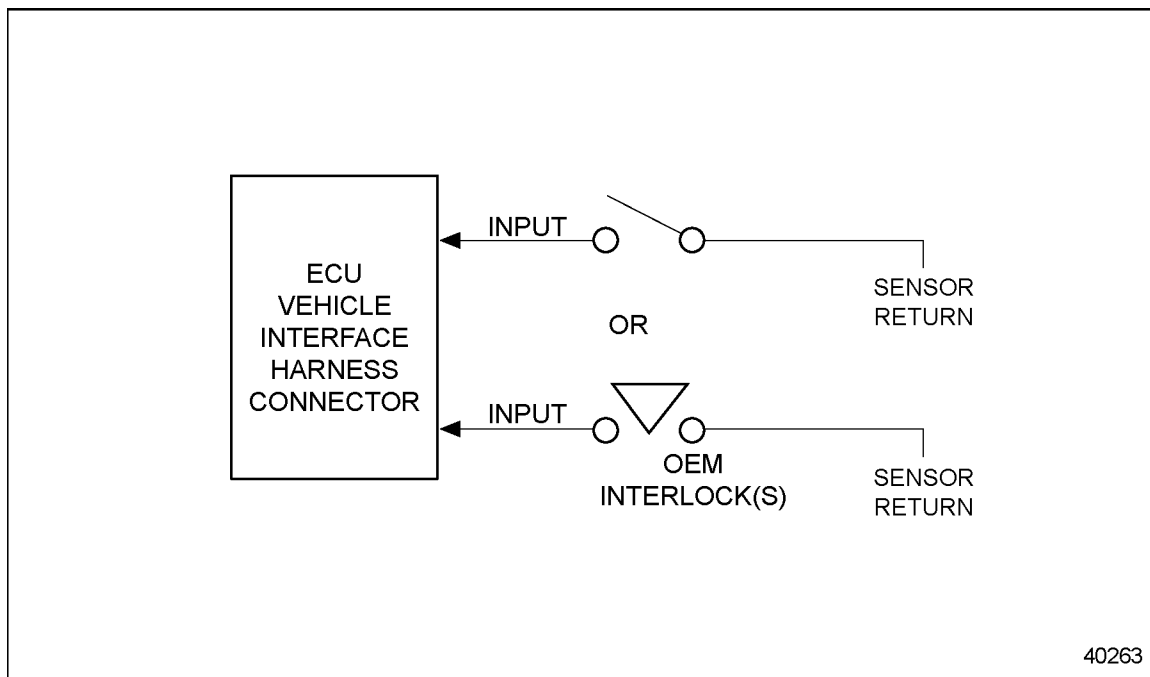


Figure 4-1 Two Methods to Activate a Digital Input Function

NOTE:

Input circuits are designed to source no more than 5 mA (DC).

The input ports located on the VIH and their functions are listed by feature in Table 4-1 and Table 4-2.

Feature	Input	Config ID
Air Compressor Controls Refer to section 4.1.1, page 4-6,	Air Compressor Load Switch	4131
	Air Compressor Pressure Sensor	40
	Set/Coast (Decrease)	4116
	Resume/Accel (Increase)	4118
Cruise Control (Uses up to five inputs) Refer to section 4.1.2, page 4-8.	Cruise Control Enable	4119
	Clutch Released	4114
	Service Brake Released	4113
	Set/Coast On	4116
	Resume/Acceleration On	4118
Engine Brake Refer to section 4.1.3, page 4-10.	Engine Brake Disable	4122
	Engine Brake Low	4097
	Engine Brake Medium	4098
Engine Protection Refer to section 4.1.4, page 4-12.	Auxiliary Shutdown #1	4099
	Auxiliary Shutdown #2	4100
	Diagnostic Request Switch	4111
	SEO/Diagnostic Request Switch	4121
Engine Ratings Refer to section 4.1.5, page 4-14.	Limiting Torque Curve	4110
	Rating Switch #1	4108
	Rating Switch #2	4109
Fan Control Refer to section 4.1.6, page 4-14.	Transmission Retarder Status	4123
	Air Conditioner Status	4125
	Fan Control Override	4128
Maintenance Alert System Refer to section 4.1.7, page 4-16	Air Filter Restriction Sensor	16
	Add Coolant Level Sensor	1040

Table 4-1 Inputs Listed by Feature (1 of 2)

Feature	Input	Config ID
Optimized Idle Refer to section 4.1.8, page 4-18.	Cruise Enable	4119
	Park Brake Interlock	4101
	Optimized Idle Thermostat	1037
Pressure Sensor Governor (PSG) Refer to section 4.1.9, page 4-19.	Pressure Sensor Governor Enable	4120
	Pressure/RPM Mode	4104
	Set/Coast (Decrease)	4116
	Resume/Accel (Increase)	4118
	Fire Truck Pump Pressure Sensor	15
Throttle Control Refer to section 4.1.10, page 4-21.	Alternate Minimum VSG/Fast Idle	4112
	Dual Throttle (ALSG) (AP)	4124
	Idle Validation	4102
	Throttle Inhibit	4105
	VSG Station Change	4129
	VSG Station Change Complement	4130
	External Engine Synchronization/Frequency Input Active	4106
	VSG Inhibit	4138
Additional Functions Refer to section 4.1.11, page 4-24.	Auxiliary Engine Coolant Level Switch	4127
	Parking Brake Interlock	4101
	RPM Freeze	4107
	Two-Speed Axle Switch	4139

Table 4-2 Inputs Listed by Feature (2 of 2)

4.1.1 AIR COMPRESSOR CONTROL

Two inputs are required for Air Compressor Control operation. Refer to section 5.1, "Air Compressor Control," for additional information. The Air Compressor Control inputs are described in the following sections.

Air Compressor Load Switch

The Air Compressor Load Switch input is used to activate the air compressor control in the ECU. This input controls when the ECU will control the engine speed based on air compressor pressure. Refer to section 5.1, "Air Compressor Control," for additional information.

Air Compressor Pressure Sensor

Air Compressor Pressure Sensor (ACP Sensor) monitors the air outlet pressure. The ECU uses this information to vary the engine speed and control the compressor inlet or outlet valve to maintain the set pump pressure.

Increase

Momentarily toggling and releasing the Increase Switch increases the set point pressure by 4% of the pressure range. Holding the switch in the increase position (switching the input to sensor return) will increase the set point pressure at a rate of two increments per second. Releasing the switch sets the compressor controls to the higher setting.

Decrease

Momentarily toggling and releasing the Decrease Switch decreases the set point pressure by a configured air compressor pressure increment (4% default) of the pressure range. Holding the switch in the decrease position (switching the input to sensor return) will decrease the set point pressure at a rate of two increments per second. Releasing the switch sets the compressor controls to the lower setting.

Programming Requirements and Flexibility

The inputs listed in Table 4-3 can be configured at the time of engine order, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Description	Config ID
Air Compressor Load Switch	4131
Air Compressor Pressure Sensor	40
Resume/Accel (Increase)	4118
Set/Coast (Decrease)	4116

Table 4-3 Air Compressor Inputs

The Air Compressor Pressure Sensor must be programmed on an input with a 51 k Ω pull-down resistor (V-22 or V-29). The digital inputs listed in Table 4-3 must be programmed on inputs that have a 1.5 k Ω pull-up resistor. Refer to section 3.4.1, "VIH Connector" on page 3-15, for a pinout.

4.1.2 CRUISE CONTROL

Up to five inputs are required (four for automatic transmission) for Cruise Control operation. Refer to section 5.3, "Cruise Control," for additional information.

Cruise Control Enable

Cruise Control is enabled, but not active when the Cruise Control Enable input is switched to sensor return.

Set / Coast On

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

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

Resume / Accel On

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

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

Clutch Released (Manual Transmissions)

This input indicates that the clutch is released and is used for suspending Cruise Control and Auto Resume. When the clutch is released, the input is at sensor return.

Cruise Control is suspended if the clutch is pressed once. If the clutch is pressed twice within three seconds, Cruise Control is automatically resumed.

NOTE:

When engine brake is configured and auto resume is enabled, the first time the clutch is depressed to suspend cruise control, engine brake activation will be delayed for three seconds.

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

NOTE:

This input should not be configured when an automatic transmission is installed.

Service Brake Released (Automatic and Manual Transmissions)

This input indicates that the brake is released when switched to sensor return. If the brake is activated, then the input is not grounded and Cruise Control is suspended. Cruise Control is resumed by using the Resume/Accel Switch.

The input logic for the Brake Switch disables Cruise Control in the unlikely event of a broken brake switch wire.

Programming Requirements and Flexibility

The inputs listed in Table 4-4 can be configured at the time of engine order, configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS). Auto resume (Clutch Released) can be disabled/enabled with DDDL or VEPS.

Description	Config ID
Cruise Enable	4119
Service Brake Released	4113
Clutch Released	4114
Set/Coast On	4116
Resume/Accel On	4118

Table 4-4 Cruise Control Inputs

The digital input functions listed in Table 4-4 can be programmed on inputs that have a 1.5 k Ω pull-up resistor. Refer to section 3.4.1, "VIH Connector," for a pinout.

Interaction with Other Features

Cruise Control cannot be used with the Pressure Sensor Governor or Air Compressor Controls.

4.1.3 ENGINE BRAKE

The inputs associated with the engine brake option are described in the following sections. Refer to section 5.7, "Engine Brake Controls" for additional information.

Engine Brake Disable

Engine Brake Disable is an optional input which is switched to sensor return whenever a vehicle system such as a traction control device does not want engine braking to occur.

The ECU, which controls the engine brake directly, will not allow engine braking when the input is switched to sensor return. For example, Allison transmissions require that this input be used in all applications using engine brakes. This is to prevent engine brake operation when the transmission is in converter mode.

Engine Brake Low

The Engine Brake Low input selects Low Engine Brake when the input is switched to sensor return.

The No Engine Brake option occurs when the Engine Brake Low and Engine Brake Medium inputs are not switched to sensor return. This can be overridden by SAE J1939 Data Link communications, even if both switches are off.

To select High Engine Brake both the Engine Brake Low and the Engine Brake Medium inputs are switched to sensor return.

Engine Brake Medium

The Engine Brake Medium input selects Medium Engine Brake for Series 60 engines.

The No Engine Brake option occurs when the Engine Brake Low and Engine Brake Medium inputs are not switched to sensor return. This can be overridden by SAE J1939 Data Link communications, even if both switches are off.

To select High Engine Brake both the Engine Brake Low and the Engine Brake Medium inputs are switched to sensor return.

Programming Requirements and Flexibility

These inputs may be ordered at the time of engine order, configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS). The inputs associated with Engine Brake and their function numbers are listed in Table 4-5.

Description	Config ID
Engine Brake Disable	4122
Engine Brake Low	4097
Engine Brake Medium	4098

Table 4-5 Engine Brake Inputs

The digital input functions listed in Table 4-5 can be programmed on inputs that have a 1.5 k Ω pull-up resistor. Refer to section 3.4.1, "VIH Connector" on page 3-15, for a pinout.

4.1.4 ENGINE PROTECTION

The inputs related to engine protection are described in the following sections.

Auxiliary Shutdown #1 and #2

The auxiliary shutdown inputs (auxiliary shutdown #1 and #2) are used by other vehicle systems when it is desirable to use the ECU's engine protection function. For example, the engine protection function may be used to protect a transmission or pump against failure. When a vehicle system needs the engine to shutdown, an input port configured as auxiliary shutdown is switched to sensor return.

The ECU can take three types of actions when an auxiliary shutdown input port is switched to sensor return: warning, rampdown or shutdown. Refer to section 5.8, "Engine Protection," for more information on engine protection.

Diagnostic Request Switch

The Diagnostic Request Switch is used to activate the AWL and RSL to flash codes. The RSL will flash the active codes and the AWL will flash the inactive codes. The inactive codes are flashed in numerical order and the active codes are flashed in the order they occur, most recent to least recent. The Diagnostic Request Switch can also be used as the Stop Engine Override (SEO) Switch.

The Diagnostic Request Switch is used to flash codes in the following circumstances:

- ☐ The engine is not running and ignition is ON
- ☐ The engine is idling

In both circumstances pressing and holding the Diagnostic Request Switch will flash out the engine codes.

Diagnostic Request Switch/Stop Engine Override Switch

A single input can be used as a Diagnostic Request Switch and an SEO Switch. The Diagnostic Request Switch is used to activate the AWL and RSL to flash codes. The RSL will flash the active codes and the AWL will flash the inactive codes. The inactive codes are flashed in the order they occur and the active codes are flashed in numerical order. The Diagnostic Request Switch is also used as the SEO Switch.

The Diagnostic Request Switch is used to flash codes in the following circumstances:

- ☐ The engine is not running and ignition is ON
- ☐ The engine is idling and not in an "engine protection" condition

In both circumstances activating and releasing the Diagnostic Request Switch will flash out the engine codes; activating the Diagnostic Request Switch a second time will stop the ECU from flashing the engine codes. Otherwise, the switch will act as a SEO Switch. The SEO Switch overrides an engine protection shutdown sequence. Refer to section 5.8, "Engine Protection," for more information on the SEO Switch.

Programming Requirements and Flexibility

The type of engine protection, warning, rampdown or shutdown can be selected at engine order entry, with DDDL, the Vehicle Electronic Programming System (VEPS), or the DDEC Reprogramming System (DRS). The inputs listed in Table 4-6 can be configured at the time of engine order, by VEPS or DRS.

Description	Config ID
Diagnostic Request Switch	4111
Stop Engine Override/Diagnostic Request Switch	4121
Auxiliary Shutdown #1	4099
Auxiliary Shutdown #2	4100

Table 4-6 Engine Protection Inputs

The digital input functions listed in Table 4-6 can be programmed on inputs that have a 1.5 k Ω pull-up resistor. Refer to section 3.4.1, "VIH Connector," for a pinout.

Diagnostics

When either Auxiliary Shutdown #1 or #2 is activated, the codes listed in Table 4-7 will be logged.

Fault	SID	FMI	Flash Code
Auxiliary Shutdown #1	25	11	26
Auxiliary Shutdown #2	61 (Software Rel 1.0) 315 (Software Rel 2.0 or later)	11	26

Table 4-7 External Protection Codes

4.1.5 ENGINE RATINGS

The inputs related to engine ratings are described in the following sections. Refer to section 5.9, "Engine Ratings," for additional information.

Limiting Torque Curve

An input activates the limiting torque curve. The limiting torque curve limits the torque with respect to speed whenever this input is switched to sensor return. This torque curve is part of the engine rating.

Rating Switch #1 and #2

Engine rating switch(es) are inputs used to switch between multiple engine ratings stored in the ECU. The first rating is the default rating and does not need to be selected with the input switches. Rating Switch #1 selects the second engine rating when the input is switched to sensor return. Rating Switch #2 selects the third engine rating when the input is switched to sensor return. The inputs and their function number are listed in Table 4-8.

Description	Config ID
Rating Switch #1	4108
Rating Switch #2	4109
Limiting Torque Curve	4110

Table 4-8 Rating Switches

To select fourth engine rating, typically the cruise-power rating, both Rating Switch #1 and Rating Switch #2 inputs are switched to sensor return. The higher rating will activate only if Cruise Control is enabled.

Refer to section 5.9, "Engine Ratings," for more information.

Programming Requirements and Flexibility

Limiting torque curve tables are generated by Application Engineering and can either be selected at the time of engine order entry or selected by DDC Technical Service.

The rating switches function must be enabled with DDDL, the DDEC Reprogramming System (DRS) or the Vehicle Electronic Programming System (VEPS). The ECU can hold up to four different engine ratings that can be selected with the use of inputs, depending upon application. Engine ratings are determined at the time of engine order.

The inputs Rating Switch #1, #2, and Limiting Torque Curve may be configured at the time of engine order, VEPS, or DRS.

The digital inputs listed in Table 4-8 can be programmed on an input with a 1.5 k Ω pull-up resistor. Refer to section 3.4.1, "VIH Connector" on page 3-15, for a pinout.

4.1.6 FAN CONTROL

The inputs related to fan control are described in the following sections. Refer to section 5.11 for further information on fan control.

Air Conditioner Status

This input indicates that the air conditioner is inactive. When an input is configured for air conditioner status and the input is open then the fan is turned ON (A/C switch is open). If A/C input is configured and not used that input must remain grounded to sensor return for proper fan operation. The input logic enables the fan in the event of a broken A/C status wire. The default minimum on-time for the fan is 180 seconds. Vehicle speed over 20 MPH disables air conditioner control of the fan.

Fan Control Override

This input is used to activate the fan when the input is switched to sensor return.

Transmission Retarder Status

This input indicates that the transmission retarder is active. When the input is switched to sensor return, the fan is turned off. When the input is open, the fan will be turned on. The fan will be ON for a minimum of 30 seconds. Refer to the transmission manufacturers documentation to determine where to connect the input.

Programming Requirements and Flexibility

The inputs listed in Table 4-9 can be configured at the time of engine order, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Description	Config ID
Air Conditioner Status	4125
Fan Control Override	4128
Transmission Retarder Status	4123

Table 4-9 Fan Control Inputs

The digital input functions listed in Table 4-9 can be programmed on inputs that have a 1.5 k Ω pull-up resistor. Refer to section 3.4.1, "VIH Connector" on page 3-15, for a pinout.

The fan on-time can be set with VEPS or DRS as listed in Table 4-10.

Parameter	Description	Choice
AC Fan Timer	The minimum duration of time the fan will remain ON after the AC status input has indicated that the A/C unit has turned OFF. The timer starts when the input is grounded after being open.	0-255 seconds

Table 4-10 Fan On-time Parameter

4.1.7 MAINTENANCE ALERT SYSTEM

The following inputs are optional for the Maintenance Alert System (MAS). Refer to section 5.17, "Maintenance Alert System" for additional information.

Air Filter Restriction Sensor

This input is used to monitor the status of the Air Filter. It is an optional sensor for the Maintenance Alert System that is OEM installed on the Vehicle Interface Harness (VIH).

Add Engine Coolant Level Sensor

The AECL Sensor is used to warn the driver that the coolant level is below the recommended add level. It is an optional sensor for the Maintenance Alert System that is OEM installed on the VIH.

Programming Requirements and Flexibility

The inputs listed in Table 4-11 can be configured at the time of engine order, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Description	Config ID
Air Filter Restriction Sensor	16
Add Engine Coolant Level Sensor	1040

Table 4-11 MAS Inputs Configured at Engine Order, by VEPS or DRS

The Air Filter Restriction Sensor can be programmed on an input with a 51 k Ω pull-down resistor (V-22 or V-29). The Add Engine Coolant Level Sensor must be programmed on pin V-37.

Diagnostics

The Diagnostic Trouble Codes logged for the Maintenance Alert System sensor failures are listed in Table 4-12.

Flash Code	PID	FMI	Description
65	107	3	Air Filter Restriction Sensor Input Voltage High
65	107	4	Air Filter Restriction Sensor Input Voltage Low
16	111	5	Add Engine Coolant Level Sensor Input Voltage High
13	111	6	Add Engine Coolant Level Sensor Input Voltage Low
81	98	3	Engine Oil Level Sensor Input Voltage High
82	98	4	Engine Oil Level Sensor Input Voltage Low
37	95	3	Engine Fuel Restriction Sensor Input Voltage High
38	95	4	Engine Fuel Restriction Sensor Input Voltage Low

Table 4-12 MAS Diagnostic Trouble Codes

4.1.8 OPTIMIZED IDLE

Three inputs are required for Optimized Idle operation. An additional input "Optimized Idle Thermostat" is optional. The Optimized Idle inputs are described in the following sections. For more information about Optimized Idle, refer to section 5.19, "Optimized Idle," or the manual, *Optimized Idle - DDEC V Installation and Troubleshooting*.

Cruise Enable/Optimized Idle Enable

When this input is switched to sensor return and the appropriate safety switches are enabled, the Optimized Idle function is enabled. This is the same input as described in "Cruise Control," refer to section 4.1.2.

Parking Brake Interlock

When this input is switched to sensor return, the ECU can determine that the vehicle is stopped and allow the Optimized Idle function to be engaged if requested by the driver. This is the same function as described in "Additional Functions," refer to section 4.1.11.

Optimized Idle Thermostat

The optional Optimized Idle thermostat input, when grounded will signal DDEC to start the engine in Optimized Idle mode.

Programming Requirements and Flexibility

The inputs listed in Table 4-13 can be configured at the time of engine order, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Description	Config ID
Cruise Enable	4119
Parking Brake Interlock	4101
Optimized Idle Thermostat	1037

Table 4-13 Optimized Idle Inputs

The input functions listed in Table 4-13 can be programmed on inputs that have a 1.5 k Ω pull-up resistor. Refer to section 3.4.1, "VIH Connector" on page refer to section 3-15, for a pinout.

4.1.9 PRESSURE SENSOR GOVERNOR

The inputs related to PSG are described in the following sections. Refer to section 5.22, "Pressure Sensor Governor," for additional information.

Pressure Sensor Governor Enable

The PSG Enable Switch is an input switch used to enable the PSG when the input is switched to sensor return. If the PSG Enable Switch is moved to the OFF position (not at sensor return), PSG operation will be interrupted.

Pressure/RPM Mode

This input switch is used in the PSG to switch between RPM and Pressure Mode. When the input is switched to sensor return, Pressure Mode is selected.

Set/Coast (Decrease)

The pressure or engine speed is set by momentarily contacting the switch to the decrease position (switching the input to sensor return). The pressure/RPM setting will decrease by 4 psi (approximately 27.6 kPa) or 25 RPM increments when the decrease switch is momentarily contacted.

Holding the switch in the decrease position (switching the input to sensor return) will decrease the pressure or engine speed. The pressure or engine speed will decrease by 4 psi (approximately 27.6 kPa) or 25 RPM increments at a rate of two increments per second. Releasing the switch sets the pressure/RPM to the lower setting (programmable).

Resume/Accel (Increase)

Momentarily contacting the Increase Switch at the initiation of PSG operation will set the pressure/RPM setting. The pressure/RPM setting will increase by 4 psi (approximately 27.6 kPa) or 25 RPM increments by momentarily contacting the Increase switch.

Holding the switch in the increase position (grounding the input), will increase the pressure or engine speed. The pressure or engine speed will increase by 4 psi (approximately 27.6 kPa) or 25 RPM increments at a rate of two increments per second. Releasing the switch sets the PSG to the higher setting.

Fire Truck Pump Pressure Sensor

This sensor provides a fire pump pressure signal to the ECU, which modulates engine fueling to maintain a constant fire truck pump pressure.

Programming Requirements and Flexibility

The inputs listed in Table 4-14 can be configured at the time of engine order, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Description	Config ID
Pressure Sensor Governor Enable	4120
Pressure/RPM Mode Switch	4104
Set/Coast (Decrease)	4116
Resume/Accel (Increase)	4118
Fire Pump Pressure Sensor	15

Table 4-14 Pressure Sensor Governor Inputs

The digital input functions listed in Table 4-14 can be programmed on inputs that have a 1.5 k Ω pull-up resistor. The Fire Pump Pressure Sensor can be programmed on an input with a 51 k Ω pull-down resistor (pin V-22). Refer to section 3.4.1, "VIH Connector" on page 3-15, for a pinout.

Interaction with Other Features

Cruise Control cannot be used with the Pressure Sensor Governor.

4.1.10 THROTTLE CONTROL

This section discusses throttle control inputs. Refer to section 5.25, "Throttle Control/Governors" for more information.

Alternate Minimum VSG Speed/Fast Idle

The Alternate Minimum VSG option (ALT MIN VSG) allows a customer-selected high idle speed to be used instead of the hot idle engine speed. The higher idle speed is called the alternate minimum VSG speed. A higher idle speed is useful in applications such as air compressors and generators.

The Alternate Minimum VSG speed is active when an input is switched to sensor return. The fast idle input is used instead of resistors on the VSG input to obtain a fast idle engine speed. When the input is switched to sensor return and the engine is running on the idle governor, the engine speed will be changed to the calibrated fast idle speed.

Dual Throttle (ALSG)

Some applications require Automotive Limiting Speed Governor (ALSG) controls at two stations. This special configuration is implemented with two Accelerator Pedals (AP) and input. The input is switched to either sensor return or system voltage to indicate which AP is active. This configuration allows an AP to be at two locations with only one AP active at any one time. Refer to section 5.25, "Throttle Controls," for more information and a schematic.

External Engine Synchronization/Frequency Input Active

External Engine Synchronization provides a method of synchronizing the engine RPM of two or more engines using a frequency signal generated by an external vehicle controller or the tach drive output of another engine. This input is one of the required conditions. Refer to section 5.25.2, "Variable Speed Governor - Nonroad."

Idle Validation

An Idle Validation Switch (IV Switch) (ALSG only) provides redundancy to assure that the engine will be at idle in the event of an in-range throttle malfunction. The Idle Validation Switch is connected to an input on the ECU. When the Idle Validation Switch on the AP is switched to sensor return, the engine speed will be at idle. There are fault detection diagnostics with the Idle Validation Switch and its wiring when compared to the Accelerator Pedal Sensor (AP Sensor) input.

NOTE:

This input is required.

Throttle Inhibit

This option disables the ALSG whenever the throttle inhibit input is switched to sensor return. The operator can depress the throttle pedal, but the engine speed will remain unchanged as long as the input is switched to sensor return. Throttle inhibit is usually offered as a standard in coach calibrations to inhibit throttle input when the rear door is open, a wheelchair lift is operated, etc.

VSG Station Change and VSG Station Change Complement

The dual throttle Variable Speed Governor (VSG) feature provides the capability of having VSG throttles at two locations, with only one throttle active at any time. The dual throttle feature requires two inputs, VSG Station Change, and VSG Station Change Complement.

DDEC monitors the switch inputs and maintains the current engine RPM when a station switch occurs until the newly selected station is qualified. The newly selected station is qualified by reducing the station position to idle and then increasing it to the current engine speed position. After qualification, the engine speed is controlled by the new station. If qualification does not occur within 30 seconds, the engine speed will be ramped down from its current value to VSG minimum speed. If the new station becomes qualified, the rampdown process will be stopped and the new station will have control. Refer to section 5.25, "Throttle Control/Governors."

VSG Inhibit

This option disables the analog VSG and Alt Min VSG whenever the VSG inhibit input is switched to sensor return. Switching the VSG input to sensor return will reduce engine speed to idle. The engine speed will remain unchanged as long as the input is switched to sensor return regardless of VSG request. When the input is switch back from sensor return, the throttle must be reset to zero before engine speed can be increased from idle. Frequency input and J1939 commands are not affected.

Programming Requirements and Flexibility

The inputs listed in Table 4-15 can be configured at the time of engine order, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

The digital input functions listed in Table 4-15 can be programmed on inputs that have a 1.5 k Ω pull-up resistor. Refer to section 3.4.1, "VIH Connector" on page 3-15, for a pinout.

Description	Config ID
Alternate Minimum VSG/Fast Idle	4112
Dual Throttle (ALSG) (AP)	4124
Idle Validation Switch	4102
Throttle Inhibit	4105
VSG Station Change	4129
VSG Station Change Complement	4130
VSG Inhibit	4138

Table 4-15 Throttle Control Inputs Programmed by VEPS and DRS

The inputs listed in Table 4-16 are programmed at engine order entry or by DRS.

Description	Config ID
External Engine Synchronization/Frequency Input Active	4106
RPM Freeze	4107
Throttle Kickdown	4103

Table 4-16 Throttle Control Inputs Programmed by DRS

4.1.11 ADDITIONAL FUNCTIONS

The following inputs are used for special applications.

Auxiliary Engine Coolant Level Switch

A digital Engine Coolant Level Switch can be connected to the ECU through an input. The digital switch is placed in the coolant tank (see Figure 4-2) to indicate low coolant and is located above the analog coolant level sensor. This is not the same as the Add Engine Coolant Level Sensor used with the Maintenance Alert System.

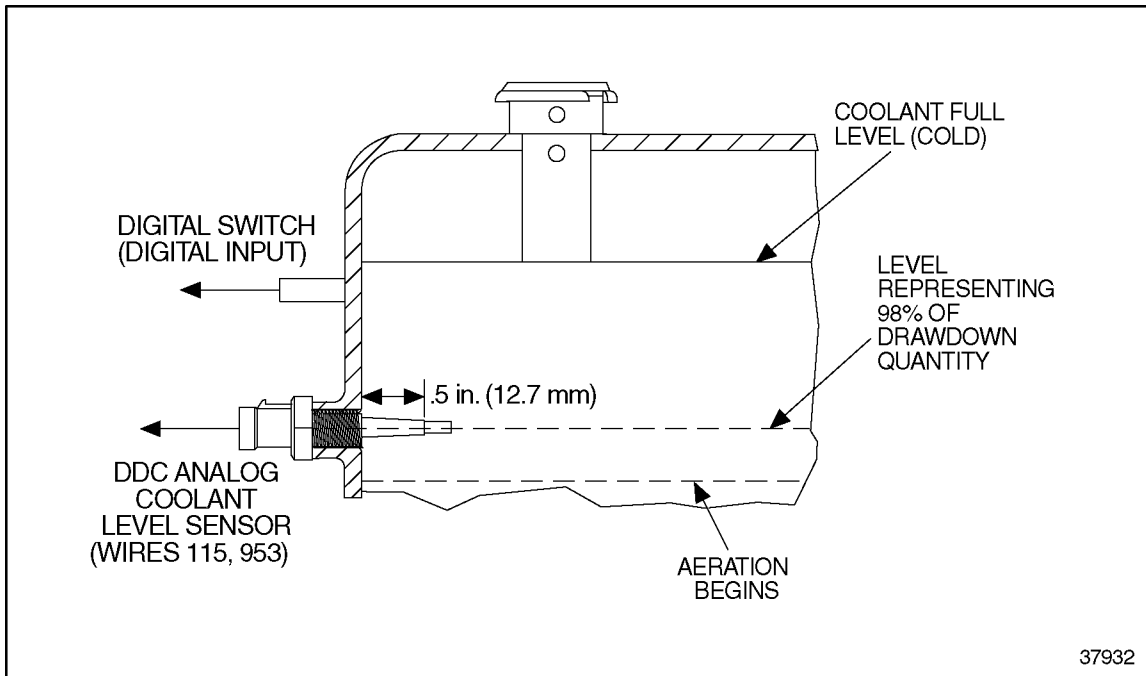


Figure 4-2 Engine Coolant Level Switch Location

When the digital switch is in coolant, the input to DDEC is switched to sensor return. When the coolant level is below the digital switch (input open) for a period of time (to ignore the effects of slosh) a digital output is switched to sensor return.

The digital output can be used to drive an Engine Coolant Level Low Lamp to avoid a Red Stop Lamp event. A warning that the coolant is getting low occurs before the coolant level falls below the analog Engine Coolant Level Sensor. If the coolant is below the analog sensor, the engine may be programmed for the Amber Warning Lamp to come on. This will not activate the Maintenance Alert System AECL Sensor and will not log a code. Refer to section 4.2, "Digital Outputs," for more information. DDC recommends that the auxiliary Engine Coolant Level Module be used to drive a dash lamp directly. Refer to section 3.11.20, "Engine Coolant Level Sensor," for additional information.

Park Brake Interlock

Several DDEC functions need an indication that the vehicle is stopped before the function can be engaged. By using the park brake to switch an input to sensor return when in use, the ECU can determine that the vehicle is stopped and engage the function. The functions include: Half Engine Idle, Idle Shutdown Timer, Optimized Idle and Cruise Switch VSG.

RPM Freeze

The RPM Freeze feature allows the operator to request that the VSG governor maintain the current engine RPM. Locking onto a fixed engine RPM is desirable in applications where the input is subjected to electrical noise which in turn causes the engine RPM to fluctuate.

The operator can request that the VSG maintain the current engine speed by switching this input to sensor return.

Two-Speed Axle Ratio Switch

The Two-Speed Axle Ratio switch feature allows a second axle ratio to be used to calculate vehicle speed when the switch is grounded. The vehicle must be stopped (0 mph) before the second axle ratio will be used.

Programming Requirements and Flexibility of Additional Functions

The inputs listed in Table 4-17 can be configured at the time of engine order, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Description	Config ID
Auxiliary Engine Coolant Level Sensor	4127
Park Brake Interlock	4101
RPM Freeze	4107
Two-Speed Axle	4139

Table 4-17 Additional Functions Inputs

The digital input functions listed in Table 4-17 can be programmed on inputs that have a 1.5 k Ω pull-up resistor. Refer to section 3.4.1, "VIH Connector" on page 3-15, for a pinout.

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4.2 DIGITAL OUTPUTS

DDEC V has eight available low-side digital output ports located on the Vehicle Interface Harness as listed in Table 4-18. The Application Code System (ACS) sets the default function number for each of the eight available ports. Pin V-54 is dedicated to the Optimized Idle starter and cannot be used for any other function.

The digital outputs can be configured for various functions. These functions can be configured at the time of engine order, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Pin No.	Output Type
V-4	Digital Output - Low Side
V-5	Digital Output - Low Side
V-6	Digital Output - Low Side
V-7	Digital Output - Low Side
V-40	Digital Output - Low Side
V-53	Digital Output - Low Side
V-54	Digital Output - Low Side
V-55	Digital Output - Low Side

Table 4-18 Low-side Digital Outputs

A low-side digital output function is activated by the ECU when the digital output wire is switched to sensor return, except fan controls #1 and #2. See Figure 4-3.

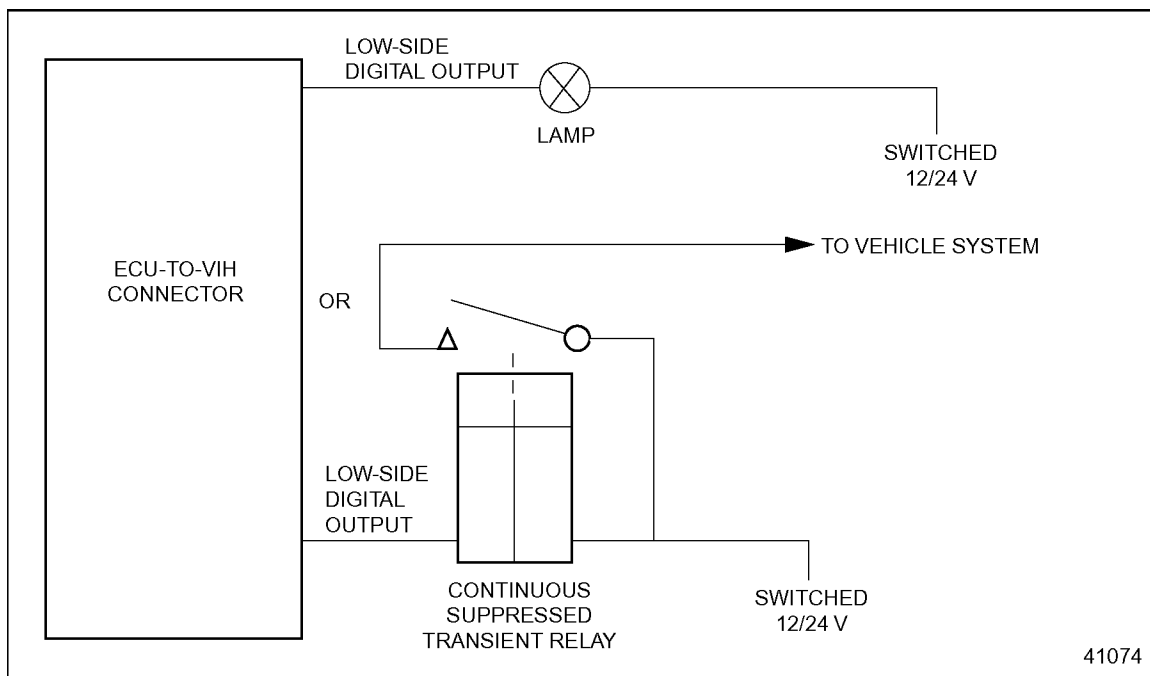


Figure 4-3 Two Methods to Use a Low-side Digital Output

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

The digital output functions are listed in Table 4-19.

Digital Output Function	Function Number	Section
Air Compressor Load Solenoid	21	Refer to section 4.2.1, page 4-29
Cruise Control Active Lamp (PSG Active Lamp)	11	Refer to section 4.2.2, page 4-29
Deceleration Lamp	15	Refer to section 4.2.3, page 4-30
Engine Brake Active	16	Refer to section 4.2.4, page 4-30
Engine Coolant Level Low Lamp	10	Refer to section 4.2.5, page 4-31
Engine Overspeed	39	Refer to section 4.2.6, page 4-32
Ether Start	24	Refer to section 4.2.7, page 4-33
External Engine Brake Enable	8	Refer to section 4.2.8, page 4-33
External Engine Synchronization/Frequency Input Active*	4	Refer to section 4.2.9, page 4-33
Fan Control #1 & Fan Control #2	13 & 14	Refer to section 4.2.10 page 4-35
High Coolant Temperature Lamp	20	Refer to section 4.2.11, page 4-36
High Oil Temperature Lamp	19	Refer to section 4.2.12, page 4-37
Low DDEC Voltage Warning Lamp	3	Refer to section 4.2.13, page 4-38
Low Oil Pressure Lamp	18	Refer to section 4.2.14, page 4-39
Optimized Idle Active Lamp	26	Refer to section 4.2.15, page 4-40
Optimized Idle Alarm	43	Refer to section 4.2.16, page 4-41
Optimized Idle Starter Relay	42	Refer to section 4.2.17, page 4-42
Pressure Sensor Governor Pressure Mode Lamp	5	Refer to section 4.2.18, page 4-43
Starter Lockout	7	Refer to section 4.2.19, page 4-44
Top2 Shift Solenoid	30	Refer to section 4.2.20, page 4-44
Top2 Lockout Solenoid	31	Refer to section 4.2.21, page 4-45
Transmission Retarder	9	Refer to section 4.2.22, page 4-45
Vehicle Power Shutdown	6	Refer to section 4.2.23, page 4-45
VSG Active Indication	17	Refer to section 4.2.24, page 4-47

Table 4-19 Digital Outputs

4.2.1 AIR COMPRESSOR LOAD SOLENOID

The air compressor load solenoid digital output is switched to sensor return to open the air compressor outlet valve to begin loading the air compressor. The output is used to regulate the system pressure. When the output is open, the valve must be off. Refer to section 5.1, "Air Compressor Control," for additional information.

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 21) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

4.2.2 CRUISE CONTROL ACTIVE LAMP (PRESSURE SENSOR GOVERNOR ACTIVE LAMP)

When Cruise Control, Cruise-switch VSG or the Pressure Sensor Governor is active this digital output is switched to sensor return. This digital output can be used to drive a lamp indicating the active state of Cruise Control, Cruise-switch VSG or the Pressure Sensor Governor.

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 11) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Interaction with other Features

For VSG operation, use the VSG Active indicator instead of the Cruise Control Active Lamp.

4.2.3 DECELERATION LAMP

The Deceleration Lamp option is a lamp in the back of a vehicle to warn that the vehicle is slowing down. This digital output could be used to drive a Deceleration lamp or, more typically, a relay which drives the deceleration lamps. This digital output is switched to sensor return whenever the percent throttle is zero and Cruise Control is inactive.

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 15) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

4.2.4 ENGINE BRAKE ACTIVE

This digital output is switched to sensor return whenever the engine brake is active. This digital output could be used to drive an engine brake active lamp or give an engine brake active indication to another vehicle system.

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 16) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

4.2.5 ENGINE COOLANT LEVEL LOW LAMP

The Engine Coolant Level Low Lamp digital output is switched to sensor return when the coolant falls below the Engine Coolant Level Sensor (ECL Sensor) or a digital input configured for an Auxiliary Engine Coolant Level Switch is open for 30 seconds. This output is typically used to drive a lamp to warn the operator. The AWL and RSL will illuminate with this output when the coolant level falls below the ECL Sensor.

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 10) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS). Polarity can be set by order entry or DDC Technical Service or DRS.

Interaction with other Features

This digital output could be used with an input configured as an Auxiliary Coolant Level Switch. Refer to section 4.1, "Digital and Analog Inputs," for additional information. The Auxiliary Coolant Level Switch acts as a digital switch. When the coolant level is below the Auxiliary Coolant Level Switch or analog ECL Sensor, the Engine Coolant Level Low Lamp will illuminate.

This digital output is part of engine protection, refer to section 5.8.

4.2.6 ENGINE OVERSPEED

The engine overspeed digital output is switched to sensor return when a calibrated engine overspeed enable speed is exceeded. The output remains closed until the engine speed reaches or drops below another calibrated engine overspeed disable speed.

An option is available to log a fault code when the engine speed meets or exceeds the minimum of the overspeed enable speed and rpm overspeed calibrations. The fault that will be logged is PID 190 FMI 14, Flash Code 85 – Engine Overspeed Signal.

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements & Flexibility

ACS Sets the default function number and polarity for each of the eight available ports. This digital output (function number 39) may be ordered at the time of engine order or configured by DRS.

The enable and disable overspeed values can be set at the time of engine order or by the Application Code System (ACS).

The fault code option can be turned on at the time of engine order, ACS or DRS.

4.2.7 ETHER START

This digital output is switched to sensor return when ether should be injected into the engine for cold start purposes.

Installation

The digital output must be wired to the Ether Start Relay Module. Refer to section 5.10, "Ether Start," for additional information.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 24) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Diagnostics

If the Ether Start digital output remains activated for longer than a factory set time, the relay module will cause the inline fuse to blow. This prevents excess ether from being injected into the cylinders. If the output is shorted to battery (+), a code will be logged and the AWL will be illuminated.

4.2.8 EXTERNAL ENGINE BRAKE ENABLE

This digital output is switched to sensor return to allow an external device to be enabled when Cruise Control is inactive, and the engine retarder level is not 0.

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 8) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

4.2.9 EXTERNAL ENGINE SYNCHRONIZATION/FREQUENCY INPUT ACTIVE

When the engine is in external engine synchronization mode, this digital output is switched to sensor return. The output is cycled on and off at 2 Hz if all conditions for external engine synchronization are satisfied except the Sync RPM is less than the minimum Sync RPM.

refer to section 5.25.2, "Variable Speed Governor - Nonroad."

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 4) may be ordered at the time of engine order or configured by the DDEC Reprogramming System (DRS).

4.2.10 FAN CONTROL #1 & #2

Two digital outputs provide fan control for three different fan configurations: one single-speed fan, two separate single-speed fans, or one two-speed fan. Fan Control functions are activated by an open circuit. For additional information, refer to section 5.11, "Fan Control."

The first configuration, one single-speed fan, uses Fan Control #1 output to turn a single fan on/off. Fan Control #1 is opened to activate the fan and the digital output is switched to sensor return to turn the fan off.

The second configuration, two separate single-speed fans, uses Fan Control #1 and Fan Control #2 to operate two separate fans independently. The fans are activated by opening Fan Control #1 or #2. The fans are turned off by switching the digital output to sensor return. Fan Control #1 is typically activated by high coolant or oil temperature. Fan Control #2 is typically activated by high intake air temperature.

The third configuration, one two-speed fan, uses both fan outputs to drive a two-speed fan. When Fan Control #1 output is opened, the low speed mode is activated. The fan operates in the high speed mode if Fan Control #2 is opened. Both fan outputs must be opened for the fan to operate in high speed mode.

NOTE:

Fan Control outputs will remain enabled when the ignition is turned off until the engine speed is zero.

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function numbers 13 and 14) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

4.2.11 HIGH ENGINE COOLANT TEMPERATURE LAMP

This digital output is switched to sensor return with the AWL if Engine Overtemperature Protection (EOP) is enabled or with the AWL and the RSL when the engine coolant temperature is above the stop engine code value and EOP is not enabled. This output will be activated along with the AWL and the RSL when the ignition is cycled ON for the bulb check.

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 20) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS). This digital output is part of engine protection, refer to section 5.8.

Diagnostics

A High Engine Coolant Temperature Diagnostic Trouble Code (DTC) will be logged.

4.2.12 HIGH ENGINE OIL TEMPERATURE LAMP

This digital output is switched to sensor return to turn on the AWL if Engine Overtemperature Protection (EOP) is enabled when the oil temperature is above the check engine code value or with the AWL and the RSL when the engine oil temperature is above the stop engine code value and EOP is not enabled. This output will be activated along with the AWL and the RSL when the ignition is cycled ON for the bulb check.

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 19) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS). This digital output is part of engine protection, refer to section 5.8.

Diagnostics

A High Engine Oil Temperature Diagnostic Trouble Code (DTC) will be logged.

4.2.13 LOW DDEC VOLTAGE WARNING LAMP

This digital output is switched to sensor return when the ECU battery voltage is below a factory set value. This digital output can be used to drive a low DDEC voltage lamp.

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 3) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Diagnostics

A Diagnostic Trouble Code (DTC) is generated when the ECU battery voltage falls below a factory set value.

4.2.14 LOW ENGINE OIL PRESSURE LAMP

This digital output is switched to sensor return with the AWL and RSL when the oil pressure is below the stop engine code value. The output will be activated along with the AWL and RSL when the ignition is cycled ON for the bulb check.

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 18) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS). This digital output is part of engine protection, refer to section 5.8.

Diagnostics

A Low Engine Oil Pressure Diagnostic Trouble Code (DTC) will be logged.

4.2.15 OPTIMIZED IDLE ACTIVE LAMP

The Optimized Idle Active lamp digital output will flash at a rate of once every half second while the idle timer is counting down, after the system has initialized. The digital output is switched to sensor return after the idle timer has timed out and Optimized Idle has become active. The output will be activated along with the AWL and the RSL when the ignition is cycled ON for the bulb check. For more information on Optimized Idle, refer to section 5.19.

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 26) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Diagnostics

A Diagnostic Trouble Code (DTC) will be logged for an open or shorted circuit.

4.2.16 OPTIMIZED IDLE ALARM

The Optimized Idle Alarm digital output is switched to sensor return to turn on the Optimized Idle Alarm. The alarm will sound for five seconds prior to any Optimized Idle engine start. For more information on Optimized Idle, refer to section 5.19.

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

The DDC part number for the Optimized Idle Alarm is 23517899.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 43) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Diagnostics

A Diagnostic Trouble Code (DTC) will be logged for an open or shorted circuit.

4.2.17 OPTIMIZED IDLE STARTER RELAY

The Optimized Idle Starter Relay digital output is switched to sensor return to engage the starter solenoid for an Optimized Idle engine start. This is done using a relay. For more information on Optimized Idle, refer to section 5.19.

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

This function is dedicated to pin V-54 and can only be enabled on this pin. This pin is configured with the 6N5 group.

Diagnostics

A Diagnostic Trouble Code (DTC) will be logged for an open or shorted circuit.

4.2.18 PRESSURE SENSOR GOVERNOR PRESSURE MODE LAMP

This digital output is switched to sensor return when the PSG pressure mode is activated. This digital output can be used to drive the Pressure Mode Lamp. For more information, refer to section 5.22, "Pressure Sensor Governor."

Installation

If the output is to be used for a lamp, a 12 or 24 volt lamp of less than 2.0 A (DC) is needed depending on the ignition source.

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 5) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

4.2.19 STARTER LOCKOUT

This digital output is used to disable/enable the starter. This signal is used to inhibit starter reengagement while the engine is running. When the digital output is switched to sensor return the starter cannot be reengaged when the engine speed is above a programmable speed (typically 500 RPM). An open circuit means that the starter could be reengaged when the engine is below a programmable speed (typically 60 RPM). The RPM values can be set to any value.

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

ACS sets the default function number and polarity for each of the eight available ports. This digital output (function number 7) may be ordered at the time of engine order or configured by VEPS or DRS. The RPM values can be set to any value. The values can be selected at time of engine order, by ACS, or selected after engine order by DDC Technical Service.

4.2.20 TOP2 SHIFT SOLENOID

The shift solenoid is used to command an automatic shift between the top two gears in an Eaton® Top2 transmission. When the digital output is switched to sensor return, the shift solenoid commands a shift to the top gear position. When the output is not activated, the shift solenoid commands a shift to the gear one lower than the top position. The correct transmission type must be selected when this digital output is programmed. For additional information on Top2, refer to section 5.26, "Transmission Interface."

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The ACS sets the default function number and polarity for each of the eight available ports. This digital output (function number 30) may be ordered at the time of engine order or configured by VEPS or the DRS.

Diagnostics

A Diagnostic Trouble Code (DTC) will be logged for an open or shorted circuit.

4.2.21 TOP2 SHIFT LOCKOUT SOLENOID

The shift lockout solenoid is used to disable the driver splitter position switch in an Eaton Top2 transmission. When the digital output is switched to sensor return, the splitter position control is taken away from the driver and controlled by the ECU. The correct transmission type must be selected. For additional information on Top2, refer to section 5.26, "Transmission Interface."

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 31) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Diagnostics

A Diagnostic Trouble Code (DTC) will be logged for an open or shorted circuit.

4.2.22 TRANSMISSION RETARDER

This digital output is switched to sensor return whenever the throttle is at 0% position and cruise control is inactive. This signal in conjunction with a relay, may be used to control a transmission retarder. This output will also be enabled if a SAE J1939 data link message is received requesting transmission retarder.

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 9) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

4.2.23 VEHICLE POWER SHUTDOWN

This digital output actuates a relay that shuts down the rest of the electrical power to the vehicle. See Figure 4-4. This illustration provides a method to turn OFF the ignition when vehicle electrical power is shutdown. Refer to section 5.14, "Idle Timer and Vehicle Power Shutdown."

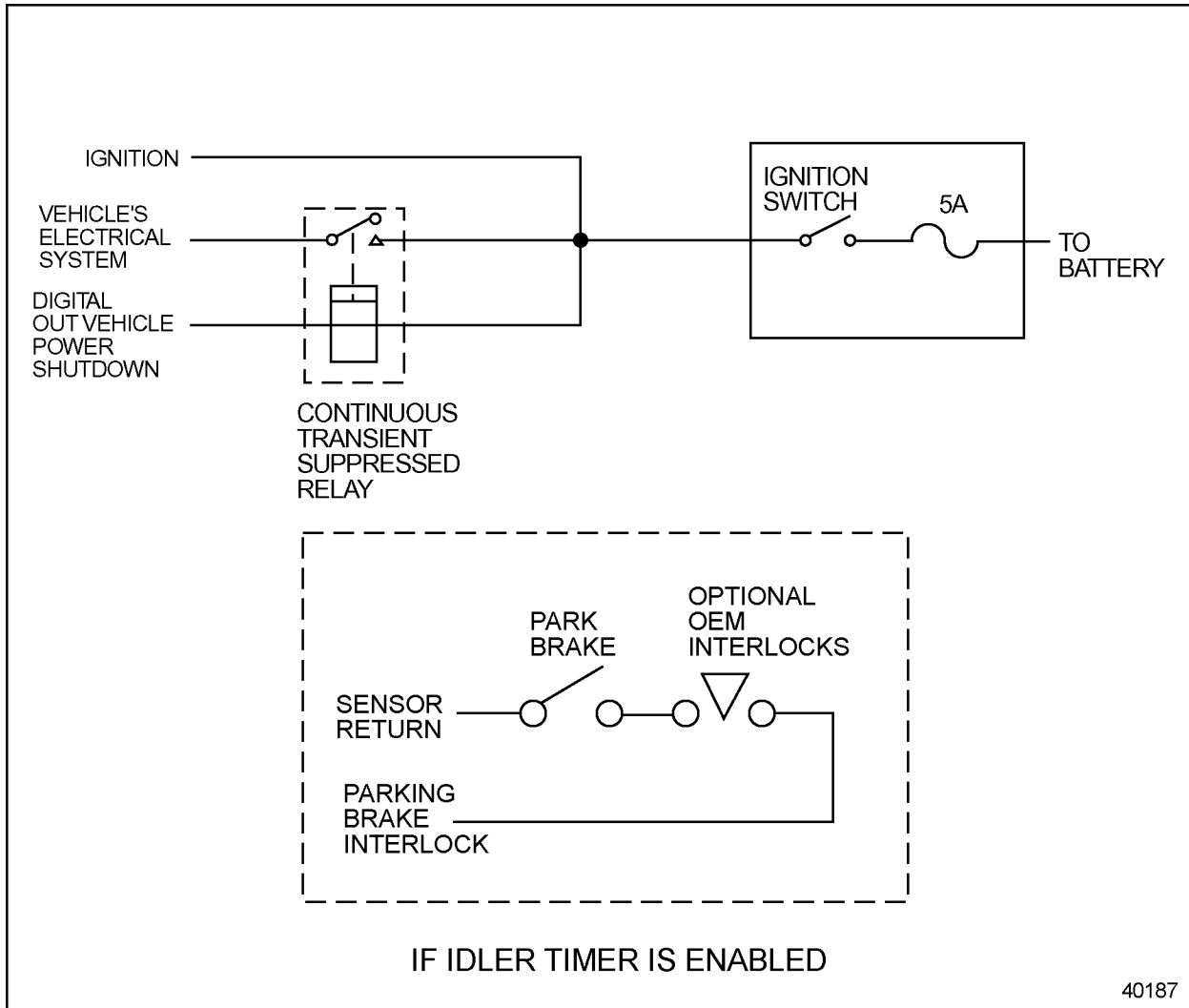


Figure 4-4 Vehicle Power Shutdown Using a Low-side Output

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 6) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Diagnostics

A Diagnostic Trouble Code (DTC) will be logged for an open or shorted circuit.

Interaction with Other Features

Vehicle Power Shutdown is used with Idle Timer Shutdown, Optimized Idle (required), or Engine Protection Shutdown.

4.2.24 VSG ACTIVE INDICATION

The VSG Active indication is used for electric drive vehicles. This digital output is used to keep the vehicle from creeping by disconnecting the wheel motor contacts while the vehicle is stopped and the engine is operating. When the ECU detects that the VSG counts are greater than 140, the digital output is switched to sensor return. If the VSG counts drop below 100, the output is opened.

Installation

A low-side digital output circuit is capable of sinking less than or equal to 2.0 A. The total current of all ten low-side digital outputs (including the RSL and the AWL) must be less than or equal to 10.0 A.

Programming Requirements and Flexibility

The Application Code System (ACS) sets the default function number and polarity for each of the eight available ports. This digital output (function number 17) may be ordered at the time of engine order or configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Interaction with Other Features

For Cruise Control state, use the Cruise Control Active Lamp instead of this output.

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4.3 PWM OUTPUTS

DDEC V has two available, low-side digital output ports on the Vehicle Interface Harness. These output channels can be configured for PWM or limited digital output functionality. The Application Code System (ACS) sets the default function for each of the available ports. These functions can be configured at the time of engine order, by VEPS or DRS. The VIH ports are listed in Table 4-20.

Pin Number	Output Type
V-46	Low Side PWM
V-52	Low Side PWM

The PWM output functions are listed in Table 4-20.

Function	Config ID	Section
PWM Transmission	Automatically Set	Refer to section 4.3.1.
PWM Fan	13	Refer to section 4.3.2.

Table 4-20 PWM Ports on the Vehicle Interface Harness

4.3.1 PWM TRANSMISSION

This function is used in combination with the transmission configuration when one of the transmissions which require a PWM signal from DDEC are configured. This function must be assigned to the PWM channel desired for the transmission interface.

4.3.2 PWM FAN

This function is used to configure a channel for a DDEC-controlled PWM cooling fan. The PWM operating parameters are controlled by DDC at the time of engine order.

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5 DDEC FEATURES

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5.1 AIR COMPRESSOR CONTROL

Air Compressor Control is an optional DDEC feature that allows DDEC to regulate engine speed and Load/Unload a valve in order to maintain a requested compressor outlet air pressure for air compressor applications.

5.1.1 OPERATION

The ECU monitors the air outlet pressure while varying the engine speed and operating a load/unload valve. The desired operating pressure may be varied by the operator, within limits preset by the OEM.

The ECU will activate the Air Compressor Governor Controls when the input "Air Compressor Load Switch" is grounded. Engine speed is governed based on the actual air compressor outlet pressure versus the desired output pressure. The Air Compressor Pressure Sensor provides a pressure signal to the ECU.

The engine response to various pressure conditions is listed in Table 5-1.

Pressure Set Point	Result
Current outlet pressure is below the pressure set point	Engine speed increases as required up to PTO maximum speed.*
Pressure in the system continues to increase and a threshold pressure is exceeded.	The air compressor solenoid digital output is enabled† (opened).
Current outlet pressure is above the pressure set point.	Engine speed decreases as required down to minimum PTO speed.

* The engine will continue to run at PTO maximum speed until the outlet pressure matches the sensor pressure.

† DDEC will open and close the loading valve as a function of pressure with hysteresis. When the pressure reaches a programmable limit above the pressure set point the DDEC digital output will be activated. This output may be used to either open an air compressor vent or close the air inlet. Once the air pressure has dropped to a lower programmable limit, the digital output will be open circuited which will either close the vent or open the air inlet

Table 5-1 Engine Operation with Air Compressor Controls

Each horsepower rating has an associated pressure range. Horsepower ratings are defined at time of order entry. The minimum and maximum pressure setting for each of the horsepower curves is set with DDDL, Vehicle Electronic Programming System (VEPS), or DRS (refer to section 5.1.3) The initial pressure set point is saved between ignition cycles.

Increase Switch (Resume/Acceleration On)

Momentarily toggling and releasing the Increase Switch (grounding the "Resume/Accel On" input) increases set point pressure by a configured air compressor increment (4% default) of the pressure range. Holding the switch in the increase position (grounding the input), will increase the set point pressure at a rate of two increments per second. Releasing the switch sets the compressor controls to the higher setting.

Decrease Switch (Set/Coast On)

Momentarily toggling and releasing the Decrease Switch decreases set point pressure by a configured air compressor pressure increment (4% default) of the pressure range. Holding the switch in the decrease position, will decrease the set point pressure at a rate of two increments per second. Releasing the switch sets the compressor controls to the lower setting.

Air Compressor Load Switch

Closing (grounding) the air compressor load switch input activates the air compressor control system. Opening the air compressor load switch input deactivates the air compressor control system.

Air Compressor Solenoid

When the pressure reaches a programmable limit above the pressure set point the DDEC digital output will be grounded. This output may be used to either open an air compressor vent or close the air inlet. Once the air pressure has dropped to a lower programmable limit, the digital output will be open circuited which will either close the vent or open the air inlet.

Air Compressor Shutdown

DDEC will respond to a proprietary immediate engine shut down message sent over the SAE J1587/J1708 Data Link by the Electronic Display Module (EDM). This feature requires both an EDM and an Auxiliary Information Module (AIM).

Multiple Pressure Ratings

The pressure ranges are linked to the engine ratings. A pressure range can be associated with each rating. The maximum number of engine ratings and pressure ranges is three. Choosing the rating, with DDDL or rating switches will automatically select the associated pressure range. The proper 6N4D group with multiple 6N4M groups must be specified. For additional information, contact your DDC Applications Engineer.

5.1.2 INSTALLATION

See Figure 5-1 for the Air Compressor Control Harness. The correct sensor return must be used based on the input pin that is selected. The inputs, sensor supply and return are listed in Table 3-20 on page 3-27.

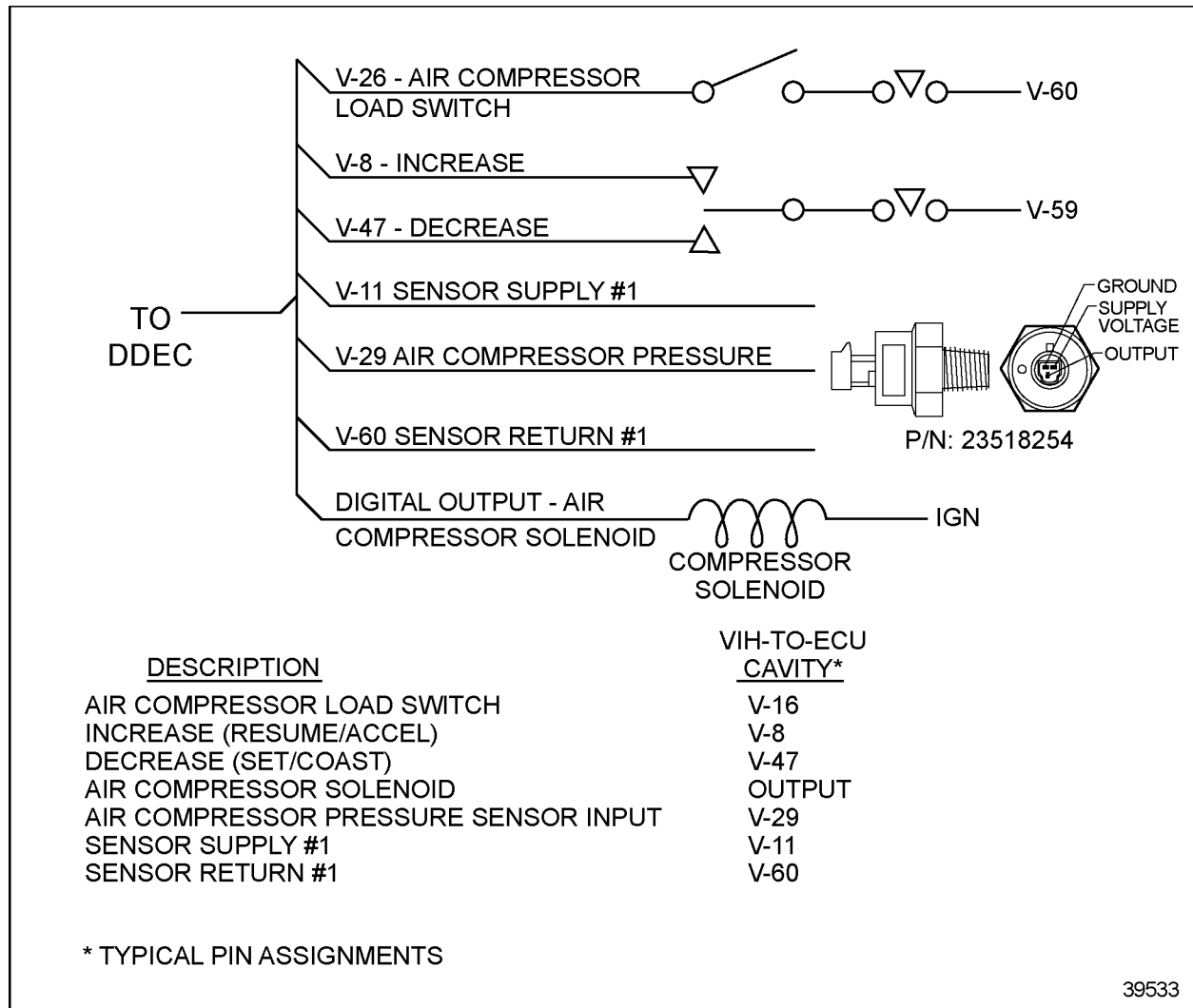


Figure 5-1 Air Compressor Control Harness

5.1.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Air Compressor Controls must be specified at the time of engine order or added to the ECU calibration by Detroit Diesel Technical Service. An Application Code (6N4C) Group must be selected that is configured for Air Compressor Control at order entry or by contacting Detroit Diesel Technical Service.

The inputs and digital outputs listed in Table 5-2 are required for Air Compressor Controls and must be configured by order entry, VEPS, or the DRS.

Description	Type	Config ID/Function Number
Decrease (Set/Coast)	Input	4116
Increase (Resume/Accel)	Input	4118
Air Compressor Load Switch	Input	4131
Air Compressor Solenoid	Digital Output	21

Table 5-2 Air Compressor Control Required Digital Inputs and Outputs

At order entry, the Application Code System (ACS) sets the default values for the parameters listed in Table 5-3. These parameters may be modified using either VEPS or DRS.

Parameter	Description	Choice/Display
Air Compressor Integral Gain	Integral Gain	0-128 RPM/(PSI x SEC)
Air Compressor Proportional Gain	Proportional Gain	0-128 RPM/PSI
Air Compressor Pressure Increment	Percent Pressure Increment	0-50% (of fuel scale pressure range)

Table 5-3 Air Compressor Control Parameters

Multiple pressure ratings can be selected with the use of rating switches. The proper 6N4D groups with multiple 6N4M groups must be specified at engine order or by Detroit Diesel Technical Service. The inputs listed in Table 5-4 are required.

Description	Type	Config ID
Rating Switch #1	Input	4108
Rating Switch #2	Input	4109

Table 5-4 Multiple Pressure Ratings Required Inputs

The VSG maximum and minimum RPM can be set with VEPS, DRS, or DDDL as listed in Table 5-5.

Parameter	Description	Choice
VSG Minimum RPM	Sets the VSG Minimum Speed	Idle to VSG Max RPM
VSG Maximum RPM	Sets the VSG Maximum Speed	VSG Min RPM to Rated Speed

Table 5-5 VSG Maximum and Minimum RPM

The minimum and maximum pressure is set with the DDDL, the Vehicle Electronic Programming System (VEPS), or the DDEC Reprogramming System (DRS) as listed in Table 5-6. There is a minimum and maximum pressure setting for each of the horsepower curves.

Parameter	Description	Range
LOAD PSI	Indicates the delta value above the current air pressure set point that will initiate the air compressor governor to reload the system.	0 to Unload PSI
UNLOAD PSI	Indicates the delta value above the current air pressure set point that will initiate the air compressor governor to unload the system.	Load PSI to 31 PSI
MIN RAT #1 PSI	Indicates the minimum allowable air pressure set point for engine rating #1.	0 to Rating 1 Max
MAX RAT #1 PSI	Indicates the maximum allowable air pressure set point for engine rating #1.	Rating 1 Min to 999 PSI
MIN RAT #2 PSI	Indicates the minimum allowable air pressure set point for engine rating #2.	0 to Rating 2 Max
MAX RAT# 2 PSI	Indicates the maximum allowable air pressure set point for engine rating #2.	Rating 2 Min to 999 PSI
MIN RAT #3 PSI	Indicates the minimum allowable air pressure set point for engine rating #3.	0 to Rating 3 Max
MAX RAT #3 PSI	Indicates the maximum allowable air pressure set point for engine rating #3.	Rating 3 Min to 999 PSI

Table 5-6 Air Compressor Parameters

5.1.4 INTERACTION WITH OTHER FEATURES

Air Compressor Control may not be used with Cruise Control or the Pressure Sensor Governor. A proprietary immediate engine shut down message for immediate air compressor shutdown is sent over the SAE J1587/J1708 Data Link by the EDM. This feature requires both an EDM and an AIM.

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5.2 ANTI-LOCK BRAKE SYSTEMS

Anti-lock Brake Systems (ABS) are electronic systems that monitor and control wheel speed during braking. The systems are compatible with standard air brake systems. Vehicle stability and control are improved by reducing wheel lock during braking.

5.2.1 OPERATION

The ECU transmits engine data via SAE J1587 Data Link, or SAE J1939 Data Link. Anti-lock brake systems monitor data on one or more of these communication links. In the event that an excessive wheel spin is detected, the ECU receives a message from the ABS requesting a 0% output torque limit. The message is transmitted on the SAE J1939 Data Link.

SAE J1939 Data Link is enabled on all DDEC V ECUs (refer to section 6.3, "SAE J1939 Data Link" on page 6-37 for addition information).

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5.3 CRUISE CONTROL

Cruise Control is available with any DDEC engine. Cruise Control will operate in either Engine or Vehicle Speed Mode and maintain a targeted speed (MPH or RPM) by increasing or decreasing fueling. The targeted speed can be selected and adjusted with dash-mounted switches. Up to five inputs are required (four for automatic transmission) for Cruise Control operation and a digital output is optional (refer to section 4.1.2 for additional information on inputs and section 4.2 for additional information on digital outputs). A Vehicle Speed Sensor (VSS) is required for Vehicle Speed Cruise Control.

5.3.1 OPERATION

There are two types of Cruise Control: Engine Speed Cruise Control and Vehicle Speed Cruise Control. Vehicle Speed Control is available only to applications using a Vehicle Speed Sensor (VSS).

NOTE:

DDEC must see a change of state on the Cruise Master Switch, Clutch Switch (if configured) and Service Brake Switch before Cruise Control can become active upon every new ignition cycle.

Engine Speed Cruise Control

Power is varied under engine speed Cruise Control to maintain constant engine speed. Vehicle speed will vary depending on engine load. Engine speed Cruise Control does not need a VSS. Engine Speed Cruise Control cannot be used with automatic transmissions.

Vehicle Speed Cruise Control

Vehicle Speed Cruise is enabled when "Enable Cruise" and a Vehicle Speed Sensor (VSS) are installed. Engine Speed and power are varied under Vehicle Speed Cruise Control to maintain the set Vehicle Speed. The maximum Cruise Control speed cannot exceed the programmed maximum Vehicle Speed limit (when programmed). The Vehicle Speed must be above a minimum 20 MPH (programmable) and the engine speed above 1,000 RPM to set Cruise Control.

This type of Cruise Control is required when either of the following conditions exists:

- Vehicle Speed Limiting -- Vehicle Speed Cruise Control is mandatory if the vehicle limit speed is programmed and Cruise Control is desired. This will prevent the ECU from fueling the engine at speeds greater than the vehicle speed limit.
- Automatic Transmissions -- Vehicle Speed Cruise Control rather than Engine speed Control must be selected if the vehicle is equipped with an automatic transmission. This will ensure proper transmission upshifts while in Cruise Control. Refer to the transmission manufacturer's manual for more information and see the Vehicle Interface Harness schematic.

Cruise Control can be overridden at any time with the Accelerator Pedal (AP), if the vehicle is not operating at the programmed vehicle speed limit. For additional information about Vehicle Speed Limiting, refer to section 5.29.

Smart Cruise

The Eaton Smart Cruise® system will send a "heart beat" message on the SAE J1939 Data Link. Manual Cruise Control and Smart Cruise will be disabled if the message is not received over the data link or the message indicates that there is a failure in Smart Cruise. To regain manual control, the driver must toggle the Cruise Master Switch twice within 10 seconds. The AWL will not illuminate for Smart Cruise faults. Smart Cruise must be configured by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System. For additional information on Smart Cruise, contact Eaton Corporation.

Cruise Enable

Cruise Control is enabled, but not active when the Cruise Control Enable input is switched to sensor return.

Set / Coast On

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

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

Resume / Accel On

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

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

Clutch Released (Manual Transmissions)

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

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

NOTE:

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

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

NOTE:

This input should not be configured when an automatic transmission is installed.

Service Brake Released (Automatic and Manual Transmissions)

This input indicates that the brake is released when switched to sensor return. If the brake is activated, then the input is not grounded and Cruise Control is suspended. Cruise Control is resumed by using the Resume/Accel Switch.

The input logic for the Brake Switch disables Cruise Control in the unlikely event of a broken brake switch wire.

Auto Resume

The Auto Resume feature will resume Vehicle Speed Cruise Control if the clutch has been pushed twice and released within three (3) seconds.

Cruise Pause

Cruise Pause saves the current Cruise Control Set Point (vehicle speed) when the Cruise Control Enable input is opened. The set point is saved for 10 seconds. This feature is intended toward transmissions with shift knobs that do not have to be moved to shift every gear and have the Cruise Control switches on the knob. The Resume/Accel Switch must be momentarily switched to sensor return to resume the saved vehicle speed after the Cruise Enable is switched to sensor return again.

Cruise Power

Cruise Power is an optional engine rating which operates on a higher horsepower during Cruise Control. The ECU automatically switches to the cruise power rating when Cruise Control is turned on. This extra power gives the driver incentive to run in Cruise Control whenever possible and gain the additional fuel economy it provides. Cruise Power can be selected with DDDL, VEPS, or with an engine rating switch provided it is part of the engine rating package. Refer to section 5.9 for additional information on engine rating switches.

5.3.2 INSTALLATION

The following is a list of switches that are required for Cruise Control operation.

- Cruise Enable Switch
- Brake Pedal Position Switch (BPP Switch)
- Clutch Pedal Position Switch (CPP Switch) -- optional for automatic transmissions
- Set/Coast Switch
- Resume/Accel Switch

A Cruise Active Lamp is optional.

See Figure 5-2 for diagrams of the Cruise Control circuit.

DDC recommends this installation for the Cruise Control (see Figure 5-2). Utilizing an input other than the recommended one will necessitate finding the sensor return for the input selected. The inputs and corresponding sensor return are listed in Table 3-20 on page 3-27.

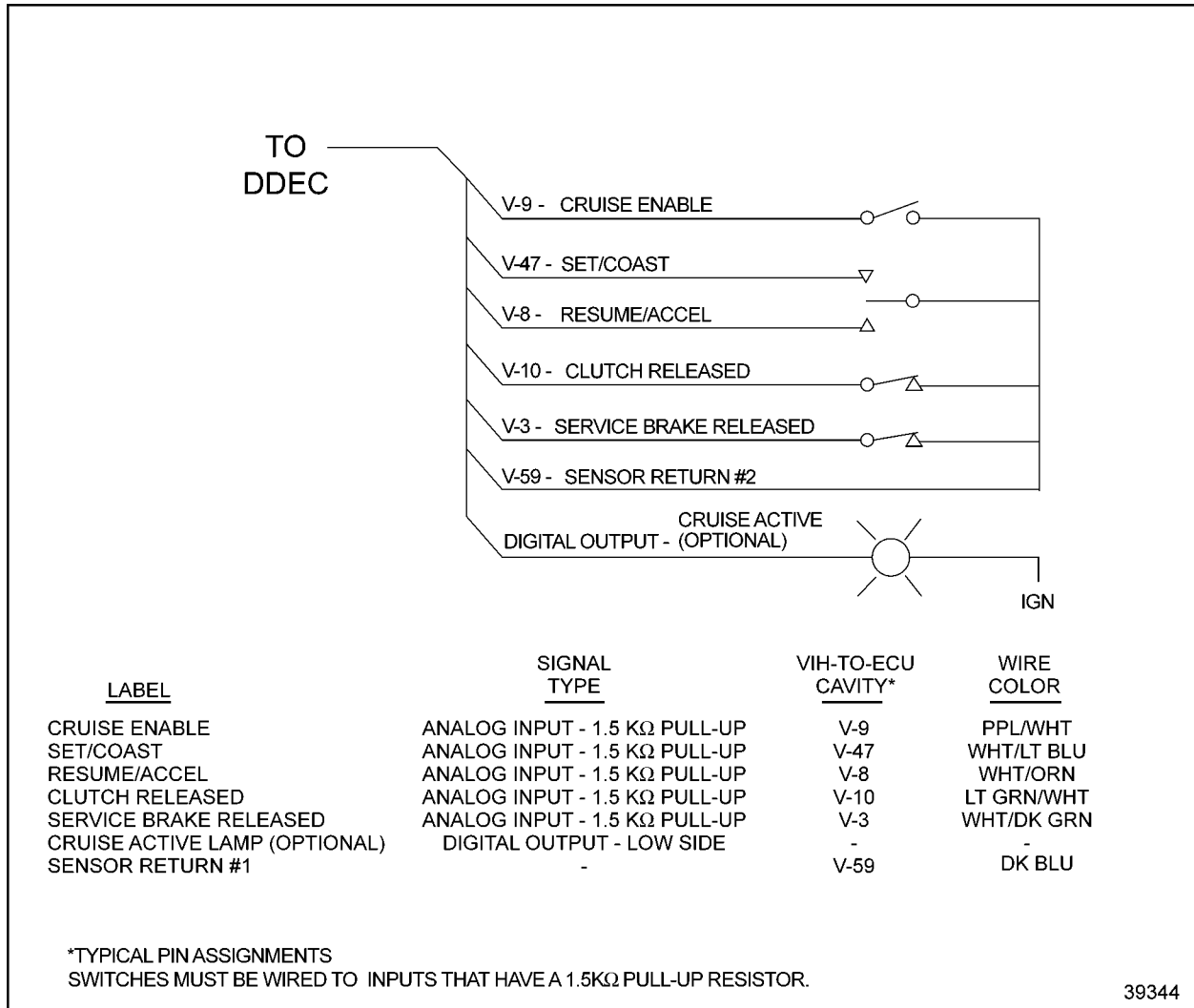


Figure 5-2 Cruise Control

5.3.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

To configure an engine for Cruise Control, the inputs and digital output listed in Table 5-7 must be selected either with the Vehicle Electronic Programming System (VEPS), DDEC Reprogramming System (DRS), or on engine order entry.

Description	Type	Config ID
Service Brake Released	Input	4113
Set/Coast	Input	4116
Resume/Accel	Input	4118
Cruise Control Enable	Input	4119
Clutch Released (required for manual transmissions)	Input	4114
Cruise Control Active Lamp (optional for Cruise Control)	Digital Output	11

Table 5-7 Cruise Control Related Input and Digital Output Signals

A Vehicle Speed Sensor must be configured for Vehicle Speed Cruise Control. Refer to section 3.11.24, "Vehicle Speed Sensor," for additional information.

If Eaton Smart Cruise is installed on the vehicle, the feature as listed in Table 5-8 must be enabled by VEPS or DRS.

Parameter	Description	Choice
Adaptive Cruise Control (Smart Cruise)	Enables or disables Smart Cruise Control feature.	YES, NO

Table 5-8 Smart Cruise

The Cruise Control parameters listed in Table 5-9 can be set by DDDL, VEPS, or DRS.

Parameter	Description	Range
ENABLE CRUISE	Enables or disables Cruise Control operation.	YES, NO
MIN CRUISE SPEED	Sets the minimum vehicle Cruise Control speed.	20 MPH to Max Cruise Speed
MAXIMUM CRUISE SPEED	Sets the maximum cruise speed in MPH or KPH.	Min. Cruise Speed to Vehicle Speed Limit or 127 mph if Vehicle Speed Limiting is not enabled.
AUTO RESUME	The Auto Resume feature provides automatic cruise control resumption upon completion of a manual gear shift change.	YES, NO
CRUISE SWITCH VSG	Allows the cruise switches to select a desired VSG set point.	YES, NO
INITIAL VSG SET SPEED	Sets the cruise switch VSG initial set speed.	VSG MIN RPM to VSG MAX RPM
RPM INCREMENT	Defines the size of increase or decrease in RPM to the existing set speed for every switch toggle.	1 to 255 RPM
CRUISE ENGINE BRAKE	Provides for automatic operation of the engine brake if the cruise set speed has been exceeded by the value of "Cruise Engine Brake Activation Speed." The engine brake is activated at the low level unless the operator has turned off the engine brakes with the dash mounted switches.	YES, NO
CRUISE/ENGINE BRAKE ACTIVATION SPEED	Delta speed at which the engine brakes will be activated during cruise control operations. Entering a 0 will disable this option.	0 to 10 MPH
ENG BRAKE INCREMENT MPH	Sets the additional incremental speed that must be reached before the engine brake will activate the medium and/or high level of retardation.	1 to 5 MPH

Table 5-9 Cruise Control Parameters

5.3.4 DIAGNOSTICS

Two faults (SID 216 FMI 14 and PID 86 FMI 14) will be logged simultaneously if Adaptive Cruise is enabled and the data is not being received, the received data is incorrect or the Adaptive Cruise unit has been removed.

If these faults are received in addition to an SAE J1939 Data Link failure (SID 231 FMI 12), then the problem is with the SAE J1939 Data Link.

5.3.5 INTERACTION WITH OTHER FEATURES

The Cruise Control logic is also used with the DDEC Pressure Sensor Governor in fire trucks. Both systems cannot be configured on the same engine. Refer to section 5.22 for more information on the Pressure Sensor Governor. DDEC can be configured to allow the engine brakes to activate during Cruise Control operation.

NOTE:

Cruise Control maximum speed cannot exceed the vehicle limit speed.

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5.4 DIAGNOSTICS

Diagnostics is a standard feature of the DDEC system. The purpose of this feature is to provide information for problem identification and problem solving in the form of a Diagnostic Trouble Code. The ECU continuously performs self diagnostic checks and monitors the other system components. Information for problem identification and problem solving is enhanced by the detection of faults, retention of Diagnostic Trouble Codes and separation of active from inactive codes.

5.4.1 OPERATION

The engine-mounted ECU includes control logic to provide overall engine management. System diagnostic checks are made at ignition on and continue throughout all engine operating modes.

Sensors provide information to the ECU regarding various engine and vehicle performance characteristics. The information is used to regulate engine and vehicle performance, provide diagnostic information, and activate the engine protection system.

Instrument panel warning lamps (see Figure 5-3), the Amber Warning Lamp (AWL) and the Red Stop Lamp (RSL), warn the engine operator.

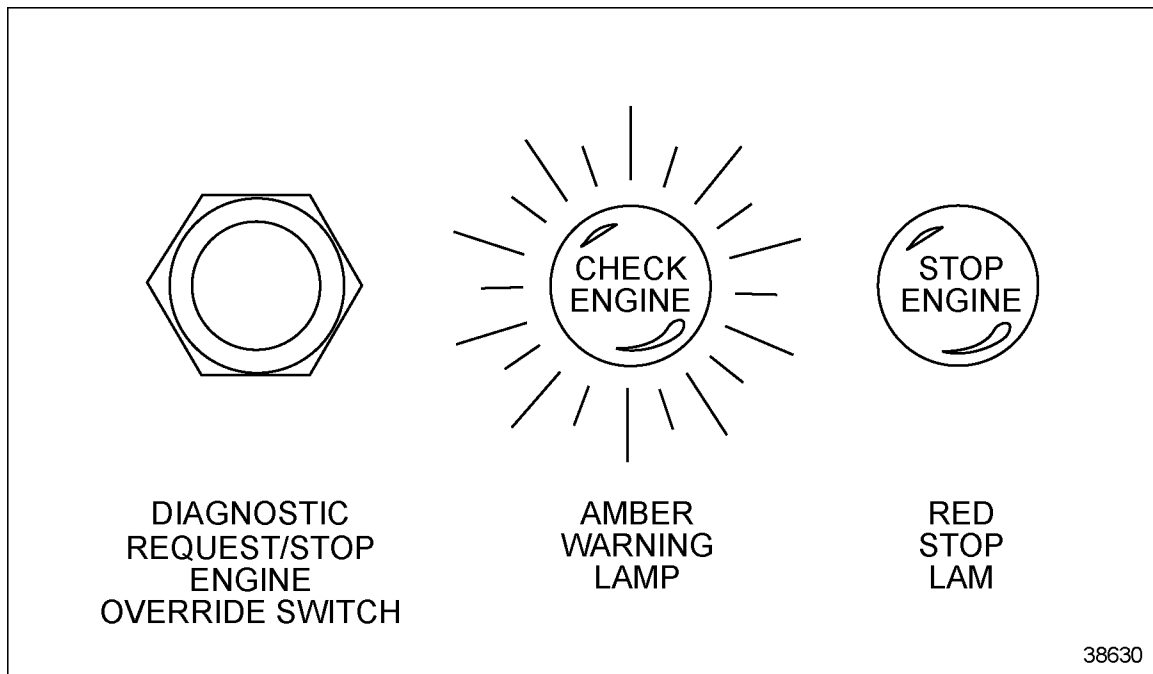


Figure 5-3 Typical Diagnostic Request/SEO Switch and Warning Lamps

The AWL is illuminated and a Diagnostic Trouble Code is stored if an electronic system fault occurs. This indicates the problem should be diagnosed as soon as possible. The ECU illuminates the AWL and RSL and stores a Diagnostic Trouble Code if a potentially engine damaging fault is detected. These Diagnostic Trouble Codes can be accessed as follows:

- Flashing the AWL and RSL with the Diagnostic Request Switch (may be combined with Stop Engine Override switch, see Figure 5-3)

- ❑ Using the Detroit Diesel Diagnostic Link® (DDDL) PC software package
- ❑ By ProDriver®DC, Electronic Fire Commander®, the Electronic Display Module (EDM), or other display

There are two types of Diagnostic Trouble Codes:

- ❑ An *active code* - a fault present at the time when checking for codes
- ❑ An *inactive code* - a fault which has previously occurred

All faults represented by Diagnostic Trouble Codes have the following information stored in the ECU:

- ❑ Engine hour, date, and time the fault was first logged
- ❑ Total time the fault was active
- ❑ Number of fault occurrences
- ❑ Number of stop engine overrides for the fault (if applicable)
- ❑ Associated parameter value (PIDs with FMI 0, 1 only - if fault is low oil pressure, lowest oil pressure recorded)

Diagnostic Request Switch

The Diagnostic Request Switch is used to activate the AWL/RSL to flash codes. Active codes are flashed on the RSL and inactive codes are flashed on the AWL (see Figure 5-4). Inactive codes are flashed in numerical order, active codes are flashed in the order received, most recent to least recent. The Diagnostic Request Switch can also be used as the Stop Engine Override (SEO) switch.

Flashing codes provide a two digit number (see Figure 5-4). This Diagnostic Trouble Code may cover several specific faults. It is provided to advise the operator of the general severity of the fault so the operator can decide if engine operation can continue without damaging the engine.

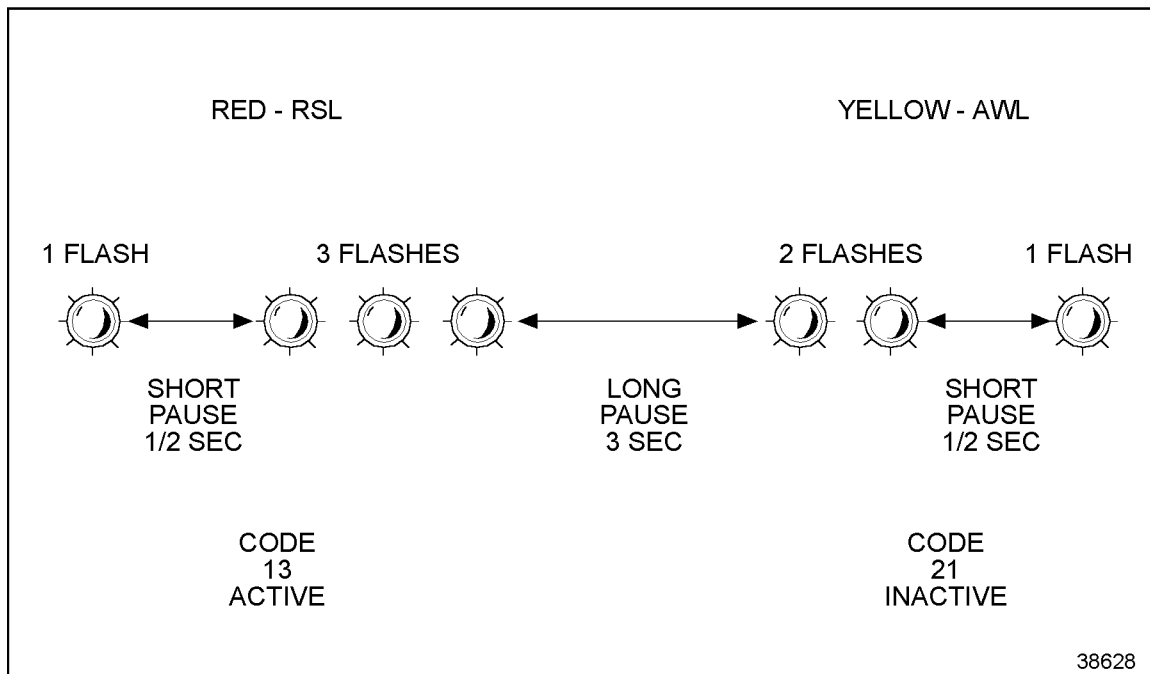


Figure 5-4 Flash Codes

The Diagnostic Request Switch is used to flash codes in the following circumstances:

- ☐ The engine is not running and ignition is ON
- ☐ The engine is idling

In both circumstances, activating and holding the Diagnostic Request Switch will flash out the diagnostic codes.

Refer to Appendix A for a list of Diagnostic Trouble Codes, the code number when flashed, the SAE J1587 Data Link number and a description of each Diagnostic Trouble Code.

Diagnostic Request Switch/Stop Engine Override

If no separate Diagnostic Request Switch is configured, the SEO switch serves as both a Diagnostic Request Switch and an SEO switch.

The Diagnostic Request/Stop Engine Override Switch is used to flash codes in the following circumstances:

- ☐ The engine is not running and ignition is on
- ☐ The engine is idling and not in an "engine protection" condition (refer to section 5.8, page 5-37)

In both circumstances, activating and releasing the switch will flash out the Diagnostic Trouble Codes; activating and releasing the switch a second time will stop the ECU from flashing the diagnostic codes. Codes will also cease flashing if the engine is no longer at idle.

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5.5 EDM AND AIM

The Construction and Industrial Electronic Display Module (EDM) and Auxiliary Information Module (AIM) are the two components which comprise the Detroit Diesel Construction and Industrial Electronic Display system for engine and equipment parameters.

5.5.1 OPERATION

The EDM (see Figure 5-5) may be used alone to display engine parameters or in conjunction with the AIM to display additional equipment parameters. AIM cannot be used without the EDM.

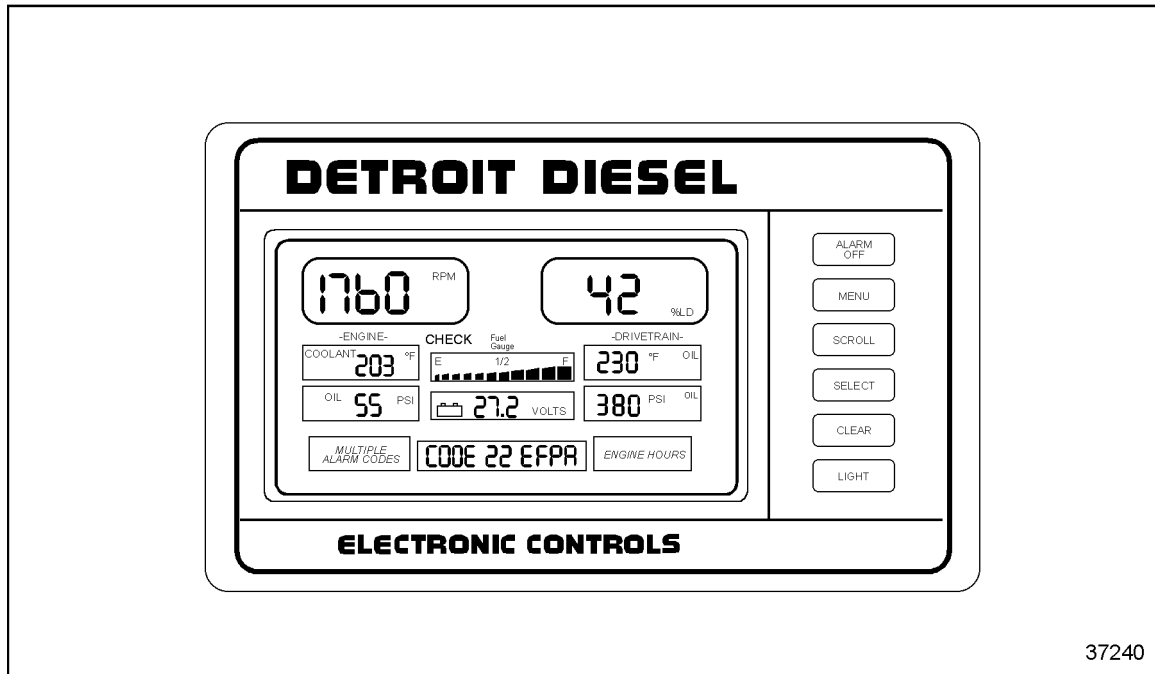


Figure 5-5 Electronic Display Module

The EDM will display the following parameters at all times if the sensor is installed on the equipment:

- ☐ Engine RPM
- ☐ Engine Coolant or Oil Temperature (Oil Temperature only when coolant temperature is unavailable from the ECU)
- ☐ Engine Oil Pressure
- ☐ ECU Battery Voltage
- ☐ Vehicle Speed or Auxiliary Pump Pressure or Engine Load
- ☐ Equipment Temperature or Pressure (Requires AIM)
- ☐ Equipment Temperature or Pressures (Requires AIM) or Engine Turbo Boost Pressure
- ☐ Fuel Level (Requires AIM)
- ☐ Check and Stop Indicators

The AIM (see Figure 5-6) is used in conjunction with the EDM to display additional equipment parameters.

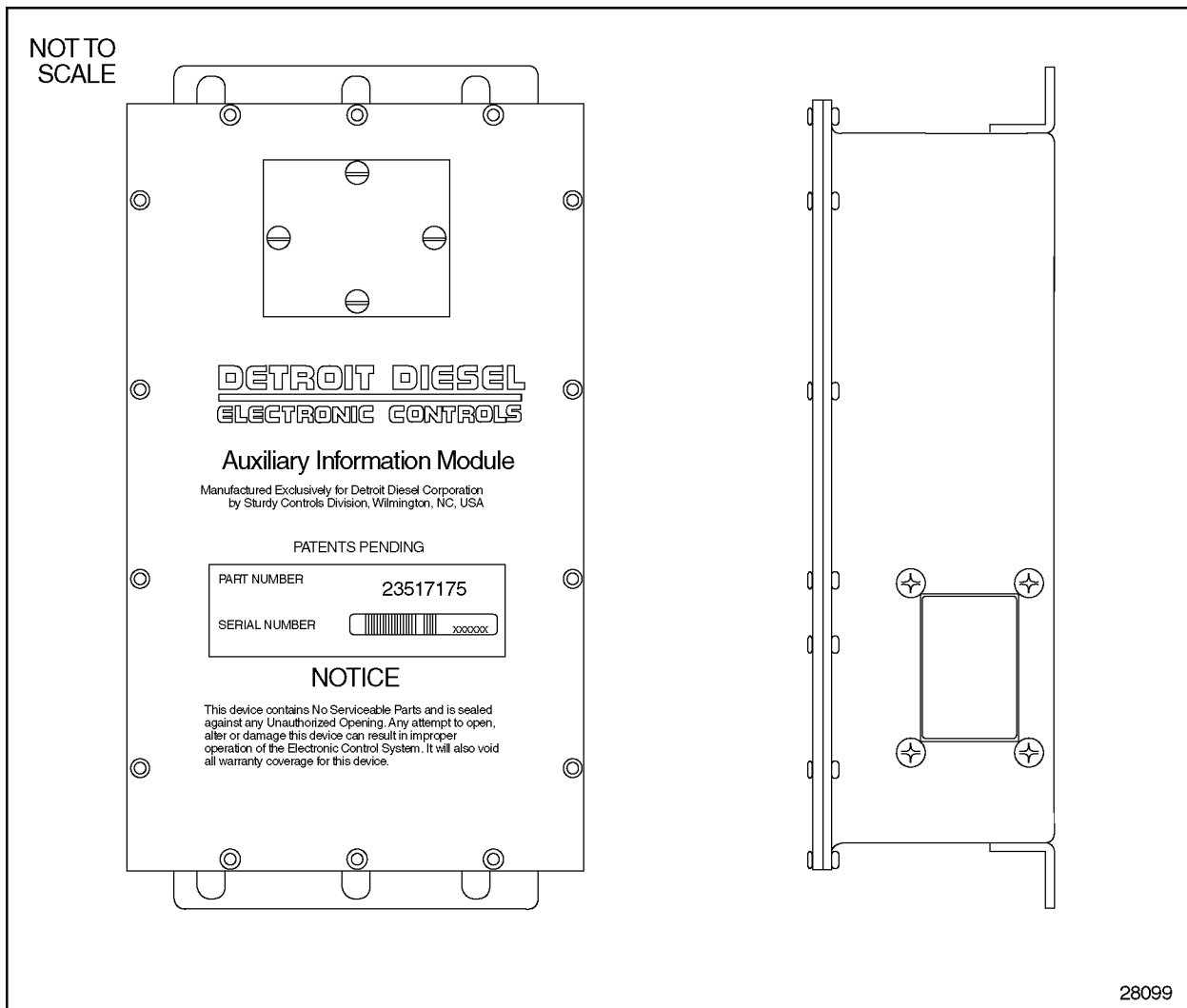


Figure 5-6 Auxiliary Interface Module

5.5.2 INSTALLATION

For information on installing the Construction and Industrial EDM and AIM refer to the *Construction & Industrial EDM and AIM Installation and Troubleshooting* manual (7SA801).

5.5.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Refer to *Construction & Industrial EDM and AIM Installation and Troubleshooting* manual (7SA801).

5.5.4 INTERACTION WITH OTHER FEATURES

DDEC installations equipped with both the EDM and AIM may initiate engine shutdowns based on equipment parameters. The shutdown options include the standard 30 second shutdown as well as an option for an immediate engine shutdown.

5.5.5 DIAGNOSTICS

Refer to the *Construction & Industrial EDM and AIM Installation and Troubleshooting* manual (7SA801).

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5.6 ELECTRONIC FIRE COMMANDER

The Detroit Diesel Electronic Fire Commander® (EFC) is designed to support DDEC V engines in the fire fighting and emergency services market. It combines the DDEC Pressure Sensor Governor (PSG), a system monitor, and a pump panel display for vital engine operating parameters into one compact, durable package (see Figure 5-7).

NOTE:

Refer to the *Electronic Fire Commander Installation and Troubleshooting* manual (6SE476) for additional information.

EFC replaces the PSG switches and many pump panel gauges as it provides complete control and monitoring of the DDEC V system on the fire truck.

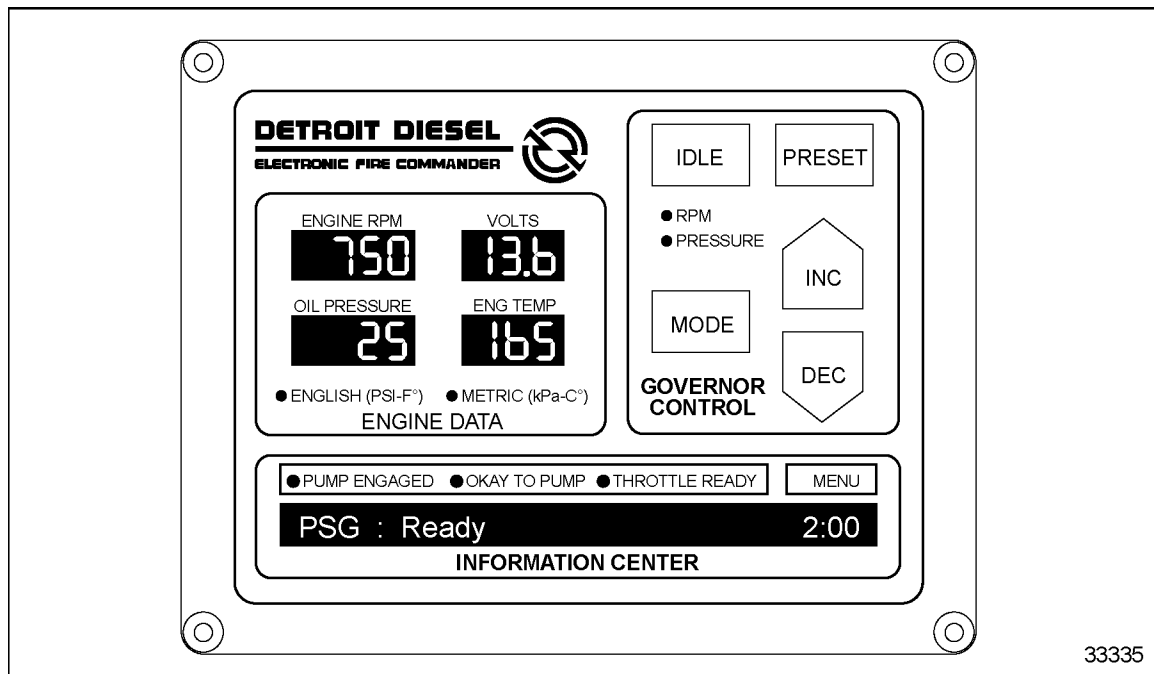


Figure 5-7 Electronic Fire Commander Pump Panel Display

RPM, Oil Pressure, Oil or Coolant Temperature, and ECU Voltage are displayed continuously in the Engine Data section of the EFC.

Messages and any known diagnostic code accompanying a check engine or stop engine condition will be displayed on the Information Center message display. The external alarm output will also be activated when the engine is running. The EFC displays the PSG status in the Information Center whenever the OEM interlocks are met. The time of day is displayed. The EFC logs the time that the pump is engaged and that time can be displayed using the Information Center.

5.6.1 OPERATION

The Electronic Fire Commander has two modes of operation:

- RPM Mode (engine speed)
- Pressure Mode (water pump pressure, psi)

RPM Mode controls engine speed to a desired RPM and Pressure Mode controls engine speed to maintain a desired discharge manifold pressure.

The operating modes are selectable and may be changed by pressing the MODE button providing the appropriate interlocks have been met. The engine will continue to run at the same speed when the mode switch is toggled between the RPM and Pressure modes.

The maximum pre-set pressure for EFC is 200 psi.

5.6.2 INSTALLATION

The Electronic Fire Commander Harness schematic shows the minimum requirements for the PSG to operate (see Figure 5-8). Additional functions and interlocks may be used. EFC may be powered from a 12/24 V supply. Refer to the *Electronic Fire Commander Installation and Troubleshooting* manual (6SE476).

5.6.3 ORDERING EFC

The hardware listed in Table 5-10 is needed for Pressure Governor installation with EFC.

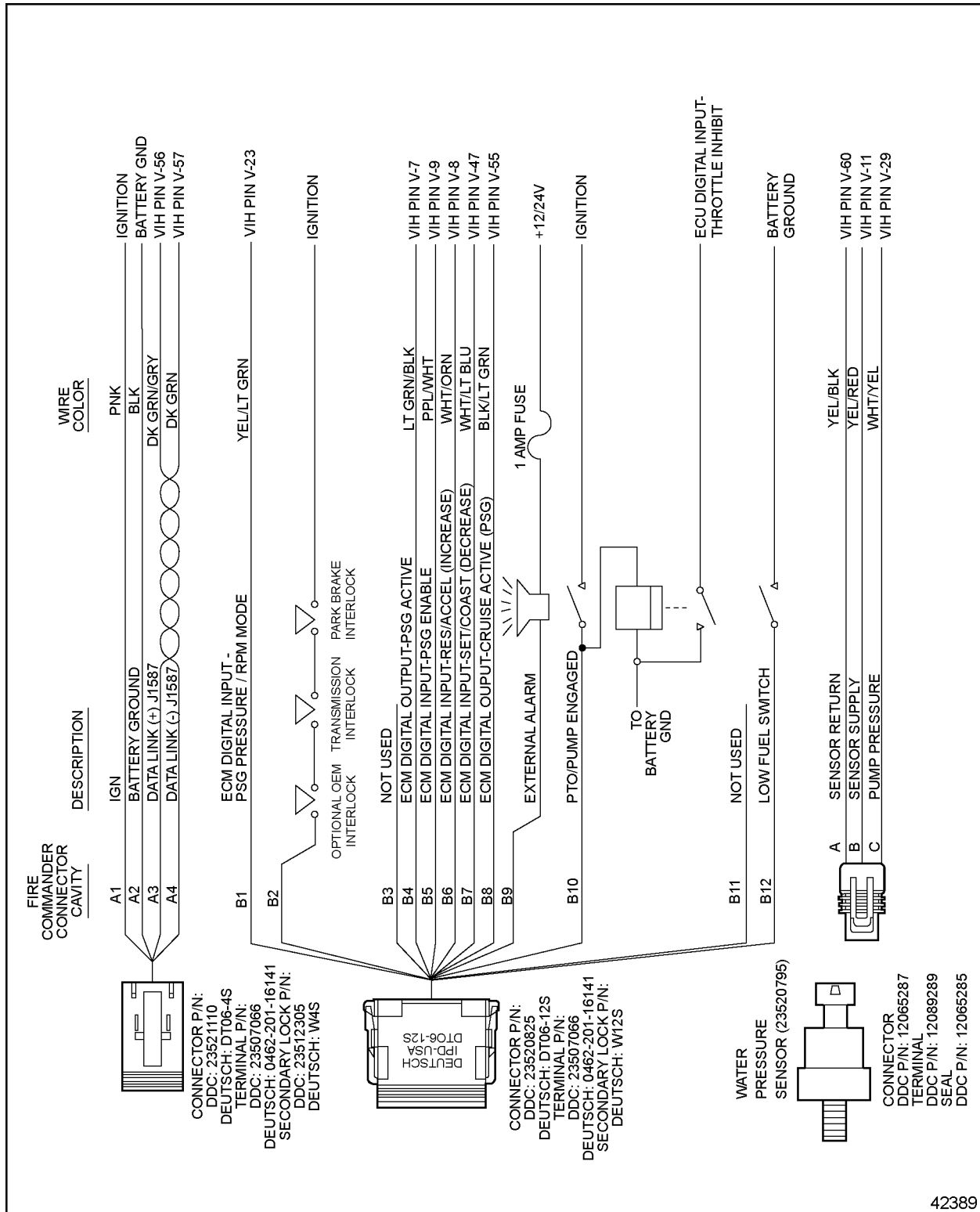
Component	Part Number
Electronic Fire Commander	23519655
Pressure Sensor	23520795
Electronic Fire Commander Harness (see Figure 5-8)	OEM Supplied
OEM Interlocks	OEM Supplied

Table 5-10 Electronic Fire Commander and Pressure Sensor

Hardware available from the DDC Parts Distribution Center for installation of Electronic Fire Commander (EFC) is listed in Table 5-11 as a complete kit. The 6N4C group must be specified at engine order entry or through Detroit Diesel Technical Service.

Component	Part Number
Electronic Fire Commander Kit (contains Electronic Fire Commander and the pressure sensor)	23520139

Table 5-11 Electronic Fire Commander Kit



42389

Figure 5-8 Electronic Fire Commander Harness

5.6.4 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The inputs listed in Table 5-12 are required for use with EFC and can be configured at engine order entry, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS). Refer to section 4.1, "Analog and Digital Inputs," for additional information.

Description	VIH-to-ECU Connector Assignment*	Config ID
Pressure/RPM Mode	V-23	4104
PSG Enable	V-9	4120
Resume/Accel (Increase)	V-8	4118
Set/Coast (Decrease)	V-47	4116

* DDC connector assignments and port assignments shown are default settings but can differ from application to application.

Table 5-12 Required Inputs for EFC

The digital outputs required for use with EFC are listed in Table 5-13 and can be configured at engine order entry, by VEPS or DRS. Refer to section 4.2, "Digital Outputs," for additional information.

Description	VIH-to-ECU Connector Assignment*	Function Number
PSG Active	V-7	5
Cruise Active	V-55	11

* DDC connector assignments and port assignments shown are default settings but can differ from application to application.

Table 5-13 Required Digital Outputs for EFC

The correct 6N4C Application Code must be specified at the time of engine order entry or by DDC Technical Service.

More information is available in the manual *Electronic Fire Commander Installation and Troubleshooting* (6SE476). This manual is available on the DDC extranet.

5.7 ENGINE BRAKE CONTROLS

The Engine Brake option converts a power-producing diesel engine into a power-absorbing air compressor. This is accomplished by opening the cylinder exhaust valves near the top of the normal compression stroke and releasing the compressed cylinder charge to exhaust. The release of the compressed air to atmospheric pressure prevents the return of energy to the engine piston on the expansion stroke, the effect being a net energy loss. Fueling is cut off when this occurs.

5.7.1 OPERATION

A dash mounted On/Off Switch is used to enable the Engine Brake option. DDEC V will directly control the engine brake solenoids and turbocharger VGT position to produce the desired low, medium, or high braking power. This braking power is based on the driver selected intensity switch for a Series 60 engine. The engine brakes are engaged every time the foot pedal is brought back to the idle position and Cruise Control is not active.

The following are features and options for Engine Brake:

- ☐ Cruise Control with Engine Brake
- ☐ Engine Brake Disable
- ☐ Engine Brake Active
- ☐ Engine Fan Braking
- ☐ Clutch Released Input
- ☐ Service Brake Control of Engine Brakes
- ☐ Min. MPH for Engine Brakes

Cruise Control with Engine Brake

The Engine Brake option can also provide Engine Brake capability when the vehicle is in Cruise Control. For example, if the vehicle is going down hill in Cruise Control while the engine brake is selected, the ECU will control the amount of Engine Brake with respect to the Cruise Control set speed. The level of Engine Brake (low, medium, high) selected with the dash switches will be the maximum amount of engine braking the ECU allows. Cruise Control with Engine Brake can be set with DDDL, VEPS, and DRS.

Engine Brake Disable

The Engine Brake Disable option uses an input which is switched to ground whenever a vehicle system, such as a traction control device, does not allow engine braking to occur. This option is required for most automatic transmissions.

Engine Brake Active

The Engine Brake Active option uses a digital output that can be used to drive an Engine Brake Active lamp. This output is switched to battery ground whenever the engine brake is active.

Engine Fan Braking

The Engine Fan Braking option turns on the cooling fan when the engine brake level is high and DDEC fan control is enabled. This creates about 20 to 40 hp additional engine braking power depending on the size of the cooling fan. This option is selected at the time of engine order or set by DDDL, VEPS or DRS. For additional information, refer to section 5.11, "Fan Controls."

Clutch Released Input

The Clutch Released input will prevent the engine brakes from being turned on when the clutch is pressed. This input is required for use with manual transmissions. Refer to section 4.1, "Digital and Analog Inputs," for additional information.

Service Brake Control of Engine Brakes

This option will allow the dash-mounted engine brake switch to be set to the ON position but not engage the engine brakes until the service brake pedal is pressed. An input must be programmed for service brake. Refer to section 4.1, "Digital and Analog Inputs," for additional information. VEPS, DDDL or DRS can set this function.

Min MPH for Engine Brakes

This option will disable the engine brakes until a minimum vehicle speed is reached. This parameter can be configured by VEPS, DRS, or DDDL. A Vehicle Speed Sensor (VSS) is required. Refer to section 3.11.24, "Vehicle Speed Sensor," for additional information.

5.7.2 INSTALLATION

See Figure 5-9 for a DDEC V internal engine brake schematic.

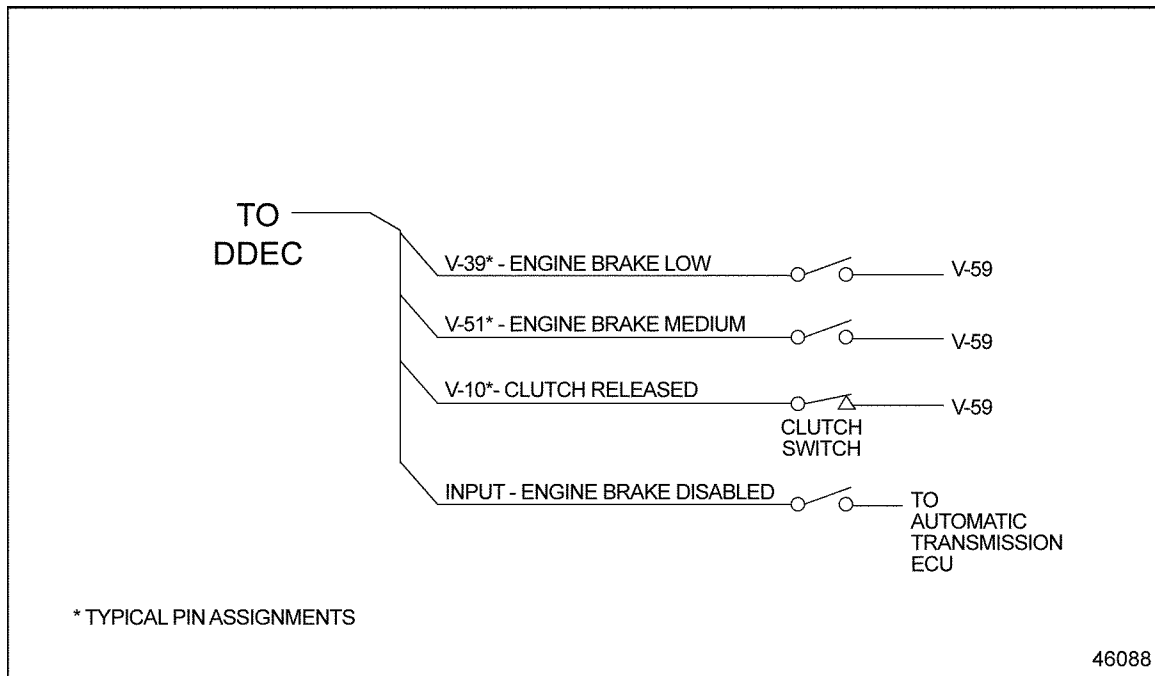


Figure 5-9 Internal Engine Brake for DDEC V

5.7.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Engine Brake must be specified at the time of engine order or by contacting Detroit Diesel Technical Service. This enables the two digital outputs required.

The digital inputs listed in Table 5-14 must be configured by order entry, VEPS, DRS:

Description	Config ID
Engine Brake Low	4097
Engine Brake Medium	4098
Engine Brake Disable (required for most automatic transmissions)	4122
Clutch Released (required for manual transmissions)	4114

Table 5-14 Required Digital Inputs for Engine Brake Controls

The parameters listed in Table 5-15 can be set by order entry, VEPS, DDDL, or DRS for the Cruise Control Engine Brake option.

Parameter	Description	Choice / Display
CRUISE CONTROL ENGINE BRAKE	Enables or disables the feature that allows the engine brake to be used while on cruise control if the vehicle exceeds the cruise set speed.	YES, NO
CRUISE/ENGINE BRAKE ACTIVATION SPEED	Sets the delta speed that the engine brake should be applied to slow the vehicle while in cruise control.	1 to 10 MPH
ENGINE BRAKE INCREMENT	Sets the additional incremental speed that must be reached before the engine brake will activate the medium and/or high level of retardation.	1 to 5 MPH

Table 5-15 Cruise Control Engine Brake Parameters

The optional digital output listed in Table 5-16 can be configured by order entry, VEPS or DRS. It can be used to drive an Engine Brake Active Lamp.

Description	Type	Function Number
Engine Brake Active	Digital Output	16

Table 5-16 Optional Digital Output for Engine Brakes

The Engine Fan Braking option as shown in Table 5-17 can be configured at the time of engine order, VEPS, DDDL or DRS.

Parameter	Description	Choice/Display
DYNAMIC BRAKING	Provides additional engine braking by activating the DDEC controlled fan whenever the engine brakes are active in high. This function requires both DDEC engine brake controls and DDEC fan controls.	YES, NO

Table 5-17 Optional Fan Braking for Engine Brakes

The parameter listed in Table 5-18 can be set by order entry, VEPS, DDDL, or DRS for the Service Brake Control of the Engine Brakes option.

Parameter	Description	Choice / Display
SERVICE BRAKE ENABLE	When this function is enabled, an input from the service brake is required in order to activate the engine brake.	YES, NO

Table 5-18 Service Brake Control of Engine Brakes Parameter

The parameter listed in Table 5-19 can be configured by order entry, VEPS, and DDDL for the Minimum Vehicle Speed for engine braking to occur.

Parameter	Description	Range
ENGINE BRAKE MIN MPH	The minimum vehicle speed required before engine braking will occur.	0–40 MPH

Table 5-19 Minimum MPH for Engine Brakes Option

5.7.4 INTERACTION WITH OTHER FEATURES

DDEC will respond to requests from other vehicle systems via SAE J1939 Data Link to disable the engine brakes.

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5.8 ENGINE PROTECTION

The DDEC engine protection system monitors all engine sensors and electronic components, and recognizes system malfunctions. If a critical fault is detected, the Amber Warning Lamp (AWL) and Red Engine Lamp (RSL) illuminate. The malfunction codes are logged into the ECU's memory.

The standard parameters which are monitored for engine protection are:

- ☐ Low coolant level
- ☐ High coolant temperature
- ☐ Low oil pressure
- ☐ High oil temperature

5.8.1 OPERATION

Engine protection is a vital part of ECU programming and software. The ECU monitors coolant level, various pressures and temperatures, and compares these parameters against the allowable limits to determine when a critical fault is reached. The AWL is illuminated and a Diagnostic Trouble Code (DTC) logged if there is an electronic system fault (Refer to Appendix A for a list of codes). This indicates the problem should be diagnosed as soon as possible. The ECU illuminates the AWL and RSL and stores a DTC if a potentially engine damaging fault is detected. Once a critical fault is reached, the AWL and RSL are illuminated and a 30 second timer starts a countdown to the desired level of protection. Temperature and pressure limits are established in the engine's calibration and may differ slightly from one engine model to another.

Engine protection consists of different protection levels:

- ☐ Warning Only
- ☐ Rampdown
- ☐ Shutdown

Warning Only

The AWL and RSL will illuminate if a fault is detected. There is no power and/or speed reduction when "Warning Only" is selected. The resulting engine protection is at the discretion of the engine operator.

NOTE:

The operator has the responsibility to take action to avoid engine damage.

Some applications require two sets of warning lamps for different control stations.

NOTE:

A diagnostic switch is not required but applications using one, must have a separate diagnostic switch for each ECU on the engine.

The Diagnostic Request Switch is used to activate the AWL and RSL to flash codes.

Rampdown

The AWL and RSL illuminate if a fault is detected. The ECU reduces torque and/or speed over a 30 second period after the RSL illuminates. The initial torque (speed), which is used for reduction, is the operating torque or speed prior to the RSL fault condition. See Figure 5-10.

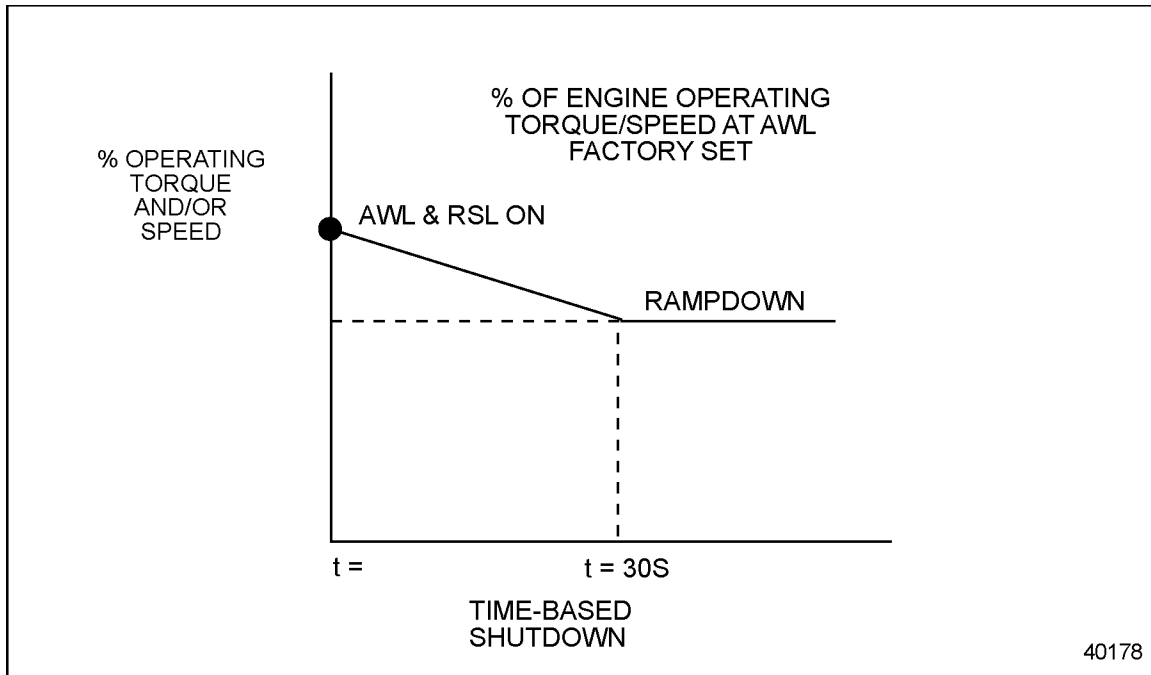


Figure 5-10 Rampdown

A Stop Engine Override (SEO)/Diagnostic Request Switch is required when this engine protection option is selected. The SEO options are available to prevent engine shutdown at the operator's discretion.

Shutdown

This option operates in the same manner as rampdown, except the engine shuts down 30 seconds after the RSL is illuminated (see Figure 5-11). (The initial torque and/or speed which is used for reduction, is the torque and/or speed which occurred immediately prior to the fault condition.)

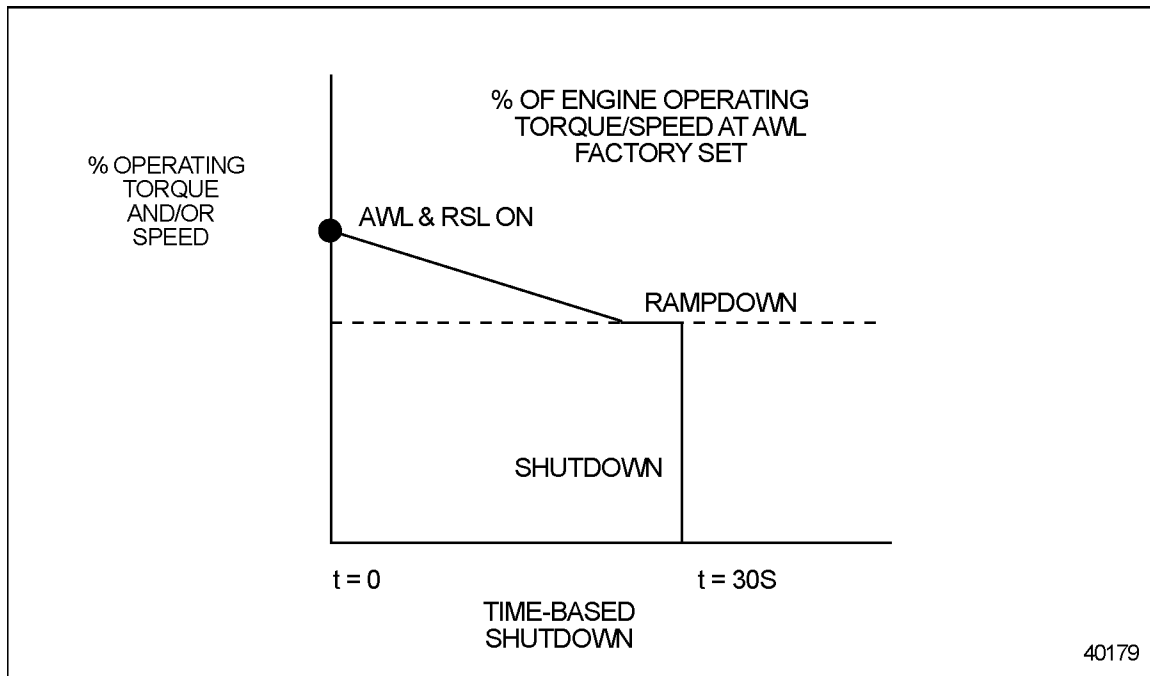


Figure 5-11 Engine Shutdown

The Stop Engine Override options are available to prevent engine shutdown at the operator's discretion.

A SEO/Diagnostic Request Switch is required when this engine protection option is selected. Refer to section 5.8.3.

5.8.2 ENGINE OVERTEMPERATURE PROTECTION

Engine Overtemperature Protection (EOP) is additional logic programmed into the ECU and used in conjunction with standard temperature protection. When EOP is part of the engine calibration, engine torque and/or speed is reduced as a function of temperature. The AWL illuminates and a DTC is logged when the EOP calibrated temperature is reached. If the temperature does not decrease as torque/speed is reduced, the RSL illuminates when a still higher temperature is reached.

The subsequent action taken by the ECU depends on customer selection of one of the following:

- ☐ Warning only (see Figure 5-12)
- ☐ 30 second rampdown (see Figure 5-13)
- ☐ Shutdown (see Figure 5-14)

Torque/speed reduction is based on the average torque/speed in use prior to the fault condition.

EOP is active even if Engine Protection is configured for Warning Only.

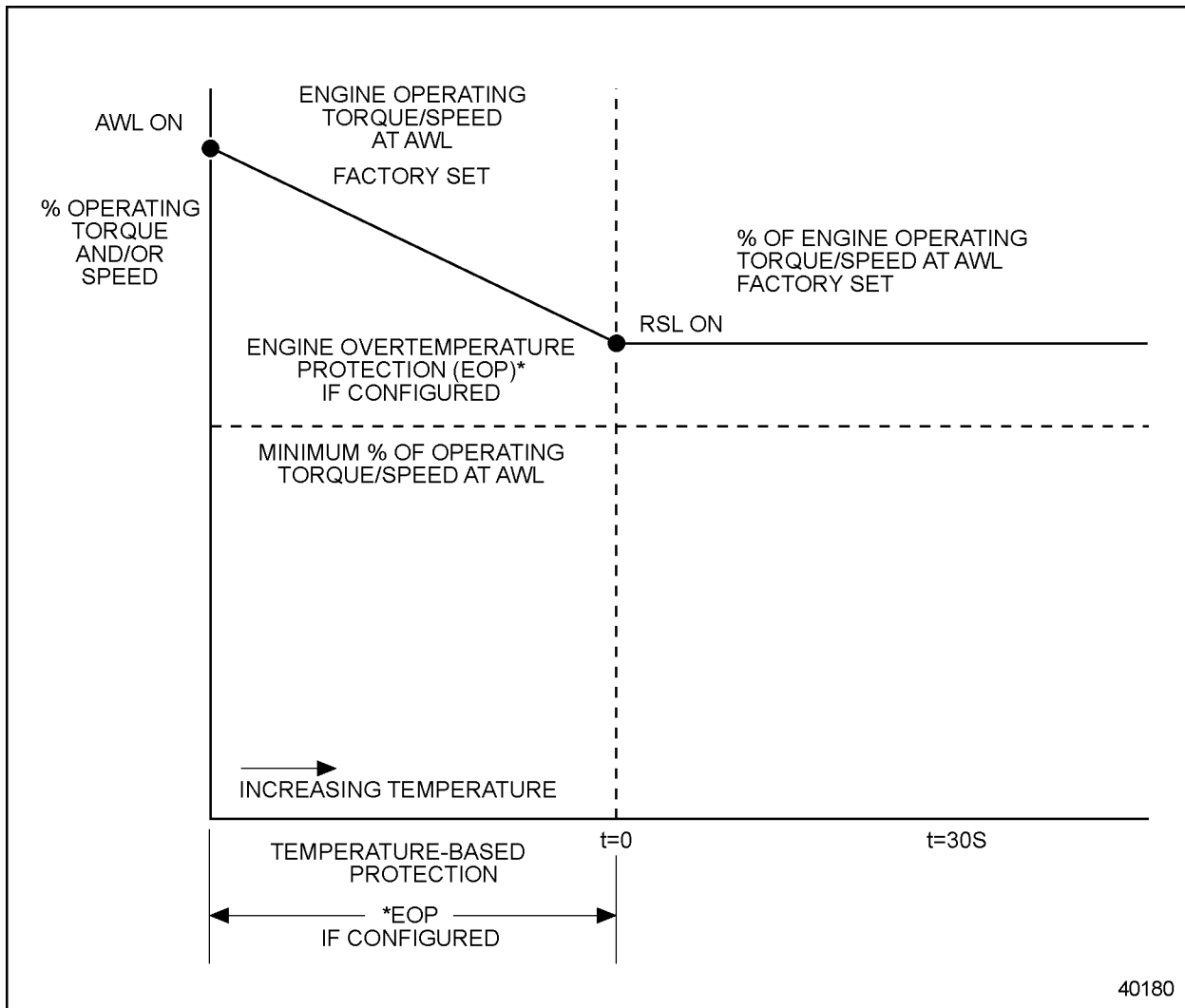


Figure 5-12 Engine Overtemperature Protection and Warning Only

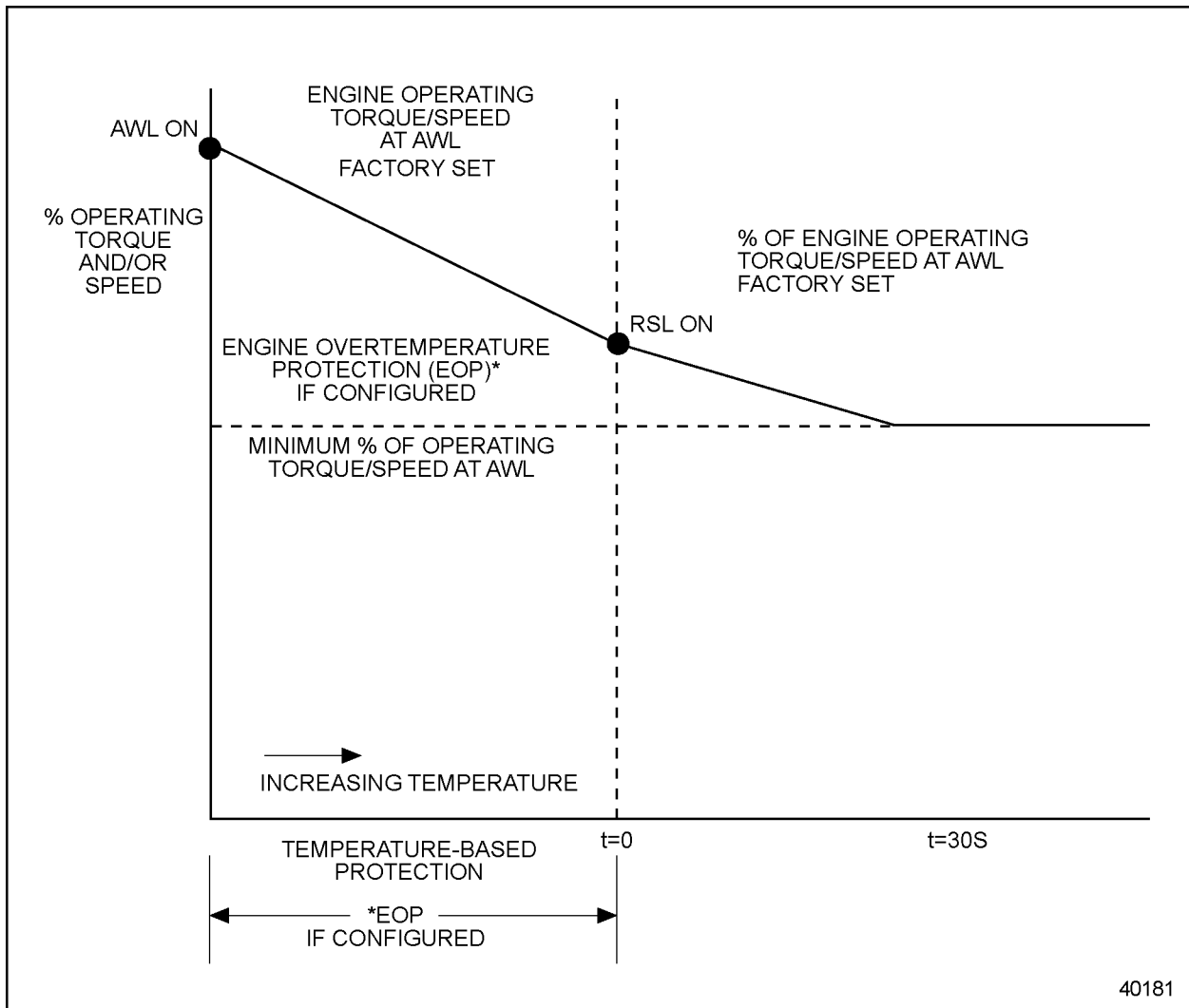


Figure 5-13 Engine Overtemperature Protection and Rampdown

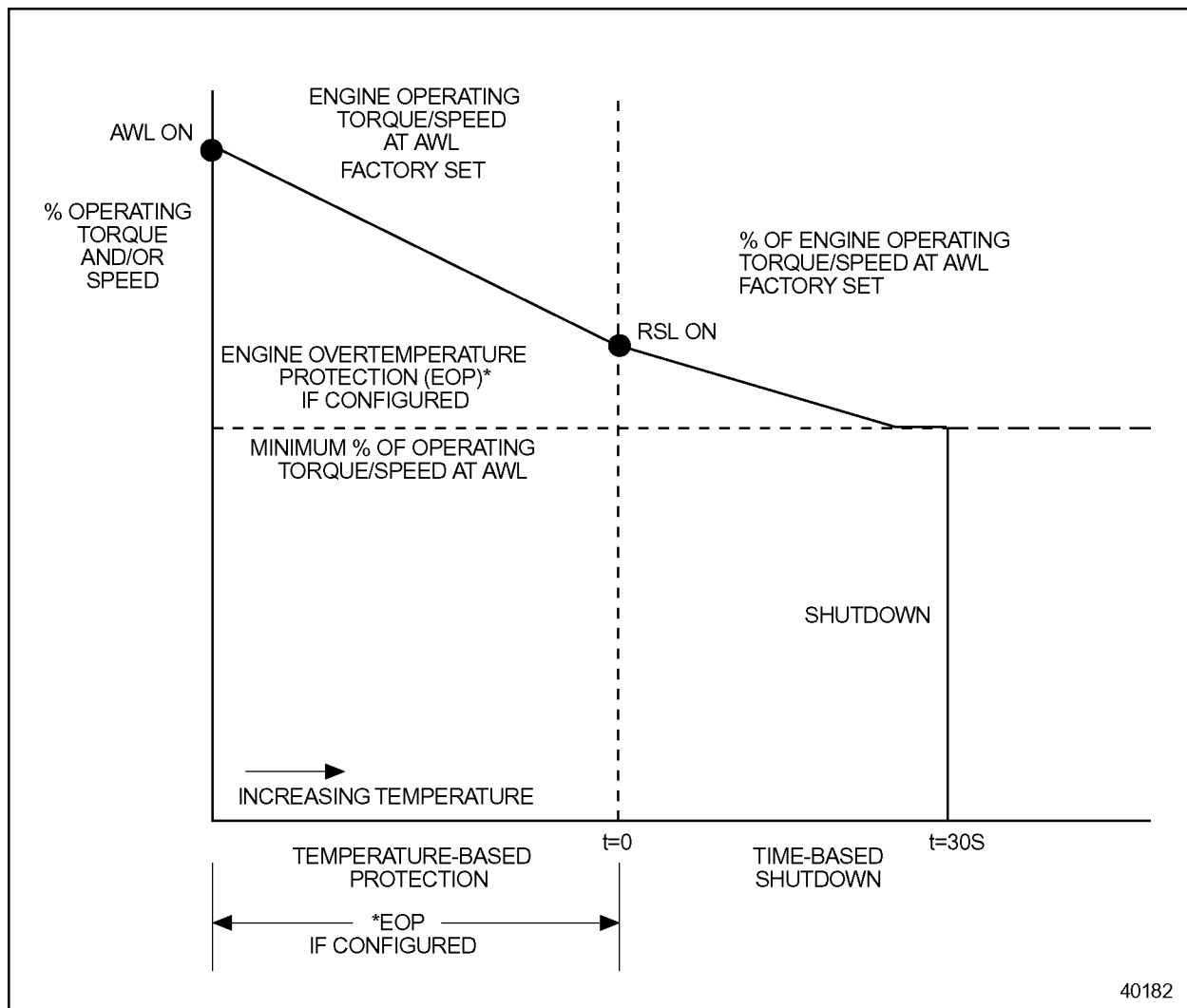


Figure 5-14 Engine Overtemperature Protection and Shutdown

Some Series 60 engines have additional logic to start the overtemperature torque reduction logic earlier without alerting the driver. Engine torque and/or speed is reduced as a function of temperature. A code is logged and torque reduction begins when the first EOP calibrated temperature is reached. The AWL illuminates and a DTC is logged when the second higher temperature limit is reached. If the temperature does not reduce as torque/speed is reduced, the RSL illuminates when a still higher temperature is reached.

The subsequent action taken by the ECU is the 30 second rampdown (see Figure 5-15) or shutdown (see Figure 5-16) depending on the customer selection. Torque/speed reduction is based on the average torque/speed in use prior to the fault condition.

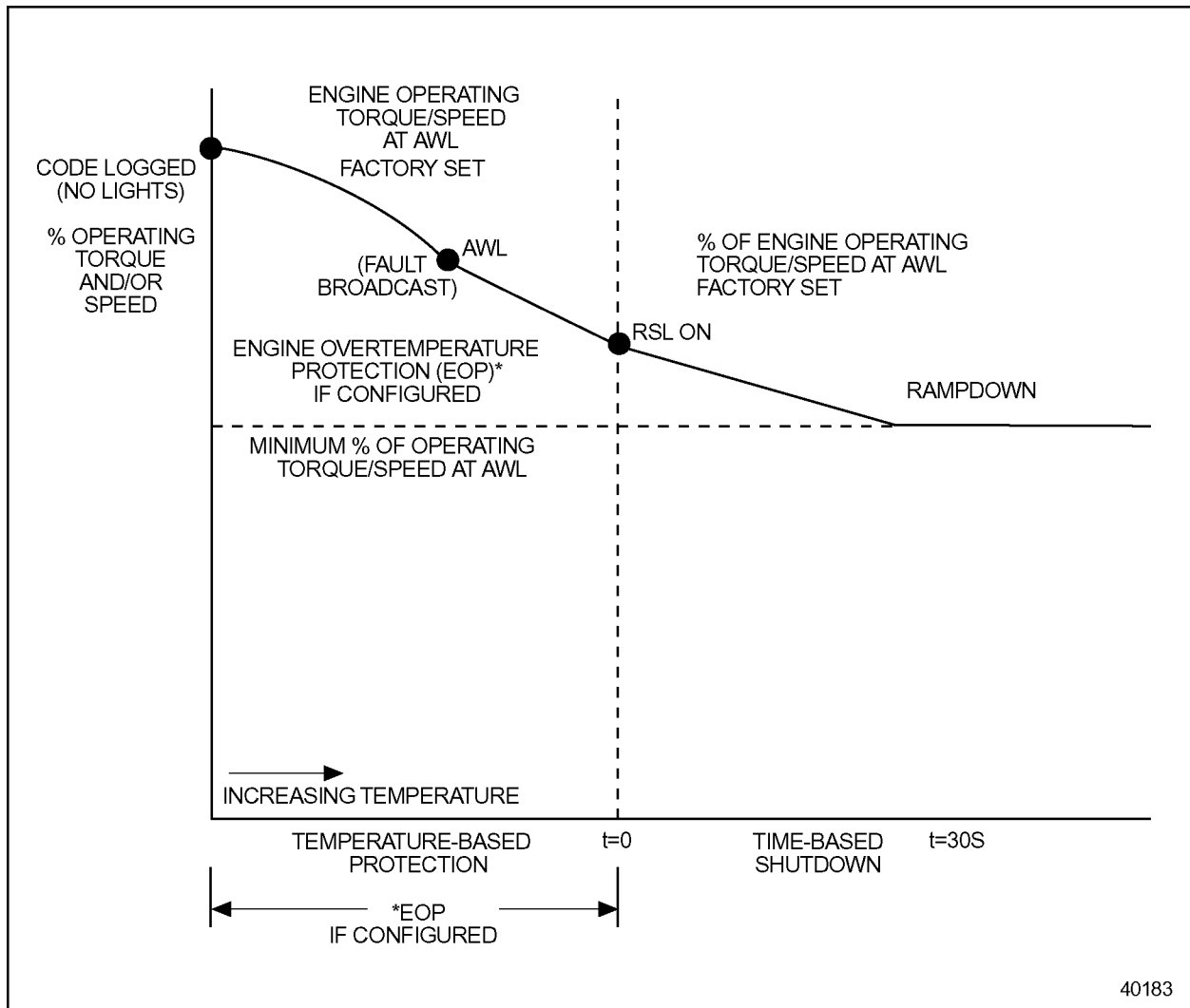


Figure 5-15 Series 60 Engine Overtemperature Protection and Rampdown

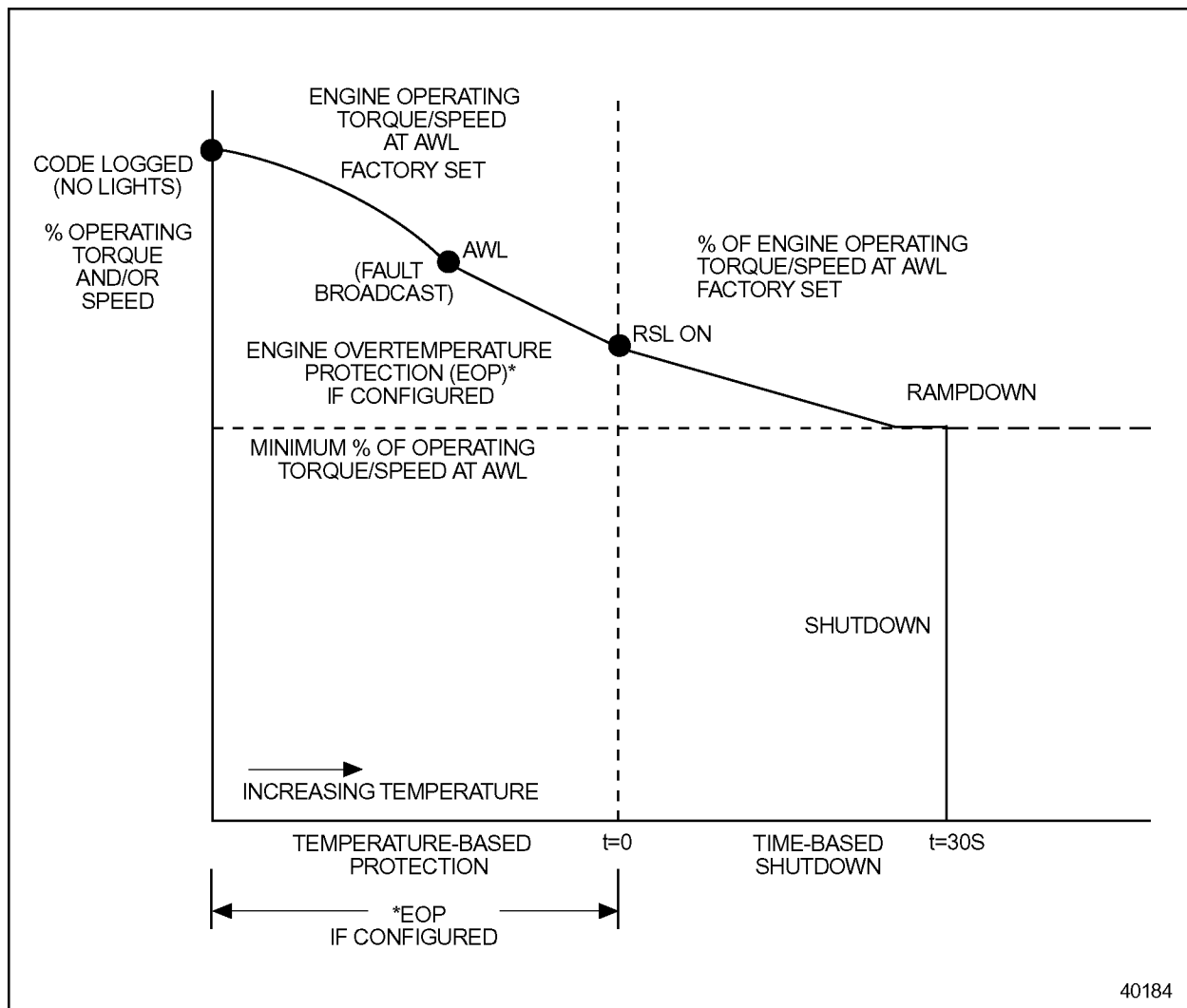


Figure 5-16 Series 60 Engine Overtemperature Protection and Shutdown

5.8.3 ENGINE PROTECTION SWITCHES

The SEO/Diagnostic Request Switch can be combined. A separate Diagnostic Request Switch is an option.

Diagnostic Request Switch

The Diagnostic Request Switch activates the AWL and RSL to flash codes (see Figure 5-17). The RSL flashes the active codes and the AWL flashes the inactive codes. The inactive codes flash in numerical order and the active codes flash in the order they occur, most recent to least recent. The Diagnostic Request Switch can also be used as the Stop Engine Override (SEO) Switch.

The Diagnostic Request Switch flashes codes when:

- ☐ The engine is not running and ignition is ON
- ☐ The engine is idling and not in an "engine protection" condition

Activating and releasing the switch will flash out the diagnostic codes for either condition. Activating and releasing the switch a second time stops the ECU from flashing the diagnostic codes. Codes also cease flashing when the engine is no longer at idle.

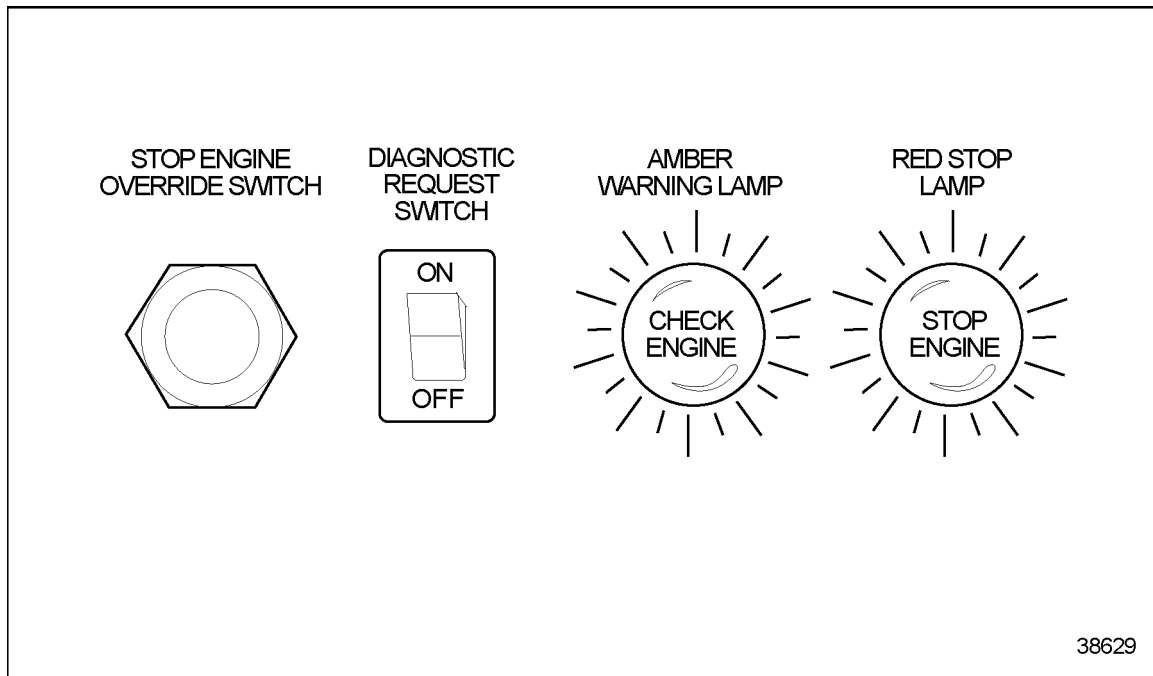


Figure 5-17 Typical SEO Switch, Diagnostic Request Switch and Warning Lamps

Flashing codes provide a two digit number (see Figure 5-18). This Diagnostic Trouble Code may cover several specific faults. It is provided to advise the operator of the general severity of the fault so the operator can decide if engine operation can continue without damaging the engine.

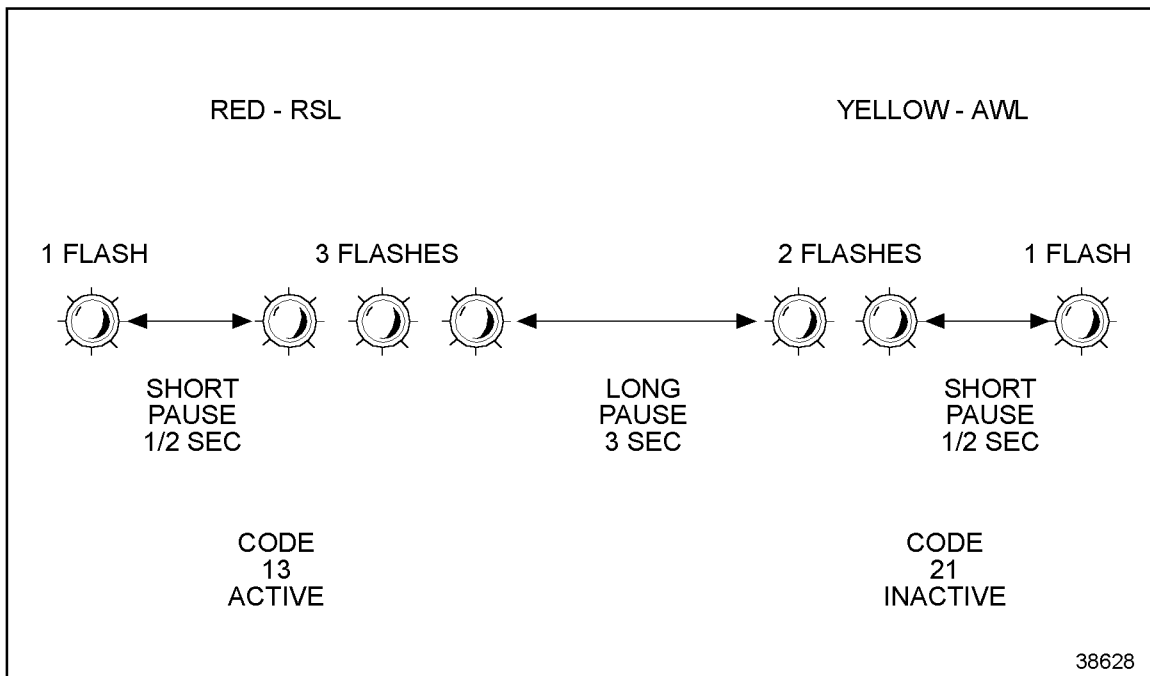


Figure 5-18 Flash Codes

5.8.4 STOP ENGINE OVERRIDE OPTIONS

Two types of stop engine overrides are available, Momentary Override and Continuous Override. Continuous Override has two options. These types are dependent upon specific engine applications. The ECU will record the number of times the override is activated after a fault occurs. Momentary or Continuous Override can be set by DDC Technical Service or at order entry.

Momentary Override - An SEO switch can override the shutdown sequence. This override resets the 30 second shutdown timer, restoring torque to the level when the RSL illuminated. The switch must be recycled after five seconds to obtain a subsequent override. See Figure 5-19.

NOTE:

The operator has the responsibility to take action to avoid engine damage.

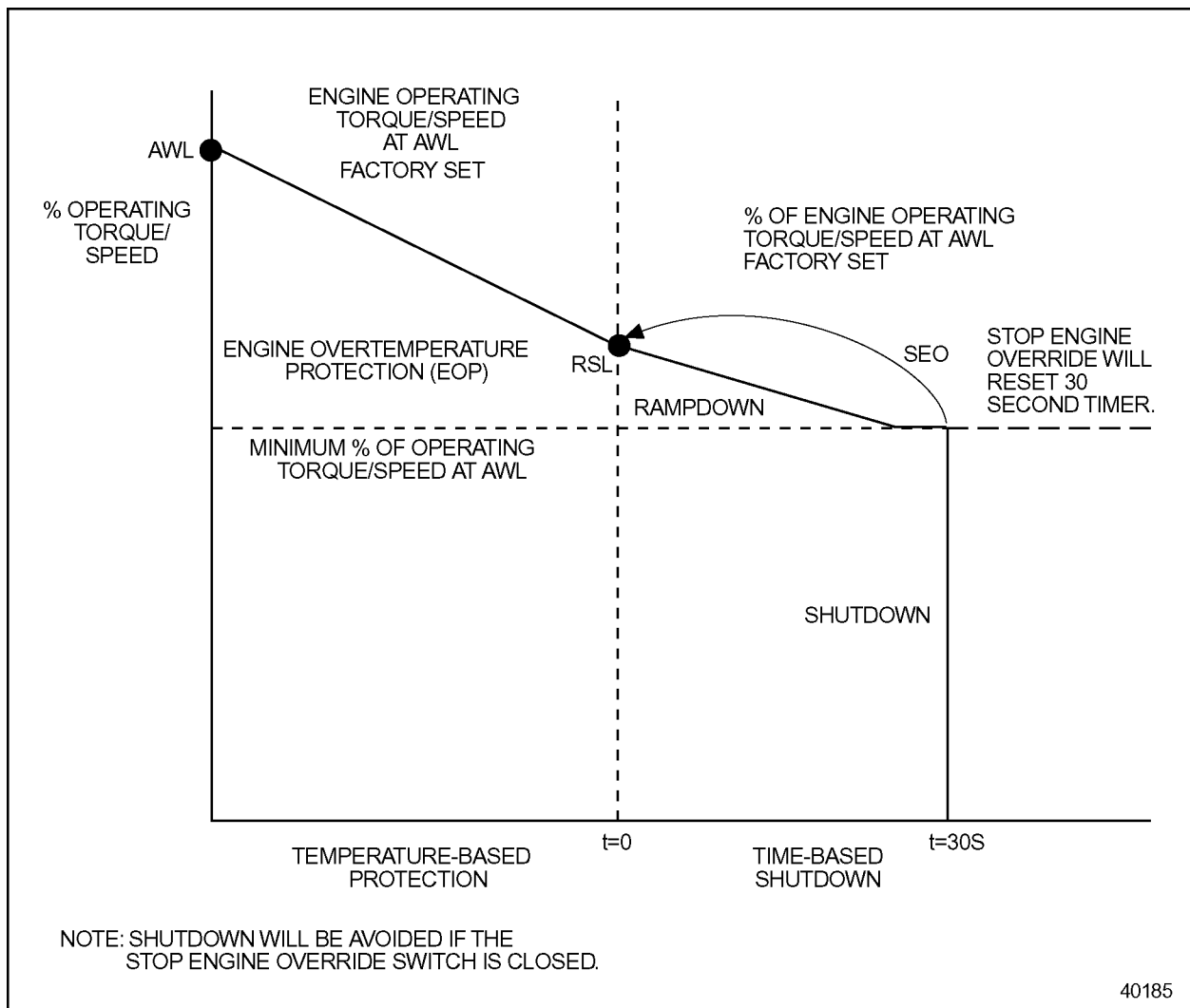


Figure 5-19 Engine Overtemperature Protection and Shutdown Protection with Stop Engine Override

Continuous Override, Option 1 -This option is available when the vehicle needs full power during a shutdown sequence. Full power capability is maintained while the override switch is pressed. This is intended for Bus/Coach applications only.

Continuous Override, Option 2 -This option, primarily used in construction and industrial applications, allows a one time continuous override of the shutdown sequence. Further engine protection is disabled until the ignition key is cycled. See Figure 5-20.

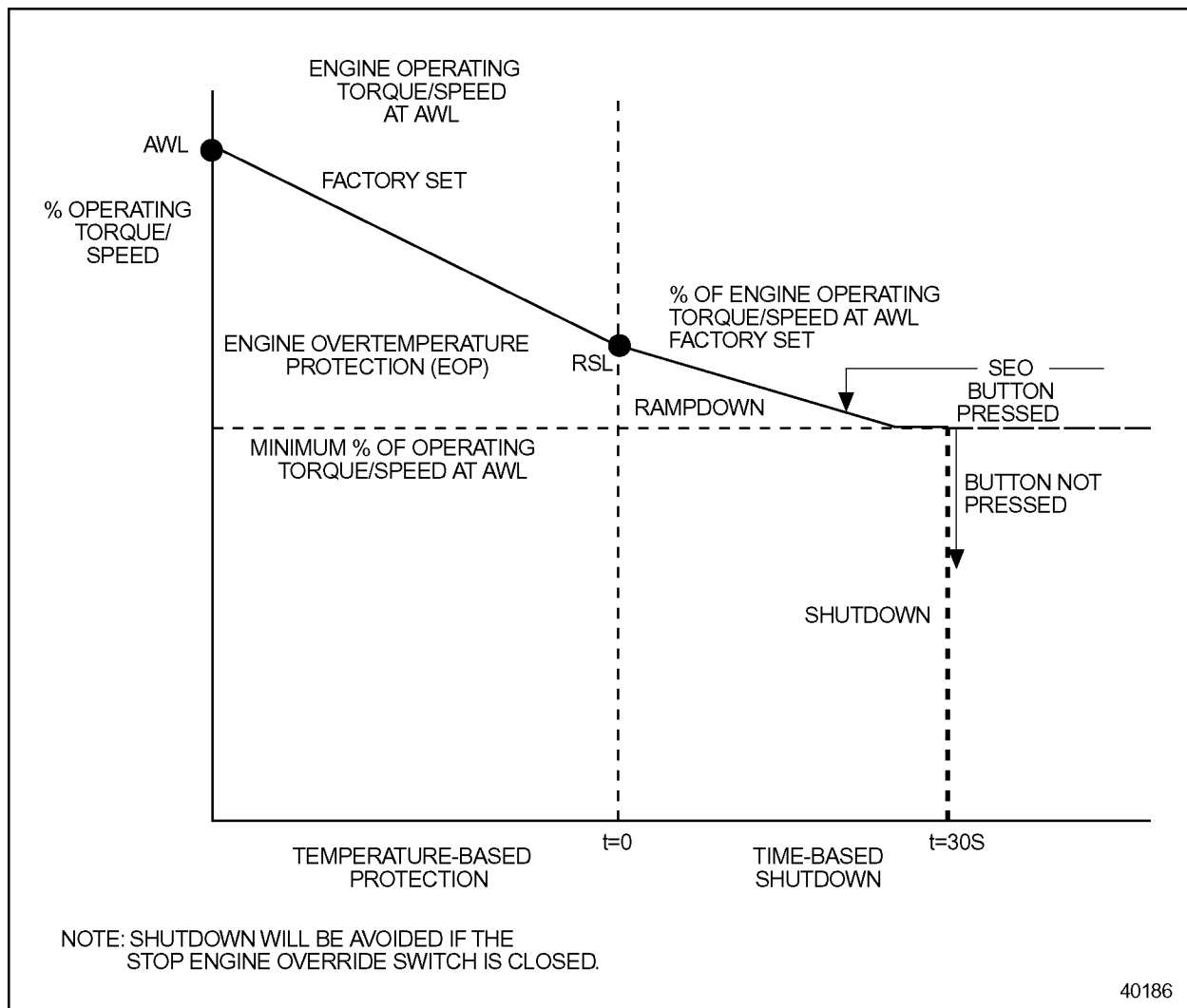


Figure 5-20 Engine Overtemperature Protection and Shutdown Protection with Continuous Override, Option 2

5.8.5 INSTALLATION

Some applications require two sets of warning lights (AWL and RSL) at different control stations.

5.8.6 PROGRAMMING FLEXIBILITY

All ECUs are programmed with pressure, temperature, and level protection limits. The level of protection can be any of the three engine protection features (Warning, Rampdown, or Shutdown) for each parameter monitored by the ECU. These can be set at time of order entry or with any of the available service tools, the Vehicle Electronic Programming System (VEPS), DDEC Reprogramming System (DRS), or DDDL.

The DDEC engine protection system monitors all engine sensors and electronic components, and recognizes system malfunctions. The choices listed in Table 5-20 are available for reprogramming Engine Protection.

Parameter	Definition	Choice
OIL PRESSURE	Determines the type of engine protection with low oil pressure.	WARNING, RAMPDOWN, SHUTDOWN
OIL LEVEL	Determines the type of engine protection with low oil level.	WARNING, RAMPDOWN, SHUTDOWN
COOLANT LEVEL	Determines the type of engine protection with low coolant level.	WARNING, RAMPDOWN, SHUTDOWN
OIL TEMP	Determines the type of engine protection with high oil temperature.	WARNING, RAMPDOWN, SHUTDOWN
COOLANT TEMP	Determines the type of engine protection with high coolant temperature.	WARNING, RAMPDOWN, SHUTDOWN
AUXILIARY SHUTDOWN 1	Determines the type of engine protection with an active auxiliary switch #1 input.	WARNING, RAMPDOWN, SHUTDOWN
AUXILIARY SHUTDOWN 2	Determines the type of engine protection with an active auxiliary switch #2 input.	WARNING, RAMPDOWN, SHUTDOWN

Table 5-20 Engine Protection**5.8.7 INTERACTION WITH OTHER FEATURES**

Cruise Control operation, Optimized Idle, and Pressure Sensor Governor (PSG) are disabled when the RSL is illuminated. Applications with both ALSG and VSG will revert to the primary governor.

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5.9 ENGINE RATINGS

Engine ratings are designated by horsepower rating and engine speed. For on-highway applications, three independent engine ratings and an additional dependent rating (cruise power) are provided. For construction and industrial applications, up to three independent ratings are provided. Although multiple ratings are stored in the ECU, only one rating is in operation at any time.

5.9.1 OPERATION

The engine rating may be selected with DDDL or OEM supplied rating switches. Detroit Diesel's method of designating engine ratings is listed in Table 5-21.

Example #1		Example #2	
445 bhp @ 1800 RPM	Rating #0	455 bhp @ 1800 RPM	Rating #0
435 bhp @ 1800 RPM	Rating #1	440 bhp @ 1800 RPM	Rating #1
425 bhp @ 1800 RPM	Rating #2	430 bhp @ 1800 RPM	Rating #2
425/445 bhp @ 1800 RPM	Rating #3	430/445 bhp @ 1800 RPM	Rating #3

Table 5-21 Examples of Engine Ratings

Detroit Diesel can provide additional security to prevent the ECU rating selection from being modified with DDDL. The additional security is not available with the use of rating switches. The Maximum Rating Security or the Rating Password (if configured) will protect DDEC V engine ratings.

Engine Rating Switches

Engine rating switches may be used to select any of the individual ratings (maximum of three) and the dependent rating. Engine rating switches are only offered on select horsepower group ratings. The rating switches must be used in conjunction with up to two digital inputs, Rating Switch #1 and Rating Switch #2.

Rating Switch #1 selects between Engine Rating #0 and Engine Rating #1 when used without Rating Switch #2 as listed in Table 5-22.

Rating	Switch #1 Position
Engine Rating #0	OFF
Engine Rating #1	ON

Table 5-22 Rating Selections with One Rating Switch

Rating Switch #2, in conjunction with Rating Switch #1, is used to select any of the four engine ratings (three independent and one dependent) as listed in Table 5-23.

Rating	Switch #1	Switch #2
Engine Rating #0	OFF	OFF
Engine Rating #1	ON	OFF
Engine Rating #2	OFF	ON
Engine Rating #3	ON	ON

Table 5-23 Rating Selections with Two Rating Switches

Cruise Power

Cruise Power is an optional engine rating which operates on a higher horsepower curve during Cruise Control operation. The ECU provides the higher horsepower when Cruise Control is ON and not being overridden with the foot pedal. The additional power provides an incentive for the driver to operate in Cruise Control.

Refer to section 5.3, "Cruise Control," for additional information about Cruise Power.

Limiting Torque Curve Option (Digital Torque Limiting)

The Limiting Torque Curve option provides the ability to operate the engine on a reduced torque curve when the appropriate digital input is enabled. Limiting torque curve tables are generated by Applications Engineering and can either be selected at the time of engine order or selected after engine order by DDC Technical Service.

The Limiting Torque Curve option use is shown in the following examples:

- Articulated Coach - The Limiting Torque Curve option is used to limit torque in an extreme articulated condition, which could occur during reverse operation.
- Transmission - The Limiting Torque Curve option provides a customized reduced torque curve during conditions which would otherwise exceed the maximum allowable torque limit set by the transmission manufacturer.
- Locomotive - The Limiting Torque Curve option provides a reduced torque to reduce wheel slip at low vehicle speed.

The following must be considered when using the Limiting Torque Curve option:

- The DDEC system cannot detect or display a malfunction of the digital input wiring.
- Limiting vehicle speed is best accomplished by utilizing DDEC's Vehicle Speed Limiting (VSL) feature. Refer to section 5.29.
- The % Load display on DDDL is a function of the main rating torque curve.
- ALSG droop is added to the speed limit.

5.9.2 INSTALLATION

The rating switches must be used in conjunction with up to two inputs, Rating Switch #1 and Rating Switch #2. Refer to section 4.1, "Digital and Analog Inputs," for additional information.

See Figure 5-21 for an installation using one rating switch.

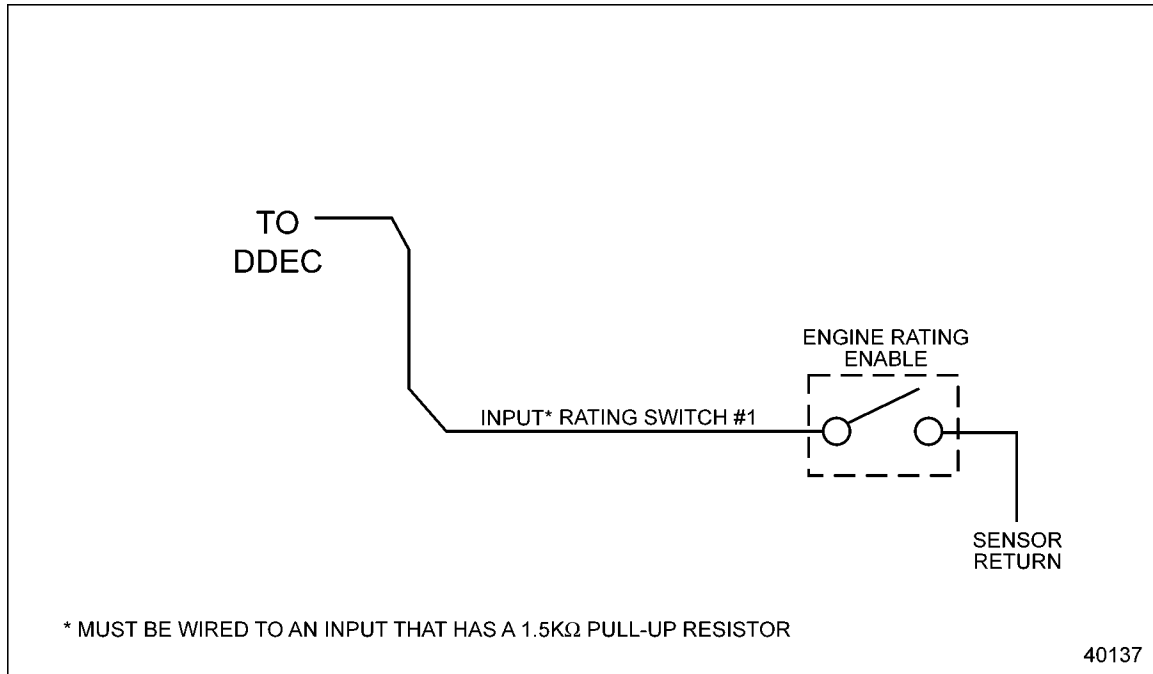


Figure 5-21 Simple Engine Rating Switch

See Figure 5-22 for an installation using two rating switches.

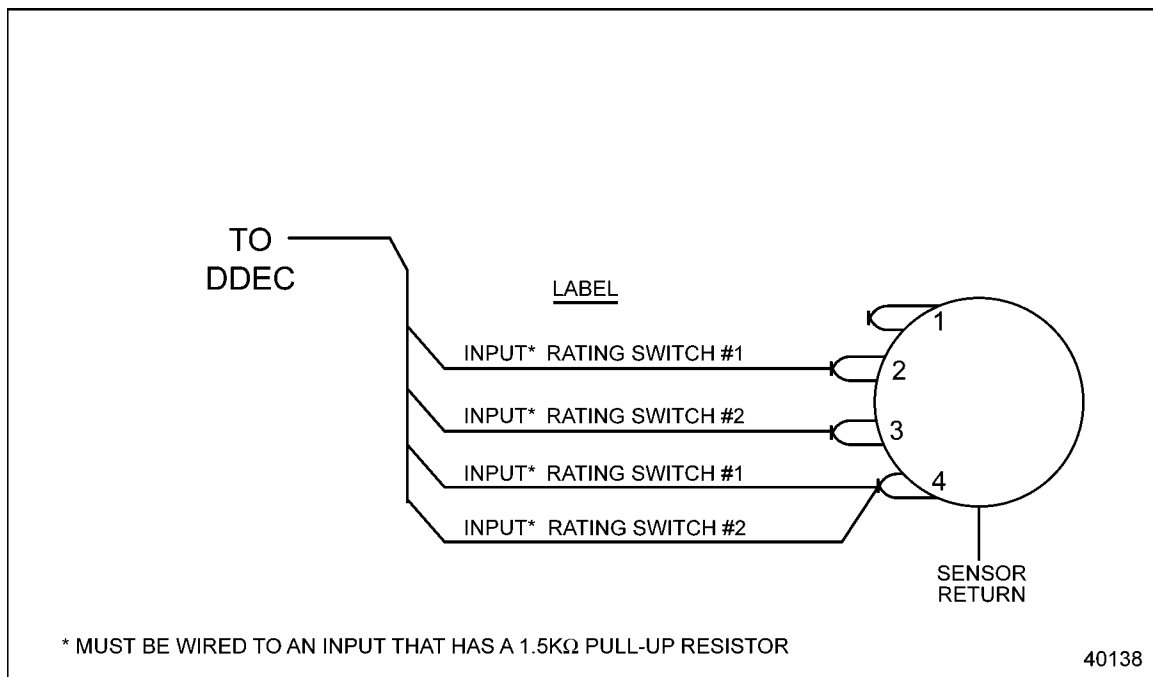


Figure 5-22 Rotary Switch for Multiple Engine Ratings

5.9.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The Maximum Rating Security to protect DDEC V engine rating must be enabled at the time of engine order entry. Maximum Rating Security locks out all other ratings and will only operate on the rating selected at order entry. DDDL cannot change a rating selection if the rating is maximum security protected.

The Rating Password is a four digit alphanumeric password that may be set at the time of engine order entry, by DDDL, or VEPS. This offers additional protection above and beyond the standard DDDL password protection.

Rating Switches

The Rating Switches option and the digital inputs listed in Table 5-24 must be configured by order entry, VEPS, or DRS.

Description	Type	Config ID
Rating Switch #1	Digital Input	4108
Rating Switch #2	Digital Input	4109

Table 5-24 Rating Switches Digital Input Requirements

Cruise Power

Cruise Power may be selected at the time of engine order, by VEPS, DDDL or using the engine rating switches.

Limiting Torque Option

Limiting Torque Curves must be selected at the time of engine order or selected after engine order by Technical Service.

The digital input listed in Table 5-25 must be configured by order entry, VEPS, or DRS.

Description	Type	Config ID
Limiting Torque Curve	Digital Input	4110

Table 5-25 Limiting Torque Curve Option Digital Input Requirements

5.10 ETHER START

The DDEC Ether Start System is a fully-automatic engine starting fluid system used to assist a DDEC equipped diesel engine in cold starting conditions. The amount of ether is properly controlled to optimize the starting process and prevent engine damage. DDEC will control ether injection using standard sensors to control the ether injection hardware.

A diesel engine must crank at a fairly high speed to start in cold weather. Worn out batteries, partially discharged batteries, and poor or loose cable connections will reduce the cranking speed. Cables and connections should be cleaned and tightened regularly, battery conditions should be maintained for optimum performance.

For an engine to start and keep running, fuel must flow through the injection system. Unblended diesel fuel no.2 "clouds," forming filter-clogging wax at temperatures around 15°F (-10°C), making starting and running impossible. DDC recommends that fuel have a cloud point at least 10°F (5°C), below the coldest anticipated temperature.

Engine lubricating oil gets thicker at lower temperatures. Many oils that flow freely at 70°F (-21°C) are extremely thick at 0°F (-18°C). Follow DDC's recommendations regarding oil viscosity for the coldest temperatures your engine will encounter.

5.10.1 OPERATION

Ether Start will occur in two modes, preload (before cranking) and block load (during and after cranking). The mode and duration of injection is determined by DDEC based on engine speed and coolant, air and oil temperatures. Since excessive preloading could be harmful to engine components, DDEC will not allow multiple preloads. The engine speed must exceed 1500 RPM to reset the preload.



WARNING:

FLAMES, EXPLOSION AND TOXICITY

To avoid injury from flames, explosion, and toxicants when using ether, the following precautions must be taken:

- ☐ **Do not smoke when servicing ether system.**
- ☐ **Work in well ventilated area.**
- ☐ **Do not work near open flames, pilot flames (gas or oil heaters), or sparks.**
- ☐ **Do not weld or carry an open flame near the ether system if you smell ether or otherwise suspect a leak.**

The system is composed of the DDEC ECU, Ether Injection Relay Module, ether canister, Dieselmatic valve, injection nozzle, metering orifice, nylon tubing, harness and miscellaneous hardware (see Figure 5-23).

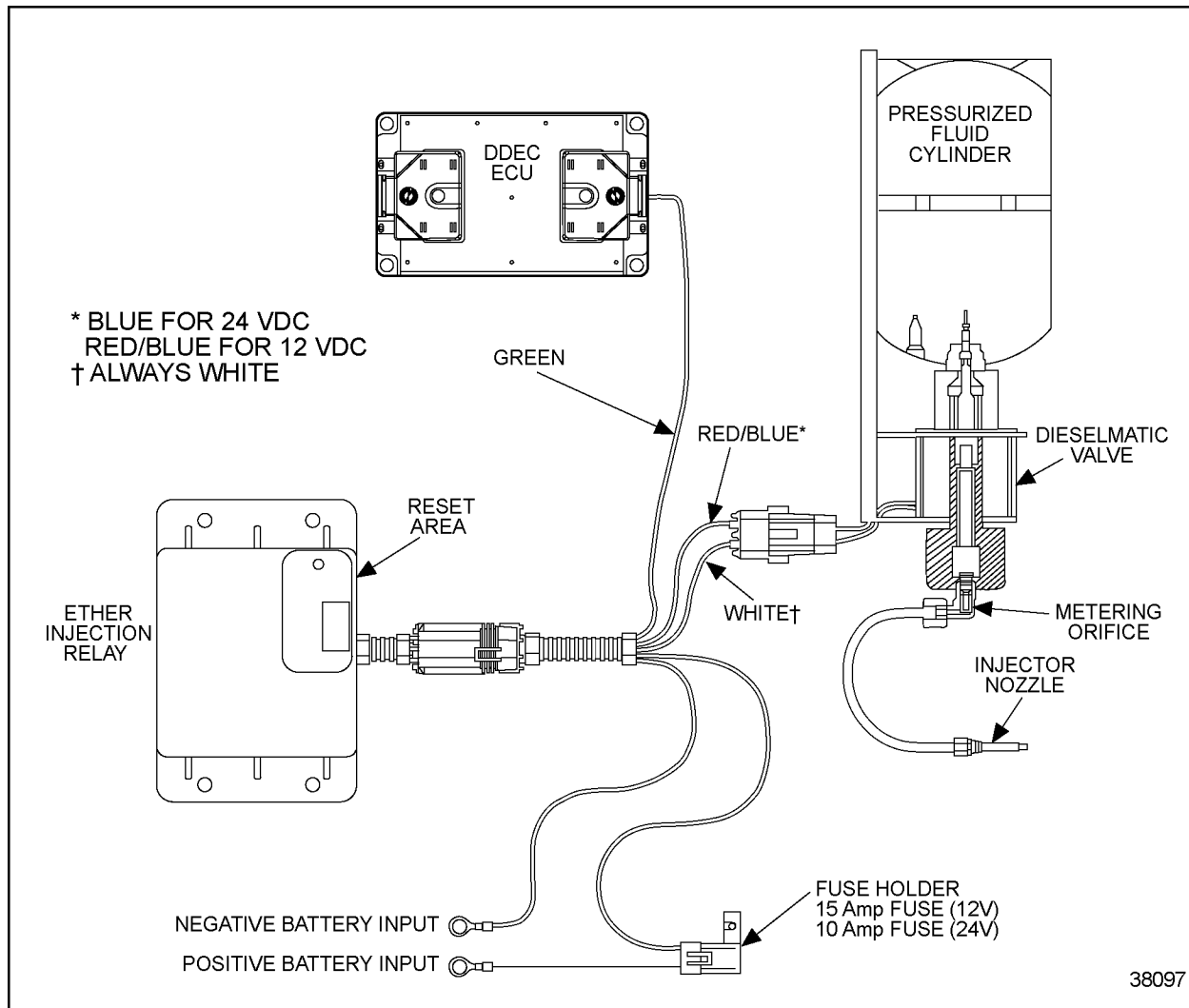


Figure 5-23 DDEC Ether Start System

The relay module performs a number of important functions. The module will not allow ether injection unless it receives a signal from DDEC, it will prevent ether injection in the event of a faulty signal, and it will illuminate a light on the module when the ether canister is 90% consumed.

If the digital output remains grounded for longer than a factory set time, the relay module will cause an inline fuse to blow to prevent excessive ether from being injected into the cylinders. If the output is shorted to ground, a code will be logged by DDEC and the Amber Warning Lamp (AWL) will be illuminated. The system does not operate without the fuse in place. The cause of the digital output short must be fixed before replacing the fuse.

5.10.2 INSTALLATION

Install the various components of Ether Start as described in the following sections.

Injector Nozzle

Install the injector nozzle in the correct location for proper operation. The proper location on the Series 60 engine is in the intake manifold. The manifold has a 1/4 in. NPT tapped hole for installation (see Figure 5-24).

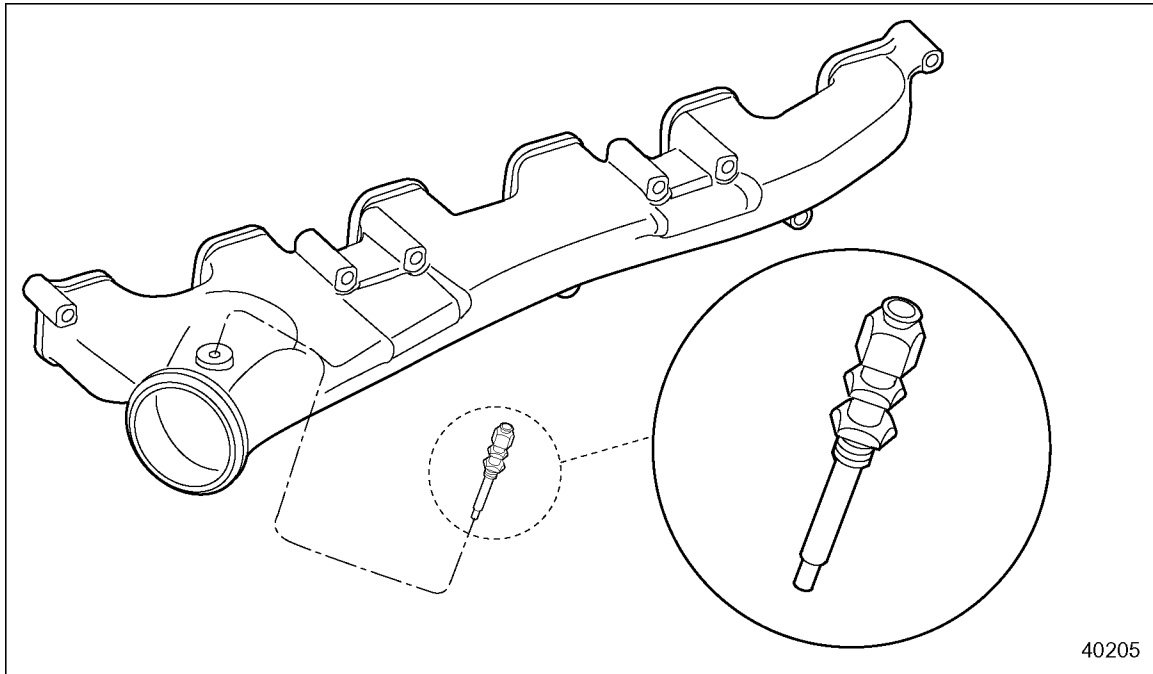


Figure 5-24 Series 60 Intake Manifold - Injector Nozzle Location

NOTICE:
Manifold preheat systems should be disconnected when the DDEC Ether Start System is used, as it can ignite starting fluid prematurely and cause engine damage.

To install the nozzle:

1. Remove the plug from the tapped hole.
2. Tighten nozzle with reducer bushing.
3. Ensure that the red dot, which indicates the direction of spray, is pointed against the airflow.

Valve and Cylinder Assembly

The cylinder assembly should be mounted vertically in an accessible location away from extreme heat such as the exhaust system and protected from road dirt, ice and snow. If protected, it can be mounted in the engine compartment on the firewall, frame or any other convenient location.

NOTICE:

Do not mount the unit on the engine or drive train because excessive vibration can cause premature failure.

It is recommended that the assembly is mounted vertically although the assembly does not have to be mounted in a direct upright position. Some usable fluid will not be dispensed if the assembly is tipped too far from vertical. The reduction in usable fluid is listed in Table 5-26.

Angle from Vertical, degrees	Usable Fluid
22.5	92%
45	89%
57	83%
70	75%
90	28%

Table 5-26 Reduction in Usable Fluid When Not Mounted Vertically

NOTE:

The low cylinder indicator light will not be accurate for cylinders tipped more than 22.5 degrees from vertical.

When selecting a mounting location, do the following:

1. Hold the assembly in place to determine if it will clear the hood and other movable parts.
2. Check that the distance from the assembly's bottom to the nozzle location does not exceed the length of tubing provided. Ensure that there is adequate clearance to change the fluid cylinder after installation.
3. The mounting plate may be used as a template, but a paper template is provided in this manual. If the mounting plate is used and the cylinder is removed from the valve, the top of the valve should be protected from debris by installing the plastic valve cap.

NOTE:

Four-point mounting is recommended for maximum resistance to vibration. Mounting point locations should be spaced symmetrically about the center of mass, above and below the "X" axis. See Figure 5-25 and Figure 5-26.

4. Four bolts, lock washers (or jam nuts), and nuts are provided for mounting the valve and cylinder assembly.
5. Space the mounting bolts as widely apart as possible to eliminate any unnecessary vibration of the unit.
6. Center punch and drill the holes for mounting.
7. Bolt the assembly into place.



WARNING:
FIRE AND TOXICITY

Some pressurized fluid may be trapped in the system. To avoid personal injury, loosen all connections slowly to avoid contact with fluid. When required, spray fluid into a proper container. The engine starting fluid used in DDEC Ether Start Systems contains extremely flammable and toxic substances.

8. If the mounting plate was used as a template, the starting fluid cylinder should be properly installed back onto the valve by turning the cylinder in the direction of the arrow (clockwise) until the cylinder dirt and moisture seal (O-ring) contacts the valve.
9. Tighten the cylinder an additional 1½ turns (540°).
10. Check that the cylinder clamp is tightened.

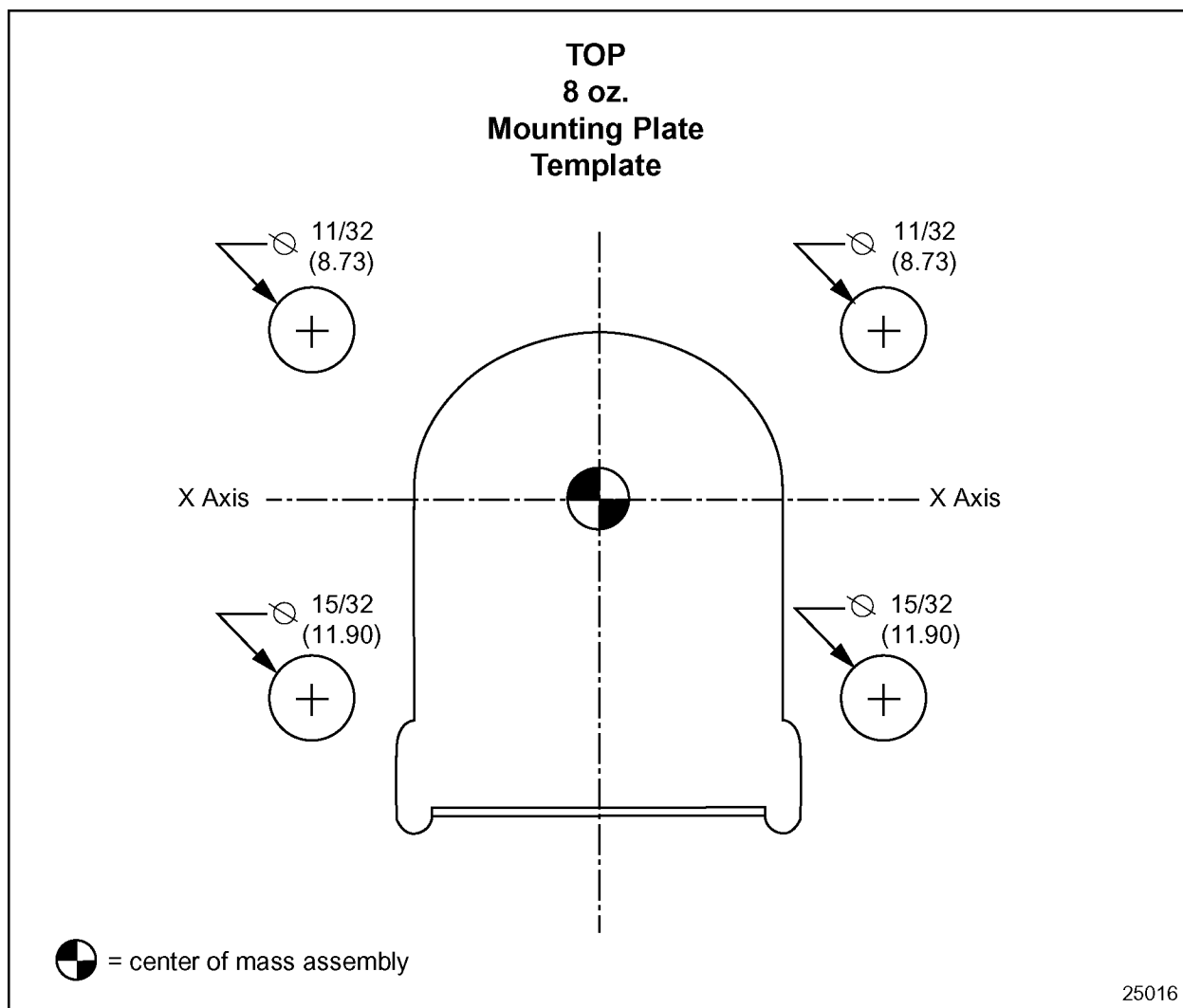


Figure 5-25 Valve Assembly 8 oz

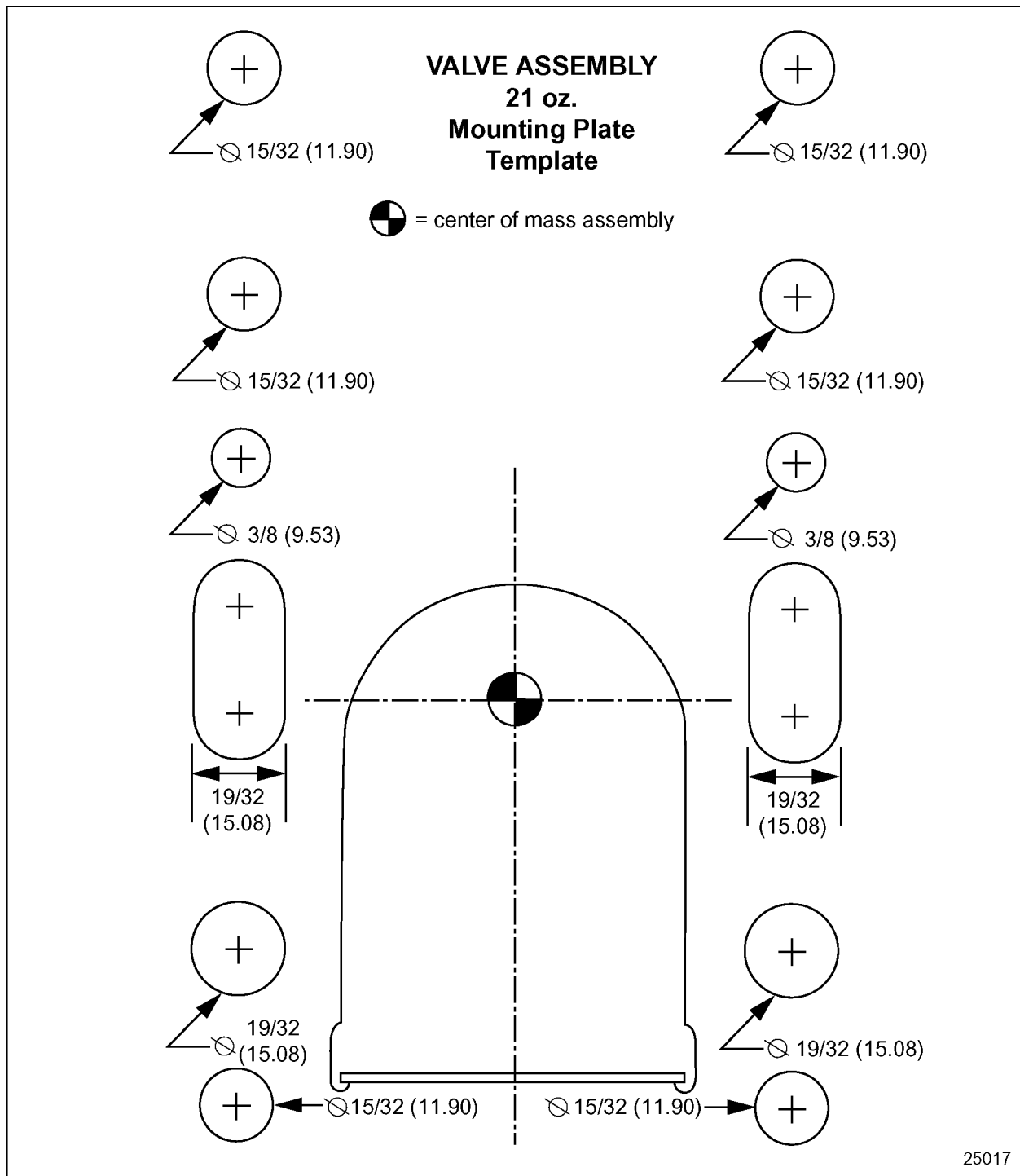


Figure 5-26 Valve Assembly 21 oz

Ether Injection Relay

The Ether Injection Relay (EIR) should be located near the valve and cylinder assembly. The EIR connector is designed to use 18 AWG wire to the DDEC digital output and 16 SXL wire for all other connections. The wire from the valve and cylinder assembly to the power source should be sized as listed in Table 5-27.

Length from Valve and Cylinder Assembly to Battery or Bus Bar (ft)	Minimum Wire Size (ga)
0 to 12	16
1 to 19	14
1 to 31	12
1 to 50	10
1 to 79	8
1 to 126	6

Table 5-27 Wire Length for Valve and Cylinder Assembly to the Power Source

1. When selecting a location, hold the EIR in place to determine if it will clear the hood and other movable parts.

NOTE:

Four-point mounting is recommended for maximum resistance to vibration.

2. Four bolts, lock washers (or jam nuts), and nuts are provided for mounting the valve and cylinder assembly. Space the mounting bolts as widely apart as possible to eliminate any unnecessary vibration of the unit.
3. Center punch and drill the holes, using the dimensions on the template, for mounting. Bolt the assembly into place.

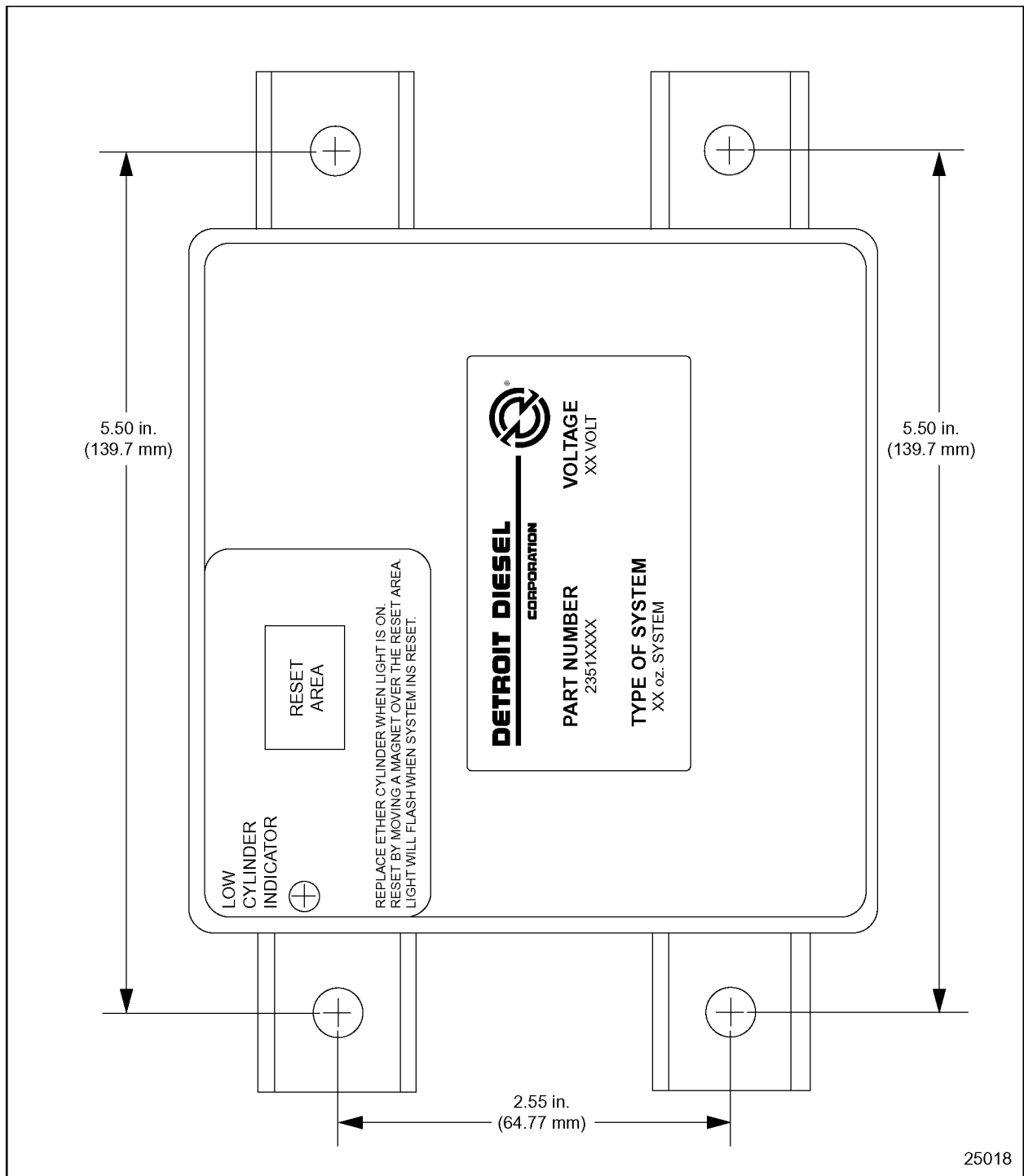


Figure 5-27 EIR Template

Tubing and Metering Orifice

The DDEC Ether Start System's "metered flow" feature is controlled by the special (metering orifice) fitting which has to be installed into the bottom of the valve.

NOTICE:

Nylon tubing length must not be shorter than two feet to assure the proper vaporization of the starting fluid as it is propelled from the metering orifice to the injector nozzle.

1. The metering orifice end that is to be inserted into the bottom of the valve has left-hand dry seal threads. Install this end into the valve, finger tight.
2. Seal insertion by tightening the fitting with a wrench approximately one to two turns, depending on desired orientation.
3. A length of protective sheathing for the nylon tubing, to protect the nylon tubing from chafing, has been supplied in your kit. Be sure to insert the nylon tubing into the sheathing prior to connecting the tubing to the metering orifice and to the nozzle.
4. Route nylon tubing from the metering orifice installed in the valve to the nozzle installed in the intake manifold in such a way that it does not come in contact with the exhaust system.
5. Ensure that the tubing will not be damaged by vibration or by the engine enclosure, etc. Avoid contact with all objects that may cut or wear the tubing. If tubing is cut to a shorter length, be sure to cut it squarely. A bias cut may cause leaks or cause it to disconnect since the nut sleeve will not seal properly.
6. When connecting the tubing to the metering orifice and to the nozzle, keep the tubing fully seated while tightening the nut.
 - [a] Avoid over tightening since the sleeve can become distorted or collapsed, restricting fluid flow through the tubing.
 - [b] The nut should be tightened approximately one (1) turn after it is finger tight.
7. Check all fittings and tubing connections for leaks and make sure they are secure.

Wiring Harness

NOTICE:

The standard DDEC Ether Start solenoid valve assembly is not a continuous-duty type solenoid design. Any deviation from the standard wiring circuit which would allow prolonged activation of the solenoid valve, may result in premature valve failure. Contact DDC directly for any unique applications you may have.

The EIR controls the ether valve. The EIR receives a signal from DDEC V when the engine (oil and coolant) and air temperatures indicate the need for ether. This signal is provided to the module by a digital output from DDEC V. The digital output provides a ground when ether should be injected into the engine. The EIR requires a constant power supply even when the ignition is turned off in order to preserve the memory of the amount of ether used. There is an internal backup circuit that allows the EIR to retain its memory for 72 hours without a battery connection. If the battery is disconnected for longer than 72 hours, the EIR will reset. The ether cylinder should be replaced to synchronize the counter with the amount of ether left in the cylinder.

The EIR connector is designed to accept 18 gauge GXL to the DDEC digital output. 16 gauge SXL (0.95 - 1.0 mm²) is standard wall thickness cable for all other connections.

Connect the wiring as follows:

1. Disconnect the battery.
2. Connect pin D of the EIR to the pin B on the valve and cylinder assembly.
3. Connect pin E of the EIR to pin A on the valve and cylinder assembly.
4. Connect pin A of the EIR to pin B of the fuse holder. Confirm that the EIR matches the voltage of the system. P/N 23517772 and 23517780 are for 12 VDC systems and P/N 23517775 and 23517781 are for 24 VDC systems.
5. Connect pin A of the fuse holder to battery positive.
6. Insert the fuse (15 Amp fuse on 12 V systems, 10 Amp fuse on 24 V systems) into the holder and replace the cover onto the fuse holder.
7. Connect pin B of the EIR to battery ground.
8. Reconnect the battery.

NOTICE:

Use <i>only</i> battery ground to reduce electrical noise from other systems. An improper connection may damage the EIR.

9. Test the valve before connecting the remaining wire to the EIR. With the fluid cylinder installed on the valve, activate the EIR by momentarily touching pin C of the EIR to battery ground. Ether will spray from the bottom of the valve if the valve is functioning.

**CAUTION:**

To avoid personal injury, spray the fluid from the bottom of the valve into an appropriate container. The engine starting fluids used in DDEC Ether Start Systems contain ethyl and is extremely flammable and toxic.

NOTICE:

To prevent damage to internal seals in the DDEC Ether Start valve, do not repeat this procedure more than twice.

10. Connect pin C of the EIR to the DDEC V ECU output pin for ether start.
11. Secure wiring with wire ties.
12. Check all connections for proper crimping and insulation.

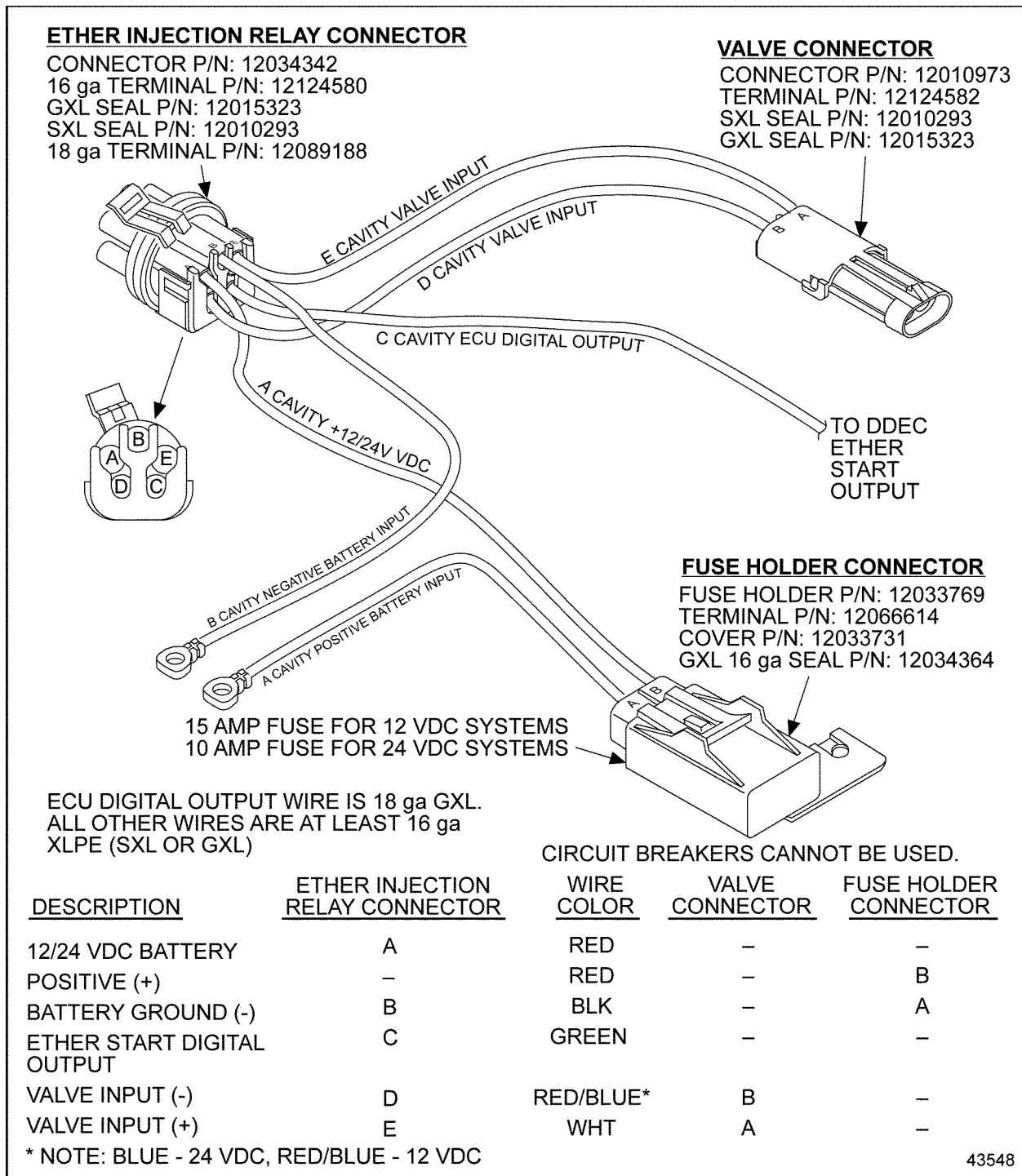


Figure 5-28 DDEC Ether Start Harness

5.10.3 PARTS

There are several kits that allow for OEM or after-market installation of Ether Start.

OEM – Ether Start Kits for the Series 60 Engines

The OEM Ether Start Kits, kit components, and part numbers are listed in Table 5-28, Table 5-29, Table 5-30, and Table 5-31.

Series 50/60 Ether Start 8 oz, 12 V Kit – PN: 23517766		
Part Number	Description	Quantity
23517770	Valve Kompac 12 V 740 CID Ether Cold Start	1
23517705	Clamp Cyl 3 inch Ether Cold Start	1
23517696	Blockor AMS .21mm Ether Cold Start	1
23517771	Nozzle Inj 1/4 stght Ether Cold Start	1
23517772	Module Kompac 12 V CIM Ether Cold Start	1
23518508	Label Ether Start Air Filter	1

Table 5-28 OEM – DDEC Ether Start 8 oz, 12 Volt Kit

Series 50/60 Ether Start 21 oz, 12 V Kit – PN: 23517768		
Part Number	Description	Quantity
23517776	Valve DM 12 V 740 CID Ether Cold Start	1
23517706	Clamp Cyl 4 inch Ether Cold Start	1
23517696	Blockor AMS .21mm Ether Cold Start	1
23517771	Nozzle Inj 1/4 stght Ether Cold Start	1
23517780	Module DM 12 V CIM Ether Cold Start	1
23518508	Label Ether Start Air Filter	1

Table 5-29 OEM – DDEC Ether Start 21 oz, 12 Volt

Series 50/60 Ether Start 8 oz, 24 V Kit – PN: 23517767		
Part Number	Description	Quantity
23517773	Valve Kompac 24 V 740 CID Ether Cold Start	1
23517705	Clamp Cyl 3 inch Ether Cold Start	1
23517696	Blockor AMS .21mm Ether Cold Start	1
23517771	Nozzle Inj 1/4 stght Ether Cold Start	1
23517775	Module Kompac 24 V CIM Ether Cold Start	1
23518508	Label Ether Start Air Filter	1

Table 5-30 OEM – DDEC Ether Start 8 oz, 24 Volt

Series 50/60 Ether Start 21 oz, 24 V Kit – PN: 23517769		
Part Number	Description	Quantity
23517779	Valve DM 24 V 740 CID Ether Cold Start	1
23517706	Clamp Cyl 4 inch Ether Cold Start	1
23517696	Blockor AMS .21mm Ether Cold Start	1
23517771	Nozzle Inj 1/4 stght Ether Cold Start	1
23517781	Module Kompac 24 V CIM Ether Cold Start	1
23518508	Label Ether Start Air Filter	1

Table 5-31 OEM – DDEC Ether Start 21 oz, 24 Volt**After-market Ether Start Kits for the Series 50 and Series 60 Engines**

The Series 50/60 engine Ether Start After-market Kit (8 oz., 12 V) contains three kits that may be ordered separately. The all inclusive kit and parts are listed in Table 5-32. The separated kits and their parts are listed in Table 5-33, Table 5-34, and Table 5-35.

Part Number	Description	Quantity
23517766	Kit DDEC Ether Start 8 oz, 12 V	1
23519066	Kit Tubing Aftermarket Ether Start	1
23519064	Kit Aftermarket Misc. Parts	1
7SA727	DDEC Ether Start System Installation Manual	1

Table 5-32 DDEC Ether Start After-market All Inclusive Kit 8 oz, 12 V, P/N: 23518052

Part Number	Description	Quantity
23517770	Valve Kompac 12 V 740 CID Ether Cold Start	1
23517705	Clamp Cyl 3 inch Ether Cold Start	1
23517696	Blockor AMS .21mm Ether Cold Start	1
23517771	Nozzle Inj 1/4 stght Ether Cold Start	1
23517772	Module Kompac 12 V CIM Ether Cold Start	1
23518508	Label Ether Start Air Filter	1

Table 5-33 DDEC Ether Start After-market Kit 8 oz, 12 V, P/N: 23517766

Part Number	Description	Quantity.
23519059	Tubing Teflon 10' Ether Start	1
23517707	Wire Protector Tubing 10' Ether Start	1
23519123	Nut & Sleeve Ether Tubing Kit	2

Table 5-34 DDEC Ether Start After-market Tubing Kit 8 oz, 12 V, P/N: 23519066

Part Number	Description	Quantity.
12004008	Fuse 15 A DDEC 3	1
12033769	Connector 2 way 630 Metri-Pack Fuse	1
12066614	Terminal 10 Female 12 Ga 630	2
12033731	Cover Fuse Holder DDEC	1
12089045	Ring Terminal 16 Ga	2
12124582	Terminal EEC Governor Male	2
12010293	Seal Cable Weather-Pack 280	2
12010973	Connector DDEC Wire Harness	1
12047680	Terminal Metri Pack 150 Series	1
23517722	Hardware Mtg 5/16-18 Ether Start	1
23517680	Hardware Mtg 3/8-16 Ether Start	1
23518066	Harness DDEC Ether Start 12 V	1
23518068	Conduit Convoluted 10' Ether Start	1

Table 5-35 DDEC Ether Start After-market Misc. Parts Kit 8 oz, 12 V, P/N: 23519064

The Series 50/60 engine Ether Start After-market Kit (8 oz., 24 V) contains three kits that may be ordered separately. The all inclusive kit and parts are listed in Table 5-36. The separated kits and their parts are listed in Table 5-37, Table 5-38, and Table 5-39.

Part Number	Description	Quantity
23517767	Kit DDEC Ether Start 8 oz, 24 V	1
23519066	Kit Tubing Aftermarket Ether Start	1
23519065	Kit Aftermarket Misc. Parts	1
7SA727	DDEC Ether Start System Installation	1

Table 5-36 DDEC Ether Start After-market All Inclusive Kit 8 oz, 24 V, P/N: 23518053

Part Number	Description	Quantity
23517773	Valve Kompac 24 V 740 CID Ether Cold Start	1
23517705	Clamp Cyl 3 inch Ether Cold Start	1
23517696	Blockor AMS .21mm Ether Cold Start	1
23517771	Nozzle Inj 1/4 stght Ether Cold Start	1
23517775	Module Kompac 24 V CIM Ether Cold Start	1
23518508	Label Ether Start Air Filter	1

Table 5-37 DDEC Ether Start After-market Kit 8 oz, 24 V, P/N: 23517767

Part Number	Description	Quantity
23519059	Tubing Teflon 10' Ether Start	1
23517707	Wire Protector Tubing 10' Ether Start	1
23519123	Nut & Sleeve Ether Tubing Kit	2

Table 5-38 DDEC Ether Start After-market Kit Tubing Kit 8 oz, 24 V, P/N: 23519066

Part Number	Description	Quantity
12004007	Fuse 10 A DDEC 3	1
12033769	Connector 2 way 630 Metri-Pack Fuse	1
12066614	Terminal 10 Female 12 Ga 630	2
12033731	Cover Fuse Holder DDEC	1
12089045	Ring Terminal 16 Ga	2
12124582	Terminal EEC Governor Male	2
12010293	Seal Cable Weather-Pack 280	2
12010973	Connector DDEC Wire Harness	1
12047680	Terminal Metri-Pack 150 Series	1
23517722	Hardware Mtg 5/16-18 Ether Start	
23517680	Hardware Mtg 3/8-16 Ether Start	1
23518067	Harness DDEC Ether Start 24 V	1
23518068	Conduit Convoluted 10' Ether Start	1

Table 5-39 DDEC Ether Start After-market Misc. Parts Kit 8 oz, 24 V, P/N: 23519065

The Series 50/60 engine Ether Start After-market All Inclusive Kit (21 oz., 12 V) contains three kits that may be ordered separately. The all inclusive kit and parts are listed in Table 5-40. The separated kits and their parts are listed in Table 5-41, Table 5-42, and Table 5-43.

Part Number	Description	Quantity
23517768	Kit DDEC Ether Start 21 oz, 12 V	1
23519066	Kit Tubing Aftermarket Ether Start	1
23519064	Kit Aftermarket Misc. Parts	1
7SA727	DDEC Ether Start System Installation	1

Table 5-40 DDEC Ether Start After-market All Inclusive Kit 21 oz, 12 V, P/N: 23518054

Part Number	Description	Quantity
23517776	Valve DM 12V 740 CID Ether Cold Start	1
23517706	Clamp Cyl 4 inch Ether Cold Start	1
23517696	Blockor AMS .21mm Ether Cold Start	1
23517771	Nozzle Inj 1/4 stght Ether Cold Start	1
23517780	Module DM 12V CIM Ether Cold Start	1
23518508	Label Ether Start Air Filter	1

Table 5-41 DDEC Ether Start After-market Kit 21 oz, 12 V, P/N: 23517768

Part Number	Description	Quantity
23519059	Tubing Teflon 10' Ether Start	1
23517707	Wire Protector Tubing 10' Ether Start	1
23519123	Nut & Sleeve Ether Tubing Kit	2

Table 5-42 DDEC Ether Start After-market Tubing Kit 21 oz, 12 V, P/N: 23519066

Part Number	Description	Quantity
12004008	Fuse 15 A DDEC 3	1
12033769	Connector 2 way 630 Metri-Pack Fuse	1
12066614	Terminal 10 Female 12 Ga 630	2
12033731	Cover Fuse Holder DDEC	1
12089045	Ring Terminal 16 Ga	2
12124582	Terminal EEC Governor Male	2
12010293	Seal Cable Weather-Pack 280	2
12010973	Connector DDEC Wire Harness	1
12047680	Terminal Metri-Pack 150 Series	1
23517722	Hardware Mtg 5/16-18 Ether Start	1
23517680	Hardware Mtg 3/8-16 Ether Start	1
23518066	Harness DDEC Ether Start 12 V	1
23518068	Conduit Convuluted 10' Ether Start	1

Table 5-43 DDEC Ether Start After-market Misc. Parts Kit 21 oz, 12 V, P/N: 23519064

The Series 50/60 engine Ether Start After-market All Inclusive Kit (21 oz., 24 V) contains two kits that may be ordered separately. The all inclusive kit and parts are listed in Table 5-44. The separated kits and their parts are listed in Table 5-45, and Table 5-46.

Part Number	Description	Quantity
23517769	Kit DDEC Ether Start 21 oz, 12 V	1
23519066	Kit Tubing Aftermarket Ether Start	1

Table 5-44 DDEC Ether Start After-market All Inclusive Kit 21 oz, 24 V, P/N: 23519063

Part Number	Description	Quantity
23517779	Valve DM 24V 740 CID Ether Cold Start	1
23517706	Clamp Cyl 4 inch Ether Cold Start	1
23517696	Blockor AMS .21mm Ether Cold Start	1
23517771	Nozzle Inj 1/4 stght Ether Cold Start	1
23517781	Module DM 24V CIM Ether Cold Start	1
23518508	Label Ether Start Air Filter	1

Table 5-45 DDEC Ether Start After-market Kit 21 oz, 24 V, P/N: 23517769

Part Number	Description	Quantity
23519059	Tubing Teflon 10' Ether Start	1
23517707	Wire Protector Tubing 10' Ether Start	1
23519123	Nut & Sleeve Ether Tubing Kit	2

Table 5-46 DDEC Ether Start After-market Tubing Kit 21 oz, 24 V, P/N: 23519066

5.10.4 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

To configure an engine for Ether Injection, digital output function number 24 must be selected with the Vehicle Electronic Programming System (VEPS), DDEC Reprogramming System (DRS), or on engine order entry. The digital output may be wired to any available digital output pin on the Vehicle Interface Harness. This feature does not have any reprogrammable parameters.

5.10.5 DIAGNOSTICS

If the digital output remains grounded for longer than a factory set time, the relay module will cause an inline fuse to blow to prevent excessive ether from being injected into the cylinders. If the output is shorted to ground, a code will be logged by DDEC and the AWL will be illuminated. The system does not operate without the fuse in place. The cause of the digital output short must be fixed before replacing the fuse.

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5.11 FAN CONTROL

The purpose of the Fan Control feature is to electronically control engine cooling fan activation and to provide a load for vehicle retardation, when required. DDEC Fan Controls are designed to optimally control the engine cooling fan(s) based on engine cooling requirements. Fan Controls are also designed to use other system inputs such as A/C pressure switches, transmission retarder status, and operator requested fan operation. Transmission Retarder Status may be received via the Transmission Retarder input or by the SAE J1587 or J1939 Data Link.

NOTE:

Fan Controls are required for some on-highway truck and on-highway bus applications.

5.11.1 OPERATION

The ECU continuously monitors and compares the coolant, oil, and air temperature, engine torque, engine operation mode, and various optional inputs to calibrated levels stored within the ECU. These limits are factory configured based on application.

When these temperature levels exceed the preset fan ON temperature value, the ECU will enable the fan control output(s) that activate the fan. The fan will remain on, cooling the engine with the increased air flow until the temperature levels reach the preset fan OFF temperature. At this point, the ECU will disable the output which will deactivate the fan, effectively maintaining the coolant temperature between the two preset levels.

DDEC V provides fan control for four different fan configurations:

- ☐ Single fan (refer to section 5.11.3, page 5-77)
- ☐ Dual fans (refer to section 5.11.4, page 5-82)
- ☐ Two-speed fan (refer to section 5.11.5, page 5-84)
- ☐ Variable speed single fan (PWM) (refer to section 5.11.6, page 5-87)

In accordance with the proposed Truck Maintenance Council (TMC) Standard, the minimum fan-on time for on-highway applications is 30 seconds.

NOTE:

Fan Control outputs will remain enabled when the ignition is turned off until the engine speed is zero.

5.11.2 INSTALLATION

This section provides a schematic of the specific connection from the ECU to the fan (see Figure 5-29 and Figure 5-30). The correct sensor return must be used based on the input pin selected. The inputs and corresponding sensor return are listed in Table 3-20 on page 3-27. Compatible fans may be obtained from several vendors.

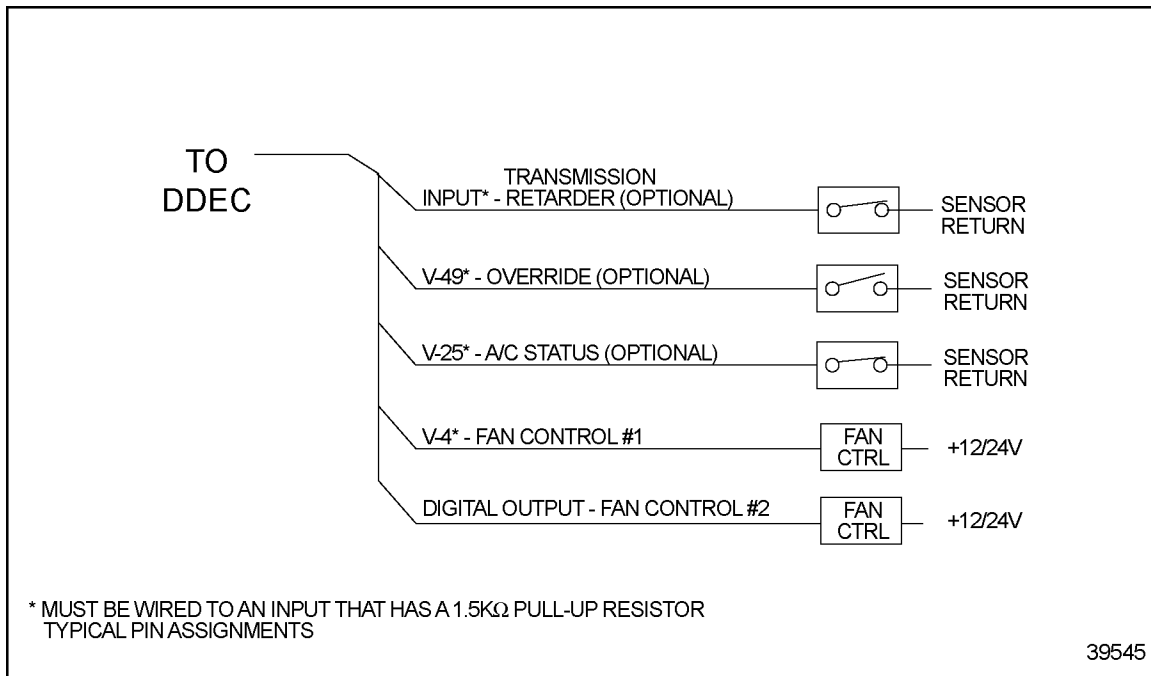


Figure 5-29 Fan Control Inputs with Two Digital Outputs

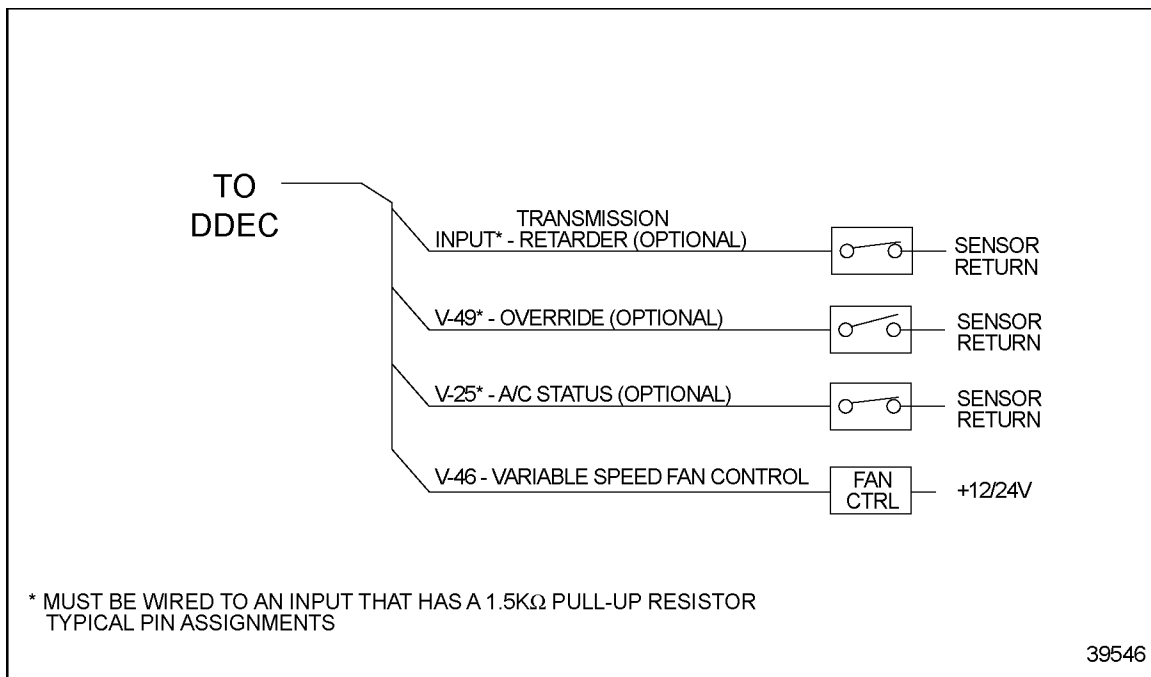


Figure 5-30 Fan Control Inputs with PWM Output for Variable Speed Fan Control

5.11.3 SINGLE FAN

The single-fan control uses one digital output to drive a single-speed fan. The digital output is called Fan Control #1. Fan Control #1 is deactivated to turn the fan OFF. The fan remains ON for a minimum 30 seconds when turned ON. The fan output will not be enabled until five seconds after the engine has started.

NOTE:

Digital output circuit are designed to sink no more than 2.0 A (DC) current.

Fan Control #1 is activated (open-circuited) when at least one of the following conditions occur:

- ☐ Oil or coolant temperature above DDC factory set levels
- ☐ Air temperature and engine torque above DDC factory set levels
- ☐ Air conditioner is active (OEM supplied A/C switch is opened), the fan remains ON for three minutes (the default) after the switch is grounded if vehicle speed is less than 20 MPH
- ☐ Engine Oil Temperature Sensor, Engine Coolant Temperature Sensor, or Intake Air Temperature Sensor fails
- ☐ Fan engine brake enabled and engine brake is active at high level for a minimum of five seconds and air temperature is above factory set levels
- ☐ Transmission retarder is active and coolant temperature above DDC factory set level
- ☐ Fan Control Override Switch is enabled
- ☐ Pressure Sensor Governor is active

NOTE:

If either the A/C or transmission retarder inactive input is configured, the input must be grounded to prevent continuous fan operation.

The inputs and digital outputs for a single fan are listed in Table 5-47.

Fan State	Fan Control Output 1	A/C Input	Override Input	Jake Brake® Status	Trans Retarder Status	Primary Control
On	Open	Grounded	Open	Not in High Mode	Grounded	Engine Temperature Sensors
Off	Grounded	Grounded	Open	Not in High Mode	Grounded	Engine Temperature Sensors
On	Open	Open	Don't Care	Not in High Mode	Grounded	OEM A/C Switch
On	Open	Don't Care	Grounded	Not in High Mode	Grounded	OEM Override Switch
On	Open	Don't Care	Don't Care	High Mode	Grounded	Jake Brake in High Mode and Air Temperature Above Limit
On	Open	Don't Care	Don't Care	Not in High Mode	Open	Transmission Retarder Active and Coolant Temperature Above Limit

Table 5-47 Single Fan Inputs and Digital Outputs

Installation

See Figure 5-31 for the specific connection from the ECU to the fan. The correct sensor return must be used based on the input pin selected. The inputs and corresponding sensor return are listed in Table 3-20 on page 3-27.

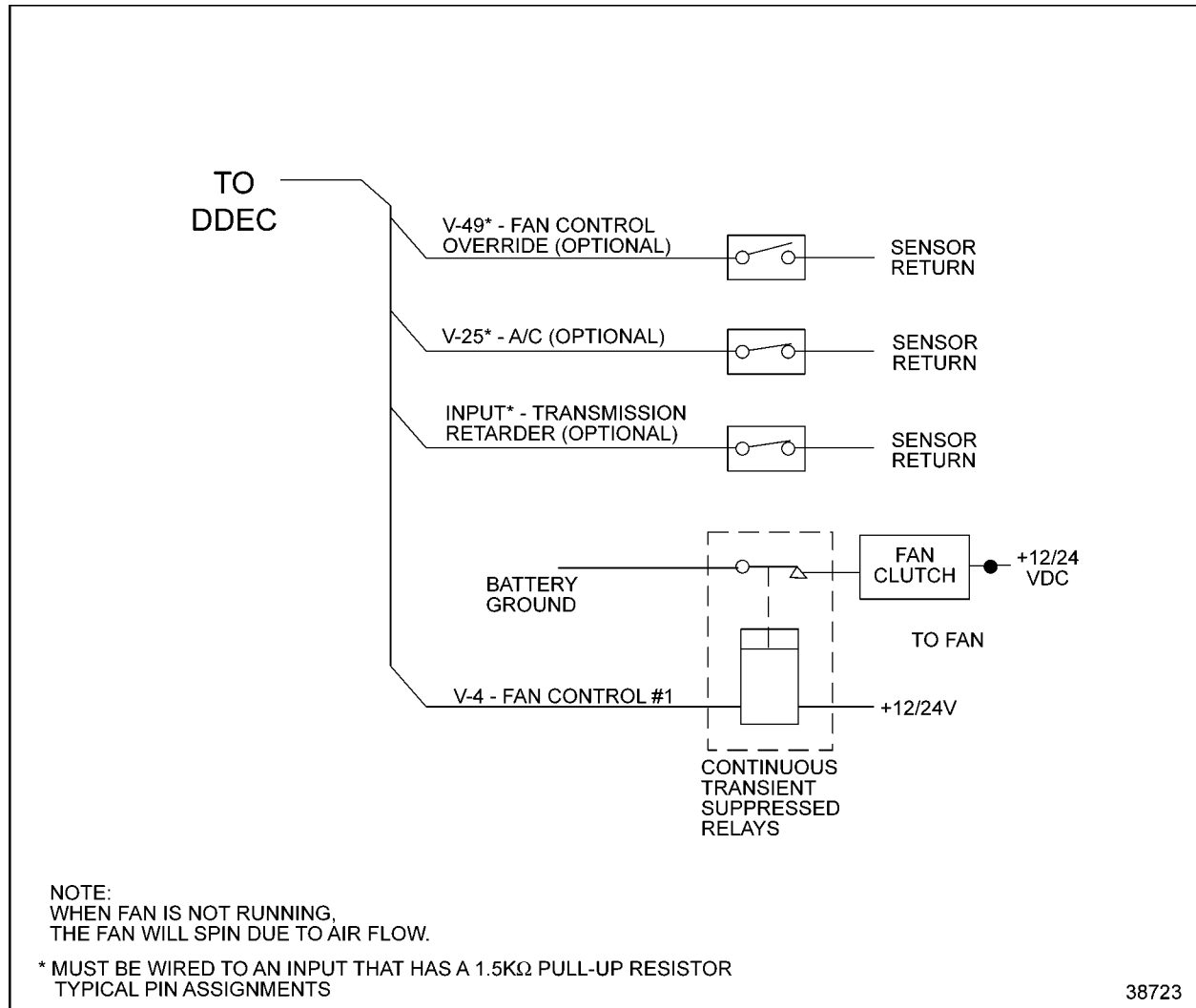


Figure 5-31 Fan Control Inputs and Output Electro Magnetic Single-Speed Digital Fans (Linnig)

For additional information, contact the fan vendor:

Linnig U.S.A.

5131 S. Royal Atlanta Drive
Tucker, GA 30084
Phone: (770) 414-9499

See Figure 5-32 for the specific connection from the ECU to the fan. The correct sensor return must be used based on the input pin selected. The inputs and corresponding sensor return are listed in Table 3-20 on page 3-27.

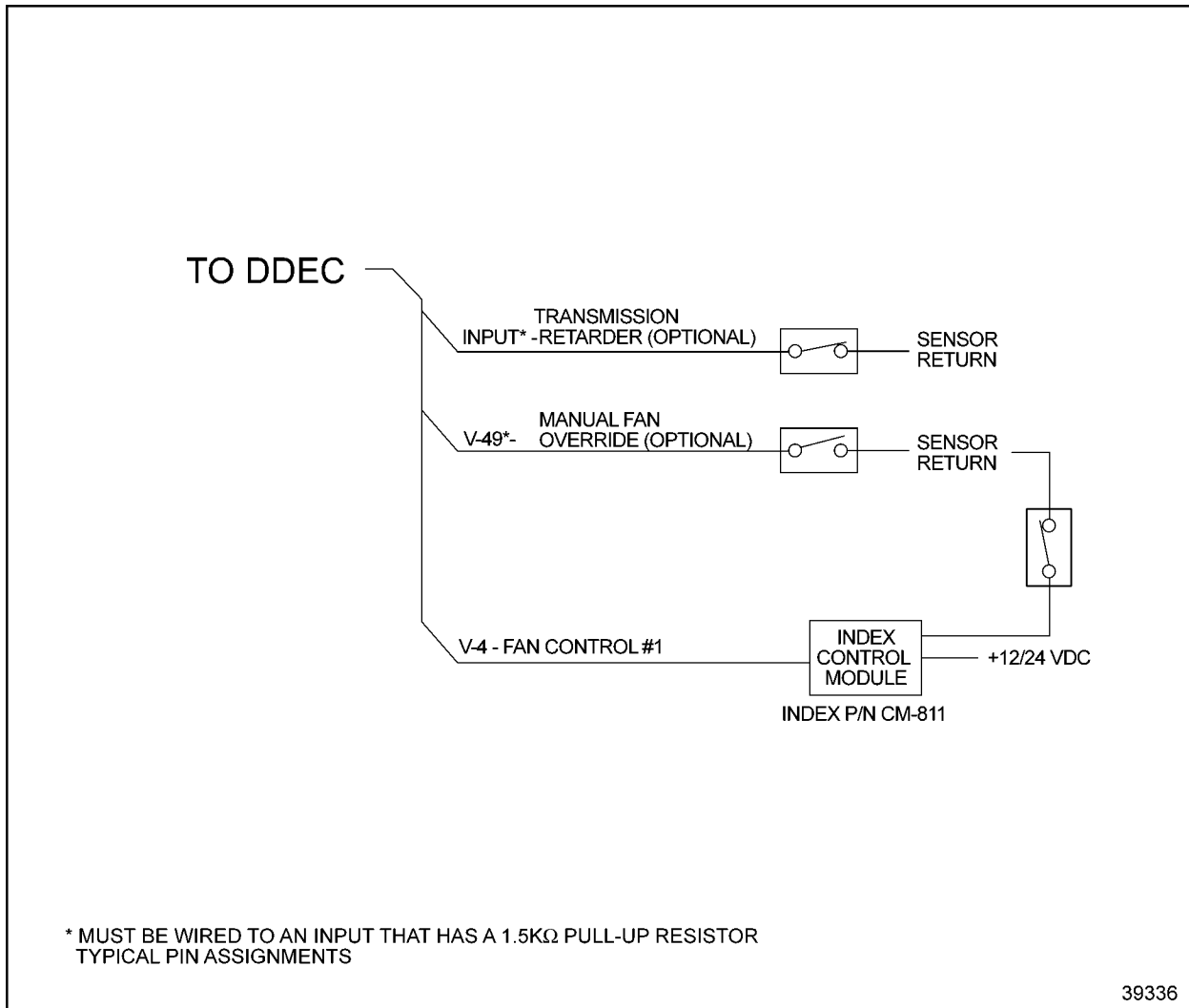


Figure 5-32 Fan Control Inputs and Output (Index Control Module)

For additional information, contact the fan vendor:

Index Sensors and Controls, Inc.

7112 265th St. NW
 Stanwood, WA 98292
 Phone: 1-800-726-1737
 Fax: 360-629-0838
 www.indexsensors.com

See Figure 5-33 for the specific connection from the ECU to the control module. The correct sensor return must be used based on the input pin selected. The inputs and corresponding sensor return are listed in Table 3-20 on page 3-27.

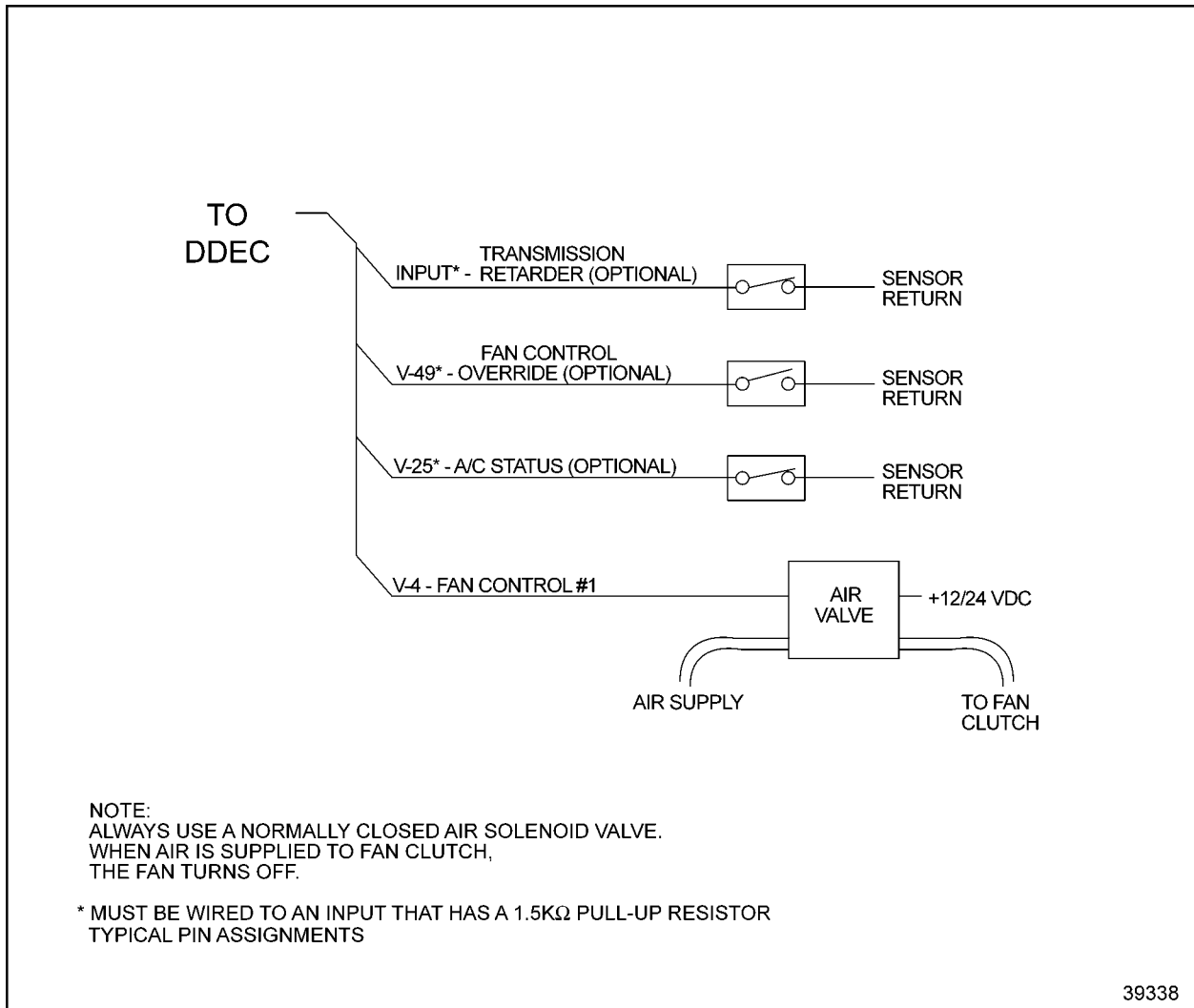


Figure 5-33 Fan Control Inputs - Normally Closed Air Solenoid Single Speed Fan (BorgWarner®, Bendix

For additional information, contact the fan vendors:

Borg Warner

Phone: 1-800-828-8127

Bendix Commercial Vehicle Systems

901 Cleveland Street

Elyria, OH 44035

Phone: 1-800-AIR-BRAKE

www.bendix.com

5.11.4 DUAL FANS

This configuration uses two digital outputs, Fan Control #1 and Fan Control #2, to drive two separate single-speed fans. Fan Control #1 and Fan Control #2 are deactivated to turn OFF each fan respectively. The fan remains on for a minimum 30 seconds whenever it is turned ON. The fan outputs will not be enabled until five seconds after the engine has started.

The two fans are independent of one another and are controlled by different conditions. Both fans will be activated when either the Fan Control Override is enabled or when the conditions are met for Fan Engine Brake.

Fan Control #1 is activated (open-circuited) when at least one of the following conditions occur:

- ☐ Air temperature and engine torque above DDC factory set levels
- ☐ Intake Air Temperature Sensor fails
- ☐ Air conditioner is active (OEM supplied A/C switch is opened), the fan remains ON for a minimum of three minutes (the default) after the switch is grounded if vehicle speed is less than 20 MPH
- ☐ Fan engine brake enabled and engine brake level is active at high level and air temperature is above DDC factory set levels
- ☐ Fan control override switch is enabled
- ☐ Pressure Sensor Governor system is active

Fan control #2 is enabled (opened) when one of the following conditions occur:

- ☐ Oil or coolant temperature above DDC factory set levels
- ☐ Engine Oil Temperature Sensor, or Engine Coolant Temperature Sensor fail
- ☐ Fan engine brake enabled and engine brake level is active at high level and air temperature is above DDC factory set levels
- ☐ Fan control override switch is enabled
- ☐ Transmission retarder is active and coolant temperature above DDC factory set level

NOTE:

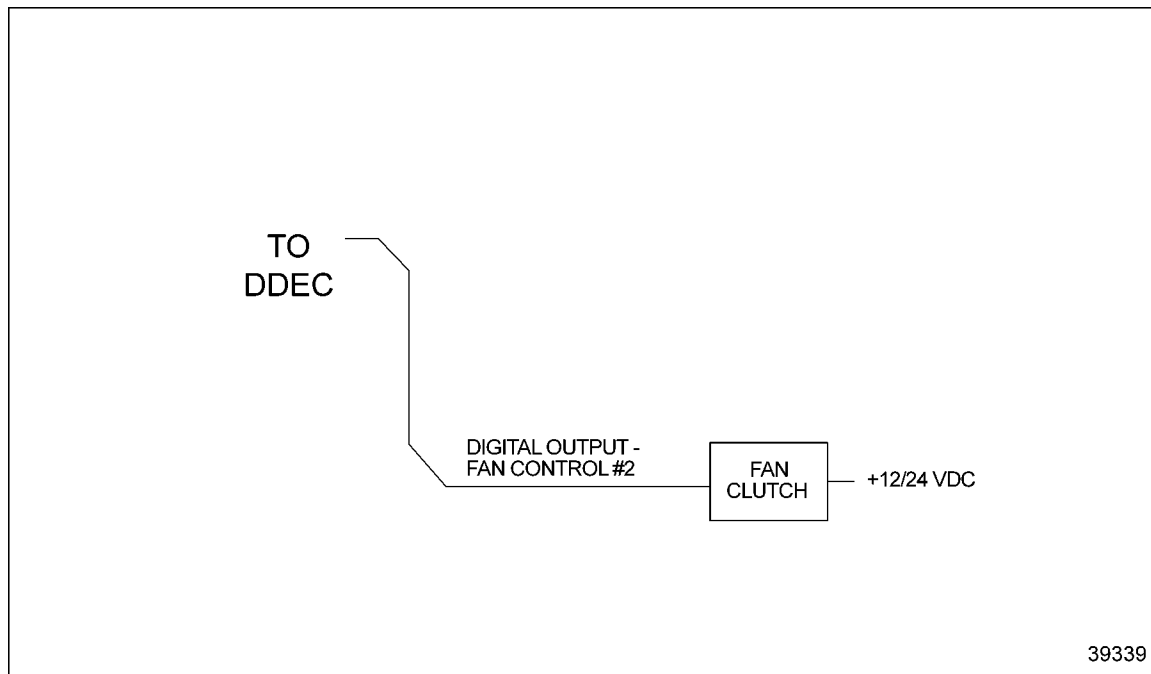
If either the A/C or transmission retarder inactive input is configured, the input must be grounded to prevent continuous fan operation.

The inputs and digital outputs for dual fans are listed in Table 5-48.

Fan State	Fan Control Output 1	Fan Control Output 2	A/C Input	Override Input	Jake Brake® Status	Trans Retarder Status	Primary Control
1-On 2-On	Open	Open	Grounded	Open	Not in High Mode	Don't Care	Engine Temperature Sensors
1-On 2-Off	Open	Grounded	Grounded	Open	Not in High Mode	Grounded	Engine Temperature Sensors
1-Off 2-On	Grounded	Open	Grounded	Open	Not in High Mode	Don't Care	Engine Temperature Sensors
1-Off 2-Off	Grounded	Grounded	Grounded	Open	Not in High Mode	Grounded	Engine Temperature Sensors
1-On 2-Off	Open	Grounded	Open	Don't Care	Not in High Mode	Grounded	OEM A/C Switch
1-On 2-Off	Open	Grounded	Don't Care	Grounded	Not in High Mode	Grounded	Override Switch
1-On 2-Off	Open	Grounded	Don't Care	Don't Care	High Mode	Grounded	Jake Brake in High Mode
1-Off 2-On	Grounded	Open	Don't Care	Don't Care	High Mode	Open	Transmission Retarder Active and Coolant Temperature Above Limit

Table 5-48 Dual Fans Inputs and Digital Outputs**Installation - Dual Fans**

The compatible fan manufacturers are the same as the manufacturers for the single fan. Follow the wiring diagrams for single fans for the first fan. See Figure 5-34 for the specific connection from the ECU to the second fan.

**Figure 5-34 Fan Control Inputs and Outputs - Second Fan**

5.11.5 TWO-SPEED FAN

This configuration uses two digital outputs, Fan Control #1 and Fan Control #2, to drive a two-speed fan. When Fan Control #1 output is activated (open circuit), the fan operates in low-speed mode. When Fan Control #1 and Fan Control #2 are both activated (open circuit), the fan operates in high-speed mode.

Fan Control #1 is activated (open-circuited) when at least one of the following conditions occur:

- ☐ Oil or coolant temperature above DDC factory set levels
- ☐ Air temperature and engine torque above DDC factory set levels

Fan Control #1 and Fan Control #2 are both activated (open-circuited) when one of the following conditions occurs:

- ☐ Oil or coolant temperature above DDC factory set levels
- ☐ Air temperature and engine torque above DDC factory set levels
- ☐ Engine Oil, Engine Coolant, or Intake Air Temperature Sensor fails
- ☐ Air conditioner is active (OEM supplied A/C switch is opened), the fan remains ON for a minimum of three minutes (the default, typically three minutes) after the switch is grounded if vehicle speed is less than 20 MPH
- ☐ Fan engine brake enabled and engine brake level is active at high level and air temperature is above DDC factory set levels
- ☐ Fan control override switch is enabled
- ☐ Pressure Sensor Governor is active
- ☐ Transmission retarder is active and coolant temperature above DDC factory set level

Once the fan has been enabled due to the Transmission Retarder, the fan will remain on high speed until the Transmission Retarder is deactivated. The Fan will remain on high speed for a minimum of 30 seconds.

NOTE:

If either the A/C or transmission retarder inactive input is configured, and not used, it should be deconfigured.

The inputs and digital outputs for a two-speed fan are listed in Table 5-49.

Fan State	Fan Control Output 1	Fan Control Output 2	A/C Input	Override Input	Jake Brake® Status	Trans Retarder Status	Primary Control
Off	Grounded	Grounded	Grounded	Open	Not in High Mode	Grounded	Engine Temperature Sensors
Low	Open	Grounded	Grounded	Open	Not in High Mode	Grounded	Engine Temperature Sensors
High	Open	Open	Grounded	Open	Not in High Mode	Don't Care	Engine Temperature Sensors
High	Open	Open	Open	Don't Care	Not in High Mode	Don't Care	OEM A/C Switch
High	Open	Open	Don't Care	Grounded	Not in High Mode	Don't Care	Override Switch
High	Open	Open	Don't Care	Don't Care	High Mode	Don't Care	Jake Brake in High Mode
High	Open	Open	Don't Care	Don't Care	Not in High Mode	Open	Transmission Retarder Active and Coolant Temperature Above Limit

Table 5-49 Two-speed Fan Digital Inputs and Outputs

Installation -Two-speed Fans

See Figure 5-35 for the specific connection from the ECU to the fan. The correct sensor return must be used based on the input pin selected. The inputs and corresponding sensor return are listed in Table 3-20 on page 3-27.

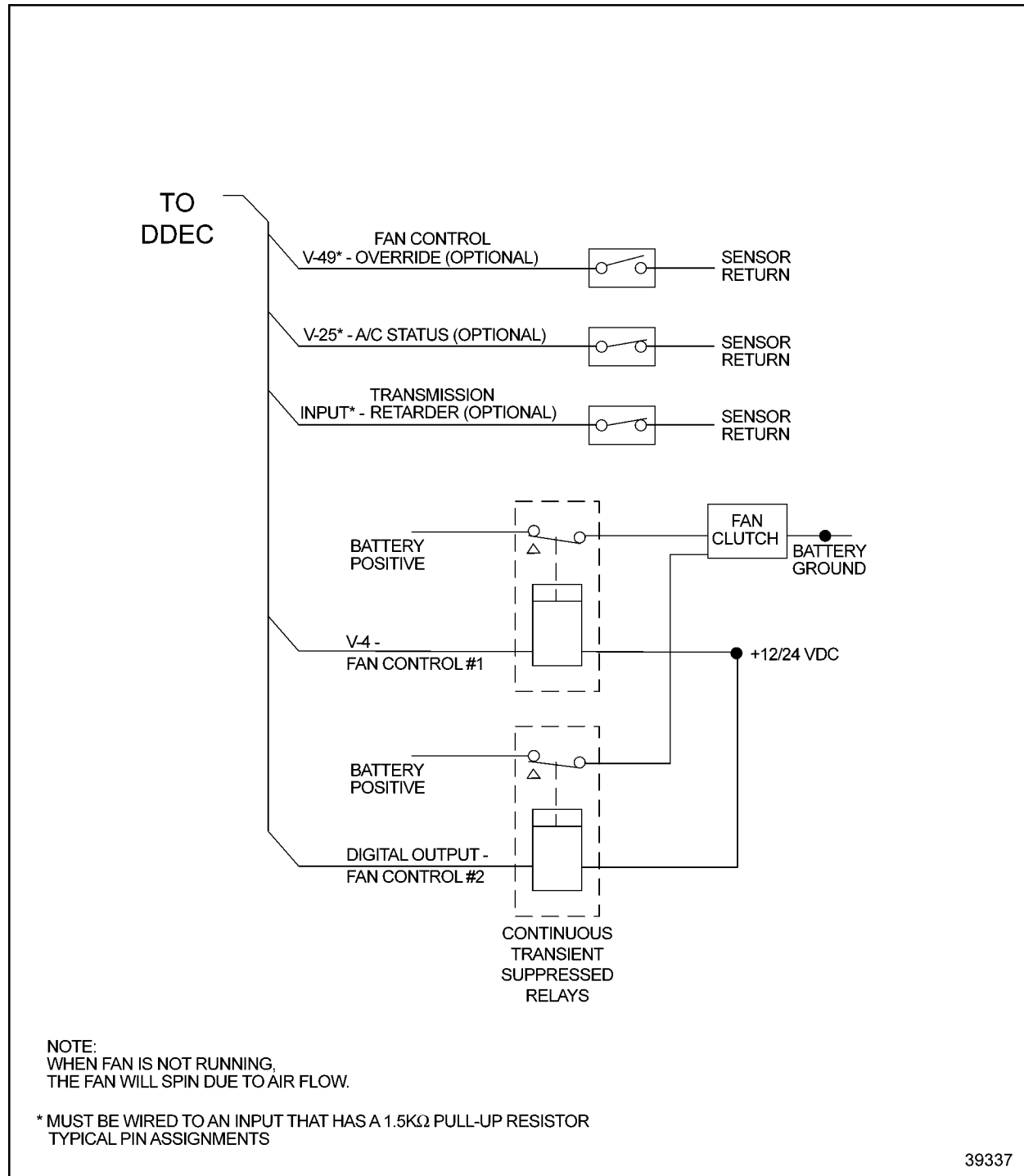


Figure 5-35 Fan Control Inputs and Outputs - Electro Magnetic Two-Speed Fans (Linnig)

For additional information, contact the fan vendor:

Linnig U.S.A.

5131 S. Royal Atlanta Drive

Tucker, GA 30084

Phone: (770) 414-9499

www.linnig.com

5.11.6 VARIABLE SPEED SINGLE-FAN

DDEC uses a pulse width modulated (PWM) output to drive a variable speed fan. Specifications for the Series 60 are listed in Table 5-50.

Engine Series	Frequency	Duty Cycle @ Minimum Fan Speed	Duty Cycle @ Maximum Fan Speed
Series 60	50 Hz	90%	10%

Table 5-50 Variable Speed Single-fan Specifications

The fan may be enabled by specific engine temperature sensors and various other inputs. The fan will ramp up to the requested speed in order to reduce noise, shock-loading, and belt slippage. If the fan is turned on for any reason other than high temperature, it will ramp up to the full fan speed. The ramp rate is set by the Application Code System (ACS). A decrease in fan speed will occur after a short time delay and will step down to the value dictated by the highest sensor request. If the A/C switch is opened, the fan will increase speed at the ramp rate until it is at a maximum. After the A/C switch is grounded the fan will remain on for a short time delay and then turn off.

The PWM output is initiated when at least one of the following conditions occur:

- ☐ Air, oil, or coolant temperatures above DDC factory set limits
- ☐ Air conditioner is active (OEM supplied A/C switch is opened), the fan remains on for a minimum of three minutes (the default) after the switch is grounded if vehicle speed is less than 20 mph
- ☐ Engine Oil Temperature Sensor, Engine Coolant Temperature Sensor, or Intake Air Temperature Sensor fails
- ☐ Fan Control Override Switch is enabled

NOTE:

If A/C input is configured and not used, the input must be deconfigured.

The inputs and output for PWM fan control are listed in Table 5-51.

Fan State	PWM Output	A/C Input	Override Input	Jake Brake Status	Primary Control
On	Modulated	Grounded	Open	Not in High Mode	Engine Temperature Sensors
Off	Open	Grounded	Open	Not in High Mode	Engine Temperature Sensors
Full On	Grounded	Open	Don't Care	Not in High Mode	OEM A/C Switch
Full On	Grounded	Don't Care	Grounded	Not in High Mode	OEM Override Switch
Full On	Grounded	Don't Care	Don't Care	High Mode	Jake Brake in High Mode and Air Temperature Above Limit
Full On	Grounded	Don't Care	Don't Care	Not in High Mode	Transmission Retarder Active and Coolant Temperature Above Limit

Table 5-51 PWM Fan Control Inputs and Output

Installation - Variable Speed Single-Fan

See Figure 5-36 for the specific connection from the ECU to the fan. The correct sensor return must be used based on the input pin selected. The inputs and corresponding sensor return are listed in Table 3-20 on page 3-27.

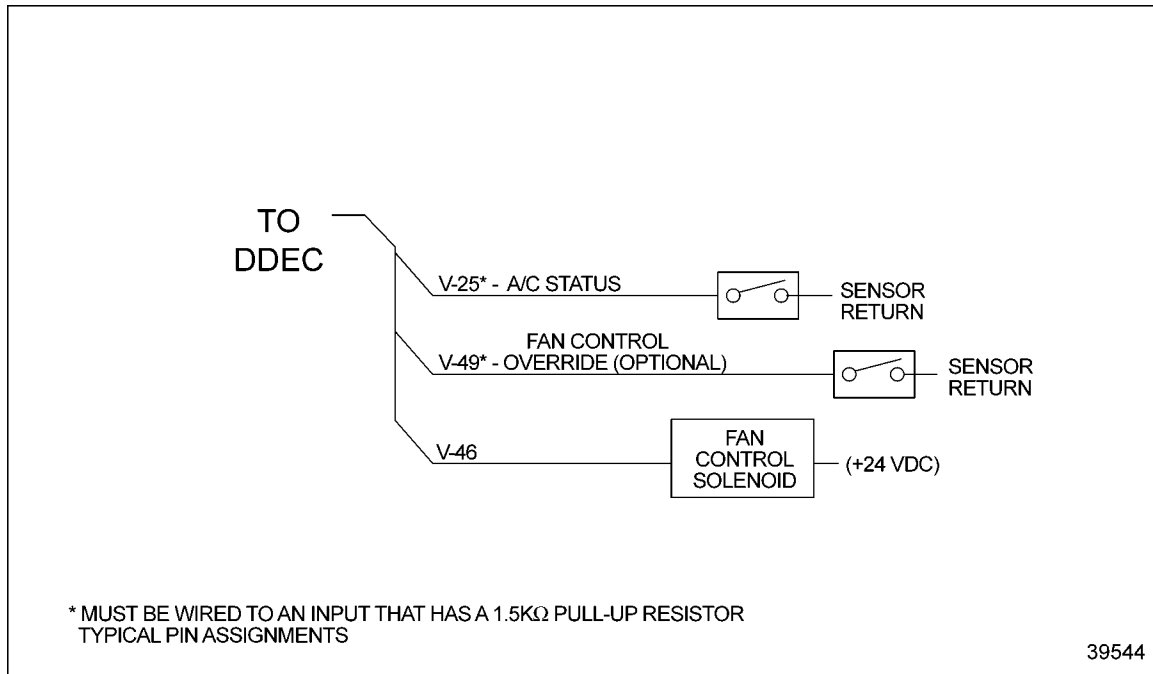


Figure 5-36 Variable Speed Single-fan Control Inputs and Output

For additional information, contact the clutch manufacturer:

Rockford Powertrain, Inc.
 1200 Windsor Road,
 Rockford, IL 61111
 Phone: (815) 633-7460
www.rockfordpowertrain.com

5.11.7 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

To have fan control for single, two-speed or dual fans, fan control must be enabled and a fan type has to be defined at engine order entry or by DDC Technical Service.

For single, dual, and two-speed fans, the inputs and digital outputs listed in Table 5-52 may be required based on the fan vendor's requirements. The inputs and digital outputs can be configured by order entry, VEPS or DRS.

Description	Type	Config ID/Function Number
Fan Control #1	Digital Output	13
Fan Control #2	Digital Output	14
Transmission Retarder (Optional)	Input	4123
Fan Control Override (Optional)	Input	4128
Air Conditioner Status (Optional)	Input	4125

Table 5-52 Fan Control Input and Digital Outputs - Single and Dual Speed Fans

The digital output functions (Fan Control #1 and Fan Control #2) can be programmed on PWM outputs if desired. Functionality will be the same as the digital output function. The PWM outputs, listed in Table 5-53, can be programmed by order entry, VEPS, or DRS.

Description	Type	Function Number
Fan Control #1 - Digital Output	PWM Output	3
Fan Control #2 - Digital Output	PWM Output	4

Table 5-53 Fan Control PWM Outputs

NOTE:

Program the fan control function on either the PWM output or digital output, not both.

For variable speed fans, the PWM output is enabled at the time of engine order or by ACS. The inputs listed in Table 5-54 may be required based on fan vendor's requirements. The inputs can be configured by order entry, VEPS or DRS.

Description	Type	Config ID
Transmission Retarder	Input	4123
Fan Control Override	Input	4128
Air Conditioner Status	Input	4125

Table 5-54 Fan Control Input - Variable Speed Fans

VEPS or the DRS can set the minimum A/C Fan time. The default for the parameter listed in Table 5-55 is three minutes.

Parameter	Description	Choices
AC Fan Timer	The minimum duration of time the fan will remain ON after the AC status input has indicated that the AC unit has turned OFF. The timer starts when the input is grounded after being open.	0-255 seconds

Table 5-55 Fan Timer Parameter

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5.12 FUEL ECONOMY INCENTIVE

Fuel Economy Incentive is a standard DDEC feature for on-highway Detroit Diesel engines. The purpose of this feature is to allow the fleet manager to set a target fuel economy while providing the driver an incentive to meet the target.

5.12.1 OPERATION

Using the Fuel Economy Incentive option, a fleet manager can set a target fuel economy for each engine. If this fuel economy is exceeded, the driver will be given a slightly increased vehicle speed limit.

Target fuel economy, road speed limit, maximum MPH increase, conversion factor for MPH/MPG and the option of total average fuel economy or trip fuel economy are all calibrated using Detroit Diesel Diagnostic Link, the Vehicle Electronic Programming System (VEPS), the DDEC Reprogramming System (DRS) or at engine order entry. The feature is enabled by setting the Maximum MPH to a non-zero value.

In this example the following limits are set as listed in Table 5-56.

Item	Set Limit
Vehicle Speed Limit	60 MPH
Maximum MPH - the maximum allowable increase in vehicle speed to allow	5 MPH
Conversion Factor	20 MPH/MPG
Target Fuel Economy	7 MPG

Table 5-56 Fuel Economy Limits

If the driver has an average fuel economy of 7.1 MPG then the new vehicle speed limit is 62 MPH. $(60 \text{ MPH} + (7.1 - 7.0 \text{ MPG}) \times (20 \text{ MPH/MPG})) = 62 \text{ MPH}$

The maximum vehicle speed obtainable regardless of the fuel economy is 65 MPH.

5.12.2 PROGRAMMING FLEXIBILITY

The parameters listed in Table 5-57 can be set using DDDL, VEPS, or DRS.

Parameter	Definition	Limits
MINIMUM ECONOMY	Indicates the minimum economy fuel economy goal.	5 to 10 MPG
MAXIMUM MPH	Indicates customer set maximum vehicle speed.	0 to 10 MPH
CONVERT FACTOR	The miles per hour desired for each full mile per gallon above the minimum MPG.	0.1 to 20 MPH/MPG
CALC TYPE	FILTERED bases the calculations on the fuel information, by periodic sampling of fuel consumption, recorded in the ECU. TRIP bases the calculation on the trip portion of the fuel usage information.	FILTERED, TRIP

Table 5-57 Fuel Economy Incentive Parameters

5.12.3 INTERACTION WITH OTHER FEATURES.

Fuel Economy Incentive will increase the Cruise Control and vehicle speed limits.

A vehicle can be set up with both PasSmart and Fuel Economy Incentive, but the extra speed increments provided by the two features do not add together. For example, a vehicle with a Fuel Economy Incentive set up to give 7 MPH of extra speed when the driver hits the maximum fuel economy target and a 5 MPH PasSmart increase has a resulting speed increase of 7 MPH, not 12 MPH.

5.13 HALF ENGINE IDLE

Half Engine Idle (HEI) mode allows the engine to run on half the cylinders. Running in HEI significantly reduces white smoke in cold engine operation, after startup or during extreme cold weather operation. The HEI logic continuously reviews several engine conditions to determine if it should be deactivated such as higher engine torque.

5.13.1 OPERATION

HEI can be disabled or enabled-cold. If HEI is set to "enabled-cold" mode, the conditions necessary for operation are listed in Table 5-58.

Engine	DDR Configuration Allowed	Parking Brake Required	Vehicle Speed Limit	Intake Air Temperature	Max torque
Series 60	Yes	Yes	<5 MPH	<12.5°C	<~25%

Table 5-58 Conditions for HEI

HEI will be deactivated when any of the above conditions are not met.

5.13.2 INSTALLATION

Series 60 engines require a park brake input to run in HEI.

5.13.3 PROGRAMMING FLEXIBILITY

DDDL may configure HEI mode (enabled-cold/disabled). The rest of the parameters are factory set and cannot be changed. VEPS is not capable of setting the HEI mode.

5.13.4 DIAGNOSTICS

DDDL display will tell the user if the engine is running in HEI. This display is part of the Data List menu.

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5.14 IDLE SHUTDOWN TIMER AND VEHICLE POWER SHUTDOWN

The Idle Shutdown Timer will shutdown the engine if it remains idling for a specified period of time. There are five options that can operate with Idle Shutdown Timer.

- ☐ Idle Shutdown Override
- ☐ Vehicle Power Shutdown
- ☐ Variable Speed Governor (VSG) Shutdown
- ☐ Ambient Air Temperature Override Disable
- ☐ Ambient Air Temperature Automatic Override

5.14.1 OPERATION

There are two types of idle shutdown:

- ☐ The engine has been idling for a specified time period.
- ☐ The engine has been idling for a specified time period and the ambient temperature is within a specified range.

Certain conditions must be met for the entire time-out period for shutdown to occur. These conditions include:

- ☐ Oil temperature above 104°F (40°C)
- ☐ Engine operation at idle or VSG minimum (Alt Min VSG)
- ☐ The parking brake interlock input switched to sensor return
- ☐ OEM supplied interlocks enabled
- ☐ Ignition ON

Fueling is stopped after the specified idle time; the ignition circuit remains active after the engine shuts down. The ignition switch must be cycled to OFF (wait 10 seconds) and back to ON before the engine will restart, if shutdown occurs. The AWL will blink until the ignition is turned off to indicate shutdown has occurred. If the ignition is not turned off within 20 minutes, then the ECU will begin its low power mode which will cause the AWL to turn off. In low power mode, the ignition cycle will be considered over and all steps which normally occur after the ignition cycle is turned off will occur even though the ignition switch is still on. This prevents excessive battery drain by the ECU.

A Park Brake Switch must be installed (see Figure 5-37). Idle Shutdown Timer operates with an input configured as a park brake and switched to sensor return. The time can range from 1 to 100 minutes in one minute intervals. An optional digital output can be programmed for vehicle power shutdown. This is used with Idle Timer Shutdown or the Engine Protection Shutdown features to shut off any electrical loads on the vehicle.

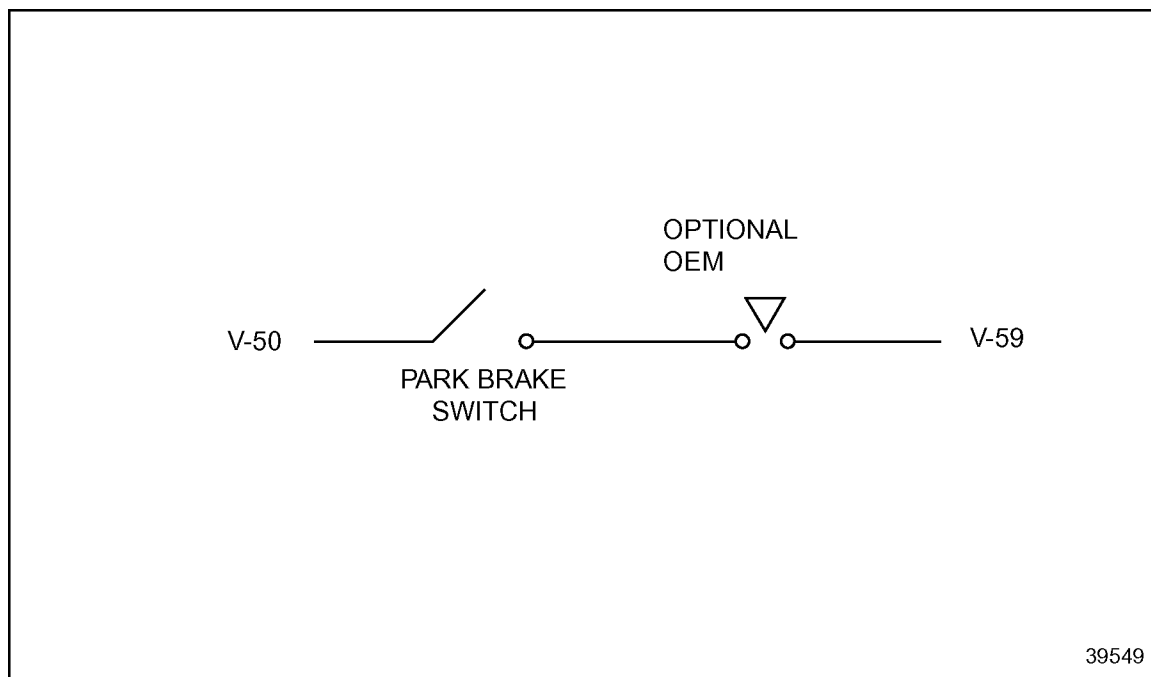


Figure 5-37 Park Brake Input

Idle Shutdown Override - Optional

Idle Shutdown Override allows the operator to override the idle shutdown to keep the engine idling if this feature is enabled.

Ninety seconds before the specified idle time is reached, the AWL will begin flashing. The idle timer can be disabled if the percent throttle is increased to greater than 1%. This will allow the idle timer to be overridden if longer engine idling is desired. The timing sequence can be reinitiated by disengaging and reapplying the parking brake, by cycling the ignition OFF (waiting 10 seconds) and back to ON or by once again increasing the percent throttle greater than 1%.

Vehicle Power Shutdown - Optional

Vehicle Power Shutdown is used with Idle Timer Shutdown or Engine Protection Shutdown. After the idle timer times out or engine protection shuts the engine down, the Vehicle Power Shutdown relay shuts down the rest of the electrical power to the vehicle.

A Vehicle Power Shutdown relay can be installed to shutdown all electrical loads when the engine is shutdown (see Figure 5-38). This figure also provides a method to turn OFF the ignition while the idle timer is active. The engine will shutdown after the specified idle time and will reset the relay (ignition circuit).

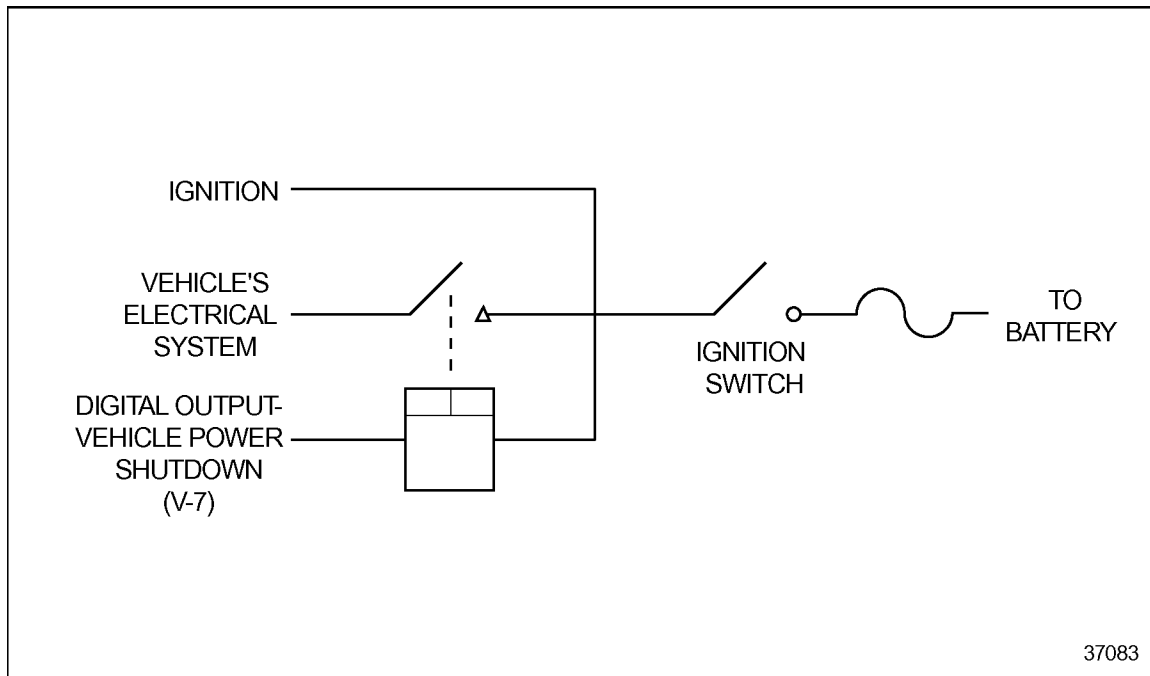


Figure 5-38 Vehicle Power Shutdown Relay

All electrical loads that should be turned OFF when the engine shuts down should be wired through this relay.

Refer to section 4.2, "Digital Outputs" for additional information.

Enabled on Variable Speed Governor (VSG) - Optional

This option, when enabled, allows the engine to be shutdown when operating on the VSG when the conditions are met for the Idle Timer Shutdown.

Ambient Air Temperature Override Disable - Optional

This option allows the override to be disabled based on ambient air temperature. If the upper and lower temperature limits are set and the ambient temperature is within the specified limits, the override will be disabled and the engine will be shutdown after the specified time limit is met. If the ambient air temperature is outside the specified range, the override would be allowed by increasing the percent throttle to greater than 1%. To disable this feature, the upper and lower limits must be set to 167°F.

For example, if the upper limit is set to 80°F and the lower limit is set to 65°F, the override would be disabled if the ambient air temperature was between 65°F and 80°F (see Figure 5-39).

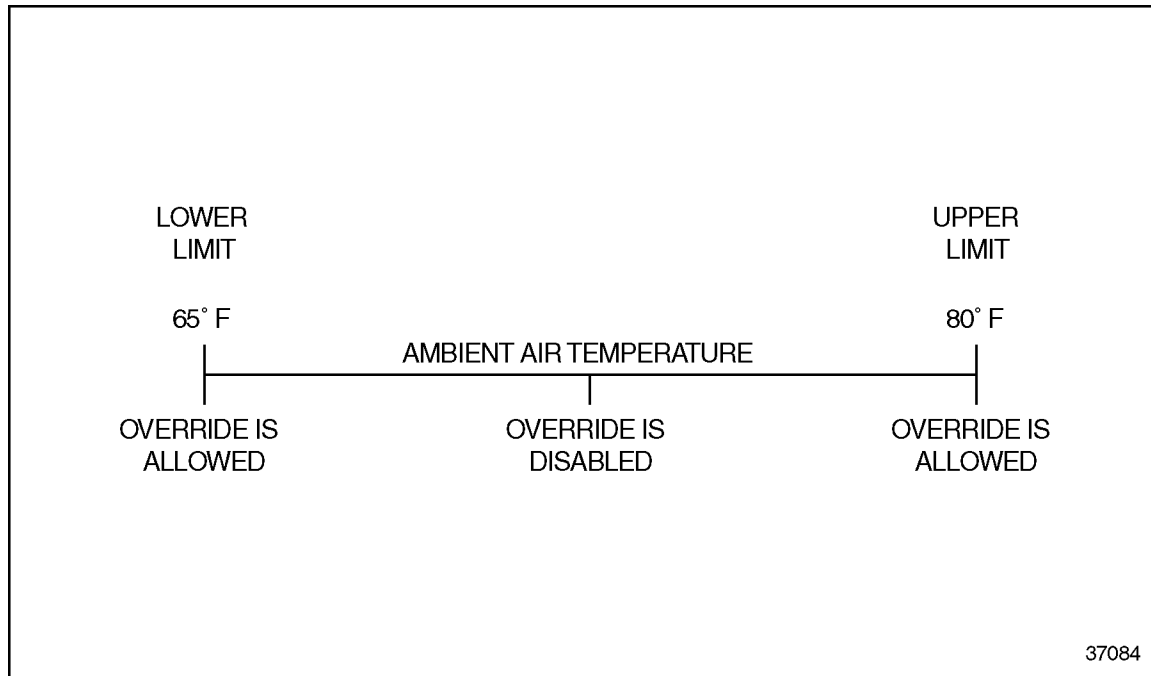


Figure 5-39 Ambient Air Temperature Override Disabled

To improve the accuracy of ambient air temperature sensor readings, an Ambient Air Temperature Sensor (AAT Sensor) can be installed. This installation is recommended if the ambient air temperature shutdown feature is enabled.

Ambient Air Temperature Automatic Override

This option allows an automatic override if the ambient temperature is out of the specified range as described above. Driver intervention is not required.

Inactive Shutdown

The idle timer can be defeated by holding down the throttle or by not setting the park brake. The inactive timer will shutdown the engine after twenty minutes if fueling is not sufficient to accelerate the vehicle.

5.14.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

To program the Idle Shutdown timer, the input listed in Table 5-59 must be configured by engine order entry, the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Description	Type	Config ID/Function Number
Park Brake/ISD	Input	4101
Vehicle Power Shutdown - optional	Digital Output	6

Table 5-59 Idle Shutdown Timer Input and Output

The Idle Shutdown timer options listed in Table 5-60 can be programmed by Detroit Diesel Diagnostic Link, VEPS or DRS.

Parameter	Description	Choice / Display
ENABLE IDLE SHUTDOWN	Enables or Disables the Idle Shutdown feature. N/A will be displayed if the parking brake has not been configured as an input.	YES, NO
TIME (MIN)	The amount of engine idle time that is allowed before the idle shutdown feature stops fueling the engine.	1 to 100 minutes
OVERRIDE	The override will flash the AWL 90 seconds before shutdown to allow the driver to cancel the shutdown by pressing the accelerator pedal.	YES, NO
ENABLED ON VSG	Enables or disables the idle timer shutdown feature when operating on the Variable Speed Governor.	YES, NO
OVERRIDE TEMPERATURE DISABLE LOWER LIMIT	The lower limit of the ambient air temperature range that will disable the idle shutdown override feature based on ambient air temperature. 167°F will disable this feature.	-40 to "UPPER LIMIT" °F
OVERRIDE TEMPERATURE DISABLE UPPER LIMIT	The upper limit of the ambient air temperature range that will disable the idle shutdown override feature. 167°F will disable this feature.	"LOWER LIMIT" to 167°F
AMBIENT AIR TEMP AUTO OVERRIDE	Enables an automatic override if the ambient air temperature is out of a specified range.	YES, NO

Table 5-60 Idle Shutdown Timer Programming Options

5.14.3 INTERACTION WITH OTHER FEATURES

The Idle Shutdown Timer is required for Optimized Idle. Refer to section 5.19, "Optimized Idle," for additional information.

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5.15 IRIS

The InfraRed Information System (IRIS®) is an optional feature that provides two—way communication between a vehicle and a PC.

Detailed IRIS installation information can be found in the *IRIS User and Installation Guide* (7SA804).

5.15.1 OPERATION

IRIS replaces direct cable hook-up with an infrared beam (see Figure 5-40).

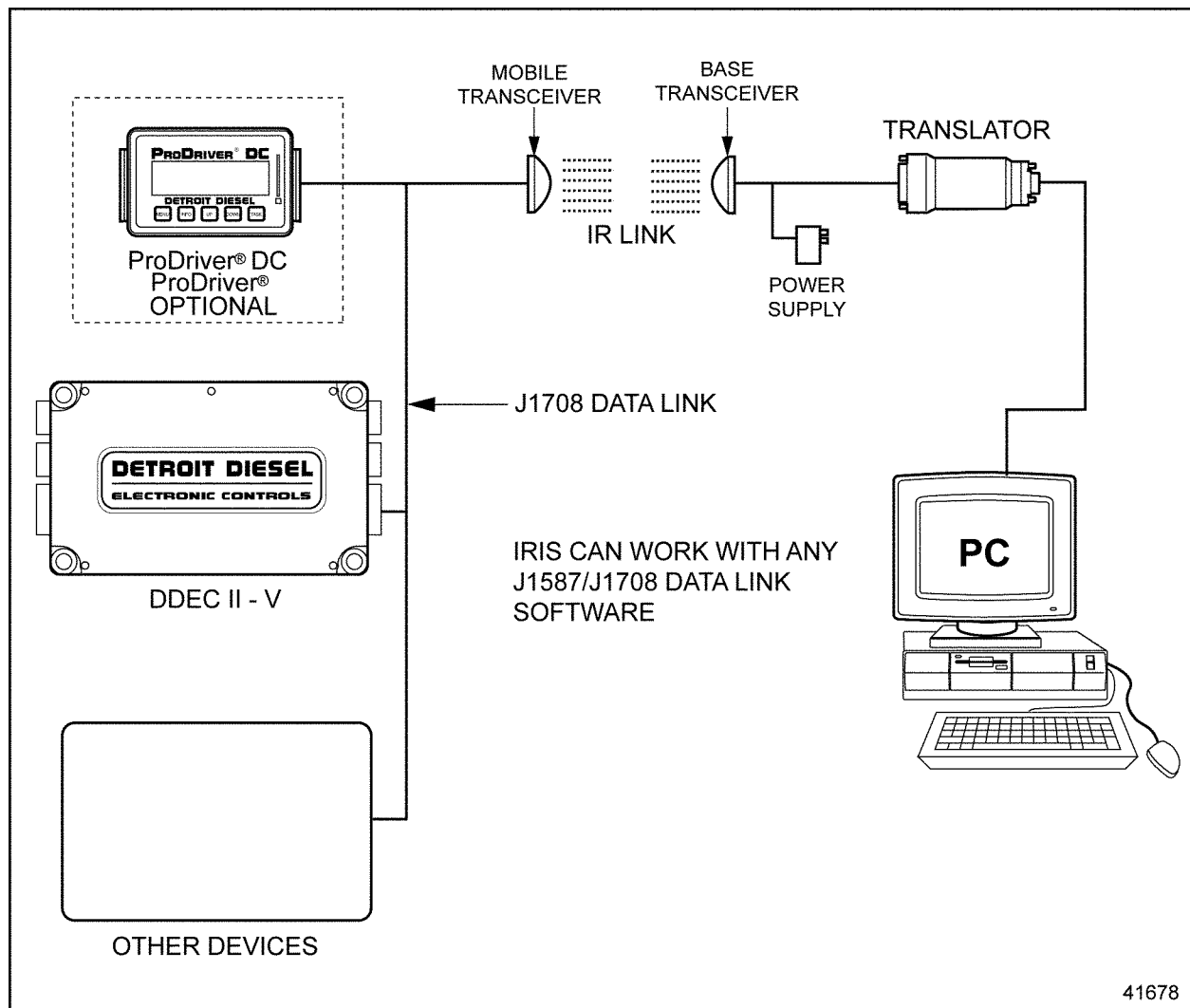


Figure 5-40 IRIS Configuration

All data which is currently transmitted via cable, can now be sent using IRIS. This includes downloading of all information in the ECU, ProDriver DC, engine diagnosis, and complete engine reprogramming. Downloading and uploading with IRIS takes approximately the same amount of time as a direct cable connection.

IRIS eliminates the need for the driver to exit the vehicle, locate a cable and plug into the vehicle. No physical connections between the vehicle and the PC are required. IRIS can also be used in a service bay with diagnostic equipment, eliminating the need to bring the computer cart to the vehicle.

IRIS works with most devices communicating via the J1708 Data Link.

IRIS consists of an infrared transceiver (see Figure 5-41) for the vehicle side of the IR beam and another infrared transceiver for the base side of the IR beam.

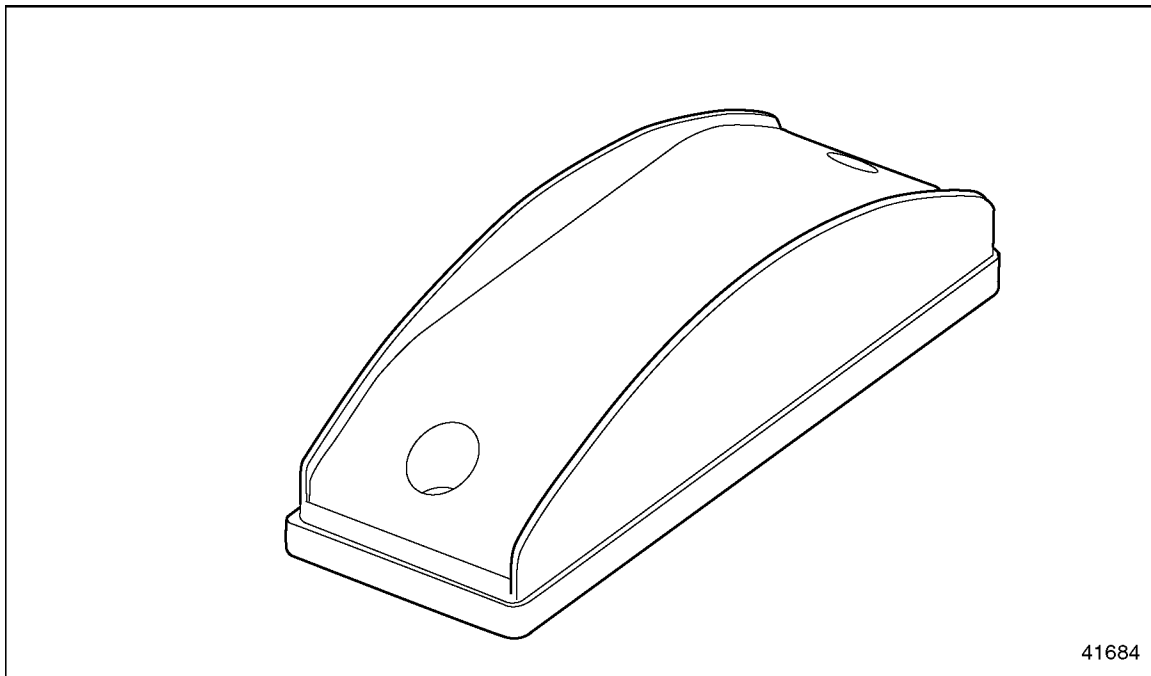


Figure 5-41 IRIS Transceiver

The mobile transceiver is mounted on the vehicle. The base transceiver is located where information is extracted, such as the entrance to the shop or the fuel island. The base transceiver is continuously polling for a vehicle; conversely the mobile transceiver is silent until it receives a message from the base transceiver. When the mobile transceiver on the vehicle is in general alignment with the base transceiver, handshaking will take place and establish the infrared link. (see Figure 5-42).

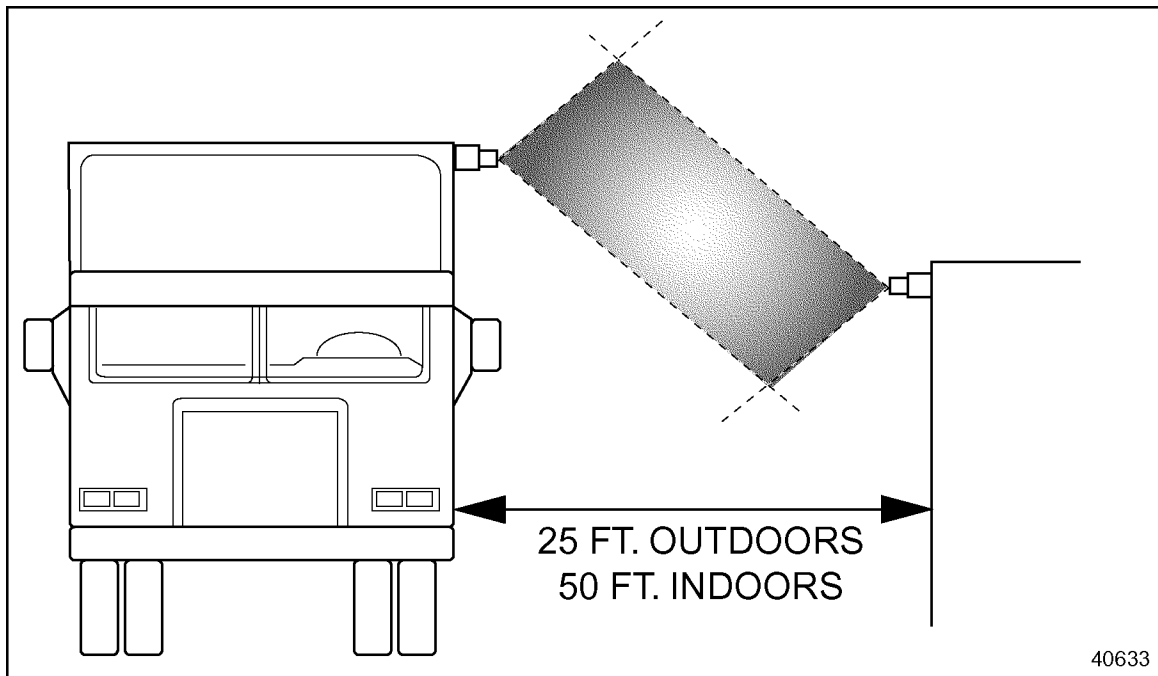


Figure 5-42 IRIS - Infrared Two-way Communication

There are two visible Light Emitting Diodes (LEDs) on the face of the transceiver. These LEDs are used for diagnostic purposes only. The LEDs will illuminate at the beginning of the ignition cycle and then turn off and remain off during system operation. The LEDs will illuminate for a maximum of 15 seconds.

The red LED indicates that the unit has proper power. The green LED indicates that the unit is receiving valid J1708 messages. The two LEDs may not always come on simultaneously, but they will always go off together.

The base transceiver will only communicate with one mobile transceiver at a time. The connection must be interrupted for a sustained period of time, or the ignition must be turned off for the base transceiver to start polling for another vehicle.

The IRIS dash light will flash during the handshaking communication between the two transceivers. Once the infrared link is established the light will be solidly illuminated until the connection is broken.

5.15.2 INSTALLATION

As long as the two transceivers are in general alignment, IRIS will function up to a distance of 25 ft outdoors to 50 ft indoors (see Figure 5-43).

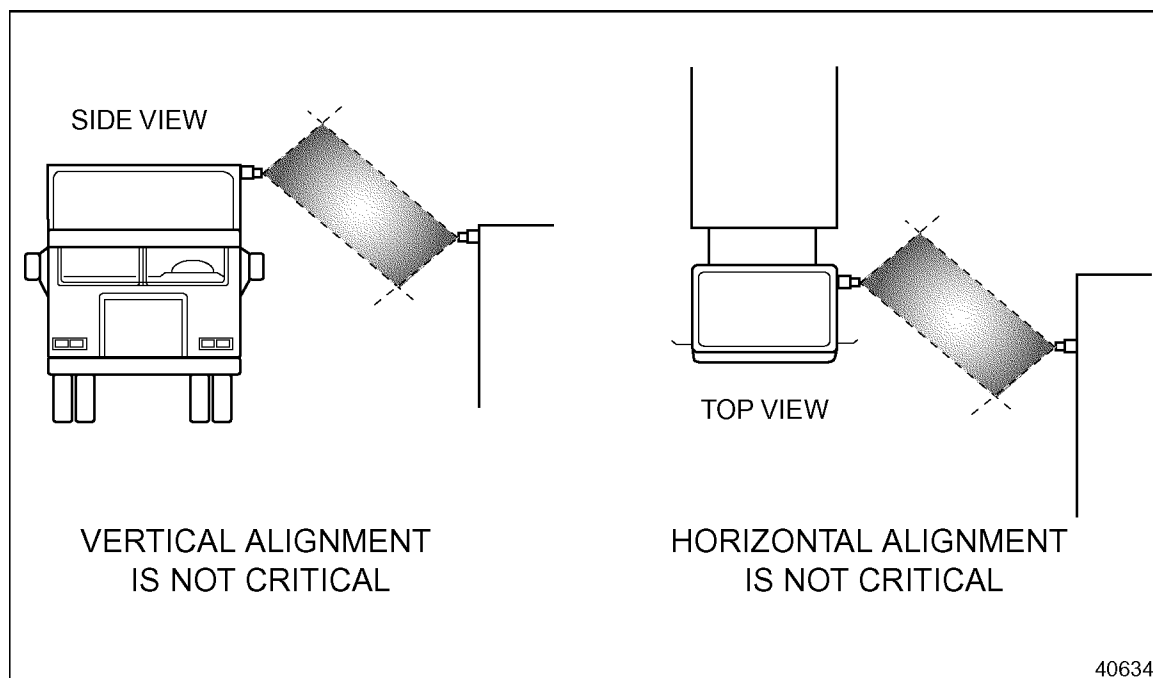


Figure 5-43 Horizontal and Vertical Alignment is not Critical

Use the following guidelines when installing IRIS:

- ❑ Shade the transceiver from bright sunlight to obtain more distance outdoors.
- ❑ Do not shine electronic ballast fluorescent lights into the transceiver.
- ❑ Do not install transceivers where they are exposed to strobe lights.

Mobile Unit Installation

The mobile transceiver should be mounted outside of the vehicle either on the side or the front. (see Figure 5-44).

NOTE:

For optimal performance, mount the mobile transceiver at least seven feet above the ground to minimize beam obstruction during operation.

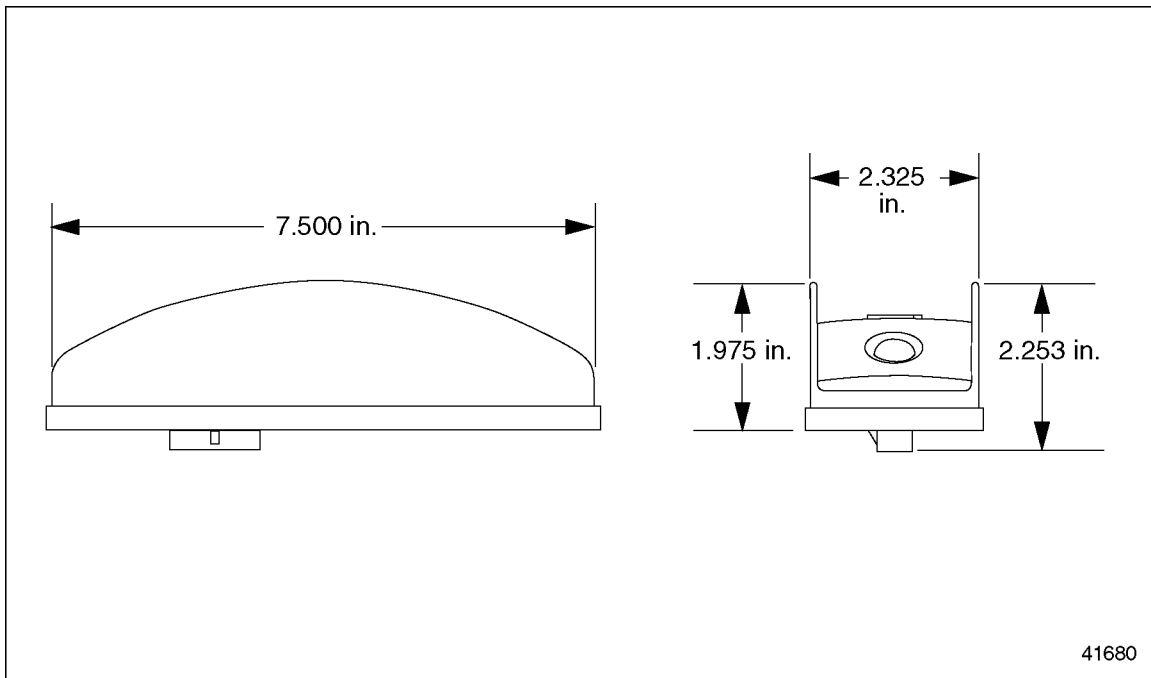


Figure 5-44 IRIS Transceiver Dimensions

The transceiver should be located on the vehicle so it aligns with the transceiver at the extraction site. Precise alignment of the transceivers is recommended but is not critical. IRIS transceivers have a wide beam pattern to assure an infrared connection.

See Figure 5-45 for the recommended cut out pattern.

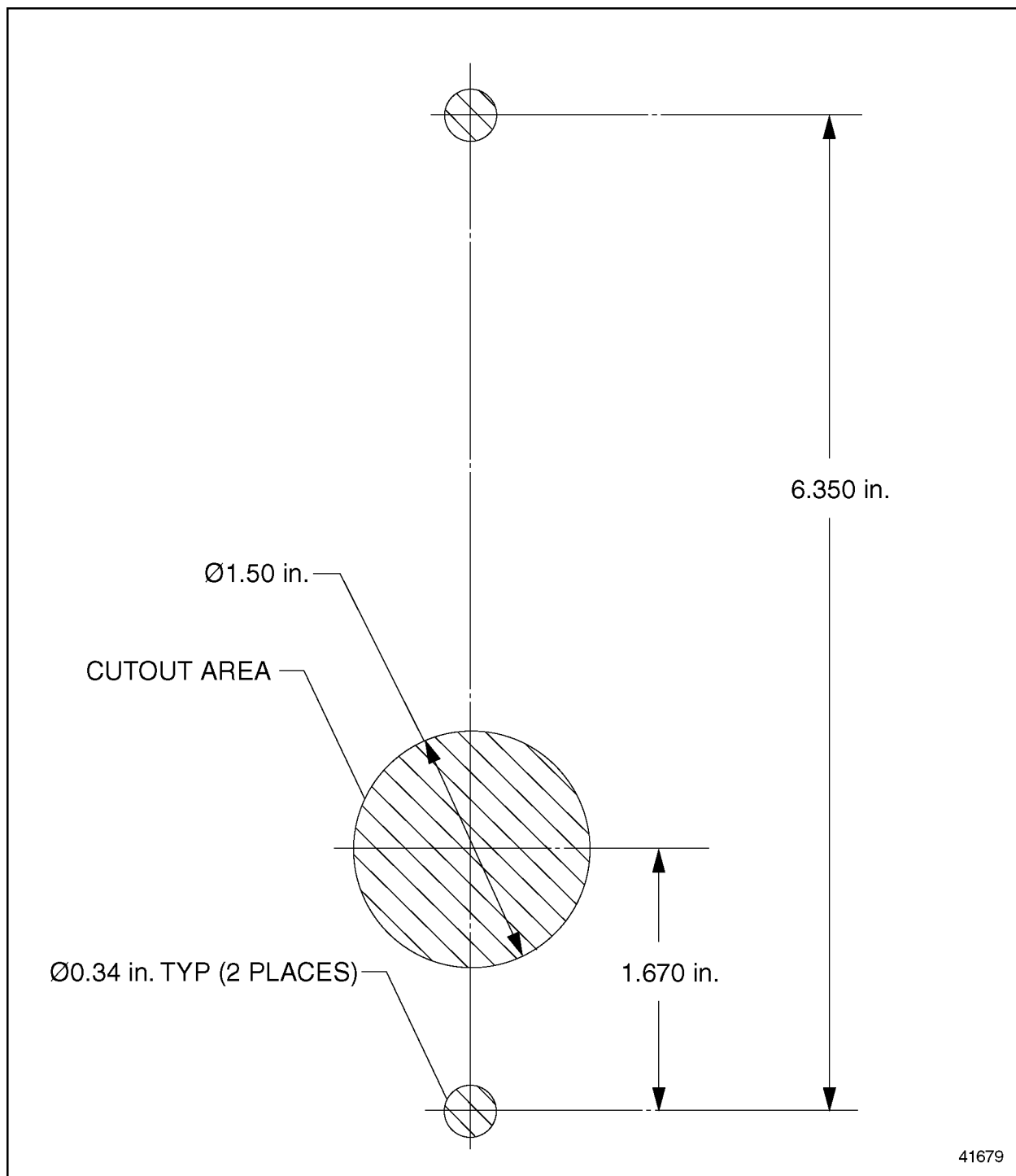


Figure 5-45 Recommended Cut Out Pattern

The IRIS dash light indicates when the IR connection is established (see Figure 5-46).

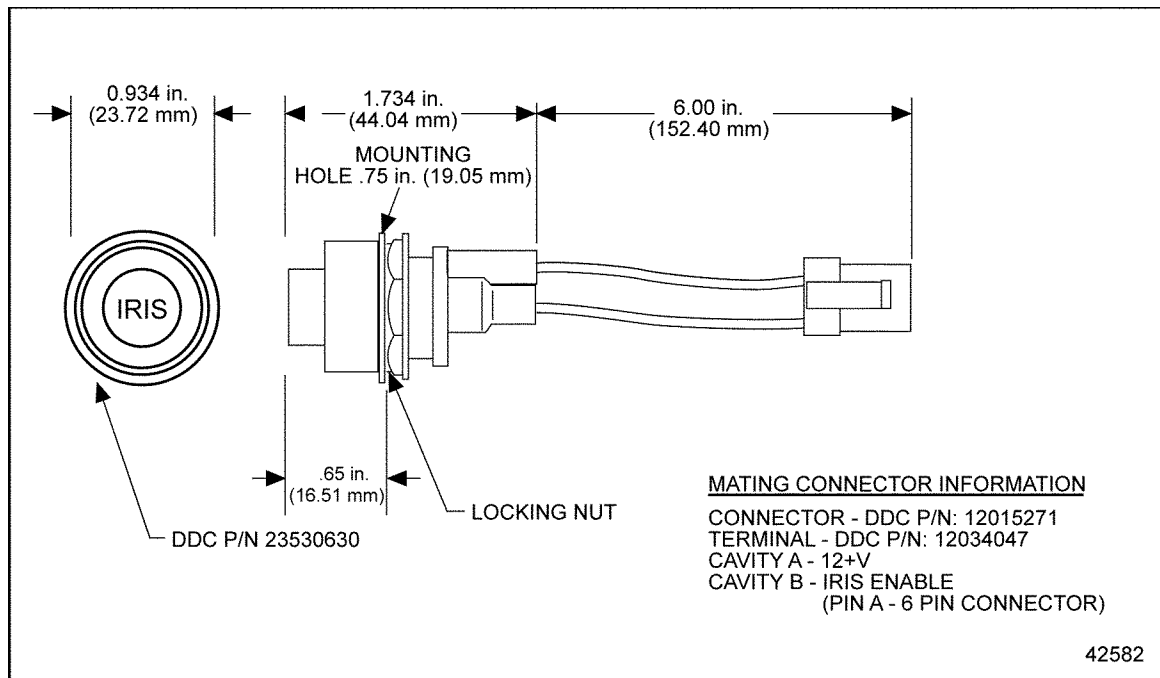


Figure 5-46 IRIS Dash Light

Two 1/4–20 grade 8 or greater stainless steel bolts are required to secure the transceiver to the vehicle. Bolt torque is 7–9 lb·ft.

The IRIS transceiver is capable of sinking 15 mA maximum for the dash light output. An LED type dash light is required. The part number for the IRIS LED dash light is 23530630.

The 6-pin connector on the mobile transceiver is used for power (ignition, ground), dash light, and data link communications. See Figure 5-47 for the interface to the vehicle.

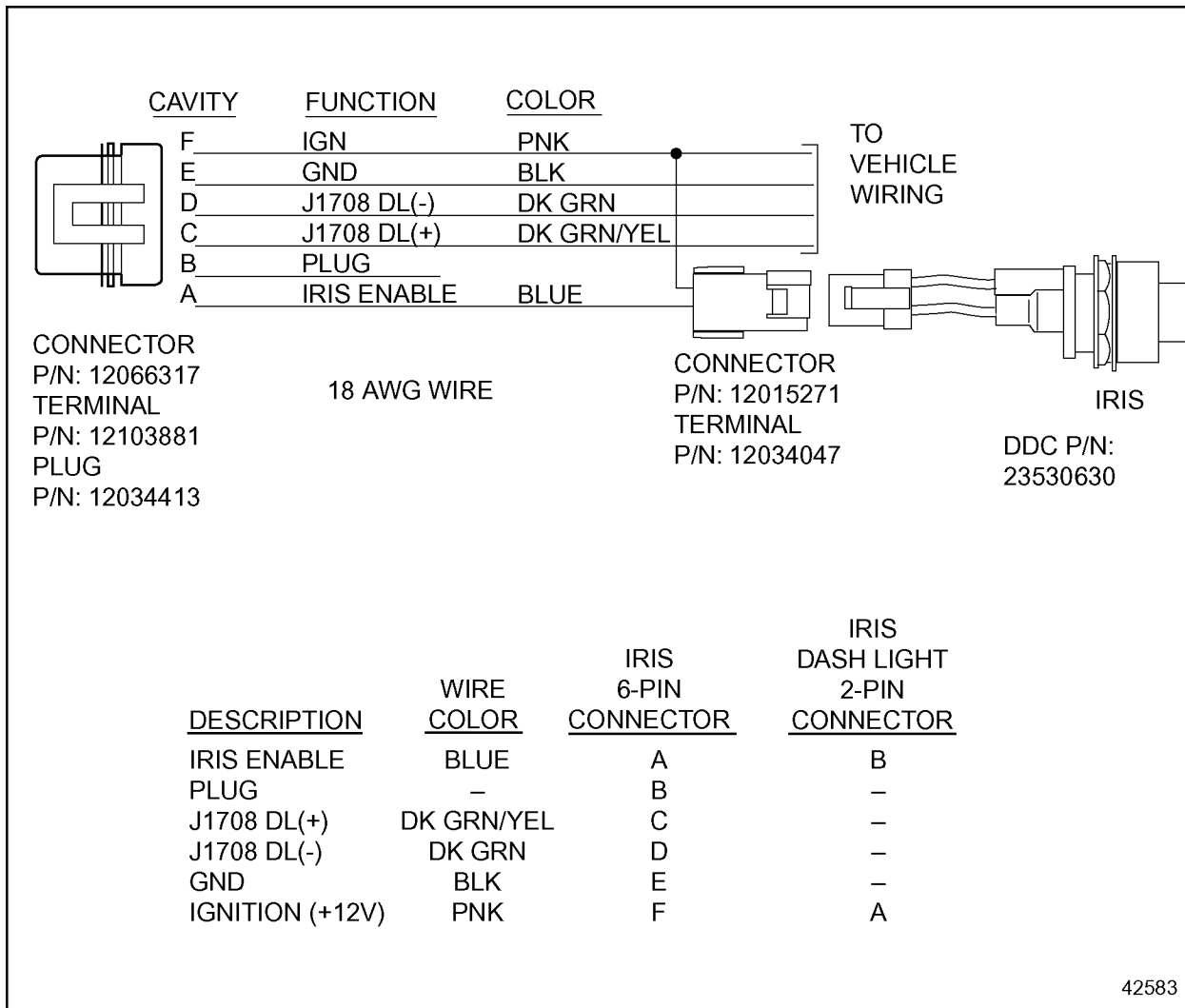


Figure 5-47 IRIS Harness

The IRIS module can only be powered by a 12 V supply. The current draw is 0.5 amps during steady state operations.

IRIS Hardware and Kits

IRIS hardware is listed in Table 5-61.

Part Number	Component
23529807	IRIS Base Transceiver, 12 V
23530585	IRIS Communication/Power Harness – 6 ft (white translator box)
23528561	IRIS Standard Harness – 96 in.
23528639	IRIS-RDI Adapter Kit
23530571	IRIS Base Adapter Harness (6-pin Deutsch)
23530627	IRIS Power Supply Harness
23530630	IRIS Active Light w/Connector
23528945	IRIS LED Replacement
551004	Lite Link Translator
23515869	Cable 6 ft DDEC Interface PC Download
23515957	Adaptor 6-pin Deutsch to 15-pin DB Conn, Diag
23523893	Adapter 6-pin to 9-pin Deutsch
23520540	Cable RS232 9-pin serial, 6 ft
23520539	Adapter DB25 to DB9
23529808	IRIS Mobile Transceiver, 12 V
23528559	IRIS Mobile Service Interface Harness
23530629	IRIS Mounting Bracket
7SA804	IRIS Installation Instructions
23530586	IRIS Communication/Power Harness 100 ft (white translator box)
23535770	IRIS Communication/Power Harness 6 ft (Multi Link/Lite Link translator box)
23535771	IRIS Communication/Power Harness 100 ft (Multi Link/Lite Link translator box)
23528637	Wire Clamp
23519359	Splice Clips, 18–22 AWG
23530631	IRIS Base “Y” Adapter Harness (6-pin and 9-pin Deutsch)
23530892	IRIS Active Light (no connector)

Table 5-61 IRIS Hardware

The IRIS kits listed in Table 5-62, Table 5-63, Table 5-64, and Table 5-65 are available.

Part Number	Component	Quantity
23529807	IRIS Base Transceiver, 12 V	1
23535770	IRIS Communication/Power Harness – 6 ft (Multi Link/Lite Link translator box)	1
23530627	IRIS Power Supply Harness	1
23530629	IRIS Mounting Bracket (includes screws, nuts, wire clamps)	1
18SP 570	Planning an IRIS Installation	1
7SA821	IRIS Installation Instructions	1

Table 5-62 IRIS Base Adapter Kit — P/N: 23530730

Part Number	Component	Quantity
23529807	IRIS Base Transceiver, 12 V	1
23535770	IRIS Communication/Power Harness – 6 ft (Multi Link/Lite Link translator box)	1
23530627	IRIS Power Supply Harness	
7SA821	IRIS Installation Instructions	1
551004	Lite Link Translator	1
23515869	Cable 6 ft DDEC Interface PC Download	1
23515957	Adaptor 6-pin Deutsch to 15-pin DB Conn, Diag	1
23523893	Adaptor 6-pin to 9-pin Deutsch	1
23520540	Cable RS232 9-pin serial, 6 ft	1
23520539	Adapter DB25 to DB9	1
23530629	Base Mounting Bracket (includes screws, nuts, wire clamp)	1
18SP 570	Planning An IRIS Installation	1

Table 5-63 IRIS PC Extraction Kit – 23530731

Part Number	Component	Quantity
23529808	IRIS Mobile Transceiver, 12 V	1
23528559	Harness, IRIS Mobile Service Interface	1
23530629	IRIS Mounting Bracket	1
7SA804	IRIS Installation Instructions	1

Table 5-64 IRIS Mobile Service Kit, 12 V – P/N: 23530734

Part Number	Component	Quantity
23529808	IRIS Mobile Transceiver, 12 V	1
23530892	IRIS Active Light (no connector)	1
23528561	IRIS Standard Harness (96 in.)	1
23519359	Splice Clips 18–22 AWG	9
7SA804	IRIS Installation Instructions	1

Table 5-65 IRIS Mobile Retrofit Kit, 12 v – P/N: 23530733

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5.16 LOW GEAR TORQUE LIMITING

Low Gear Torque Limiting is an optional feature that allows a transmission to be used with engines capable of producing more torque than the transmission's peak torque rating.

5.16.1 OPERATION

Low Gear Torque Limiting provides a limit on the available torque if the ratio of vehicle speed to engine speed is below a set point. This limits full torque in lower gears and allows a transmission to be used with engines above the transmission's regular torque rating. Low Gear Torque Limiting is valid below 20 MPH.

For example, the customer wants to hold the torque to 1400 ft lb up to 8th gear. The transmission operates with the ratios listed in Table 5-66.

Gear	Transmission Gear Ratio
5	3.57
6	2.79
7	2.14
	<< Threshold
8	1.65
9	1.27
10	1.00

Table 5-66 Transmission Ratios

Under Low Gear Torque Limit, set the "torque limit" (actual maximum torque you want to limit to) to 1400 and "threshold" to 1.89 (value between the gear you want to limit and the previous gear's ratio).

To summarize, the customer wants to limit torque up to the 8th gear to 1400. Find the ratio between 7th and 8th (1.89). From 8th gear on up, the full rated torque will be available.

5.16.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

A Vehicle Speed Sensor (VSS) or output shaft speed message over J1939 is required, refer to section 3.11.24. The Vehicle Electronic Programming System (VEPS) or DDEC Reprogramming System (DRS) can enable the parameters listed in Table 5-67.

Parameter	Description	Choice / Display
LOW GEAR TORQUE LIMITING	Provides a limit on the available torque if the ratio of vehicle speed to engine speed is below a set point.	0 to 65535 ft lb 65535 ft lb disables this feature.
LOW GEAR THRESHOLD	The gear ratio below which torque is limited.	0.47 to 300

Table 5-67 Low Gear Torque Limiting Parameters

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5.17 MAINTENANCE ALERT SYSTEM

The Maintenance Alert System (MAS) is an optional feature that monitors engine fluid levels and filter restrictions and notifies the driver and/or technician when maintenance is required. MAS parameters that can be monitored are:

- ☐ Air Filter Restriction - OEM installed sensor
- ☐ Add Engine Coolant Level - OEM installed sensor
- ☐ Engine Oil Level - factory installed sensor
- ☐ Engine Fuel Restriction - factory installed sensor

The Engine Oil Level Sensor (EOL Sensor) and Engine Fuel Restriction Sensor (EFR Sensor) are standard MAS sensors.

The AWL and RSL may be used to indicate the codes or an optional MAS display, ProDriver® DC or Detroit Diesel Diagnostic Link (DDDL) may be used.

5.17.1 OPERATION

DDEC continuously monitors the various sensors and logs and displays a code when a fault occurs. MAS faults do not engage any Engine Protection features (rampdown or shutdown).

DDEC will notify the operator/technician of maintenance requirements by one or more of the following methods:

- ☐ AWL/RSL indication
- ☐ ProDriver DC
- ☐ Maintenance Alert System Display Module
- ☐ DDDL



WARNING:

PERSONAL INJURY

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

For mobile applications, DDDL, or MAS display must be used by personnel other than the vehicle operator.

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

Oil level can only be determined when the engine is not running (i.e. after the ignition is turned off and after the drain down period or before the engine has been started). There is a minimum of four minutes and a maximum of 15 minutes (based on oil temperature) to determine the oil level after the engine has shutdown.

The Air Filter Restriction Sensor (AFR Sensor) has two trip points, one at 18 inches of water and the second at 25 inches of water. The EFR Sensor will log a fault at 12 in.Hg.

An air filter is considered to be restricted if the AFR Sensor read 18 in.H₂O and the engine is operating below 1500 rpm or the AFR Sensor reads 25 in. H₂O at any engine speed. The air filter restriction logic will look for either of these two restriction that have occurred at least 24 engine hours apart but no more than 72 hours apart. When this condition is met, the ECU will activate an air filter restriction fault.

The air filter restriction fault and fuel restriction fault will remain active for the entire ignition cycle. If the MAS display is used, the fault will be latched in the display until a FILTER RESET is done.

An air filter restriction and engine fuel restriction fault will remain active for the entire ignition cycle.

ECU Power Down Behavior

If the Add Engine Coolant Level Sensor (AECL Sensor) or EOL Sensor are configured, the ECU will go into a reduced activity mode after ignition off. In this mode, the ECU will not continuously broadcast data, but will still accept and respond to requests for two hours. The ECU will continue to monitor all the sensors, but the injectors will not fire. Just before the ECU is powered down, it will broadcast the fluid levels, all faults (active and inactive) and preventative maintenance status. After the ECU has powered down, it will not respond to data link requests.

AWL/RSL Flashing

There are four options for using the AWL and RSL for MAS, which may be set with DDDL, the Vehicle Electronic Programming System (VEPS), or the DDEC Reprogramming System (DRS).

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

DDDL, VEPS, or DRS can set options for filter restriction and fluid levels independently. For example, filter restrictions can be set so the AWL/RSL does not flash, but the sensor code is logged and the fluid levels can be set so that AWL will turn on when the warning is active. The factory set defaults are listed in Table 5-68.

Parameters	Default
Fluid Levels	AWL and RSL flash for 15 seconds when the ignition is first turned on.
Filter Restrictions	AWL will illuminate while the warning is active.

Table 5-68 Factory Set Defaults for AWL and RSL

ProDriver DC

ProDriver DC will display any active faults and descriptions as they occur.

Maintenance Alert System Display Module

The MAS display is cab mounted to easily display the current maintenance conditions. The display (see Figure 5-48) has seven tricolor LEDs and two switches (FILTER RESET and CHECK), each labeled for their function.

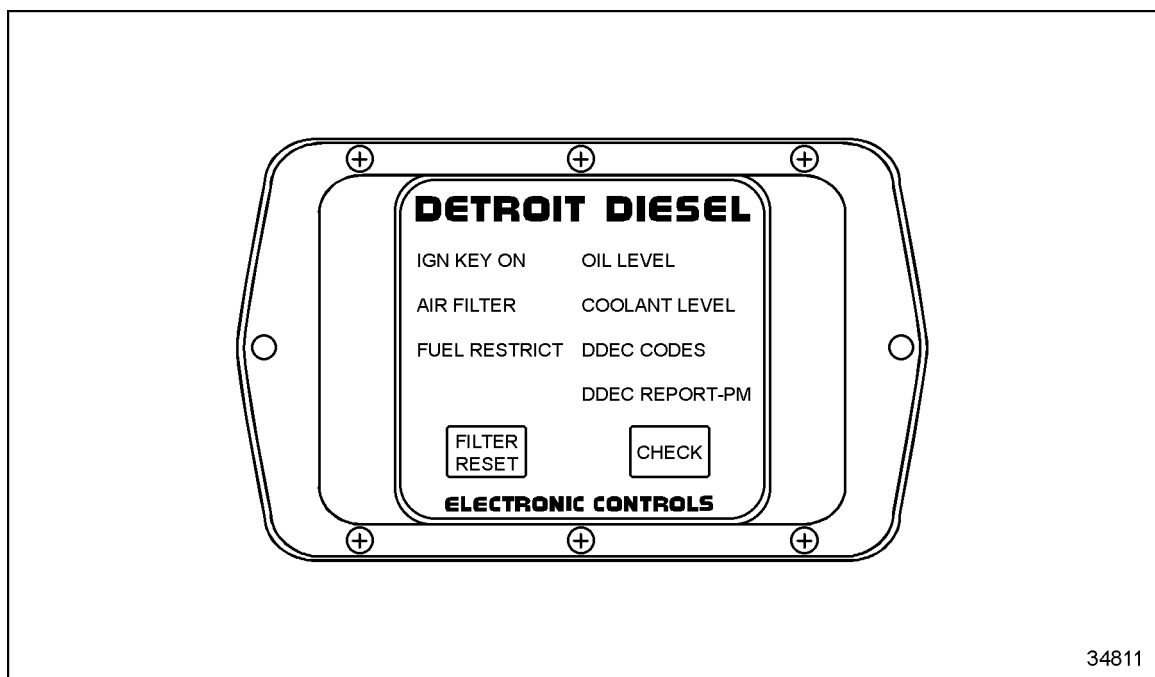


Figure 5-48 Maintenance Alert System Display (P/N: 23525655)

To display the current status of MAS parameters (listed in Table 5-69), press the CHECK button at any time to start the bulb check sequence.

Parameter	Green	Amber	Flashing Red	Blank
Air Filter	OK	N/A	Filter restriction is high.	Sensor fault or not configured.
Coolant Level	OK	N/A	Coolant Level is low. (Add coolant)	Sensor fault or not configured.
DDEC Codes	No Sensor Diagnostic Trouble Codes	Inactive sensor Diagnostic Trouble Codes present; No Active codes	Active sensor Diagnostic Trouble Code is present.	N/A
DDEC Reports	Preventive Maintenance configured, no maintenance required	N/A	Preventive Maintenance configured and needs service.	Preventive Maintenance not configured.
Fuel RESTRICT	OK	N/A	Filter restriction is high.	Sensor fault or not configured.
IGN Key ON	N/A	N/A	ECU asleep, memory data displayed.	ECU active, current data displayed.
Oil Level	OK	Oil is still draining to the oil pan.	Low oil level (minimum of 4 quarts)	Sensor fault or not configured.

Table 5-69 Maintenance Alert System Display Light Status

During the bulb check the display will request the current Preventative Maintenance (PM) data and update its memory with the received information. The LEDs will go through the following bulb check sequence:

1. All of the LEDs turn on and are green for approximately one (1) second.
2. All LEDs turn off very briefly.
3. All LEDs turn on and are red for approximately one (1) second.
4. All LEDs turn off very briefly.
5. The current information from memory will turn the LEDs to their appropriate color.
6. The LEDs will turn off after approximately 10 seconds with no switch activity.

The display will latch the fault for filter restrictions until cleared from the display. To reset the faults, press and hold the FILTER RESET button for three (3) seconds while the data is displayed. This will initiate the reset sequence for filters. This reset will only clear the display memory for each of the configured filters. FILTER RESET will change the flashing red filter LEDs to green until new and/or differing data is received and stored. If a filter LED is off and stays off after a reset this indicates that a problem other than Filter Restriction High (FMI 0) exists for that filter. The other LEDs (not used for filters) will still display the current data as they did before the reset sequence was initiated.

The MAS display will also perform minor diagnostics to inform the operator if the connection to the data link has been broken while the ignition is on. When this condition occurs, the display will flash all LEDs red at roughly two times/second while the ignition is on and until the FILTER RESET button is pushed, at which time the display will go blank. If the MAS display is energized via the CHECK button before the link connection has been repaired, the LEDs will again flash red in place of the normal service item status until the 10 second "no activity" timer has expired. After the display sees data bus activity, it will revert back to normal operation with the currently stored data and normal updates to the stored data.

Detroit Diesel Diagnostic Link

The DDDL Maintenance Alert menu (Diagnostics/Maintenance Alert) will display the current status of the MAS parameters and preventative maintenance status as listed in Table 5-70.

Parameter	Description	Choices
ENGINE OIL LEVEL	Indicates the engine oil level. NOTE: While the engine is running, or for a maximum of 15 minutes after shutting down, the engine oil level will be UNKNOWN.	OK, ADD, N/A, UNKNOWN, FAIL
ENGINE COOLANT LEVEL	Indicates the coolant level in the reservoir.	FULL, ADD, LOW, N/A, FAIL
AIR FILTER RESTRICTION	Indicates the relative amount of restriction measured at the air inlet filter.	OK, PLUGGED, ERROR, N/A
ENGINE FUEL RESTRICTION	Indicates the restriction measured at the fuel pump inlet.	OK, PLUGGED, ERROR, N/A
PREVENTATIVE MAINTENANCE STATUS SERVICE A	Indicates the status of preventative maintenance limits.	EXPIRED, NOT EXPIRED, NOT CONFIGURED
PREVENTATIVE MAINTENANCE STATUS SERVICE B	Indicates the status of preventative maintenance limits.	EXPIRED, NOT EXPIRED, NOT CONFIGURED
PREVENTATIVE MAINTENANCE STATUS SERVICE C	Indicates the status of preventative maintenance limits.	EXPIRED, NOT EXPIRED, NOT CONFIGURED

Table 5-70 DDDL Maintenance Alert Menu List of MAS Parameters

The DDDL Instrumentation menu will display the MAS parameters as listed in Table 5-71 under the "User ~6" tab.

Parameter	Description	Choices
ENGINE OIL LEVEL	Indicates the engine oil level. NOTE: While the engine is running, or for a maximum of 15 minutes after shutting down, the engine oil level will be UNKNOWN.	OK, ADD, N/A, UNKNOWN, FAIL
ENGINE COOLANT LEVEL	Indicates the coolant level in the reservoir.	FULL, ADD, LOW, N/A, FAIL
AIR FILTER RESTRICTION PRESSURE	Indicates the relative amount of restriction measured at the air inlet filter.	0.0 to 99.9 "H2O 0.0 to 99.9 kPa FAIL, N/A
ENGINE FUEL RESTRICTION PRESSURE	Indicates the restriction measured at the fuel pump inlet.	0.0 to 99.9 "Hg 0.0 to 99.9 kPa FAIL, N/A

Table 5-71 DDDL Instrumentation Menu List of MAS Parameters

NOTE:

After replacing the filter, DDDL will display PLUGGED until the inactive or maintenance codes are cleared.

Maintenance Codes can be cleared by DDDL under the Maintenance Alert menu (Diagnostics/Maintenance Alert). Only the MAS faults listed in Table 5-72 will be cleared under the Maintenance Alert menu.

PID	FMI	Description
98	1	Engine Oil Level Low
111	1	Engine Coolant Level Low
107	0	Air Filter Restriction High
95	0	Fuel Restriction High

Table 5-72 MAS Maintenance Codes DDDL Can Clear Under the Maintenance Alert Menu

5.17.2 INSTALLATION

The Engine Oil Level Sensor (EOL Sensor) and the Engine Fuel Restriction Sensor (EFR Sensor) are factory installed. The Air Filter Restriction Sensor (AFR Sensor), the Add Engine Coolant Level Sensor (AECL Sensor), and the MAS Display Module are installed by the OEM.

Air Filter Restriction Sensor

The AFR Sensor (see Figure 5-49) is mounted downstream of the air filter and upstream of the turbocharger.

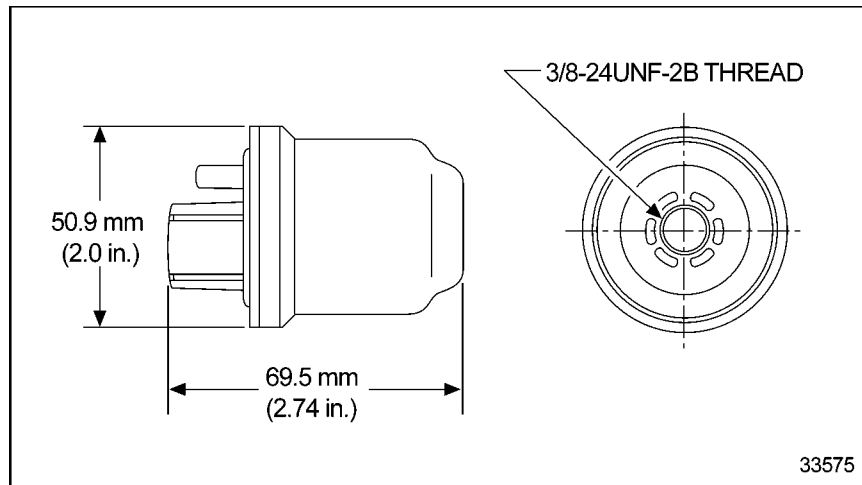


Figure 5-49 Air Filter Restriction Sensor

The AFR Sensor 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).

NOTE:

The AFR Sensor and associated wiring is OEM installed.

Two fittings are provided with the sensor (see Figure 5-50). Each OEM can pick the application appropriate fitting.

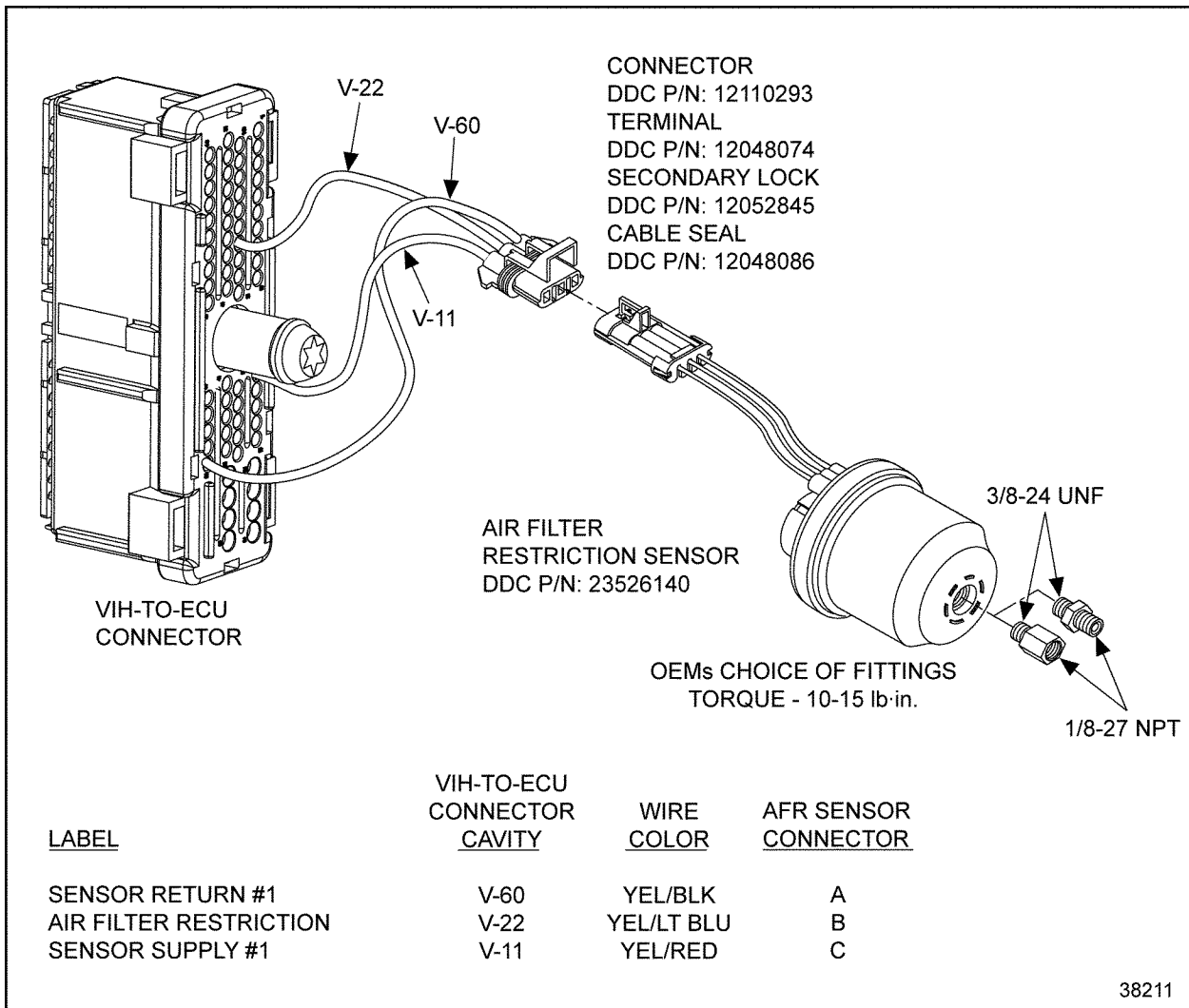


Figure 5-50 Air Filter Restriction Wiring Diagram

Add Engine Coolant Level Sensor

AECL Sensor is used to warn the driver that the coolant level is below the recommended level but engine damage is not imminent. If the tank is equipped with an "ADD" level, the sensor should be installed there. This sensor will be activated approximately mid-way between the cold full level and the level where the standard (engine protection) ECL Sensor is located (see Figure 5-51). An ECL Sensor warning tells the driver that engine damage is imminent.

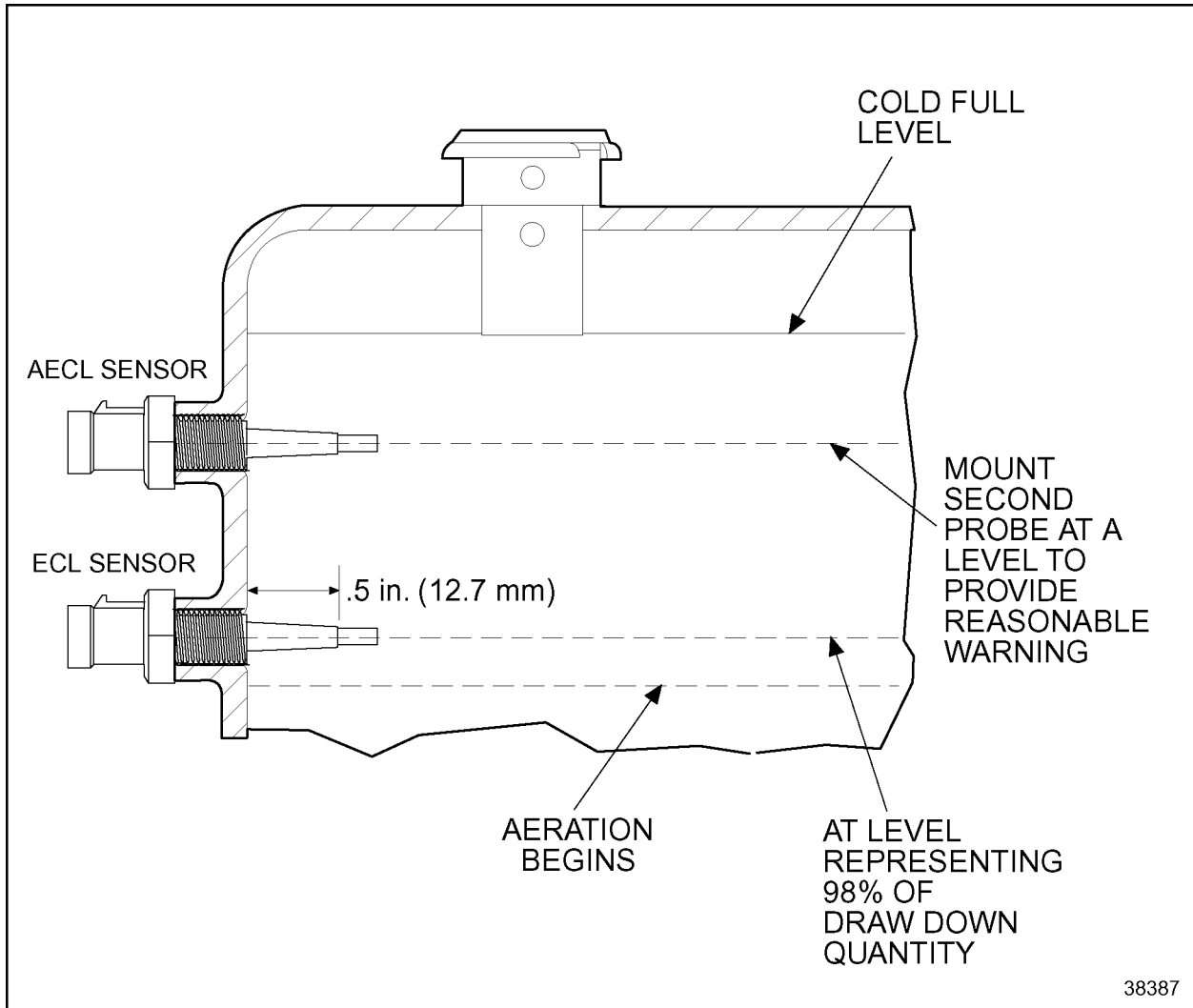


Figure 5-51 Add Engine Coolant Level Sensor Location - Radiator Surge Tank

The AECL Sensor must be enabled with VEPS or DRS.

NOTE:

All AECL Sensor components are OEM installed.

See Figure 5-52 for wiring schematic.

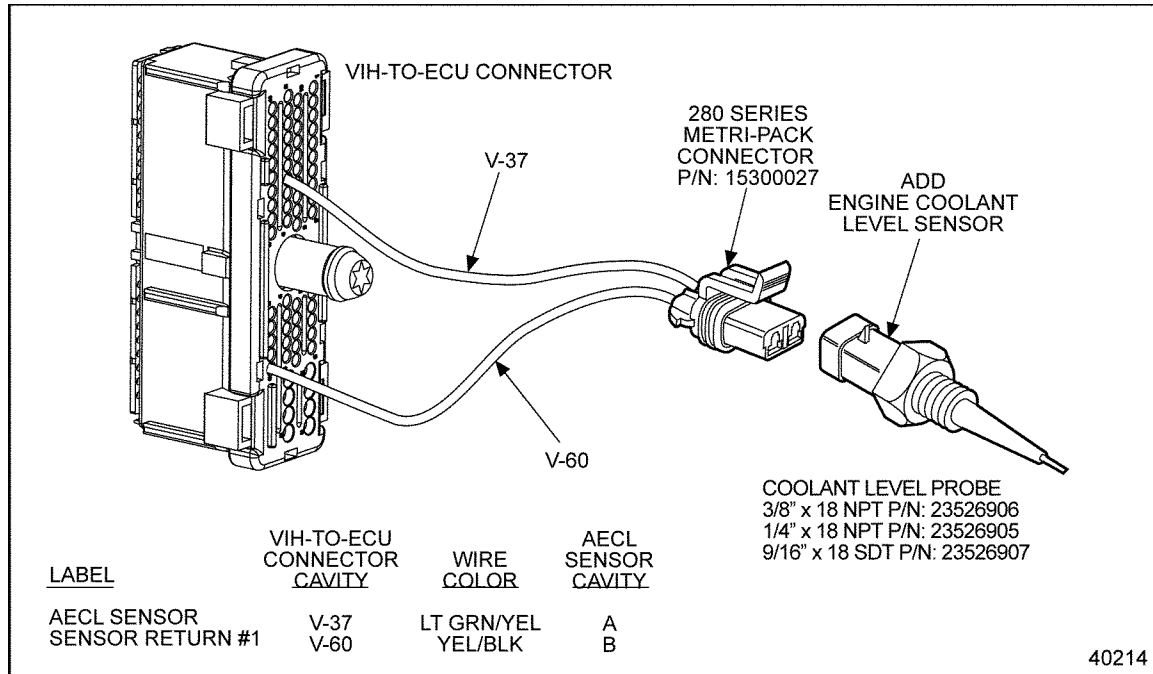


Figure 5-52 Add Engine Coolant Level Sensor Installation

Engine Fuel Restriction Sensor

The EFR Sensor is factory installed at DDC and is incorporated into the DDC Engine Harness (see Figure 5-53).

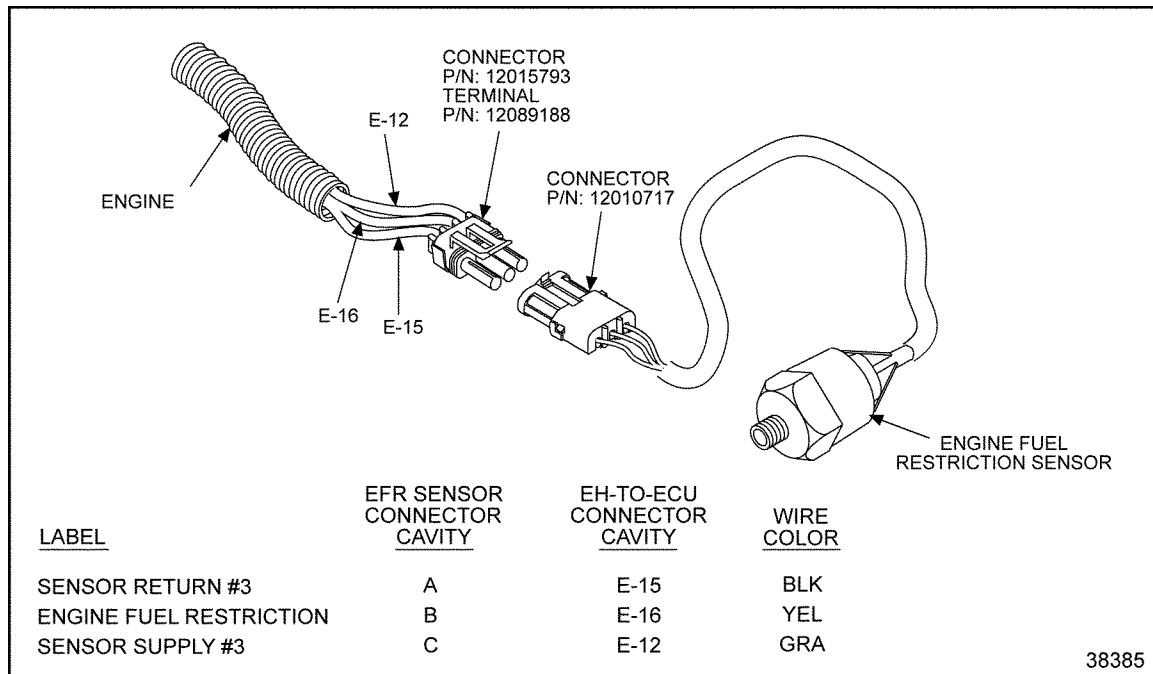


Figure 5-53 Engine Fuel Restriction Sensor Installation

No OEM installation is required. The proper 6N4C and 6N4 groups must be specified.

The EFR Sensor will log a diagnostic trouble code at 12 in. Hg.

Engine Oil Level Sensor

The EOL Sensor is factory installed at DDC and is incorporated into the DDC Engine Harness (see Figure 5-54). No OEM installation is required. The proper 6N4C and 6N4 groups must be specified. The EOL Sensor is mounted in the oil pan at four quarts low.

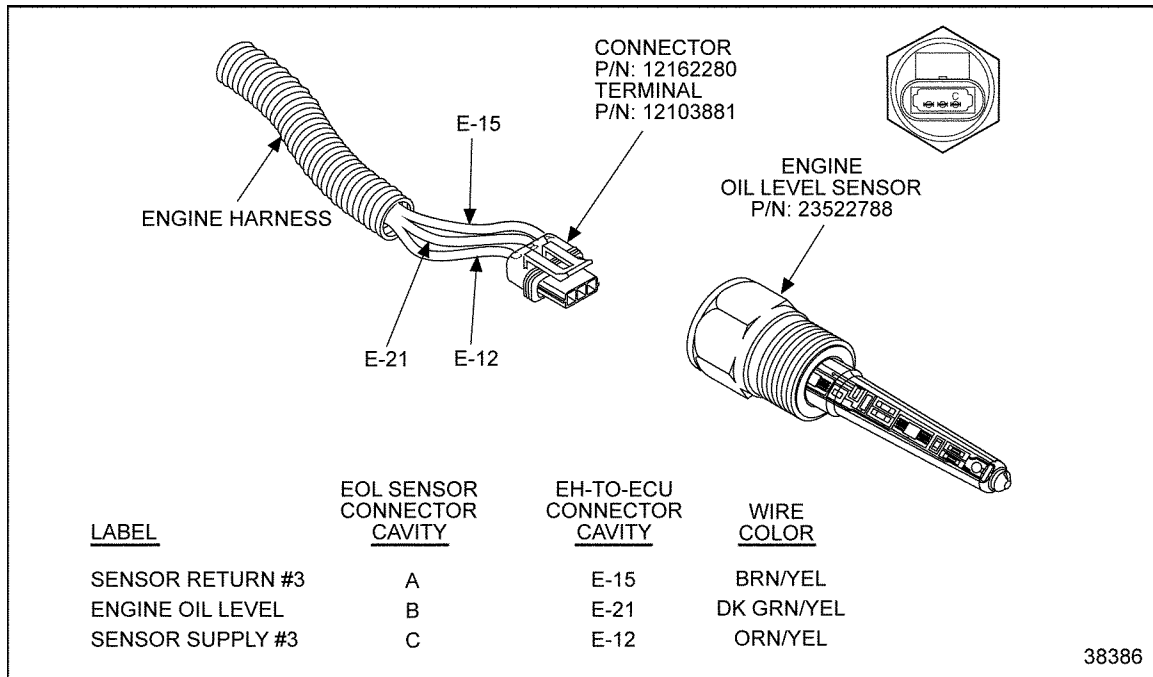


Figure 5-54 Engine Oil Level Sensor Installation

Maintenance Alert System Display Module Installation

The display must be mounted in an interior location easily accessible from outside the vehicle for mechanics and other service personnel to view. It cannot be mounted in the engine compartment. The part number for the MAS display is P/N: 23525655. See Figure 5-55 for the dimensions of the MAS display.

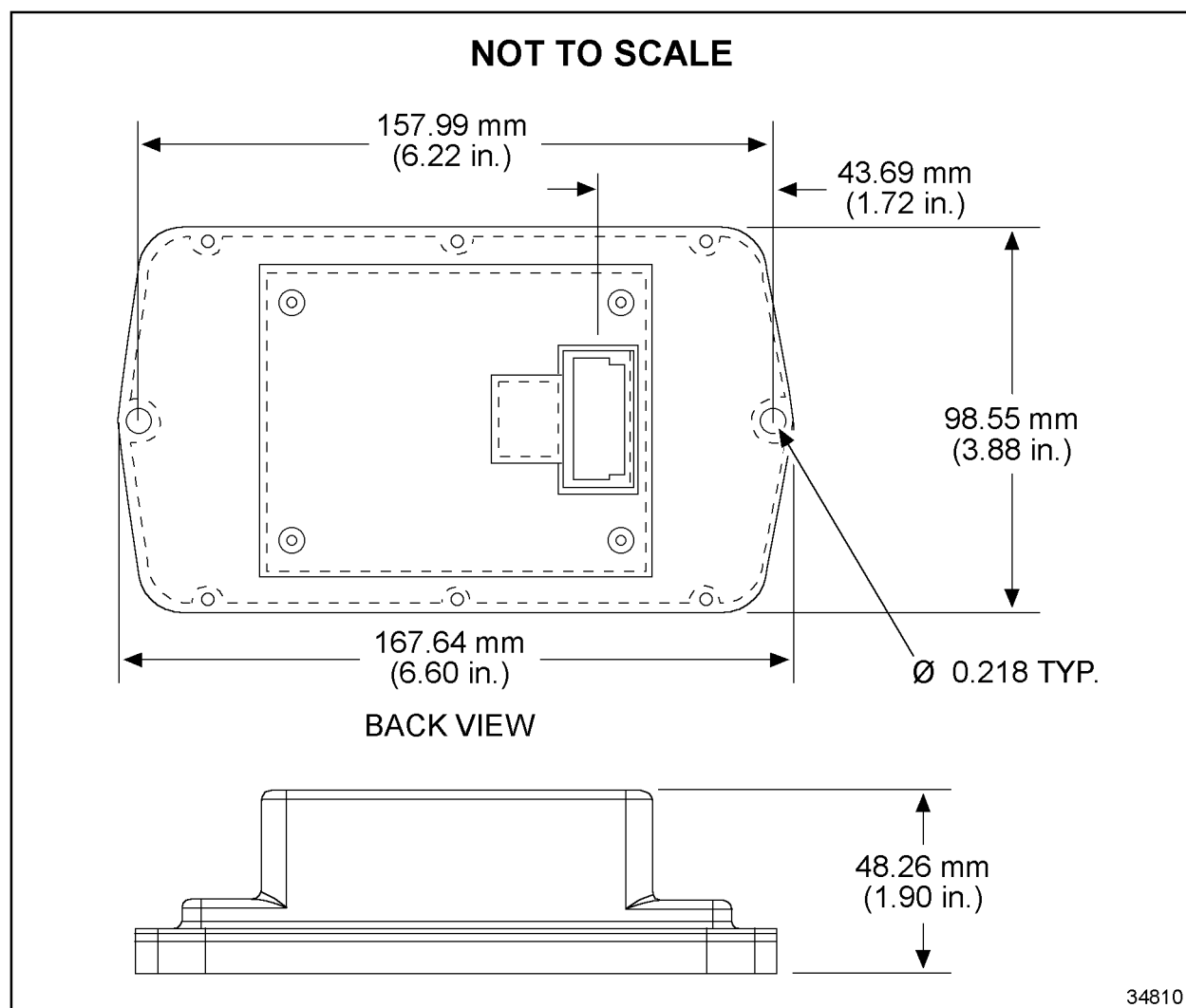


Figure 5-55 Maintenance Alert System Display Dimensions

The display may be installed in other enclosed areas such as a bus battery compartment. If the display is installed anywhere outside the vehicle cab or passenger compartment, it must be completely sealed inside a protective enclosure to protect it from dirt and moisture.

An example of a typical bracket used to mount the MAS display may be seen in the next two illustrations (see Figure 5-56 and Figure 5-57).

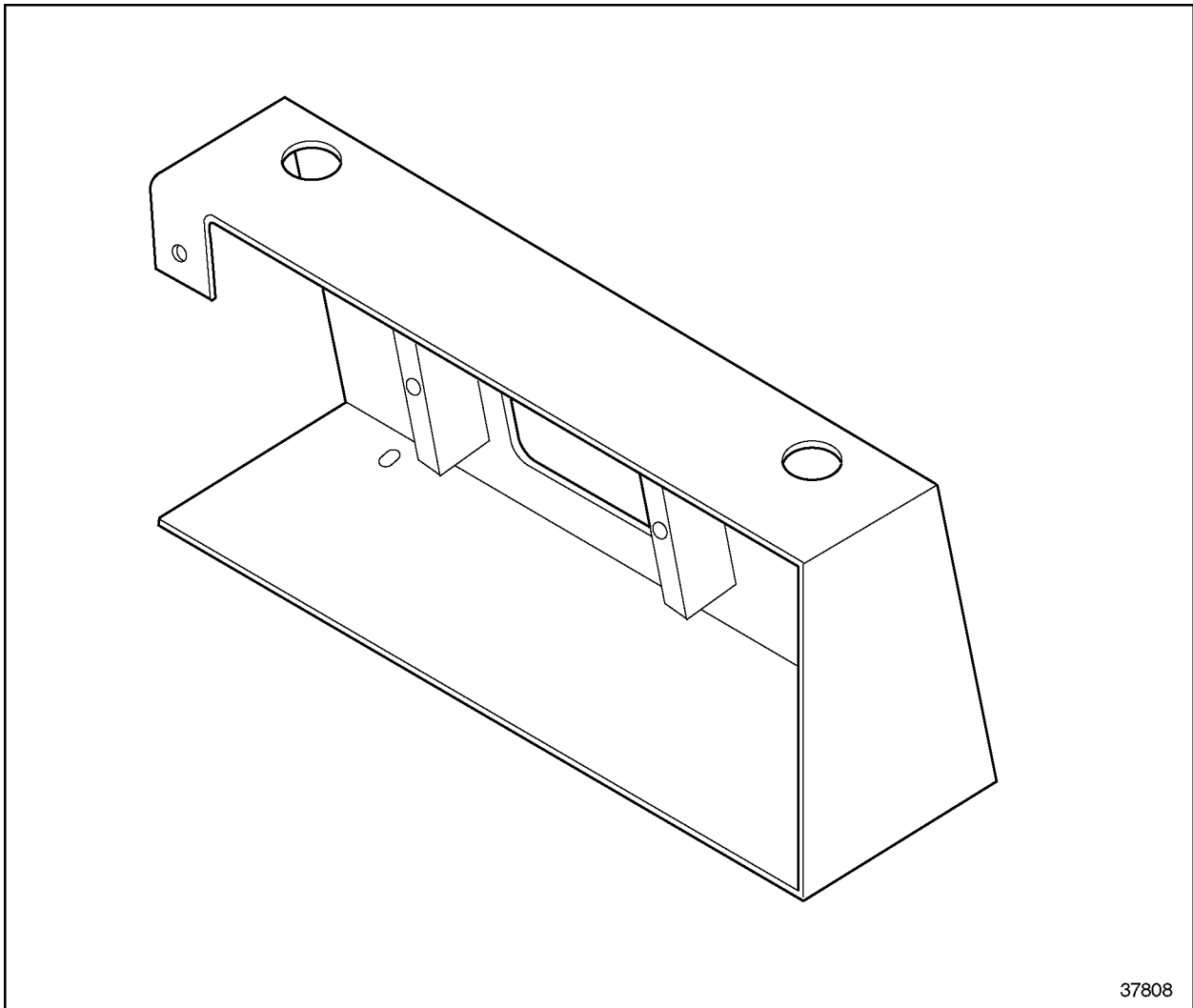
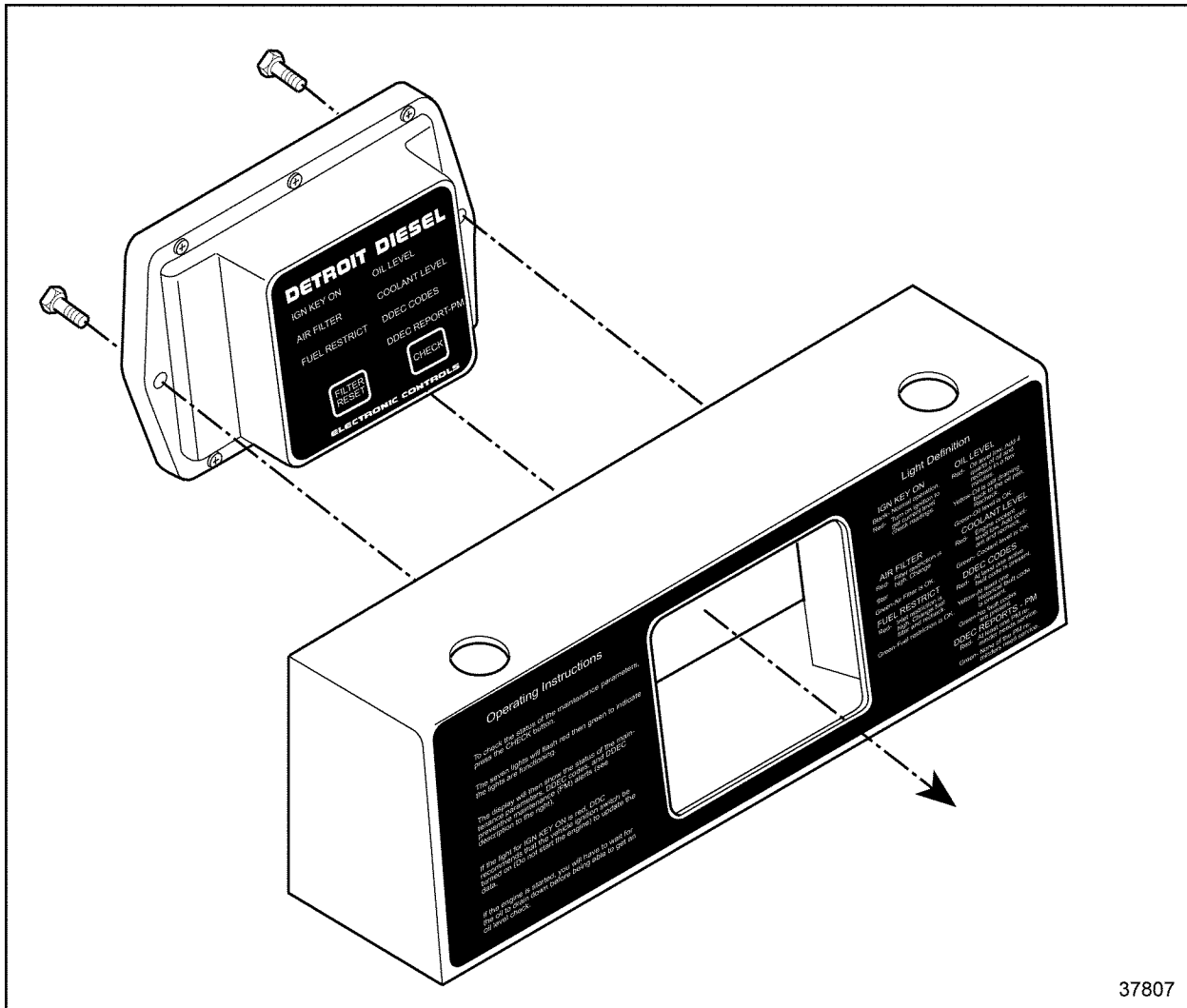


Figure 5-56 Maintenance Alert Display Bracket



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Figure 5-57 Maintenance Alert Display and Bracket

The bracket is the responsibility of the OEM. A label on the front face of the bracket should be used for operating instructions and light definition. See Figure 5-58 for an example.



Figure 5-58 Maintenance Alert Display Bracket with Label

Maintenance Alert System Display Harness

The connector for the MAS display is a molded integral connector that mates to Delphi Packard P/N: 12065425 with the connections shown in the following schematic. See Figure 5-59 for the wiring schematic.

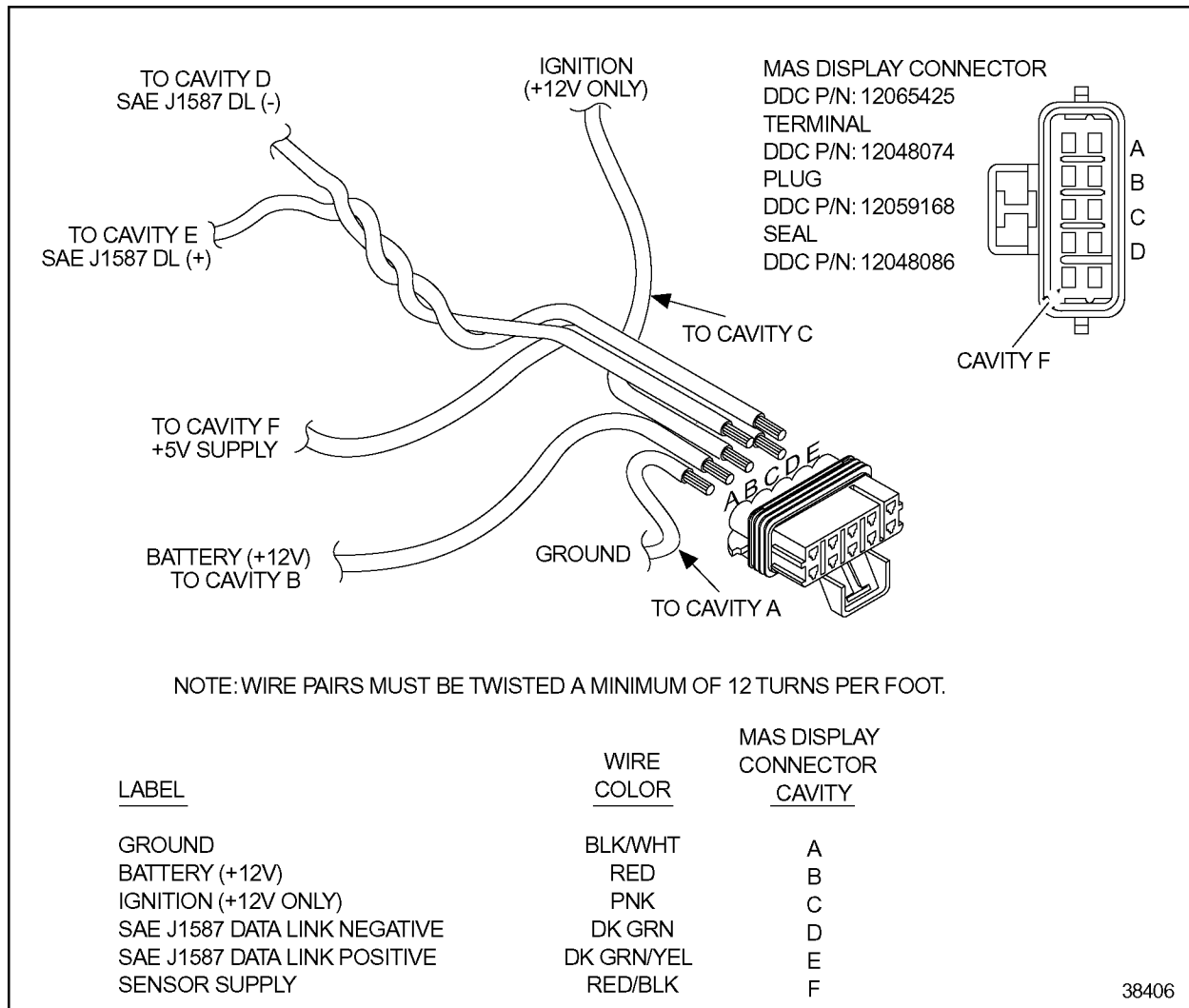


Figure 5-59 Maintenance Alert System Display Harness

5.17.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The EOL Sensor and EFR Sensor must be specified with the correct 6N4C and 6N4 groups.

The OEM installed sensors must be setup by VEPS or DRS. These sensors are the AFR Sensor, AECL Sensor.

NOTE:

The MAS display must only be wired to a +12 V battery and +12 V ignition source.

5.17.4 DIAGNOSTICS

The codes that will be logged are listed in Table 5-73.

DDC Code # (Flashed)	SAE J1587 Data Link Code # (PID)	FMI	Description
13	111	4	(Engine Protection) Engine Coolant Level (ECL Sensor) Circuit Failed Low
13	111	6	Add Engine Coolant Level (AECL Sensor) Circuit Failed Low
16	111	3	(Engine Protection) Engine Coolant Level (ECL Sensor) Circuit Failed High
16	111	5	Add Engine Coolant Level (AECL Sensor) Circuit Failed High
37	95	3	Engine Fuel Restriction Circuit Failed High
38	95	4	Engine Fuel Restriction Circuit Failed Low
43	111	1	Engine Coolant Level (ECL Sensor or AECL Sensor) Low
65	107	3	Air Filter Restriction Circuit Failed High
65	107	4	Air Filter Restriction Circuit Failed Low
73	107	0	Air Filter Restriction High
81	98	3	Engine Oil Level Circuit Failed High
82	98	4	Engine Oil Level Circuit Failed Low
84	98	1	Engine Oil Level Low
89	111	12	Maintenance Alert System Coolant Level Fault*
89	95	0	Engine Fuel Restriction High

* This fault will be logged when the Add Engine Coolant Level Circuit (AECL Sensor) reports the coolant level is OK and the (Engine Protection) Engine Coolant Level Circuit (ECL Sensor) reports that coolant is low.

Table 5-73 Maintenance Alert System Codes

NOTE:

Filter restrictions will latch a high restriction fault to active status for the entire ignition cycle.

5.17.5 INTERACTION WITH OTHER FEATURES

ProDriver and ProDriver DC will display any active faults as they occur.

There are four options for using the AWL and RSL for MAS, which may be set with DDDL.

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5.18 MANAGEMENT INFORMATION PRODUCTS

The Management Information Products comprise a modular system that provides monitoring of any DDEC-equipped engine. These products provide substantial storage capacity, flexible data extraction and communication capabilities. Members of the system that collect data include DDEC Data, and ProDriver® DC. DDEC Reports and Detroit Diesel Data Summaries are both PC software that can be used for data analysis and reporting.

5.18.1 OPERATION

The Management Information Products are designed to provide instantaneous feedback to the driver via ProDriver DC display module. These driver-friendly features help provide an understanding of the effect of the driver's actions on the engine and vehicle performance.

The DDEC ECU provides engine control and monitoring as well as a stored summary of engine performance.

Data in these devices can be extracted and analyzed with the two PC software products.

DDEC Reports and Detroit Diesel Data Summaries extract data from all hardware devices and analyzes data from DDEC Data. All these products allow printing of comprehensive reports for managing vehicle operation.

Additional diagnostic data available from Management Information includes:

- ☐ Instantaneous and average fuel economy
- ☐ Trip time, miles, fuel, total fuel used economy, and average speed
- ☐ Driving time, percentage, miles, fuel, and fuel economy
- ☐ Idle time, fuel and percentage
- ☐ Cruise time, percentage, miles, fuel, and fuel economy
- ☐ Top gear time, percentage, miles, fuel used, and fuel economy
- ☐ One gear down time (below top gear), percentage miles, fuel used and fuel economy
- ☐ VSG time, fuel, and percentage
- ☐ Overspeed time and percentage for two speed thresholds
- ☐ Over-rev time and percentage
- ☐ Maximum speed and RPM
- ☐ Coasting time and percentage
- ☐ Driving average load factor
- ☐ Automated oil change interval tracking
- ☐ Hard braking incident records
- ☐ Driver initiated incident records
- ☐ Stop and check engine code logs

- Optimized Idle active time, idle time, and estimated fuel savings
- SAE J1587 data link timeouts and power interruptions
- Leg time, distance, fuel used, fuel economy, average speed, and cruise time and percentage
- Last Stop records

5.18.2 DDEC DATA

DDEC Data is a standard part of the DDEC V ECU. DDEC Data utilizes available memory and processing speed, along with the built-in, battery-backed clock/calendar to document the performance of the driver and vehicle. Data is stored in three monthly records and in a trip file that may be reset at extraction. Data on periodic maintenance intervals, hard brake incidents, last stop records, daily engine usage, and ECU diagnostics is also stored.

Data can be extracted to a PC hard drive through a wide range of options:

- Direct extraction using a DDEC translator box and cables connected to a PC running DDEC Reports.
- A Remote Data Interface (RDI) which adds automation to the process. This weatherproof extraction module is usually located at a fuel island and the PC it connects to is remotely located. The PC will be operating the communication part of DDEC Reports called DDEC Communications.
- Wireless extraction via cellular telephone, satellite or radio communications equipment. The PC can be operating DDEC Reports or DDEC Communications.

5.18.3 DETROIT DIESEL DATA SUMMARIES

This new PC program for Windows 95/98 is used to analyze and report trip data from DDEC Data and ProDriver DC. Data Summaries can report trip data one vehicle at a time, summary reports for the whole fleet, and reports of driver trip activity.

Trip extractions from individual vehicles are loaded into Data Summaries database. The database divides trip extractions into yearly files. New extractions are added to the current year database making it possible to run reports for any time period within the year. This makes it possible for the user to form summary reports of the entire fleet, for a group of vehicles, or an individual vehicle. It is also possible to do the same for all drivers, groups of drivers, or individual drivers.

Data Summaries also supports ProDriver DC. Utilities in Data Summaries allow the user to format and setup the different data card types, such as the Driver Card, the Configuration Card, etc. A driver ID can be placed on Driver Cards. The extracted data is read from Driver Cards and placed into the database.

5.18.4 DDEC REPORTS

After the data is extracted from the ECU, DDEC Reports software produces a wide range of diagnostic and management reports. DDEC Reports produces comprehensive trip reports in both on-highway and nonroad markets. The on-highway reports are:

- ☐ Trip Activity
- ☐ Vehicle Speed/RPM
- ☐ Overspeed / Over Rev
- ☐ Engine Load/RPM
- ☐ Vehicle Configuration
- ☐ Periodic Maintenance
- ☐ Hard Brake Incident
- ☐ Last Stop
- ☐ DDEC Diagnostic
- ☐ Profile
- ☐ Monthly Activity
- ☐ Daily Engine Usage
- ☐ Life to Date

The nonroad reports are:

- ☐ Period Activity
- ☐ High RPM
- ☐ Engine Load/RPM
- ☐ Configuration
- ☐ Periodic Maintenance
- ☐ DDEC Diagnostic
- ☐ Profile
- ☐ Monthly Activity
- ☐ Daily Engine Usage
- ☐ Life to Date

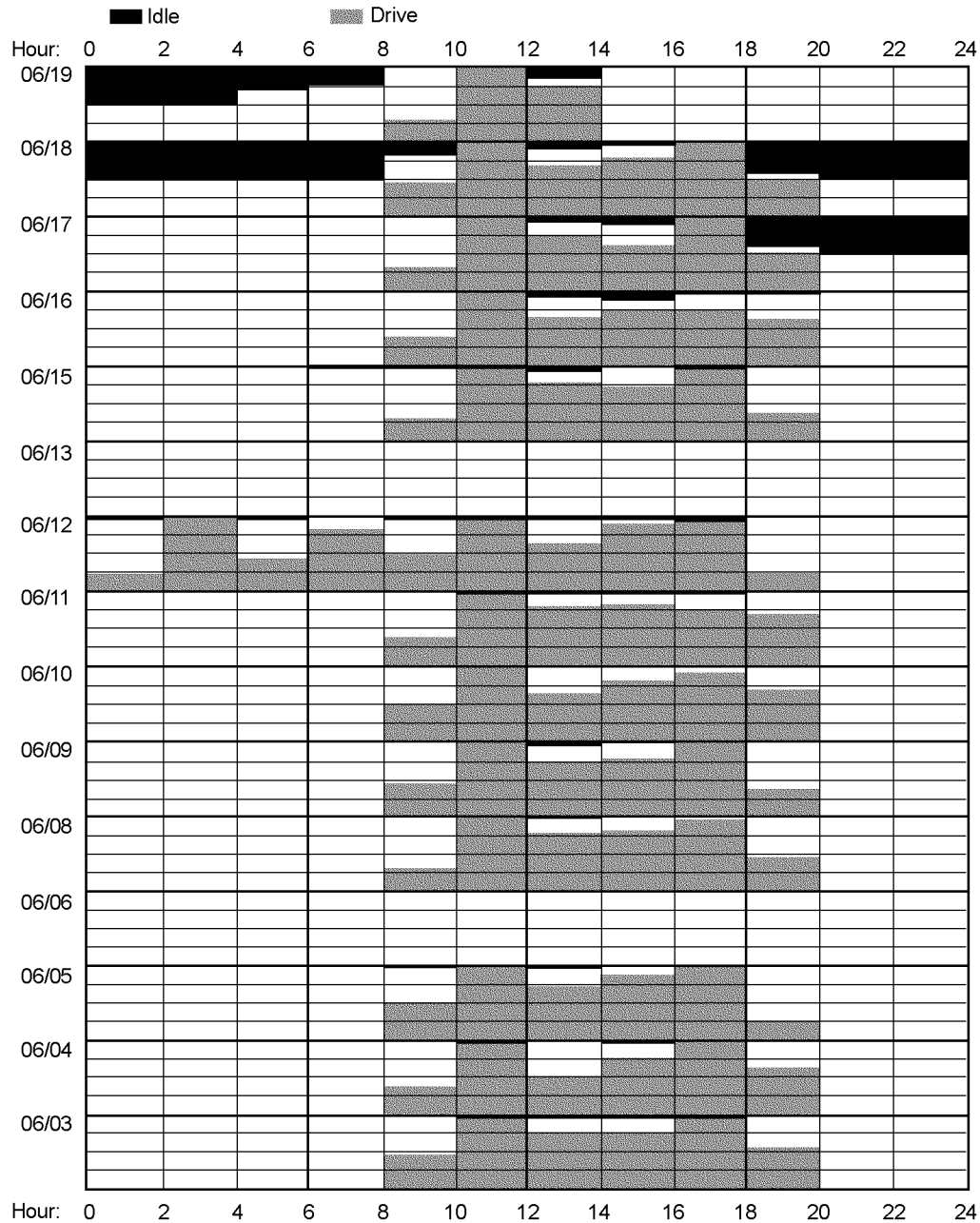
See Figure 5-60, Figure 5-61, and Figure 5-62 for examples of on-highway DDEC Reports. See Figure 5-63, Figure 5-64, and Figure 5-65 for examples of construction and industrial DDEC Reports. This Windows® 95/98/NT/2000 compatible product is included as part of the Detroit Diesel Diagnostic Link (DDDL) service tool. DDDL is designed for the service technician and with the built-in troubleshooting manual it is ideal for extracting data, analyzing and printing information from the ECU. A set of marine reports is available in DDEC Reports 3.10.

DDEC® Reports - Daily Engine Usage

Print Date: July 3, 2000 04:10 PM

Detroit Diesel
13400 Outer Drive, West
Detroit, MI 48239-4001
313-592-5500

Date Range: 6/02/00 to 6/19/00
Vehicle ID: PDCPM
Driver ID:



40217

Figure 5-60 DDEC Reports, On-highway - Idle and Drive Time

DDEC® Reports - Daily Engine Usage

Print Date: July 3, 2000 08:27 AM

Detroit Diesel
13400 West Outer Drive
Detroit, MI 48239
313-592-5500

Date Range: 6/02/00 to 6/19/00
Vehicle ID: PDCPM
Driver ID:

Date:	6/19/2000
Start Time:	01:00:00 (EST)
Odometer:	58068.5 mi
Distance:	205.1 mi
Fuel:	28.00 gal
Fuel Economy:	7.33 mpg
Average Speed:	49.4 mph

Total (hh:mm)	04:09	03:24	16:27
Hour (EST)	Drive (min)	Idle (min)	Off (min)
00:00-02:00	0	61	59
02:00-04:00	0	61	59
04:00-06:00	0	38	82
06:00-08:00	3	27	90
08:00-10:00	36	2	82
10:00-12:00	118	2	0
12:00-14:00	92	13	15
14:00-16:00	0	0	120
16:00-18:00	0	0	120
18:00-20:00	0	0	120
20:00-22:00	0	0	120
22:00-24:00	0	0	120

Date:	6/18/2000
Start Time:	01:00:00 (EST)
Odometer:	57650.6 mi
Distance:	418.0 mi
Fuel:	66.50 gal
Fuel Economy:	6.29 mpg
Average Speed:	47.4 mph

Total (hh:mm)	08:49	07:37	07:34
Hour (EST)	Drive (min)	Idle (min)	Off (min)
00:00-02:00	0	61	59
02:00-04:00	0	61	59
04:00-06:00	0	61	59
06:00-08:00	0	61	59
08:00-10:00	56	20	44
10:00-12:00	117	3	0
12:00-14:00	80	10	30
14:00-16:00	95	6	19
16:00-18:00	119	1	0
18:00-20:00	62	51	7
20:00-22:00	0	61	59
22:00-24:00	0	61	59

Date:	6/17/2000
Start Time:	08:55:59 (EST)
Odometer:	57233.0 mi
Distance:	417.6 mi
Fuel:	62.50 gal
Fuel Economy:	6.68 mpg
Average Speed:	48.8 mph

Total (hh:mm)	08:33	03:13	12:14
Hour (EST)	Drive (min)	Idle (min)	Off (min)
00:00-02:00	0	0	120
02:00-04:00	0	0	120
04:00-06:00	0	0	120
06:00-08:00	0	2	116
08:00-10:00	56	2	75
10:00-12:00	117	2	0
12:00-14:00	80	8	25
14:00-16:00	95	10	36
16:00-18:00	119	3	0
18:00-20:00	62	44	4
20:00-22:00	0	61	59
22:00-24:00	0	61	59

40218

Figure 5-61 DDEC Reports, On-highway - Daily Engine Usage

DDEC® Reports - Engine Load / RPM

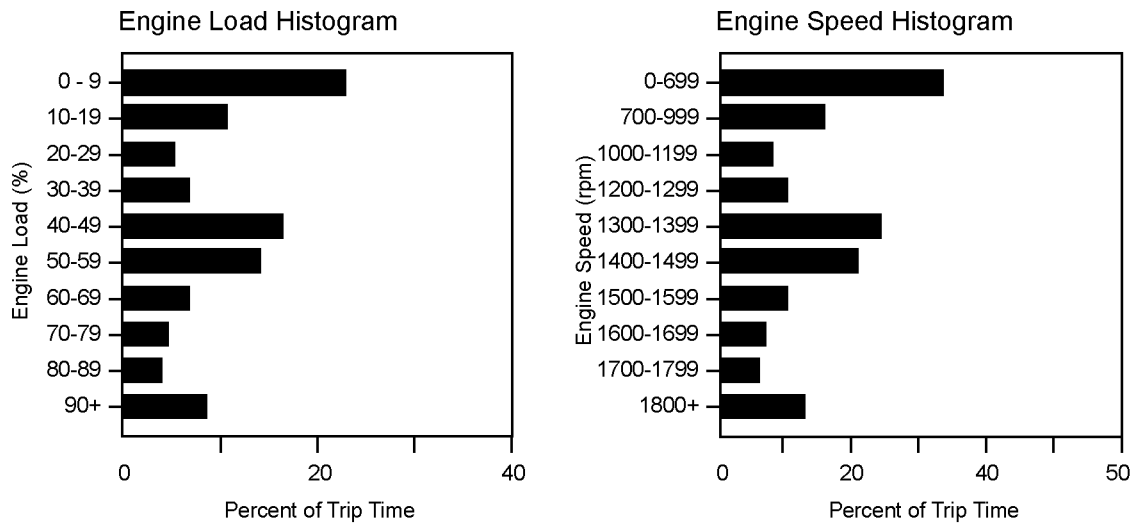
Print Date: July 3, 2000 08:26 AM

Detroit Diesel
13400 West Outer Drive
Detroit, MI 48239
313-592-5500

Trip: 6/02/00 to 6/19/00
Vehicle ID: PDCPM
Driver ID:
Odometer: 58273.6 mi

Trip Distance: 5698.9 mi
Trip Fuel: 831.13 gal
Fuel Economy: 6.86 mpg
Avg. Drive Load: 46 %
Avg. Vehicle Speed: 49.0 mph

Trip Time: 134:33:33
Fuel Consumption: 6.18 gal/h
Idle Time: 18:14:17
Idle Percent: 13.55 %
Idle Fuel: 7.63 gal



Percent of Trip Time in Load and RPM Table

Engine Load (%)

Engine RPM	0 - 9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-100	TOTAL
0-699	0.5	5.4	0.5	0.2	0.1	0.1	0.1	0.1	0.1	0.1	7.2
700-999	8.1	0.7	0.4	0.3	0.2	0.1	0.1	0.4	0.4	0.2	10.8
1000-1199	7.1	0.9	0.9	0.6	0.6	0.5	0.6	0.5	0.5	1.1	13.3
1200-1299	1.7	0.7	0.7	0.5	0.6	0.5	0.5	0.4	0.3	1.3	7.2
1300-1399	1.5	0.6	0.5	0.6	0.9	0.9	0.6	0.5	0.3	1.9	8.4
1400-1499	3.1	1.8	2.4	4.5	12.9	10.8	4.5	2.7	2.2	3.0	47.7
1500-1599	0.7	0.3	0.2	0.3	0.5	0.5	0.3	0.2	0.2	0.7	4.0
1600-1699	0.2	0.1				0.1	0.1			0.4	0.9
1700-1799	0.1									0.1	0.3
1800+											0.1
Total	22.9	10.4	7.0	7.0	15.9	13.5	6.8	4.9	4.1	8.7	

40219

Figure 5-62 DDEC Reports, On-highway - Engine Load/RPM

DDEC® Reports - Periodic Maintenance

Print Date: Apr 19, 2000 03:53 PM

DDC DDEC Lab - RDI
13400 Outer Drive West
Detroit, MI 48239
313-592-5959

Period: 04/09/2000 to 04/19/2000
Equipment ID: PDCPM
Operator ID:

Period Time	63:49:53	Idle Time	9:46:46
Period Fuel	446.00 gal	Idle Fuel	2.50 gal
Fuel Consumption	6.99 gal/h	Idle Percent:	15.32 %
Avg. Operating Load	51 %		

Maintenance Due

Name	Eng. Hrs. Left	Projected Date	Fuel Left (gal)
PM	-1	04/24/2000	250.00
PM	39	05/04/2000	550.00
PM	79	05/14/2000	850.00

Maintenance Limits

Name	Engine Hours	Days	Fuel (gal)
PM	40	10	300.00
PM	80	20	600.00
PM	120	30	900.00

Last Maintenance

Name	Eng. Hrs.	Date
PM	3318	04/14/2000
PM	3318	04/14/2000
PM	3318	04/14/2000

40220

Figure 5-63 DDEC Reports, Nonroad - Periodic Maintenance

DDEC® Reports - High RPM Detail

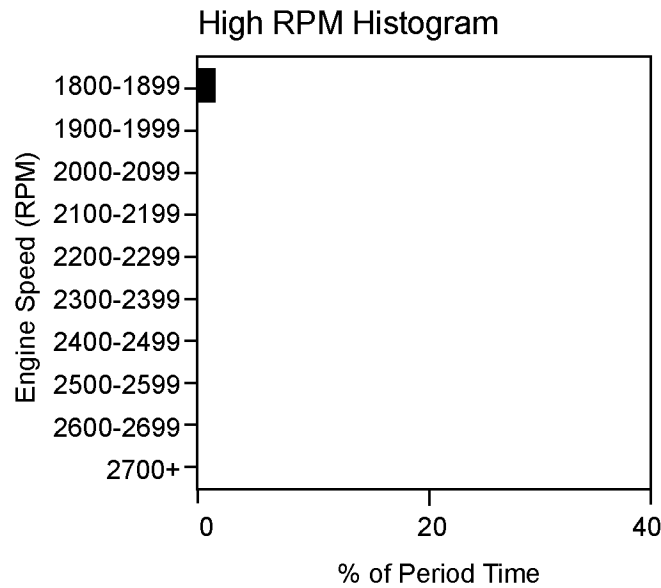
Print Date: Apr 19, 2000 03:52 PM

DDC DDEC Lab - RDI
13400 Outer Drive West
Detroit, MI 48239
313-592-5959

Period: 04/09/2000 to 04/19/2000
Equipment ID: PDCPM
Operator ID:

Period Time 63:49:53
Period Fuel 446.00 gal
Fuel Consumption 6.99 gal/h
Avg. Operating Load 51 %

Idle Time 9:46:46
Idle Fuel 2.50 gal
Idle Percent: 15.32 %



Percent of Time Spent in High RPM Bands

1800 1899	1900 1999	2000 2099	2100 2199	2200 2299	2300 2399	2400 2499	2500 2599	2600 2699	2700+
10.01	0.04								

40221

Figure 5-64 DDEC Reports, Nonroad - High RPM Detail

DDEC® Reports - Diagnostic Record #1

Print Date: Apr 19, 2000 03:53 PM

DDC DDEC Lab - RDI
13400 Outer Drive West
Detroit, MI 48239
313-592-5959

Period: 04/09/2000 to 04/19/2000
Equipment ID: PDCPM
Operator ID:

Period Time 63:49:53
Period Fuel 446.00 gal
Fuel Consumption 6.99 gal/h
Avg. Operating Load 51 %

Idle Time 9:46:46
Idle Fuel 2.50 gal
Idle Percent: 15.32 %

Diagnostic Code: [43] - Coolant Level Low
Diagnostic Time: 01/17/00 09:34:18 (EST)

Time	Engine Speed (RPM)	Boost Press (PSI)	Fuel Press (PSI)	Fuel Temp (°F)	Oil Press (PSI)	Oil Temp (°F)
09:34:18	823	0.0	0.0	46.8	63.4	79.5
09:34:13	824	0.0	0.0	46.8	63.4	79.5
09:34:08	825	0.0	0.0	47.0	63.4	79.5
09:34:03	823	0.0	0.0	47.5	63.4	79.5
09:33:58	824	0.0	0.0	47.8	63.4	79.8
09:33:53	824	0.0	0.0	48.5	63.4	80.0
09:33:48	825	0.0	0.0	49.3	63.4	80.3
09:33:43	827	0.0	0.0	50.5	63.3	80.0
09:33:38	825	0.0	0.0	51.5	63.3	80.3
09:33:33	1021	0.0	0.0	53.3	1.9	78.3
09:33:28	0	0.0	0.0	-40.0	0.0	-40.0
09:33:23	0	0.0	0.0	-40.0	0.0	-40.0

Time	Coolant Temp (°F)	Air Temp (°F)	Engine Load (%)	Throttle (%)	Pulse Width (deg)	Eng. Brake (cylinders)
09:34:18	70.0	50.0	19.0	0.0	4.4	Off
09:34:13	69.0	50.0	18.5	0.0	4.2	Off
09:34:08	69.5	50.0	17.5	0.0	4.1	Off
09:34:03	68.8	51.3	19.5	0.0	4.4	Off
09:33:58	68.8	51.0	20.0	0.0	4.5	Off
09:33:53	68.5	53.3	21.0	0.0	4.6	Off
09:33:48	68.5	54.0	21.0	0.0	4.7	Off
09:33:43	69.5	59.5	22.5	0.0	4.9	Off
09:33:38	68.0	65.0	24.0	0.0	5.2	Off
09:33:33	67.8	66.5	28.0	0.0	6.8	Off
09:33:28	-40.0	-40.0	0.0	0.0	0.0	Off
09:33:23	-40.0	-40.0	0.0	0.0	0.0	Off

40222

Figure 5-65 DDEC Reports, Nonroad - Diagnostic Record

5.18.5 PRODRIVER DC

ProDriver® DC (P/N: 23525745) is a dashboard-mounted display (see Figure 5-66) that provides real time and summary information on vehicle and engine operation. Real time graphic displays, shown when the engine is running, provide driver feedback on idle and driving performance relative to fleet goals. ProDriver DC also has a Fuel Economy Incentive Status screen and a clock/calendar with battery backup. Engine alerts provide a descriptive message when AWL or RSL are illuminated.

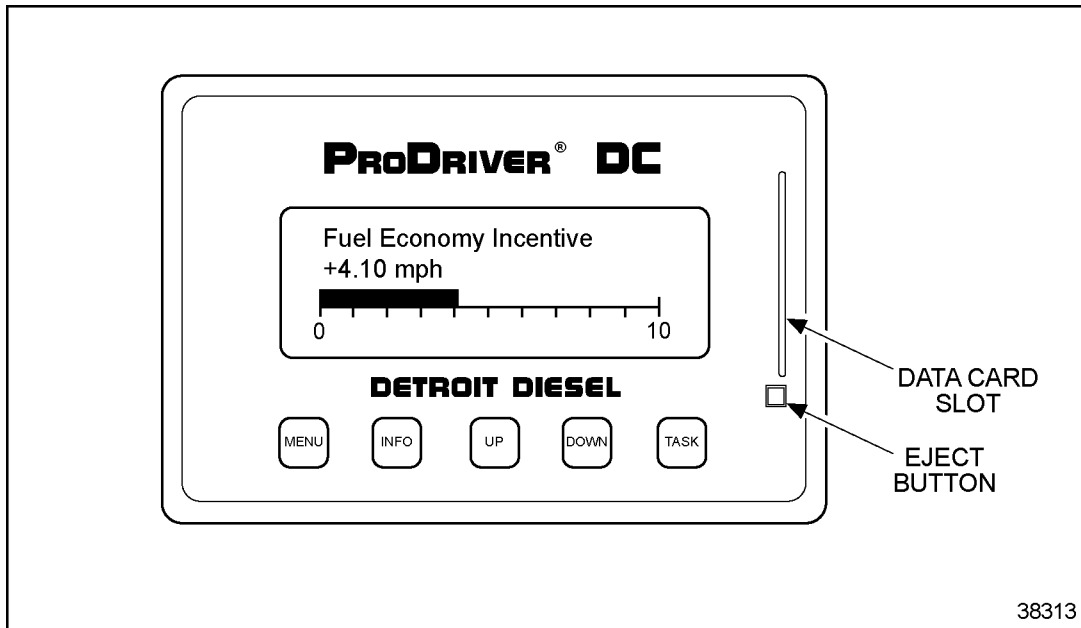


Figure 5-66 ProDriver DC with the Fuel Economy Incentive Screen

The Data Card provides a convenient way to transport data to and from the vehicle. The Data Card can hold up to 16 megabytes of data. It can also be formatted to perform various functions through the Detroit Diesel Data Summaries software. These functions are listed in Table 5-74.

Data Card	Functions
Driver Card	Assigned to a specific driver
	Capacity: 10 vehicles or 10 trips plus 2 months
Extraction Card	Extracts stored vehicle data
	Capacity: 100 extractions
Configuration Card	Loads new ProDriver DC user settings
	Multiple vehicles
	Vehicle ID and odometer not affected
Reprogramming Card	Upgrade ProDriver DC features, as new software becomes available

Table 5-74 Data Card Functions

Data Cards are the SmartMedia® product used in many digital cameras.

The ProDriver DC configuration (user settings) can be viewed and changed with Detroit Diesel Data Summaries. Configuration options that can be changed at any time are: Display Intensity, Language, Units and Alarm Status. Other setup parameters such as Vehicle Overspeed Limits can be changed, but only if the trip information in the ProDriver DC memory has first been extracted and cleared.

ProDriver DC has two access modes, Owner/Operator and Manager/Driver. The Owner/Operator mode does not require a password to change the setup. If the ProDriver access mode is set to Manager/Driver, a password is needed to enable changes to the ProDriver DC setup.

Programming ProDriver DC with a Configuration Card is perhaps more convenient. When the card is inserted in ProDriver DC, the technician will be prompted through a few simple steps. Using the same Configuration Card on all ProDriver DC units in a fleet assures that each one has the same setup.

Trip summary data may be reviewed on the ProDriver DC screen or extracted to a PC for later analysis. Extraction options include:

- ☐ Direct connection to a PC running Detroit Diesel Data Summaries software through a translator box
- ☐ Automated direct connection with the Remote Data Interface
- ☐ Wireless communications such as the Highway Master cellular telephone service
- ☐ Extraction to a Driver Card or Extraction Card
- ☐ Wireless extraction with IRIS.

ProDriver DC Installation

The ProDriver DC module should be dashboard mounted in a location that is readily visible so the driver's eyes do not have to leave the road for a long period of time. The ProDriver DC module has most of the same installation dimensions as the ProDriver module. ProDriver DC can be mounted as either a flush mount or a surface mount. The flush mount is intended to be mounted in the dash with only a bezel above the dash surface. See Figure 5-67.

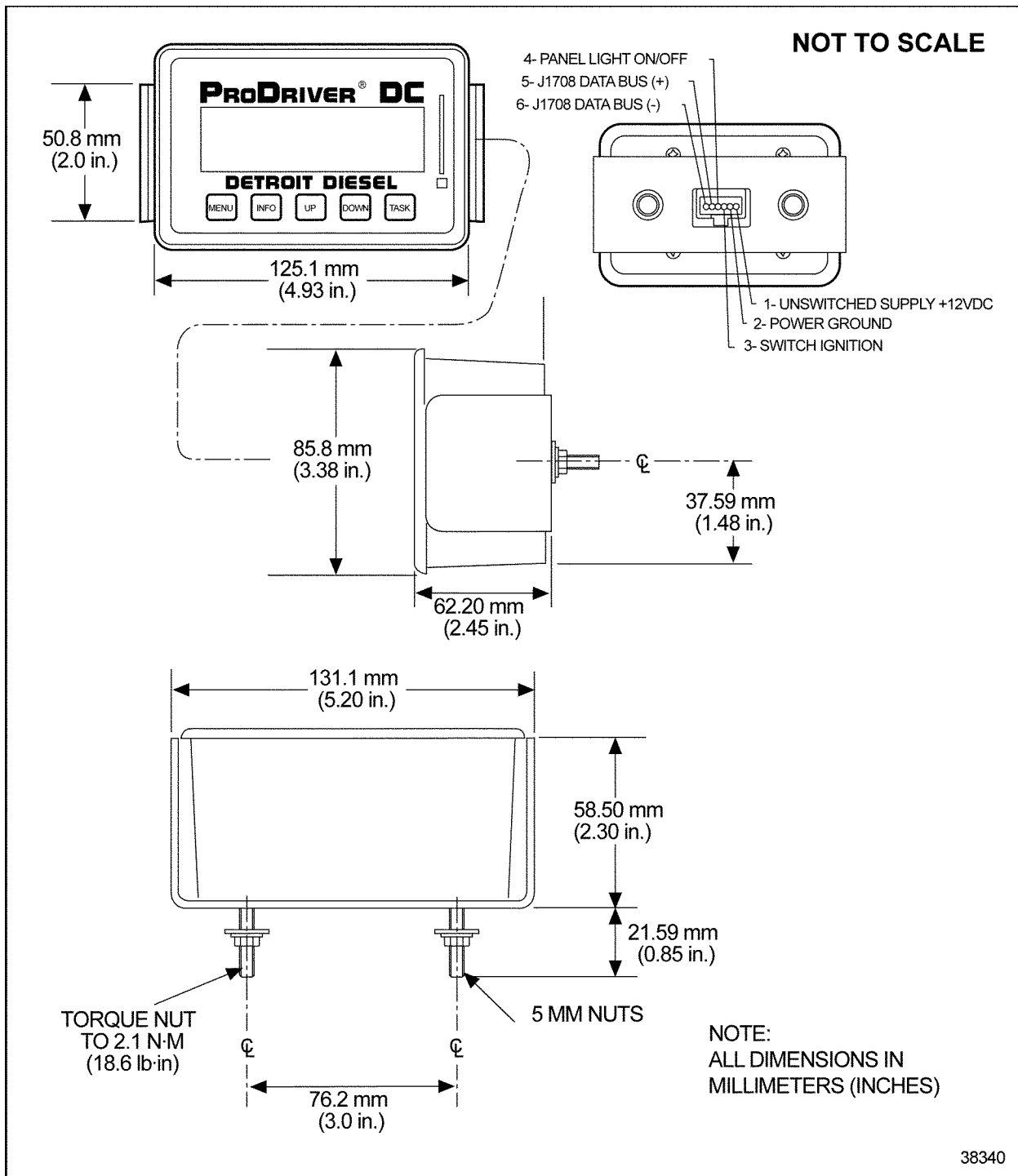


Figure 5-67 ProDriver DC Flush Mount

See Figure 5-68 for the mounting bracket for the flush mount ProDriver DC.

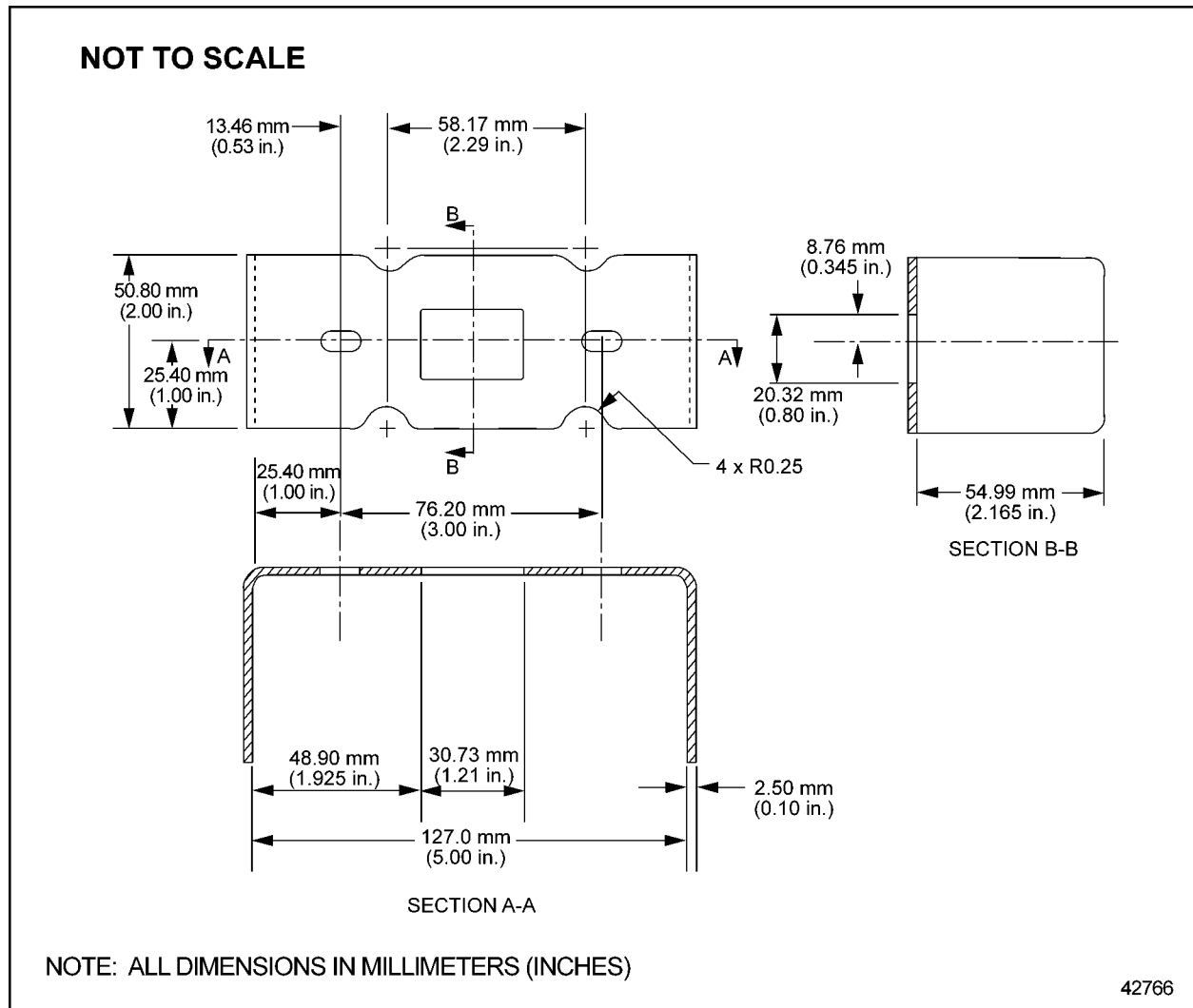


Figure 5-68 ProDriver DC Flush Mount Mounting Bracket

See Figure 5-69 for a cutout template of the flush mount display.

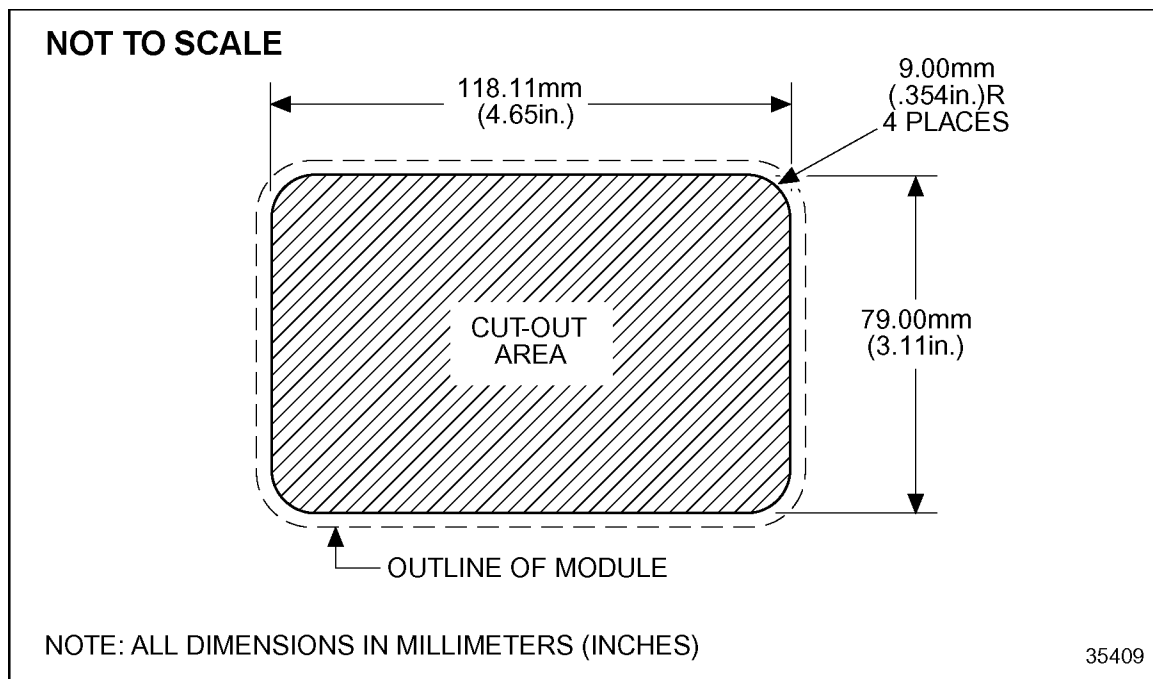


Figure 5-69 ProDriver DC Flush Mount Display Template

The surface mounted display for ProDriver DC is installed on top of the dash, the overhead or the face of the dash. See Figure 5-70.

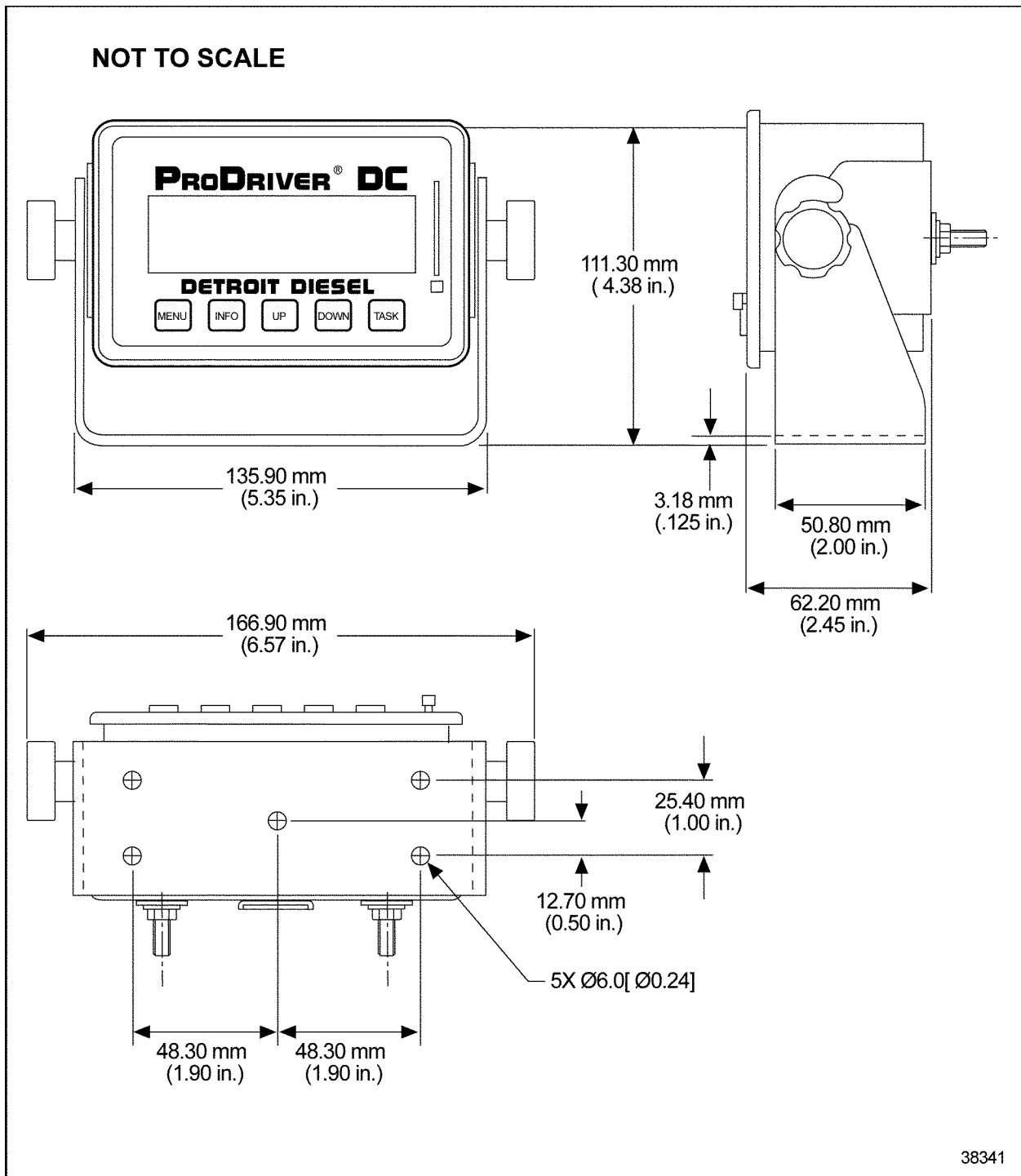


Figure 5-70 ProDriver DC Surface Mount

See Figure 5-71 for bracket dimensions and characteristics of the surface mount bracket.

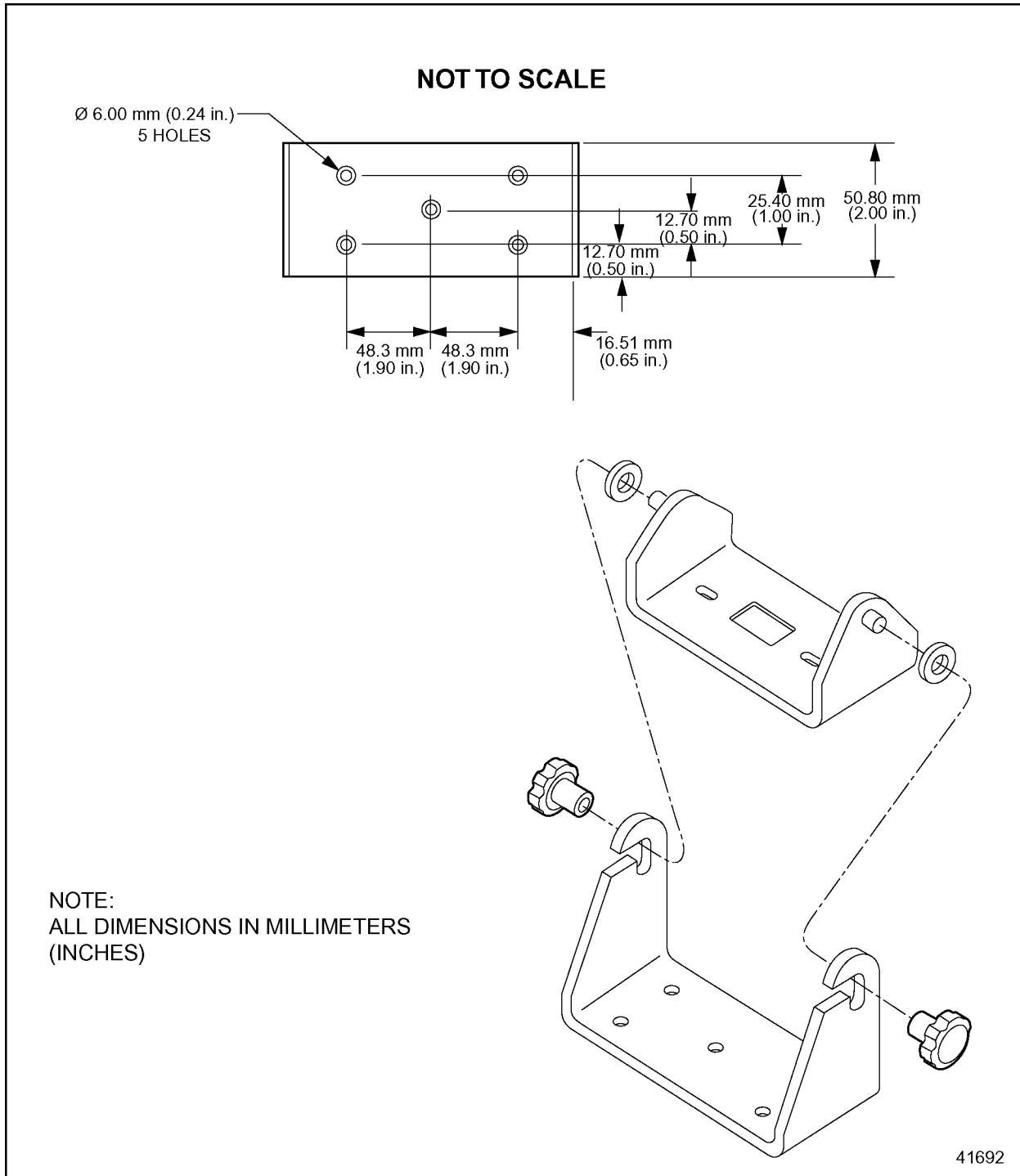


Figure 5-71 ProDriver DC Surface Mount Bracket

ProDriver DC has one harness for connection to the vehicle. The following paragraphs contain information that will be helpful in designing this harness.

The panel light on/off wire detects when the instrument panel lights are on. It is recommended that the 12 volt signal be taken from the high side of the intensity control potentiometer. This will ensure that the display intensity will change when the running lights are on as well as when the headlights are on.

See Figure 5-72 for the diagram to use when constructing a harness for ProDriver DC.

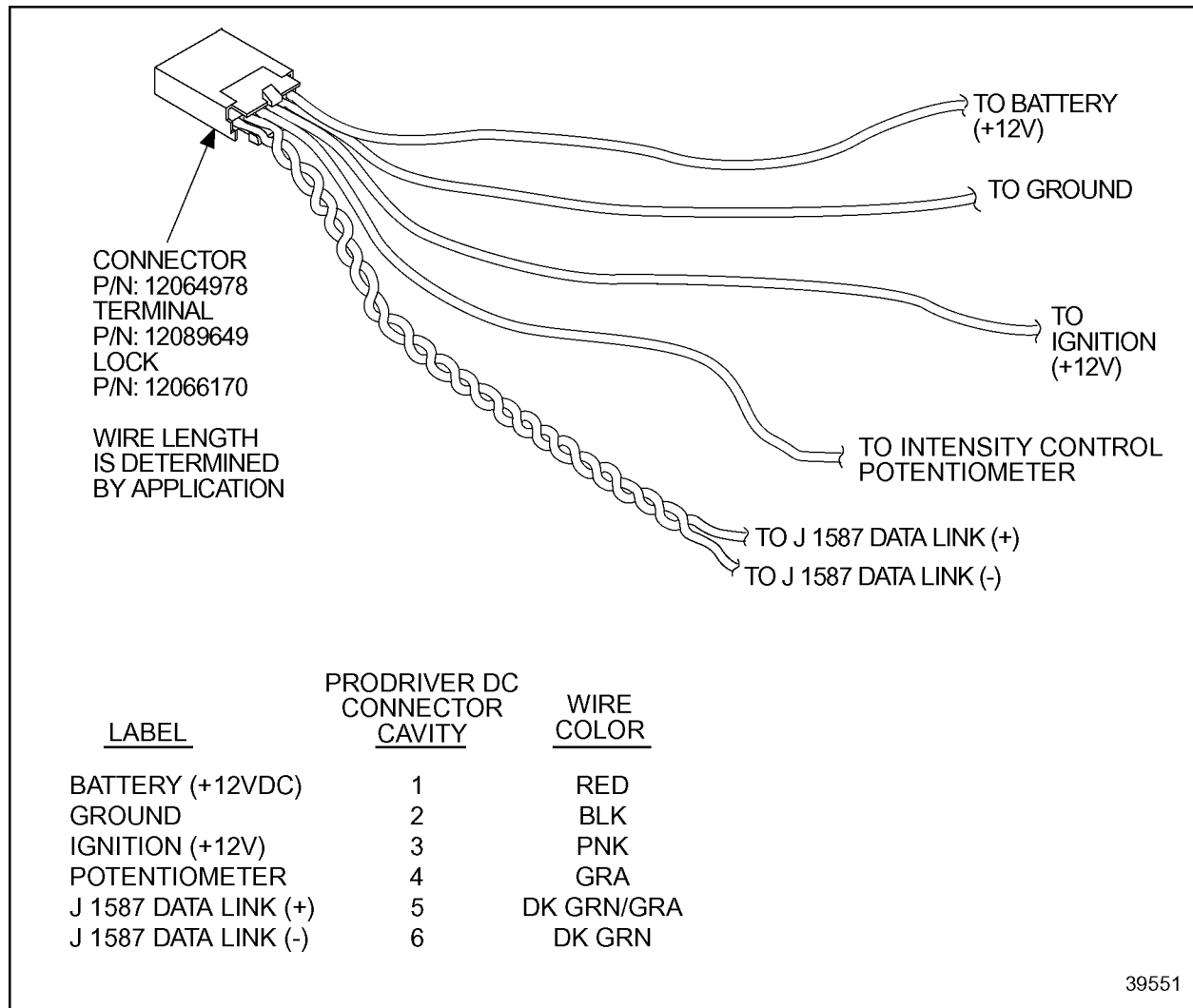


Figure 5-72 ProDriver DC Vehicle Harness

NOTE:

ProDriver DC is 12 V only. The ignition and battery wires must be connected to +12 V only.

A jumper harness (P/N: 23524862) is available to install a ProDriver DC in place of a ProDriver (see Figure 5-73).

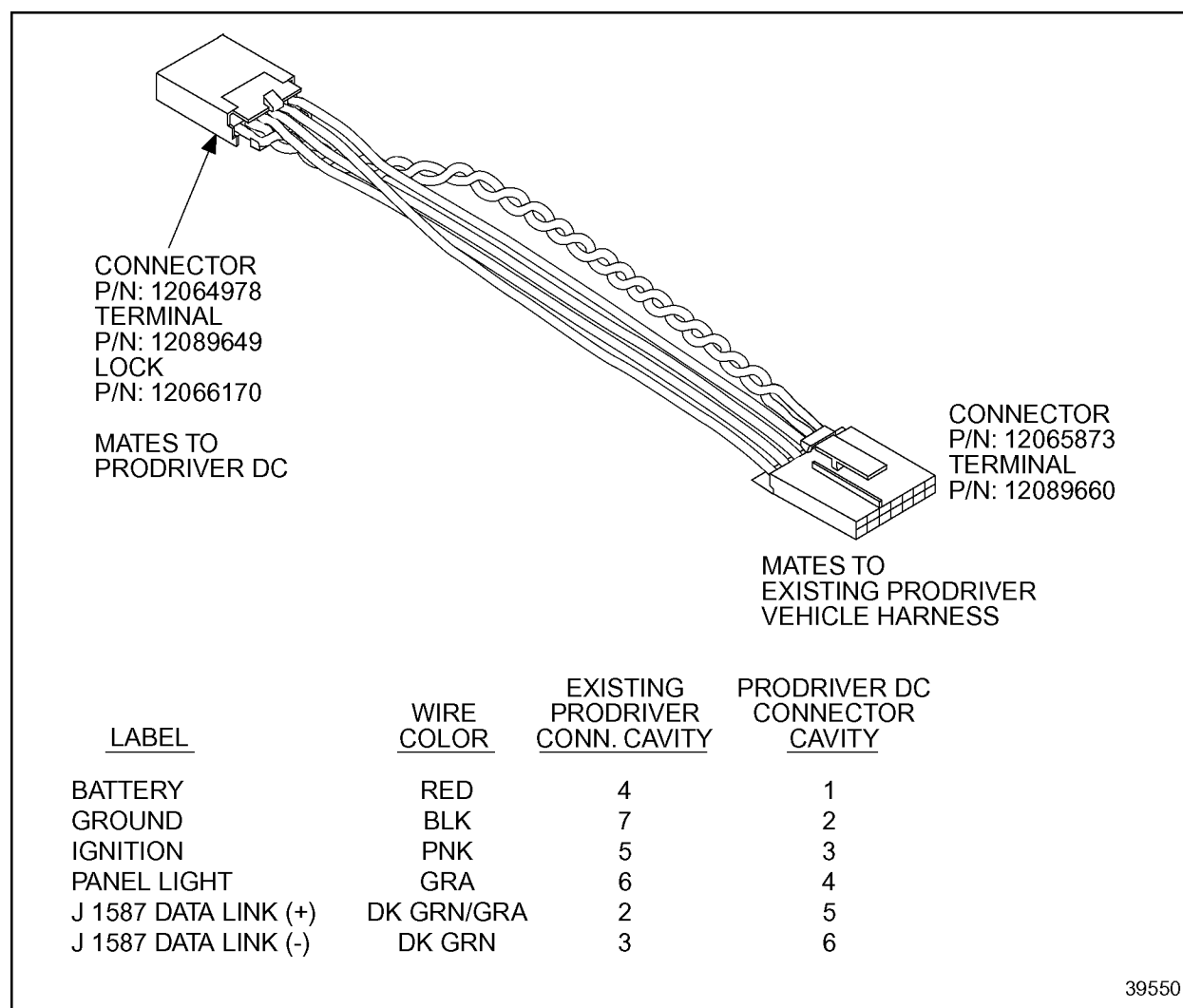


Figure 5-73 ProDriver DC Jumper Harness

5.18.6 MANAGEMENT INFORMATION PRODUCT KITS

Several kits are available to install the Management Information Products. The Management Information kits include the Data Logger, ProDriver DC, and the appropriate harness and hardware to install the system.

Management Information may be installed by the OEM or installed as aftermarket options.

ProDriver DC Kits are listed in Table 5-75, Table 5-76, and listed in Table 5-77.

Part Number	Description	Quantity
23525745	ProDriver DC Display Unit	1
23525872	ProDriver DC Flush Mount Bracket	1
23525874	ProDriver DC Wiring Harness	1
12033769	Connector 2-way 630 Metri-Pack Fuse Holder	1
12033731	Cover Fuse Holder	1
12020156	Fuse Terminals — 16 ga.	2
12004003	Fuse — 3 Amp.	1
05101020	Nylon Tie Strap	5
18SP528	ProDriver DC Installation Instructions	1
6SE703	ProDriver DC User Manual	1
7SE447	ProDriver DC Pocket Card	1

Table 5-75 ProDriver DC Flush Mount Kit P/N: 23525759

Part Number	Description	Quantity
23525745	ProDriver DC Display Unit	1
23525873	ProDriver DC Surface Mount Bracket	1
23525874	ProDriver DC Wiring Harness	1
12033769	Connector 2-way 630 Metri-Pack Fuse Holder	1
12033731	Cover Fuse Holder	1
12020156	Fuse Terminals — 16 ga.	2
12004003	Fuse — 3 Amp	1
05101020	Nylon Tie Strap	5
18SP528	ProDriver DC Installation Instructions	1
6SE703	ProDriver DC User Manual	1
7SE447	ProDriver DC Pocket Card	1

Table 5-76 ProDriver DC Surface Mount Kit P/N: 23525760

Part Number	Description
23530729	Data Card (Pack of 10)
23529276	ProDriver DC USB Data Card Reader
23529277	ProDriver DC PCMCIA Data Card Reader
23534386	ProDriver DC Reprogramming Card

Table 5-77 Other ProDriver DC Parts

The OEM ProDriver DC kits are listed in Table 5-78 and Table 5-79.

Part Number	Description
23525745	ProDriver DC Display
23525872	ProDriver DC Flush Mount Bracket

Table 5-78 OEM ProDriver DC Flush Mount Kit, P/N: 23525753

Part Number	Description
23525745	ProDriver DC Display
23525873	ProDriver DC Surface Mount Bracket

Table 5-79 OEM ProDriver DC Surface Mount Kit, P/N: 23525754

5.19 OPTIMIZED IDLE

Optimized Idle® with DDEC V reduces engine idle time by running the engine only when required. Optimized Idle automatically stops and restarts the engine to accomplish the following:

- Keep the engine oil temperature between factory set limits 60°F (16°C) - 104°F (40°C)
- Keep the battery charged >12.2 V (12 V system), >24.4 V (24 V system)
- Keep the cab/sleeper or passenger area at the desired temperature (using the optional thermostat) - On-highway truck and coach applications

Other benefits include overall reduction in exhaust emissions and noise, and improved starter and engine life (by starting a warm engine and eliminating starting aids). Idle time and fuel savings information stored in the ECU memory can be read with DDDL, ProDriver Reports or DRS. Optimized Idle run times can be accessed through DDEC Reports. The Optimized Idle Active Lamp is steadily illuminated when Optimized Idle run times are logged.

5.19.1 OPERATION

To activate Optimized Idle, the following conditions must be met:

- Idle Shutdown timer must be enabled
- Ignition ON with the vehicle idling
- Hood, cab, and/or engine compartment doors closed
- Transmission in neutral and splitter in high range (if equipped)
- Park brake set

Once the above conditions are met:

- Turn the Cruise Master Switch to the ON position (if in the ON position, turn to OFF then to ON), the Optimized Idle Active Lamp will flash.
- Turn on Thermostat Mode (if equipped and the mode is desired) by turning ON the thermostat, setting the fan controls in the bunk and cab to HIGH and enabling the vehicle heating and cooling system.

Once these conditions are met, the Optimized Idle Active Lamp will flash until the Idle Shutdown timer expires. Optimized Idle allows the operation of all DDEC features such as VSG, throttle control, and Cruise Switch VSG, while the active light is flashing.

Once Optimized Idle becomes active, the engine will either shutdown if Optimized Idle parameters are satisfied or ramp to 1100 RPM. While the system is active (OI Active Lamp is steadily illuminated), the throttle, VSG, Cruise Switch VSG functions are disabled and the engine speed is controlled by the ECU.

Optimized Idle Start Up Sequence

The following occurs during every OI engine start:

1. Optimized Idle Active Light is ON. The ECU determines when the engine needs to start to charge the battery, warm the engine, or heat/cool the vehicle interior.
2. The alarm (mounted in the engine compartment) will sound for five seconds.
3. After a short delay, the starter will engage and the engine will start. If the engine does not reach a specified RPM within a few seconds, the system will be disarmed for the rest of the ignition cycle. If the engine does not start, Optimized Idle will attempt a second engine start in 45 seconds. The alarm will sound again prior to the second engine start.
4. Once the engine starts, it will ramp up to 1100 RPM (default). This value is customer selectable with DDDL or DRS.
5. Vehicle accessories will be turned on thirty seconds after any thermostat based engine start and will not be turned on for an engine mode start. If the engine is running in engine mode, and the thermostat mode is requested, the vehicle accessories will be turned on thirty seconds after the request.

If two or more conditions exist at the same time, DDEC will satisfy all parameters before shutting down the engine. For example, if the engine started due to battery voltage, the engine will run for a minimum of two hours. If the thermostat becomes unsatisfied and requests the engine to run during this time, DDEC will control the HVAC fans through the Vehicle Power Shutdown relay, turning them on and off as required by the thermostat. At the end of the two hours, if the thermostat was not satisfied, the engine would continue to run.

Engine Mode

Engine Mode automatically stops and restarts the engine to maintain oil temperature and battery voltage. The Optimized Idle Active Light is illuminated whenever Engine Mode is active. Optimized Idle starts and stops the engine to keep the following parameters within limits while in Engine Mode.

Battery Voltage - The engine will start when the battery voltage drops below 12.2 V for 12 V systems or 24.4 V for 24 V systems. This is the default. If an Ambient Air Temperature Sensor (AAT Sensor) is installed, the customer can select an option to use a AAT Sensor vs. voltage table to determine the start threshold for the battery. The thresholds are listed in Table 5-80.

Ambient Air Temperature	Voltage Threshold
-40°C	12.5 V
-17.77°C	12.4 V
4.44°C	12.3 V
26.66°C	12.2 V
48.86°C	12.2 V

Table 5-80 Voltage Threshold Based on Ambient Air Temperature

This feature (Ambient Air Temperature) is available with Rel 2.0 or later.

There are three battery run modes: Normal Battery Run Mode, Alternate Battery Run Mode, and Continuous Battery Run Mode. These are available with Rel 2.0 or later.

Normal Battery Run Mode –While in normal battery run mode, all battery voltage Optimized Idle starts are two hours long. This mode is customer selectable by setting the Alternate Time to 0, the default mode as listed in Table 5-81.

Alternate Time	Battery Time	Single Event	First Consecutive Event	Second Consecutive Event
0	2 Hours	2 Hours	2 Hours	2 Hours

Table 5-81 Normal Battery Run Mode

Alternate Battery Run Mode –This mode is allowed only when the Alternate Time is set to a non-zero value. This parameter is customer selectable. While in Alternate Battery Run Mode, all voltage starts are based on Alternate Time unless a critical battery restart event is detected. A critical battery restart event is detected when the engine starts and runs to recharge the battery for the alternate time and then detects another battery start within one hour after the engine stops. At this point, the run time will change to two hours. The Alternate Battery Run Mode parameters are listed in Table 5-82.

Alternate Battery Run Time	Battery Time	Single Event	First Consecutive Event	Second Consecutive Event
a (Customer Selectable)	2 Hours	a	2 Hours	2 Hours

Table 5-82 Alternate Battery Run Mode

Continuous Battery Run Mode –In this mode, the engine continues to idle without shutting down when two consecutive critical battery restart events have occurred. This feature is customer selectable. The parameters for Continuous Battery Run Mode are listed in Table 5-83. A fault code is logged when this move is initiated (PID 168 FMI 14).

Alternate Battery Run Time	Battery Time	Single Event	First Consecutive Event	Second Consecutive Event	Further Events
0	2 Hours	2 Hours	2 Hours	Continuous	Continuous
a (Customer Selectable)	2 Hours	a	2 Hours	2 Hours	Continuous

Table 5-83 Continuous Battery Run Mode

Oil Temperature - The engine will start when the oil temperature drops below 60°F (15.55°C) and will run until the oil temperature reaches 104°F (40°C).

Thermostat Mode

Thermostat Mode automatically stops and restarts the engine to maintain oil temperature, battery voltage and cab temperature. For on-highway applications, Thermostat Mode is used to keep the cab/sleeper (on-highway truck) and passenger area (coach) at the desired temperature and maintain the Engine Mode parameters. The optional thermostat must be turned ON for Thermostat Mode to be active. The Optimized Idle Active Light is illuminated whenever Thermostat Mode is active.

Engine mode parameters as well as the interior temperature are monitored in Thermostat Mode. The thermostat informs the ECU when to start/stop the engine to keep the interior warm/cool based on the thermostat setting. Ambient temperature is also monitored to determine if the ambient temperature is extreme enough that the engine should run continuously.

Any accessories (HVAC fans) connected to the Vehicle Power Shutdown relay will turn ON for Thermostat Mode engine starts. The HVAC fans will remain OFF for Engine Mode starts.

If Optimized Idle starts the engine for Engine Mode, and Thermostat Mode is then requested, the HVAC fans will turn ON approximately 30 seconds after the Thermostat Mode is requested.

Thermostat Mode can be enabled for a maximum amount of time. After which, the engine will ignore any requests from the thermostat (Rel 2.0 or later).

Two automatic conditions which help keep the operator comfortable and reduce engine cycling are Continuous Run Mode and Extended Run Mode.

Continuous Run Mode - This mode allows the engine to run continuously if the outside temperature (determined by the skin temperature sensor or AAT Sensor if installed and configured) falls outside the hot or cold set limits and the thermostat set point can not be met. The default set limits are 25°F (-3.9°C) for heat mode and 90°F (32°C) for cool mode. When a skin temperature sensor is installed, these values are customer programmable in the thermostat and are password protected. When an ATT Sensor is installed these limits can be set by DDDL or DRS (Rel 2.0 or later). When the thermostat is in the Continuous Run Mode, the thermometer icon will flash along with the heat or cool icon on the thermostat if a skin temperature sensor is installed. If the thermostat set point is satisfied, the engine will shutdown regardless of the outside temperature.

Extended Idle Mode - If the Continuous Run Mode is not needed and the thermostat set point is not met within 45 minutes, the engine will shutdown for fifteen minutes and restart and run for fifteen minutes. This fifteen-minute on and off cycle will continue until the thermostat set point is reached or until the thermostat is turned off. This may be an indication that the heat or cool setting on the thermostat does not match the vehicle heating or cooling system setting. It could also be an indication of low freon, blockage in the heater system or system tampering.

Extended Idle Mode can be disabled with a customer selectable parameter. After running 45 minutes, the engine will shutdown instead of cycling at 15 minute intervals.

5.19.2 INSTALLATION

Optimized Idle utilizes up to three inputs: Park Brake Interlock (includes Park Brake Switch, Neutral Switch, and Hood Tilt Switch), OI Thermostat (optional), and Cruise Enable. Optimized Idle utilizes four digital outputs: Vehicle Power Shutdown Relay, OI Alarm, OI Starter Relay, and the Optimized Idle Active Light. A Vehicle Speed Sensor is required. See Figure 5-74 for the Optimized Idle overall system schematic. Refer to *Optimized Idle - DDEC V - Installation and Troubleshooting* for installation requirements.

Prior to installation, check the following items:

- ☐ The transmission must provide a reliable neutral signal (switch).
- ☐ There must be three inputs and four digital outputs available for the Optimized Idle devices.
- ☐ A Vehicle Speed Sensor (VSS) must be installed.
- ☐ If vehicle speed is transmitted over a data link to the ECU, a Starter Lockout Feature based on a reliable neutral signal must be provided. Otherwise the VSS must be hardwired directly to the ECU. The transmission ECU must be powered on.
- ☐ There must be an electric starter; air starters cannot be used with Optimized Idle.
- ☐ Automatic transmissions may be used, but they must have a Starter Lockout Feature installed based on a reliable neutral signal.

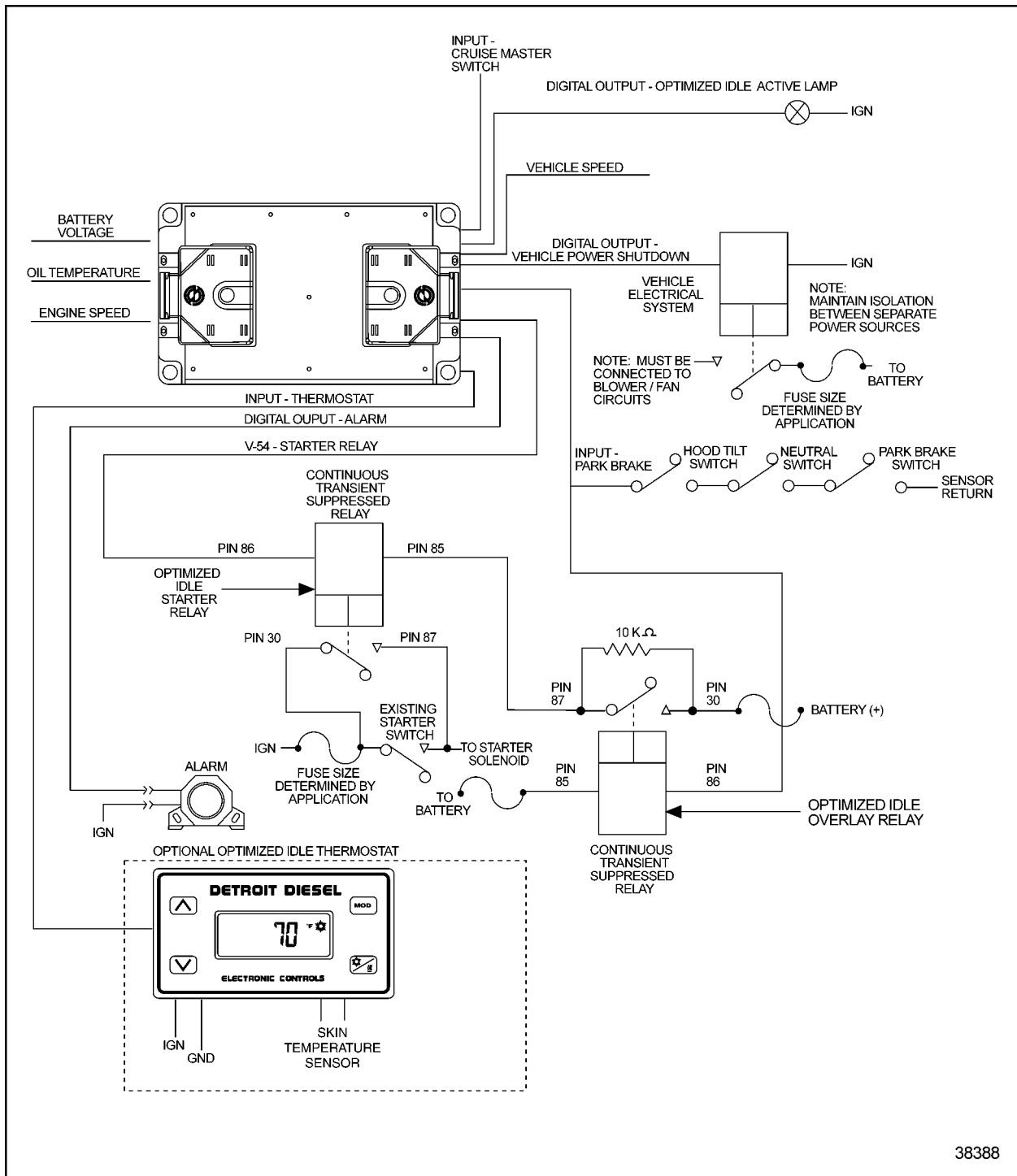


Figure 5-74 **Optimized Idle System Overview**

Inputs

The correct sensor return must be used based on the input pin selected. The inputs and corresponding sensor return are listed in Table 3-20 on page 3-27.

The inputs for Optimized Idle are listed in Table 5-84.

Description	Type	Config ID
Park Brake / ISD	Analog Input - 1.5kΩ Pull-up	4101
Cruise Enable	Analog Input - 1.5kΩ Pull-up	4119
Optimized Idle Thermostat	Analog Input - 1.5kΩ Pull-up	1040

Table 5-84 Optimized Idle Inputs

Digital Outputs

There are ten low-side digital outputs located on the VIH. The digital outputs required for Optimized Idle are listed in Table 5-85.

Description	Type	Function Number
Vehicle Power Shutdown	Digital Output	6
Optimized Idle Active Lamp	Digital Output	26
Optimized Idle Starter Relay*	Digital Output	42
Optimized Idle Alarm	Digital Output	43

* Optimized idle Starter Relay is dedicated to pin V-54. It cannot be enabled on any other pin.

Table 5-85 Required Digital Outputs for Optimized Idle

5.19.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Optimized Idle must be turned on by the factory via order entry or by Detroit Diesel Technical Service. Software group 6N5-3 must be specified.

The digital inputs and outputs listed in Table 5-86 can be programmed at engine order entry, by the Vehicle Electronic Programming System (VEPS) or DDEC Reprogramming System (DRS).

Description	Type	Config ID/Function Number
Park Brake / ISD	Analog Input - 1.5kΩ Pull-up	4101
Cruise Enable	Analog Input - 1.5kΩ Pull-up	4119
Vehicle Power Shutdown	Digital Output	6
Optimized Idle Active Lamp	Digital Output	26
Optimized Idle Starter Relay*	Digital Output	42
Optimized Idle Alarm*	Digital Output	43

* Automatically configured with order entry.

Table 5-86 Optimized Idle Inputs and Digital Outputs

The Idle Timer must be enabled by VEPS, DDDL or DRS. The recommended Idle Timer parameters are listed in Table 5-87.

Parameter	Description	Recommended Setting
ENABLE IDLE SHUTDOWN	Enables/Disables the Idle Shutdown Feature	YES (Required)
TIME (min)	The amount of engine idle time that is allowed before the idle shutdown feature stops fueling the engine	1-100 minutes (customer's choice)
OVERRIDE	Disables the Idle Shutdown Timer Override feature. The override will flash the AWL 90 seconds before shutdown to allow the driver to cancel the shutdown by pressing the accelerator pedal.	NO
ENABLED ON VSG	Allows the Idle timer to shutdown the engine when operating on VSG.	YES

Table 5-87 Idle Shutdown Timer Parameters

Optimized Idle options for battery charging and continuous run are listed in Table 5-88.

Parameter	Description	Range	Default
Battery Charging - Continuous Run	When enabled and OI has started the engine for battery three consecutive times, the engine will run continuously in OI Mode	YES/NO	NO
Battery Charging - Threshold on Ambient Air	When enabled, the battery voltage threshold will be based on ambient air temperature.	YES/NO	NO
Battery Charging - Enable Alternate Battery Run Time	Enables an alternate run time for battery starts.	YES/NO	NO
Battery Charging - Alternate Battery Run Time	Sets the alternate run time for battery starts.	20 min to 2 hrs	0 min
Continuous Run Upper Limit Temp	Set the continuous run upper limit. When the ambient air temperature is above this limit, the engine will run continuously.	70°F-120°F	90°F
Continuous Run Lower Limit Temp	Sets the continuous run lower limit. When the ambient air temperature is below this limit, the engine will run continuously.	0°F-50°F	25°F
Thermostat Max Time	Maximum amount of time the engine can run in Thermostat Mode.	0-64 hrs	0 hr
Target RPM	Sets the speed the engine will operate at in OI Mode.	1000-1800 rpm	1100 rpm

Table 5-88 Optimized Idle Options

Optimized Idle installations should have the parameters listed in Table 5-89 set to Shutdown.

NOTICE:
DDC recommends that Shutdown be enabled for all Engine Protection parameters with Optimized Idle installations.

Parameter	Description	Setting
OIL TEMP	Indication of the type of engine protection based on high engine oil temp.	SHTDN
COOLANT TMP	Indication of the type of engine protection based on high engine coolant temp.	SHTDN
OIL PRS	Indication of the type of engine protection based on low engine oil pressure.	SHTDN
COOLANT LVL	Indication of the type of engine protection based on low coolant level.	SHTDN

Table 5-89 Engine Protection Parameters

5.19.4 DIAGNOSTICS

Refer to the *Optimized Idle - DDEC V- Installation and Troubleshooting* manual for diagnostic and troubleshooting information.

5.19.5 INTERACTION WITH OTHER FEATURES

The Vehicle Power shutdown feature is used by Optimized Idle to turn off all accessory loads when the engine is shutdown. Optimized Idle will turn these loads on for thermostat mode starts.

Stop Engine Override Switch is required if "Shutdown" is enabled for Engine Protection parameters. For additional information, refer to section 5.8, "Engine Protection."

The throttle, VSG, Cruise Switch VSG functions are disabled and the engine speed is controlled by the ECU when Optimized Idle is active (Optimized Idle lamp is illuminated).

5.20 PASSMART

The PasSmart™ feature is available on selected on-highway DDEC engines equipped with a Vehicle Speed Sensor.

5.20.1 OPERATION

The PasSmart feature allows a fleet manager to enable a second Vehicle Limit Speed (VLS) above the normal VLS to assist while passing other vehicles on the highway. This second VLS is programmed for a limited duration during a given time period (interval). The passing speed interval starts when the feature is programmed. An interval of 8, 12, or 24 hours will always reset at midnight.

The driver activates PasSmart by double-pumping the Accelerator Pedal. Starting at the full throttle position, the driver releases the throttle completely, returns the throttle to the full throttle position, releases it again and then returns to full throttle. If the driver completes this action within 5 seconds, PasSmart is activated.

After double-pumping the Accelerator Pedal, the vehicle is given 20 seconds to accelerate to a speed above the normal VLS limit. If the vehicle speed does not exceed the normal VLS speed in 20 seconds, the driver must repeat the double-pump action. Once the normal VLS has been exceeded, a new higher VLS becomes the maximum vehicle speed limit. This limit is the normal VLS plus the Passing Speed Increment.

A passing speed duration timer starts when vehicle speed exceeds the normal VLS limit and continues to count until the vehicle speed drops back below the normal VLS speed. At the end of the passing event when the vehicle speed drops back below the normal VLS, PasSmart is automatically deactivated and the driver cannot exceed the normal VLS unless the Accelerator Pedal is double-pumped again.

PasSmart operates only with the foot pedal and not with the Cruise Control switches or hand throttle. However, activating PasSmart does not disturb or deactivate Cruise Control if it is on when the passing event begins. Once the driver has passed the other vehicles and PasSmart has deactivated, Cruise Control automatically takes over. To deactivate Cruise Control during the pass, the driver must turn the Cruise Control switch to off.

When the Passing Speed Duration time expires, the AWL will begin to flash one minute prior to ramping the VLS limit back down to the normal VLS limit. The rampdown event always takes 5 seconds regardless of the Passing Speed Increment programmed into the ECU. The rampdown alert can be distinguished from an engine fault warning in that the AWL flashes for the PasSmart alert and remains on constantly for an engine fault.

If intervals of 8, 12, or 24 hours are selected, the interval will always reset after the chosen interval and at midnight. This allows fleets to synchronize the reset with driver change periods. All other intervals reset from the time they are selected. For example, if you select 4 hours, then a reset will occur every 4 hours from the time of programming but not necessarily at midnight.

PasSmart still operates when there is an active (non-shutdown) system fault. In this situation the AWL goes from constant illumination to flashing one minute before the VLS limit ramps down. At the end of the passing event when PasSmart is deactivated, the AWL will return to constant illumination if the fault is still active.

If there is an active stop engine fault, the rampdown/shutdown activity overrides PasSmart. The additional passing speed is not available until the fault is cleared.

For example, if the normal fleet speed limit is 65 MPH, the fleet manager can increase the VLS an additional 5 MPH for up to 30 minutes each day with a reset interval of 8 hours. An example of these limits is listed in Table 5-90.

Parameter	Limit
Passing Speed Duration	30 minutes
Passing Speed Interval	8 hours
Passing Speed Increment	10 MPH

Table 5-90 PasSmart Limits

Each time the driver exceeds 65 MPH, the 30 minute clock counts down as long as the speed remains above 65 MPH. He or she can continue to enter and exit the PasSmart extra speed zone to pass vehicles until the entire 30 minutes of higher VLS is used up. The driver is warned by the AWL one minute before the time expires. The vehicle speed is then limited to 65 MPH until the 8 hour period expires and an additional 30 minutes of passing time is available.

5.20.2 INSTALLATION

An OEM supplied Vehicle Speed Sensor or output shaft speed over the SAE J1939 Data Link is required. Refer to section 3.11.24, "Vehicle Speed Sensor," for additional information.

5.20.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The PasSmart parameters are programmable at engine order entry or with DDDL, Vehicle Electronic Programming System (VEPS), or the DDEC Reprogramming System (DRS) as listed in Table 5-91.

Parameter	Description	Choice / Display
Passing Speed Duration	The duration of time per interval that is permitted at the higher speed. A value of zero will disable the feature.	0 to 255 minutes
Passing Speed Interval	The period of time when the ECU resets to begin a new period.	1 to 24 hours*
Passing Speed Increment	The additional vehicle speed permitted above the programmed vehicle limit speed. A value of zero will disable the feature.	0 to 20 MPH

* A value of 8, 12, or 24 will always reset the interval at midnight otherwise it resets every reset interval after the reprogramming was done.

Table 5-91 PasSmart Parameters

5.20.4 INTERACTION WITH OTHER FEATURES

PasSmart will increase the Vehicle Limit Speed.

A vehicle can be set up with both PasSmart and Fuel Economy Incentive, but the extra speed increments provided by the two features do not add together. For example, if Fuel Economy Incentive is set up to give 7 MPH of extra speed when the driver hits the maximum fuel economy target and the PasSmart increase is 5 MPH the resulting speed increase is 7 MPH, not 12 MPH.

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5.21 PASSWORDS

DDEC provides various levels of password protection such as Rating Password, Injector Password, and Customer Password. Parameter Group Lockout is needed for another level of password protection that affects groups of functions.

5.21.1 RATING PASSWORD

DDEC provides up to four preprogrammed horsepower ratings. The entry of a valid Rating Password and Customer Password are required in order to select a different rating. The rating password can be four alphanumeric characters consisting of the uppercase letters A-Z and the numerals 0-9. The default password is 0000. The Rating Password can be changed with VEPS, DRS, or DDDL. The Customer Password and the current Rating Password are required to change it.

5.21.2 INJECTOR PASSWORD

A valid Injector Password is required to update/change injector calibrations. The Injector Password can be four alphanumeric characters consisting of the uppercase letters A-Z and the numerals 0-9. The default password is 0000. The Injector Password can be changed with DDDL or DRS.

5.21.3 CUSTOMER PASSWORD

The entry of a valid password is required in order to reprogram any parameter(s). Current parameters may be read without entering a password. The password can be four alphanumeric characters consisting of the uppercase letters A-Z and the numerals 0-9.

A random Maximum Security Password can be set by VEPS or DRS for the Customer Password. When set, the factory backdoor password is required to make any changes. The factory backdoor password can be obtained from DDC Technical Service. The Customer Password can be changed with VEPS, DRS, or DDDL. The current Customer Password is required to change to another Customer Password. The default password is 0000.

Parameter Group Lockout

DDEC is capable of providing a second level of password protection for groups of functions. The entry of a valid Parameter Group Lockout Password and Customer Password are requirements before allowing changes to groups that are locked out. The lockout password can be four alphanumeric characters consisting of the uppercase letters A-Z and the numerals 0-9. The default password is 0000.

NOTE:

The parameters are not locked out until a four number non-zero lockout password has been defined.

The groups selected for additional password protection are listed in Table 5-92.

Feature with Lockout Enabled	Lockout Password Needed to Reprogram These Parameters	
Engine/Vehicle	VIN	Fuel Economy Incentive MPH Delta
	A/C Fan Timer	Fuel Economy Incentive MPH to MPG
	Dynamic Brake Enabled	Fuel Economy Incentive Trip Mileage
	Fuel Economy Incentive MPG Threshold	--
Engine Droop	ALSG Droop	VSG Droop
VSG	VSG Minimum RPM	VSG Maximum RPM
	Alternate Minimum VSG RPM	--
Cruise Control	Enable Cruise Control	Tire Revs/Mile
	Minimum Cruise Control Speed	Axle Ratio
	Max Cruise Control Speed	Top Gear Ratio
	Enable Engine Brake on Cruise Control	VSS Teeth
	Engine Brake Increment	Max Speed with Fuel
	Enable Auto Resume	Max Speed without Fuel
	Enable Vehicle Speed Limiting	Cruise Switch VSG Enable
	Maximum Vehicle Limit Speed	Cruise Switch VSG Initial RPM
	Enable Vehicle Speed Sensor	Cruise Switch VSG Increment
	Sensor Type	Enable Adaptive Cruise Control
	VSS Signal	--
Idle Shutdown Timer	Enable Idle Shutdown	Idle Shutdown Duration
	Enable Idle Shutdown on VSG	Idle Shutdown Min Ambient Temperature
	Enable Idle Shutdown Override	Idle Shutdown Max Ambient Temperature
Engine Protection	Engine Protection on Oil Temperature High	Engine Protection on Intercooler Temperature High
	Engine Protection on Coolant Temperature High	Engine Protection on Crankcase Pressure High
	Engine Protection on Oil Pressure Low	Engine Protection on Auxiliary Shutdown #1
	Engine Protection on Coolant Level Low	Engine Protection on Auxiliary Shutdown #2
Air Compressor	Air Compressor Load Delta	Air Compressor Max #2 Pressure
	Air Compressor Unload Delta	Air Compressor Max #3 Pressure
	Air Compressor Min#1 Pressure	Air Compressor Pressure Increment
	Air Compressor Min#2 Pressure	Air Compressor Gain Proportional
	Air Compressor Min#3 Pressure	Air Compressor Gain Integral
	Air Compressor Max#1 Pressure	--
Progressive Shift	Enable Progressive Shift	Low Gear #2 RPM Limit
	Low Gear #1 Off Speed	Low Gear #2 Max Limit
	Low Gear #1 RPM Limit	High Gear On Speed
	Low Gear #1 Max Limit	High Gear RPM Limit
	Low Gear #2 Off Speed	—
Top2	—	Top2 Cruise Switch
Maintenance Alert	MAS AWL/RSL to flash for Levels	MAS AWL/RSL to flash for Filters

Table 5-92 Features and Parameters Selected for Additional Password Protection

5.21.4 PROGRAMMING REQUIREMENTS & FLEXIBILITY

VEPS, DRS, or DDDL can set the group lockouts listed in Table 5-93.

Parameter	Description	Choice
ENGINE/VEHICLE OPTIONS	Enables/Disables lockout for Engine/Vehicle parameters.	YES, NO
DROOP	Enables/Disables lockout for Droop parameters.	YES, NO
VSG	Enables/Disables lockout for VSG parameters.	YES, NO
CRUISE CONTROL	Enables/Disables lockout for Cruise Control parameters.	YES, NO
IDLE SHUTDOWN TIMER	Enables/Disables lockout for Idle Shutdown parameters.	YES, NO
ENGINE PROTECTION	Enables/Disables lockout for Engine Protection parameters.	YES, NO
AIR COMPRESSOR	Enables/Disables lockout for Air Compressor parameters.	YES, NO
PROGRESSIVE SHIFT	Enables/Disables lockout for Progressive Shift parameters.	YES, NO
TOP2	Enables/Disables lockout for Top2 parameters.	YES, NO
MAINTENANCE ALERT SYSTEM	Enables/Disables lockout for Maintenance Alert System parameters.	YES, NO

Table 5-93 Group Lockout Parameters

The Lockout Password can be changed with the VEPS, DRS, or DDDL. The Customer Password and the current Lockout Password are required to change it.

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5.22 PRESSURE SENSOR GOVERNOR

The Pressure Sensor Governor (PSG) is an optional DDEC feature designed primarily for fire truck applications. PSG is a unique governor system which electronically controls engine speeds based on one of two selected modes of operation. An optional panel display is available (refer to section 5.6, "Electronic Fire Commander").

5.22.1 PSG OPERATION

The Pressure Sensor Governor operates in one of two modes:

- Pressure Mode - controls engine speed to maintain a desired discharge manifold pressure
- RPM Mode - maintains a set engine speed regardless of engine load, similar to Variable Speed Governor (VSG) operation

Once PSG has been enabled, the mode is selected with the Pressure/RPM Mode Switch. PSG is enabled by switching the input "PSG Enable" (Config ID 4120) to sensor return. The mode is selected by either switching the input (Pressure Mode) to sensor return or an open circuit (RPM Mode) to the input "Pressure/RPM Mode" (function number 4104).

The engine will maintain the engine speed or pump pressure that is current when the mode switch is toggled between the RPM and Pressure modes.

The PSG Ready Lamp illuminates when PSG is waiting for an operating point. After the Increase or Decrease button has been pressed the PSG active output will be turned on illuminating the PSG Active Lamp.

See Figure 5-75 for a schematic of the PSG system.

RPM Mode

RPM Mode allows the governor to maintain the set speed within engine operating capabilities. RPM Mode is selected when the input "Pressure/RPM Mode" (Config ID 4104) is an open circuit. If the pump is not engaged, RPM Mode can still be used to vary engine speed.

Pressure Mode

Pressure Mode allows the governor to monitor and maintain the fire pump discharge pressure. Pressure Mode is selected by switching the input Pressure/RPM Mode (Config ID 4104) to sensor return.

In Pressure Mode, the maximum allowable increase above the RPM at which the pressure setpoint was established is 400 rpm. This protects the fire fighter from a pressure surge which may result from a momentary loss of pressure if the maximum allowable increase in engine speed is not limited. Also, the maximum allowable increase in engine speed protects the pump from cavitation.

The Pressure Mode is maintained until one of the following situations occurs:

Situation 1 - The Pressure/RPM Mode switch is moved to the RPM Mode. The system reverts to RPM Mode and the same engine speed is maintained.

Situation 2 - The Pressure Sensor signal exceeds diagnostic limits. The system reverts to RPM Mode. The same engine speed is maintained. The Amber Warning Lamp (AWL) illuminates, and the ECU logs Flash Code 86 or 87 into memory.

Situation 3 - If the water pump discharge pressure falls below 40 psi and the engine RPM rises a minimum of 400 rpm above the current set point for more than five (5) seconds, the system also considers cavitation to have occurred and the following happens:

- The engine will return to idle.
- The current engine speed and discharge pressure set points will be cleared.
- The AWL will illuminate.

5.22.2 SWITCHES - INCREASE AND DECREASE

The Increase and Decrease switches follow similar logic as the Cruise Control switches (Resume/Accel On and Set/Coast On) by using inputs.

Increase Switch (Resume/Acceleration On)

Momentarily toggling and releasing the increase switch (switching the Increase (Resume/Accel) input to sensor return) at the initiation of PSG operation will set the Pressure or RPM operating point. The Pressure or RPM setting will increase by 4 psi (approximately 27.6 kPa) or 25 RPM per increment by momentarily contacting the increase (Resume/Accel) switch as listed in Table 5-94.

Holding the switch in the increase position (switching the Increase input to sensor return), will increase the pressure or engine speed by 4 psi (approximately 27.6 kPa) or 25 RPM per increment at a rate of two increments per second. Releasing the switch sets the pressure or engine speed to the higher setting.

Decrease Switch (Set/Coast On)

The pressure or engine speed is decreased by momentarily contacting the switch to the decrease position (switching the Decrease (Set/Coast) input to sensor return). The Pressure/RPM setting will decrease by 4 psi (approximately 27.6 kPa) or 25 RPM per increment when the Decrease Switch is momentarily contacted as listed in Table 5-94.

Holding the switch in the decrease position (switching the Decrease (Set/Coast) input to sensor return) will decrease the pressure or engine speed by 4 psi (approximately 27.6 kPa) or 25 RPM per increment at a rate of two increments per second. Releasing the switch sets the pressure or engine speed to the lower setting.

Mode	Switch	Amount
RPM Mode	Increase/Decrease	+/- 25 rpm
Pressure Mode	Increase/Decrease	+/- 4 psi

Table 5-94 Increase and Decrease for RPM and Pressure Mode

5.22.3 INSTALLATION

See Figure 5-75

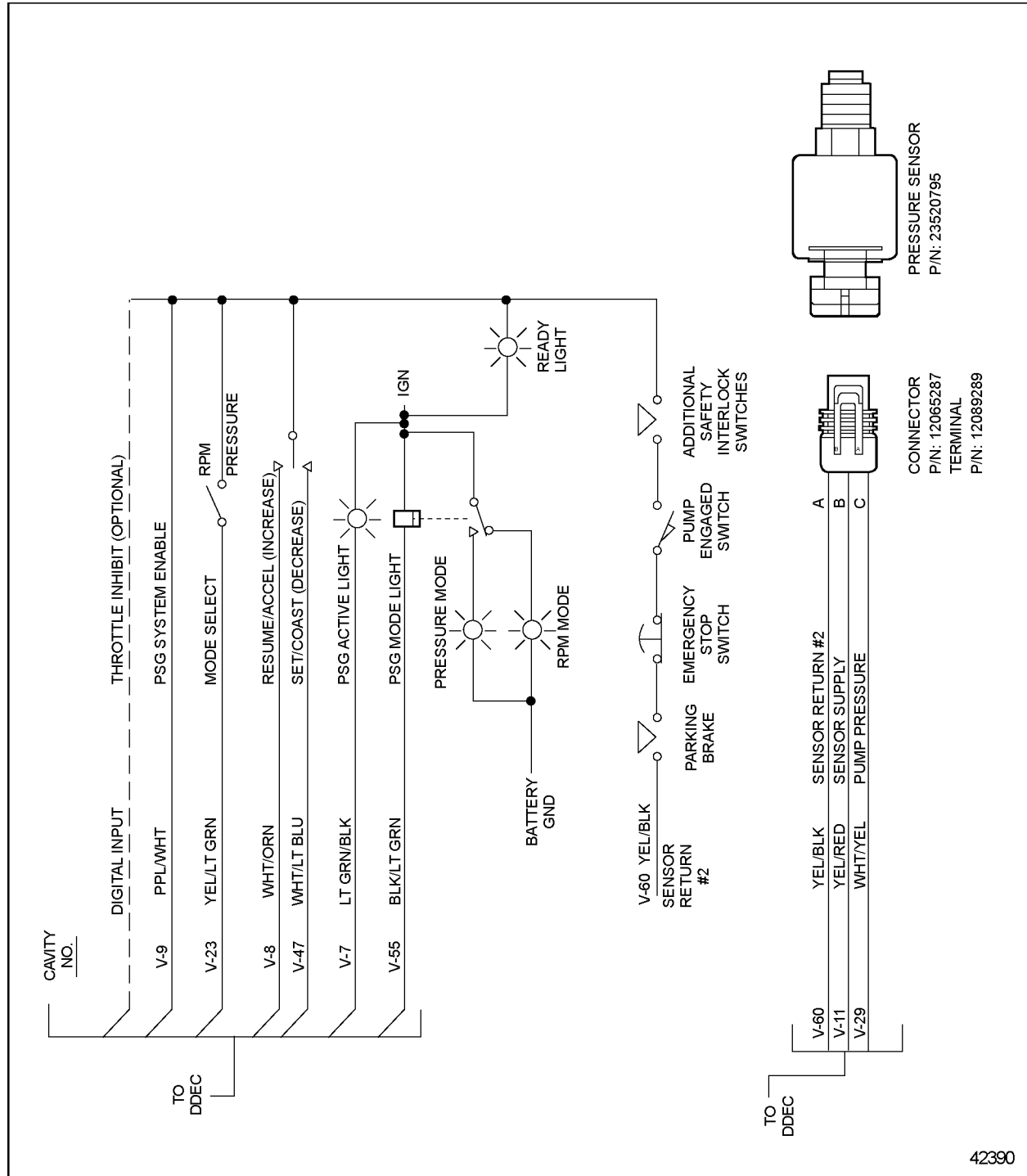


Figure 5-75 Pressure Sensor Governor System - Vehicle Interface Harness Connector

5.22.4 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

There are five inputs and two digital outputs required for PSG. The five inputs required for use with PSG are listed in Table 5-95.

Description	VIH-to-ECU Connector Assignment*	Config ID
Pressure/RPM Mode	V-23	4104
PSG Enable	V-9	4120
Resume/Accel (Increase)	V-8	4118
Set/Coast (Decrease)	V-47	4116
Fire Truck Pump Pressure Sensor	V-29	15

* DDC cavity assignments shown are default settings but can differ from application to application.

Table 5-95 Required Inputs for PSG

The digital outputs required for use with PSG are listed in Table 5-96.

Description	VIH-to-ECU Connector Assignment*	Function Number
PSG Active	V-7	5
Cruise Active	V-55	11

* DDC cavity assignments shown are default settings but can differ from application to application.

Table 5-96 Required Outputs for PSG

The Pressure Sensor Governor is programmed with unique operational parameter defaults intended to cover a wide variety and range of pump applications. The PSG parameter defaults are listed in Table 5-97.

Parameter	Default	Range
Integral Gain	10.00 rpm/(psi-s)	0.000 - 39.845
Proportional Gain	0.75 rpm/s	0.00 - 512.00
Engine Speed Increment	25.00 rpm	0 - 250
Pump Pressure Increment	4.00 psi (27.6 kPa)	0 - 99
Cavitation Time Out	5.00 s	0 - 99

Table 5-97 PSG Parameters and Defaults

Customizing the parameter defaults can be accomplished at the time of engine order, by the Vehicle Electronic Programming System (VEPS), or the DDEC Reprogramming System (DRS). Changes to the parameter defaults can not be made with DDDL.

5.22.5 INTERACTION WITH OTHER FEATURES

The Accelerator Pedal (AP) remains active while PSG is operating unless the input Throttle Inhibit (function number D9) is configured and enabled by switching to sensor return.

PSG has priority in installations where both VSG and PSG are used. The VSG input is completely independent of PSG. When the PSG Enable input is switched to sensor return, the VSG system is disabled.

PSG uses logic similar to Cruise Control and requires many of the same inputs and outputs.

Both systems cannot exist simultaneously. Therefore, neither Cruise Control or the input Cruise Enable (Config ID 4119) may be specified in conjunction with PSG. PSG cannot operate with Cruise Switch VSG (refer to section 4.1.2 for more information on Cruise Control inputs).

Refer to section 4.1.9 for more information on PSG inputs. Refer to section 5.6 for information on PSG interaction with Electronic Fire Commander.

Cruise Switch VSG cannot be used if PSG is configured.

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5.23 PROGRESSIVE SHIFT

The Progressive Shift option offers a high range maximum Vehicle Limit Speed to encourage the use of high (top) gear during cruise operation. Progressive Shift encourages the driver to upshift from a lower to a higher gear prior to reaching the engine's governed speed. The resulting lower engine speed in high range should result in improved fuel economy. Progressive shifting techniques should be practiced by every driver, but can be forced if fleet management considers it necessary. The benefits from progressive shifting are best realized during stop-and-go driving cycles.

The rate of acceleration will be limited below the programmed MPH to encourage up shifting.

As the driver accelerates beyond a specified MPH speed, the rate of engine acceleration is limited in higher RPM, to encourage (force) the operator to select the top gear.

- ☐ Progressive Shift should be used with 2100 RPM rated engines in fleet applications where the reduced driveability will not impede trip times or productivity.
- ☐ Progressive Shift is not compatible with most automatic transmission.

NOTE:

Progressive Shift may be selected only when Spec Manager is run. Progressive Shift selection without Spec Manager could result in mismatched equipment, poor fuel economy, and poor performance. Your local Detroit Diesel Distributor will run the program.

5.23.1 OPERATION

The Progressive Shift option has two sets of low ranges and one set of high range parameters, which should be selected at the time of engine order, but also are programmable with DDDL, DRS, or VEPS. Refer to section 5.23.6. The example shift pattern chart (see Figure 5-76) reflects default values when the Progressive Shift option is chosen and the low and high gear parameters are not modified.

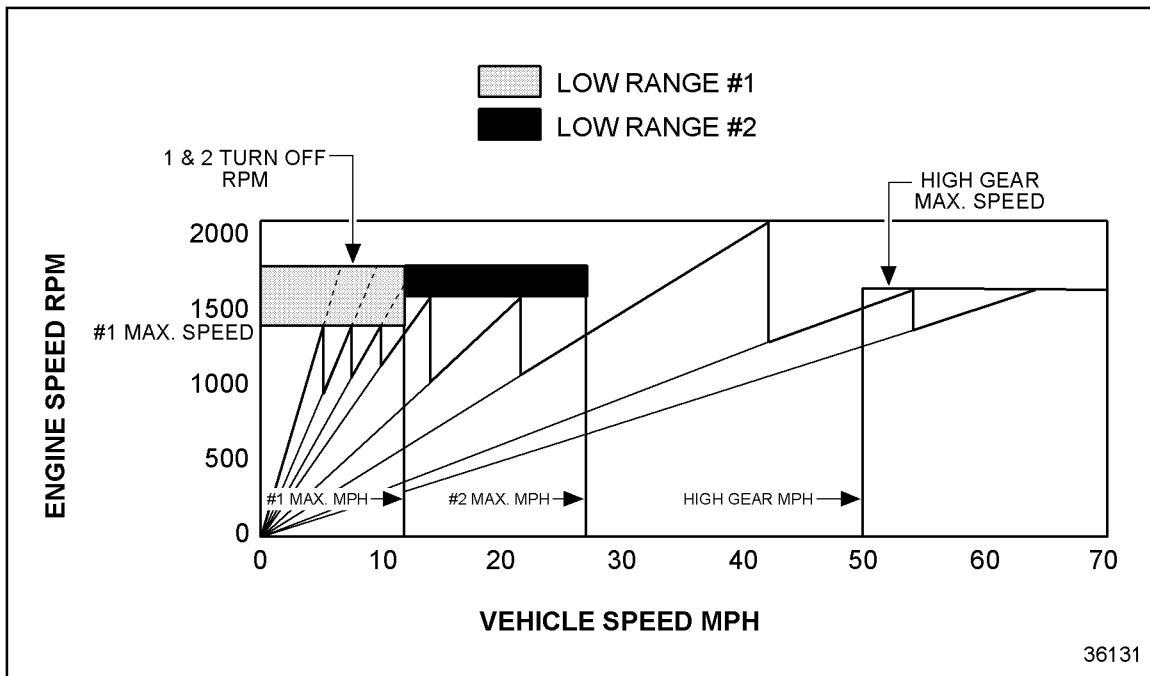


Figure 5-76 Progressive Shift Chart - Represents Default

An alternate use for the Progressive Shift option would be to encourage a driver (or force him/her) into top gear. Normally this condition exists when the gearing selected at the time of order allows a Vehicle Limit Speed to be reached in a gear lower than top gear. See Figure 5-77.

5.23.2 LOW RANGE #1

The low range #1 area of operation is bound by a maximum vehicle speed, a maximum engine speed and a maximum turn-off speed. In the first illustration (see Figure 5-76) the default values are 12 MPH (approximately 19.3 km/h), 1400 RPM and 1800 RPM, respectively. During vehicle acceleration, when the vehicle speed is below selected maximum vehicle speed for range #1, the maximum rate the engine can be accelerated is reduced to 33 RPM/s. During light load operation, the driver will feel this and be encouraged to up-shift to regain his/her rate of acceleration. If the engine continues to be operated above the low range #1 maximum speed, it may eventually reach the low range #1 turn-off speed. When the low range #1 turn-off speed is obtained, no additional increase in engine speed will be allowed. At this point, the transmission must be up-shifted if the vehicle is to continue accelerating.

5.23.3 LOW RANGE #2

The low range #2 area of operation is bounded by a maximum speed (MPH), a maximum vehicle speed and a maximum engine turn-off speed. In the first illustration (see Figure 5-76) the default values shown are 27 MPH (approximately 43.5 km/h), 1600 RPM and 1800 RPM, respectively. (The lower vehicle speed boundary is the low range #1 maximum speed value.) Different values can be selected at the time of the engine order. The engine acceleration rate for low range #2 is 25 RPM/sec.

5.23.4 HIGH RANGE

Two high range parameters should be selected; a high range maximum vehicle speed (MPH) and a high range maximum engine speed (RPM). The default values shown in the first illustration (see Figure 5-76) are 50 MPH (approximately 80.5 km/h) and 1650 RPM, respectively. Once the high range maximum engine speed is attained, the engine will not be allowed to operate above the high range maximum engine speed. This is meant to encourage up-shifting to high gear in order to increase vehicle speed (see Figure 5-77). Spec Manager should be used if the HIGH GEAR MPH is set such that it reduces the vehicle speed and the engine MPH; this limit will not work as desired.

NOTE:

The HIGH GEAR maximum engine speed could change the maximum Vehicle Limit Speed if the high gear maximum engine speed (RPM) limits the Vehicle Limit Speed. With Progressive Shift enabled, the high gear RPM limit overrides the rated speed of the engine rating.

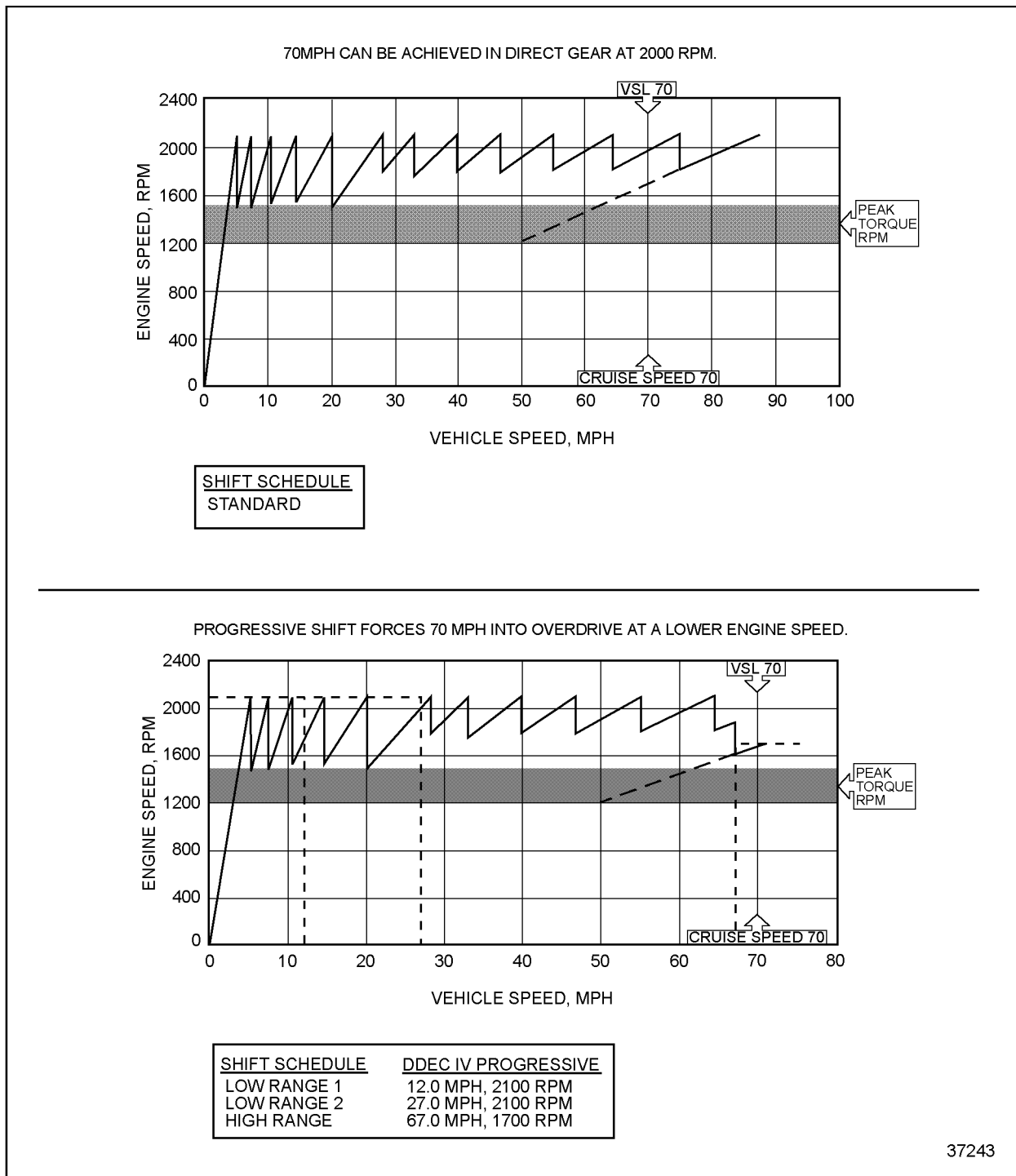


Figure 5-77 Progressive Shift Corrects Problem with High and Low Gears Modified

5.23.5 INSTALLATION INFORMATION

A Vehicle Speed Sensor (VSS) must be installed. It must be enabled, and all proper calculations entered into the ECU with DRS, DDDL, or VEPS. Refer to section 3.11.24, "Vehicle Speed Sensor," for additional information.

The Spec Manager program should be utilized to determine maximum vehicle speed for low range #1 and #2. If the maximum engine speed and maximum vehicle speed coincide, the Progressive Shift logic may not correctly compensate faster or slower on either side of the maximum vehicle speed. Spec Manager can alert the programmer to this dilemma and advise accordingly on maximum vehicle speed set points.

Example: If the maximum vehicle speed #1 was 12 MPH (approximately 19.5 kmh), the Progressive Shift logic may not determine if the maximum engine speed is 1400 or 1600 RPM. Spec Manager would advise moving the maximum vehicle speed #1 plus or minus 2 MPH (approximately 3.2 kmh) to eliminate any possible confusion.

5.23.6 PROGRAMMING FLEXIBILITY

Enabling all areas required for Progressive Shift can be performed with DDDL, VEPS, DRS, or at engine order entry.

The Progressive Shift option has two sets of low gear and one set of high gear parameters as listed in Table 5-98.

Parameter	Description	Choice
ENABLED	Indicates the enabled/disabled status of the progressive shift feature.	YES, NO
LOW GEAR #1 OFF SPEED (MPH)	Sets the low gear #1 turn off speed.	12 to 27 mph
LOW GEAR #1 RPM LIMIT	Sets the low gear #1 RPM limit.	1000 to Low Gear #1 Max RPM
LOW GEAR #1 MAXIMUM LIMIT (RPM)	Sets the low gear #1 maximum RPM limit.	1400 to Rated Speed RPM
LOW GEAR #2 OFF SPEED (MPH)	Sets the low gear #2 turn off speed.	Low Gear #1 Off Speed to High Gear On Speed MPH
LOW GEAR #2 RPM LIMIT	Sets the low gear #2 RPM limit.	1000 to Low Gear #2 Max RPM
LOW GEAR #2 MAXIMUM LIMIT (RPM)	Sets the low gear #2 maximum RPM limit.	Low Gear #1 Max Limit to High Gear RPM Limit
HIGH GEAR ON SPEED (MPH)	Sets the high gear turn on speed.	Low Gear #2 Off Speed to 127 MPH
HIGH GEAR RPM LIMIT	Sets the high gear RPM limit.	1400 to Rated Speed RPM

Table 5-98 Progressive Shift Programming

5.23.7 INTERACTION WITH OTHER FEATURES

When Progressive Shift is enabled the ECU will treat "HIGH GEAR RPM LIMIT" as the rated speed of the engine. Vehicle maximum speed or maximum Cruise Control settings can not be set higher then engine speed will allow based on the VSS data entered.

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5.24 TACHOMETER DRIVE

DDEC uses the TRS (CKP) signals to compute engine speed. The engine speed is transmitted over the SAE J1708/J1587 and J1939 Data Links. Engine speed can be displayed by connecting a tachometer from VIH connector pin V-31. This circuit provides the standardized output signals for the tachometer drive per ATA recommended practice RP123. See Figure 5-78.

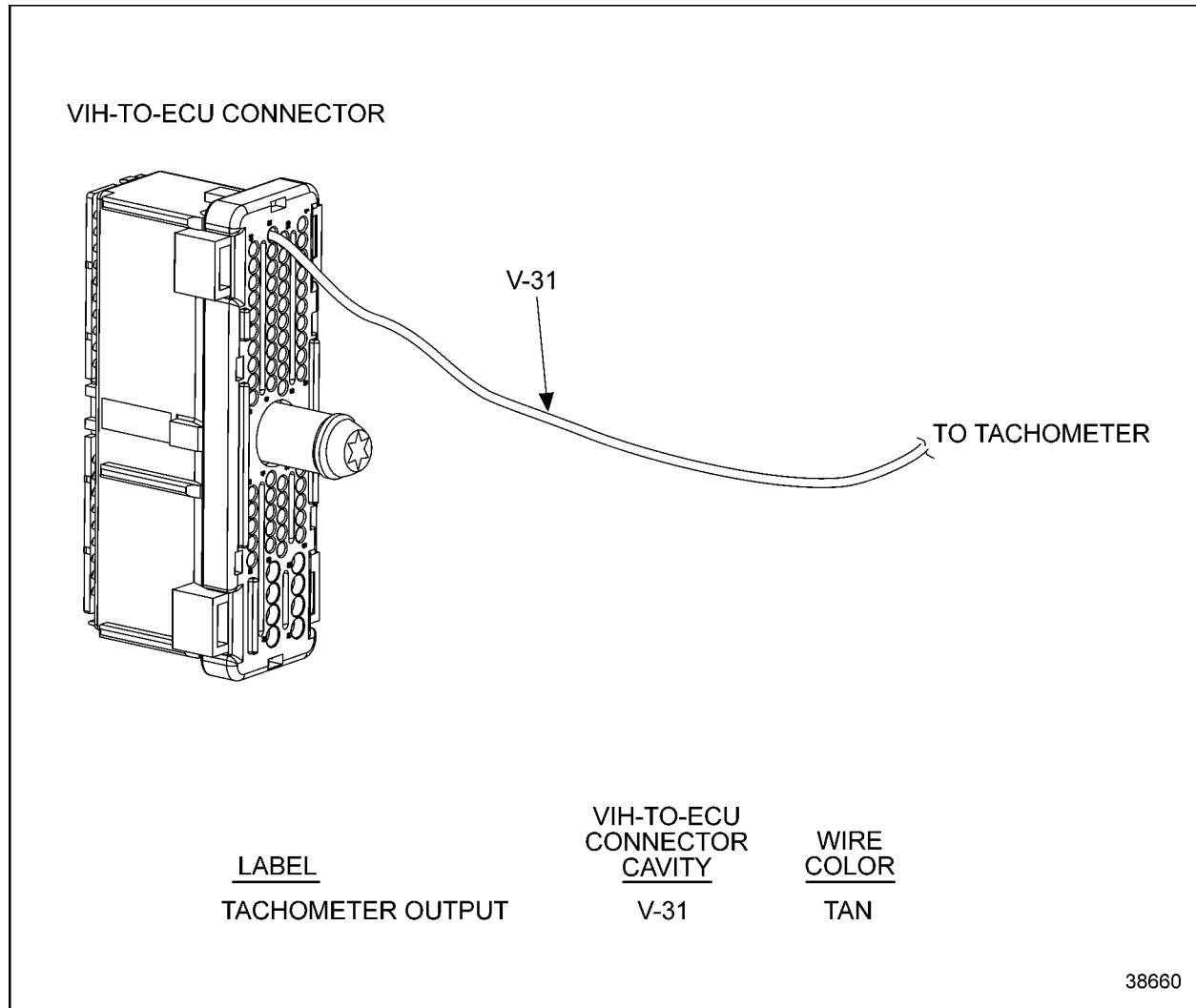


Figure 5-78 Tachometer Drive Installation

Signal output characteristics are listed in Table 5-99.

Signal	Signal Characteristics
Pulse Rate	12 Pulse/Rev (all engines)
Duty Cycle	50% $\pm$ 10%
Signal Low	0V < V < 0.5V when sinking less than 50mA out
Signal High	4.0 < V < V Batt + sourcing less than 5mA out
Frequency	10 — 2000 Hz

Table 5-99 Tachometer Drive Signal Output Characteristics

See Figure 5-79 for the tachometer output signal.

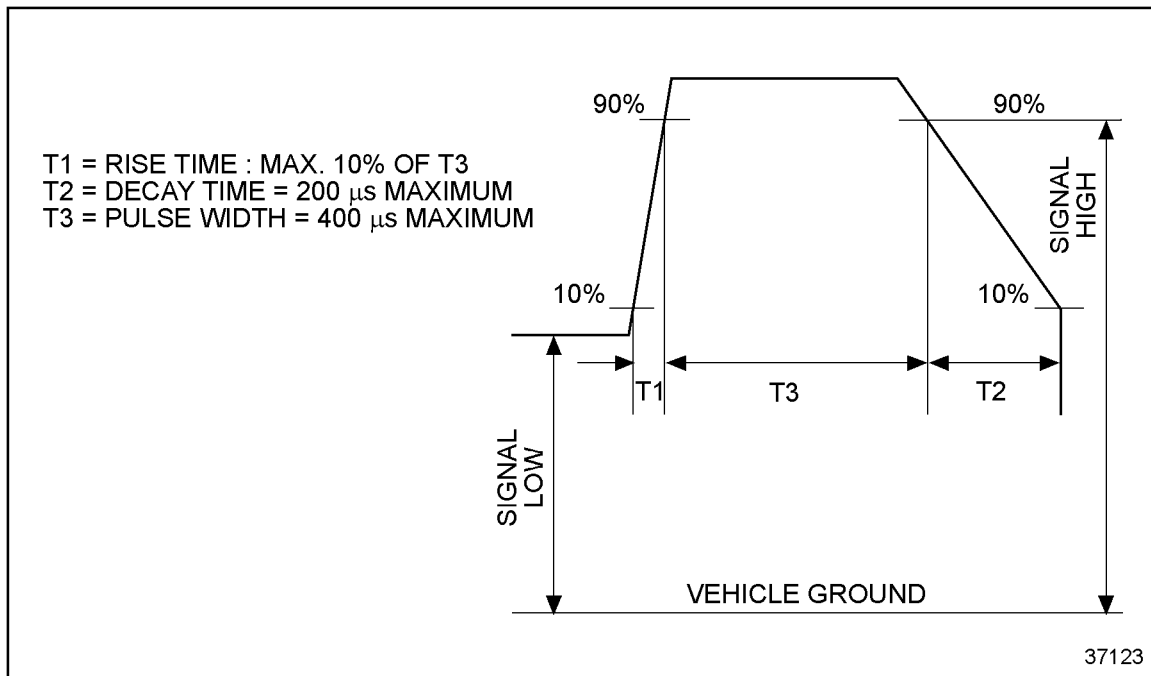


Figure 5-79 Tachometer Output Signal

5.25 THROTTLE CONTROL/GOVERNORS

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

- The Automotive Limiting Speed Governor (ALSG) for torque control, typical governor for on-highway applications (refer to section 5.25.1)
- The Variable Speed Governor (VSG) for speed control, typical governor for off-highway applications (refer to section 5.25.2)

5.25.1 AUTOMOTIVE LIMITING SPEED GOVERNOR- ON-HIGHWAY

In on-highway applications and some off-highway applications, ALSG is the primary throttle source. The throttle input in a ALSG sets percent load. The amount of fuel input to the engine is determined by the throttle position. As the load on the engine varies the resulting engine speed will vary between idle speed and rated speed.

The hot idle and governor droop are selected at the time of engine order. Both can be adjusted with DDDL. Hot idle is the engine idle RPM when the oil temperature is greater than 140°F and governor droop/overrun is the overrun beyond rated speed. The droop/overrun can be adjusted in the range from 0 to 75 RPM, for Series 60 on-highway engines.. VSG droop cannot exceed ALSG droop. The idle can be adjusted in a range from 25 RPM below to 100 RPM above hot idle depending on engine rating.

NOTE:

An Accelerator Pedal with an Idle Validation Switch (Config ID 4102, pin V-16) is required.

ALSG Primary with VSG as a Secondary Control

VSG is available as a secondary control (ALSG is primary) for specialized on-highway applications. For these applications, the ALSG is programmed to override the VSG under certain conditions.

VSG is disabled during initial startup, until the VSG throttle is moved to the idle range (less than 140 counts) and the ALSG throttle is near idle (less than 4% throttle).

VSG (including ALT MIN VSG) may be disabled when a predetermined ALSG percent throttle is exceeded as listed in Table 5-100. The ALSG percent throttle is set by the Application Code System (ACS).

Application	% Throttle
On-highway Trucks	4%
Transit Bus	100%
Fire Truck	100%
Motor Coach	100%
Crane	4%

Table 5-100 Predetermined ALSG % Throttle

VSG operation is disabled when the engine protection option has been selected and the Red Stop Lamp (RSL) is illuminated because one of the engine parameters being monitored is out of limits.

VSG low side diagnostics must be disabled or a code will be logged. The proper 6N4C group must be specified at the time of engine order or by Detroit Diesel Technical Service. For additional information, contact your DDC Applications Engineer.

For another example of VSG or ALSG only operation using two inputs see Figure 5-80. Low-side diagnostics do not have to be disabled for this implementation. Switching the VSG Inhibit input to sensor return will reduce engine speed to idle. When the VSG Inhibit input is switched from sensor return, the throttle must be reset to zero before engine speed can be increased from idle.

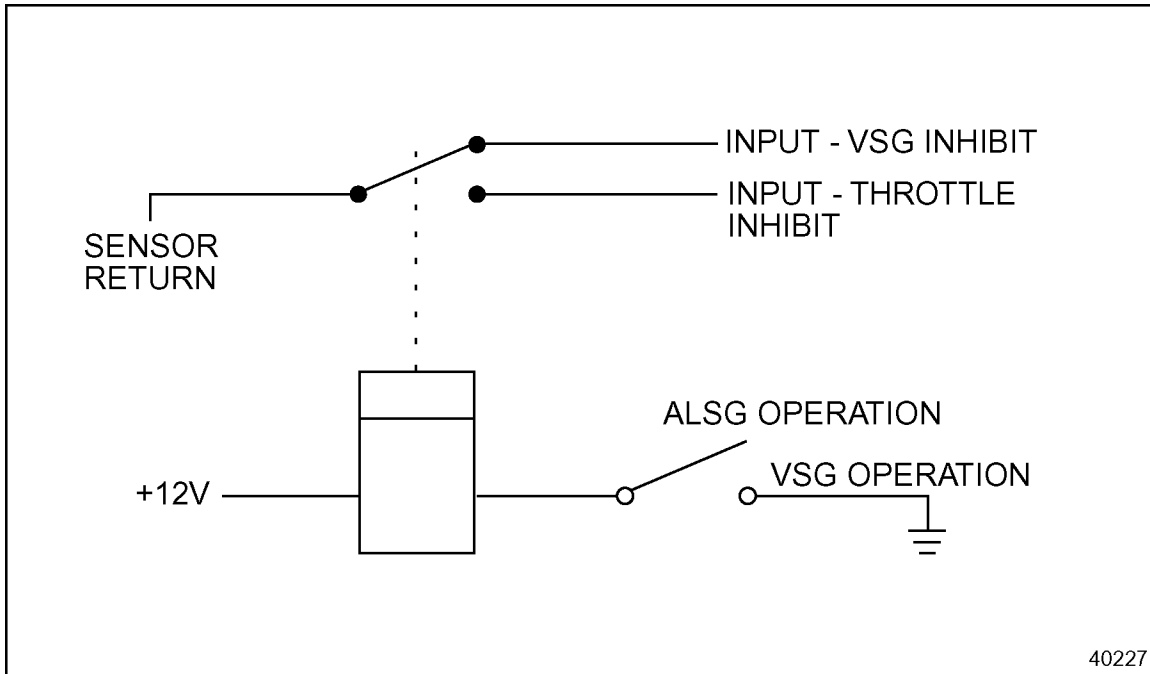


Figure 5-80 VSG or ALSG Only Operation Using VSG Inhibit

ALSG Control Options

The ALSG control options are the following:

- ☐ Accelerator Pedal (AP)
- ☐ Dual Accelerator Pedal

ALSG Accelerator Pedal

The AP sends an input signal which the ALSG uses to calculate engine power proportional to the foot pedal position. This assembly is also referred to as the Accelerator Pedal Sensor (AP Sensor) assembly.

ALSG Accelerator Pedal Installation

DDEC V is compatible with an AP, which has an output voltage that meets SAE J1843 and has less than 5% of voltage supply closed throttle variability.

NOTE:

An Accelerator Pedal with an Idle Validation Switch is required.

The AP is an OEM supplied part. Vendor sources that may be contacted for additional design and installation details are:

Williams Controls

14100 S.W. 72nd Avenue
Portland, Oregon 97223
(503) 684-8600

Bendix Heavy Vehicle Systems

901 Cleveland
Elyria, Ohio 44036
1-800-AIR-BRAKE

The AP must be wired so at low engine speed a small resistance is seen between circuits V-13 (signal) and V-60 (reference ground). At high engine speed a larger resistance must be seen between circuits V-13 and V-60 (see Figure 5-81). A Volt/Ohm meter must be used to measure resistance to ensure correct installation.

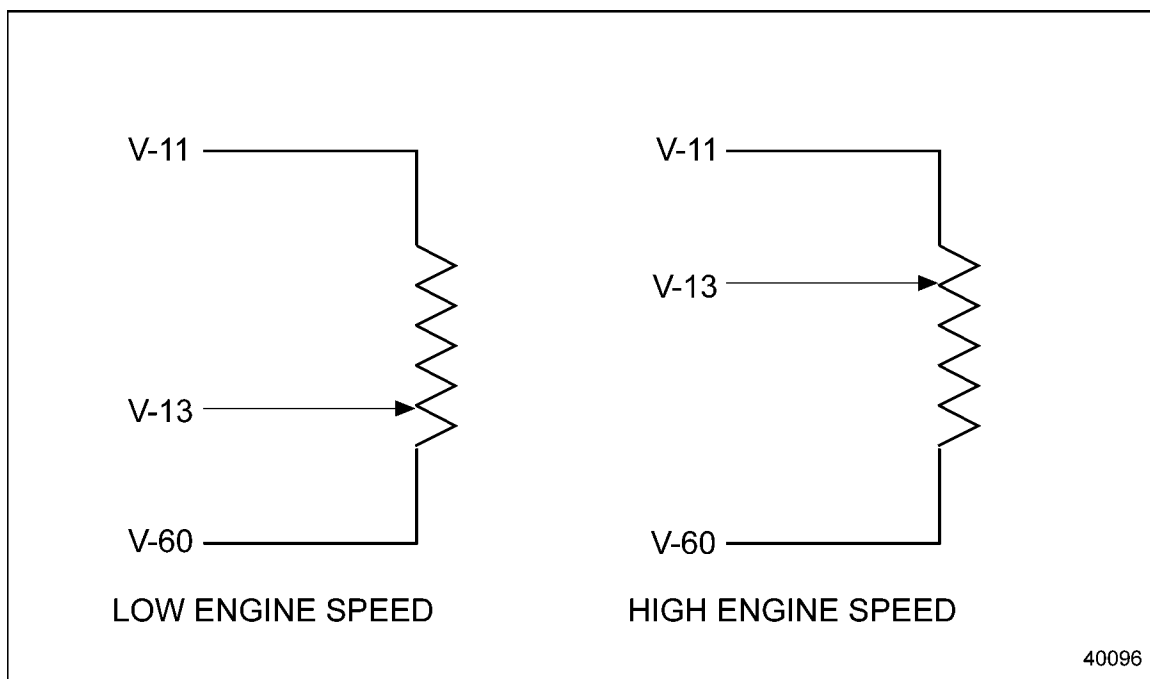


Figure 5-81 Accelerator Pedal Installation

NOTE:

The Idle Validation Switch is required. Refer to section 4.1, "Digital and Analog Inputs," for additional information.

ALSG Accelerator Pedal Diagnostics

An idle validation switch provides redundancy to assure that the engine will be at idle in the event of an accelerator pedal in-range malfunction. The idle validation switch is connected to an input on the ECU. When the idle validation switch on the AP is switched to sensor return, the engine speed will be at idle.

ALSG Dual Accelerator Pedal Throttle Controls

Some applications require ALSG controls at two stations.

ALSG Dual Throttle Control Installation

The dual AP schematic (see Figure 5-82) shows an AP at two locations with only one AP active at a time. The dual AP option requires one input. The input is switched to either sensor return or system voltage to indicate which AP is active.

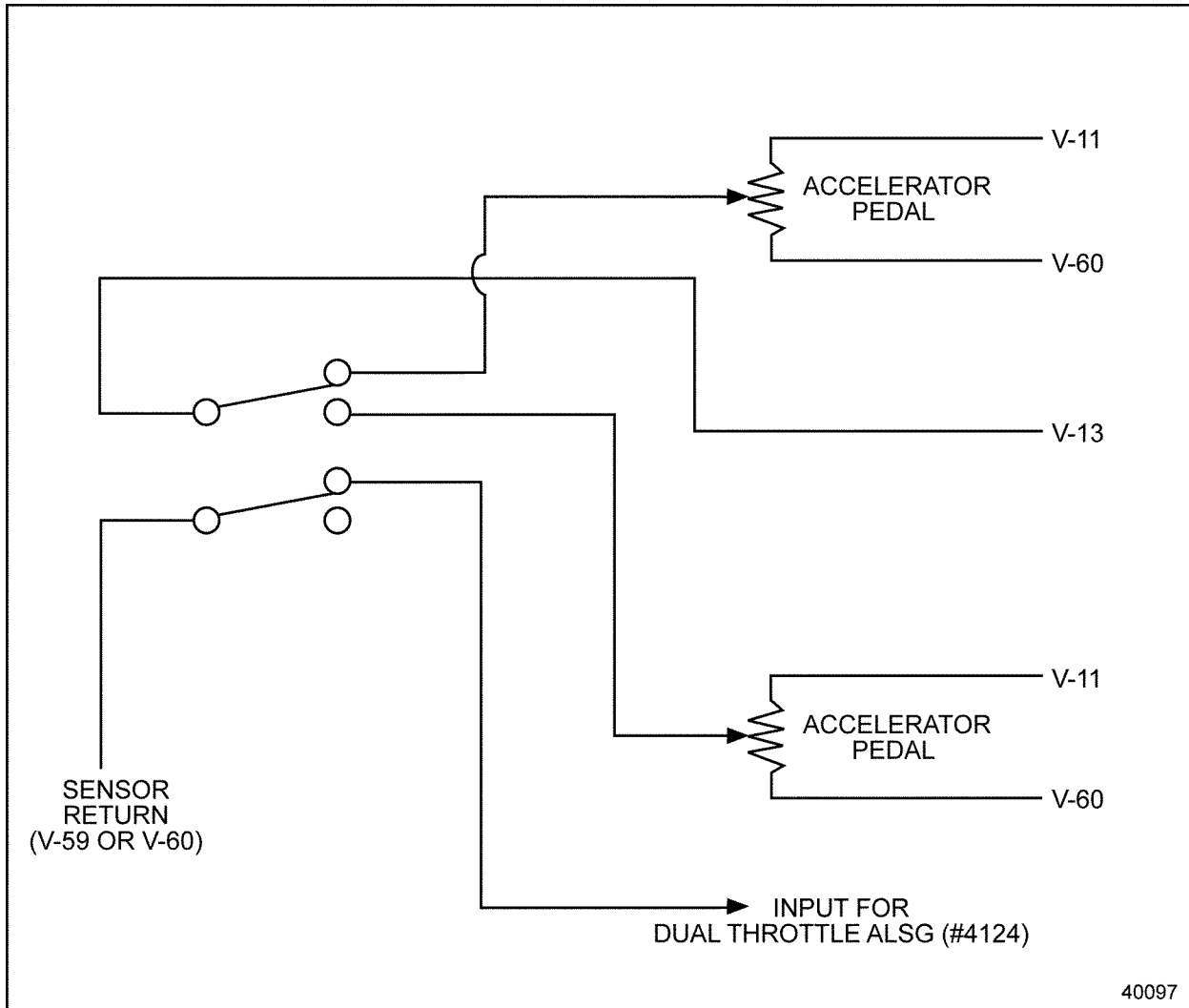


Figure 5-82 **ALSG Dual Accelerator Pedal Throttle**

ALSG Dual Throttle Control Programming Flexibility

The input listed in Table 5-101 is required for ALSG dual throttle control. This input may be ordered at the time of engine order, configured by VEPS or DRS.

Input	Config ID
Dual AP	4124

Table 5-101 ALSG Dual Throttle Control Digital Input

Refer to section 4.1, "Digital and Analog Inputs" for additional information.

ALSG Dual Throttle Control Diagnostics

System diagnostics will detect the active sensor or associated wiring malfunction and return the engine to idle speed. An Idle Validation Switch provides redundancy to assure that the engine will be at idle in the event of an in-range malfunction.

5.25.2 VARIABLE SPEED GOVERNOR - OFF-HIGHWAY

The throttle input to a VSG controls engine speed between idle and rated speed. The VSG senses load and fuels the engine to maintain a set speed (within the capability of the engine). Upon startup the engine will go to the speed selected by the VSG throttle control.

The Variable Speed Governor (VSG) throttle control options are:

- ☐ Cruise Switch VSG
- ☐ Hand Throttle
- ☐ AP
- ☐ Alternate Minimum VSG (Fast Idle)
- ☐ Voltage Dividers
- ☐ Dual Throttle Controls
- ☐ Frequency Input

In on-highway applications and some off-highway applications, the ALSG is the primary throttle source. In these applications, the following conditions must be met to operate on the VSG:

- ☐ On-highway truck applications disable VSG operation when the AP is pressed. In truck applications, the AP must be released. Coach and motor home, crane, or fire truck applications do not disable VSG operation when the AP is pressed as listed in Table 5-100.
- ☐ Once disabled, the VSG voltage must be reduced to < 0.68 volts (140 counts) before it can be reactivated.
- ☐ When diagnostic trouble code 12 (VSG voltage high) occurs, the VSG is disabled and the engine returns to idle. To regain VSG throttle control, the VSG throttle must be returned to the idle position (less than 140 counts).

- VSG will not operate when the vehicle speed exceeds a predetermined, application specific vehicle limit. Contact DDC Application Engineering for application specific details.

For applications utilizing VSG, the low side diagnostics on the VSG input (function # 21 on pin V-14) has been enabled on DDEC V engines. To avoid diagnostic fault codes a minimum of 0.5V on the signal input is required. This applies to hand throttles as well as any other VSG throttle option.

The ideal way to achieve this is to set the handle throttle (potentiometer) voltage minimum to 0.5V. Additionally, to disable the analog VSG when it is not being used, a digital input — “VSG Inhibit” (function # 4138) — can be programmed to lock out the analog VSG function whenever this input is switched to sensor return.

Another option to achieve this minimum voltage is via a resistor network. This will also ensure no less than 0.5V to prevent a low side diagnostic fault code. See Figure 5-83.

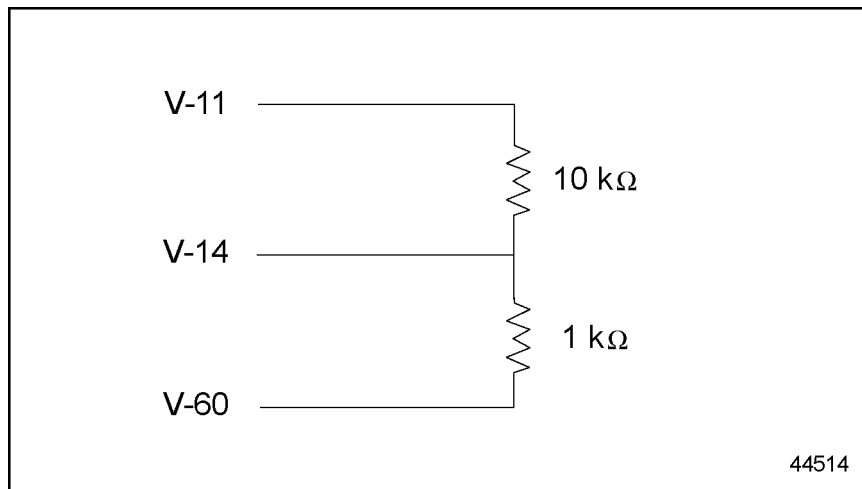


Figure 5-83 Resistor Network

VSG Programming Requirements and Flexibility

The VSG parameters which can be selected at the time of engine order or programmed with VEPS, DDDL, or DRS are listed in Table 5-102.

Parameter	Description
ANALOG VSG SENSOR ENABLE (V-14)	Enables or disables the analog VSG pin V-14. Low and high side diagnostics are enabled with this input.
VSG MIN RPM	The VSG minimum speed can be set between the hot idle speed and the rated engine speed (or VSG MAX SPD when selected). This causes the engine speed to jump from the hot idle speed to VSG idle speed when the VSG throttle position is first moved (above 140 counts).
VSG MAX RPM	The VSG maximum speed can be set between the hot idle (or VSG MIN SPD when selected) and the engine rated speed.
VSG ALT MIN RPM	The alternate minimum VSG (VSG ALT MIN SPD) option allows the customer to switch to a VSG idle speed greater than the VSG minimum speed (VSG MIN SPD). VSG ALT MIN SPD is active when its input is switched to battery ground. When VSG ALT MIN SPD is active and the throttle position is less than or equal to 140 counts, the engine speed will jump from the VSG MIN SPD directly to the VSG ALT MIN SPD. After the throttle is moved above 140 counts, the throttle will control the engine speed between VSG ALT MIN SPD and VSG MAX SPD (VSG maximum speed).
VSG DROOP RPM	The VSG droop can be programmed between 0 and ALSG droop but not greater than 300 RPM, depending on engine rating.

Table 5-102 VSG Options

Cruise Switch VSG

The Cruise Control switches can be used to control the VSG set speed. This feature is referred to as Cruise Switch VSG.

NOTE:

This option is not recommended for fire truck pumping applications or crane applications and is not available for Pressure Sensor Governor systems.

The cruise switches are used to activate and control the Cruise Switch VSG option. The Cruise On/Off switch must be turned ON and the park brake must be engaged to enable this feature.

If Cruise Switch VSG is inactive and the Cruise Switch VSG conditions are met, pressing and releasing the Resume/Accel Switch will activate Cruise Switch VSG at the VSG initial speed. The VSG initial speed can be programmed with the DDDL, VEPS, or DRS and cannot be greater than the VSG maximum speed. Pressing and releasing the Set/Coast Switch will activate Cruise Switch VSG at the current engine operating speed.

Once the VSG set speed is established, pressing and releasing the Resume/Accel Switch will increment the set speed by the amount defined by the VSG increment speed up to the VSG maximum speed. Pressing and holding the Resume/Accel Switch will initiate a speed increase, up to the VSG maximum speed. Releasing the Resume/Accel Switch will set the engine speed at the current operating speed.

Pressing and releasing the Set/Coast Switch will decrement the set speed by the amount defined by the VSG increment speed, down to the hot idle speed. Pressing and holding the Set/Coast Switch will initiate a speed decrease, down to the hot idle speed. Releasing the Set/Coast Switch will set the engine speed at the current operating speed.

NOTE:

VSG Min Speed is not recognized by Cruise Switch VSG.

Cruise Switch VSG Installation Requirements

The following must be installed for Cruise Switch VSG to operate:

- ☐ Vehicle Speed Sensor (VSS)
- ☐ Cruise Control Switches - inputs
- ☐ Park Brake Switch - input

Refer to section 4.1.2, "Cruise Control" and section 4.1, "Digital and Analog Inputs" for additional information.

Cruise Switch VSG Programming Requirements and Flexibility

The inputs listed in Table 5-103 are required for Cruise Switch VSG. These inputs may be configured at the time of engine order, configured by VEPS or DRS.

Digital Input	Config ID
Cruise Enabled	4119
Service Brake Released	4113
Clutch Released (optional)	4114
Set/Coast On	4116
Resume/Accel On	4118
Parking Brake Interlock	4101

Table 5-103 Cruise Switch VSG Inputs

Refer to section 4.1, "Digital and Analog Inputs," for additional information.

The Vehicle Speed Sensor (VSS) must be enabled at engine order entry, by DDDL, VEPS or DRS. Refer to section for additional information on VSS.

The parameters listed in Table 5-104 can be set with DDDL, VEPS or DRS.

Parameter	Description	Choice / Display
VSG MAX RPM	Sets the maximum VSG RPM.	VSG MIN RPM to (Rated Engine RPM + ALSG Droop)
ENABLE CRUISE SWITCH VSG	Enables or disables the cruise switch VSG set speed feature.	YES, NO
INITIAL RPM	Sets the cruise switch VSG initial set speed.	VSG MIN RPM to VSG MAX RPM
VSG RPM INCREMENT	Sets the cruise switched VSG RPM increment.	1 to 255 RPM

Table 5-104 Cruise Switch VSG Programming

VSG 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 1 k Ω and 10 k Ω .

NOTE:

If analog VSG is not used the hand throttle must be disabled with VEPS or DRS.

VSG Hand Throttle Installation

The hand throttle must be wired so at low engine speed a small resistance is seen between pin V-14 (signal) and V-60 (sensor return). The low engine speed position is typically fully counter-clockwise. At high engine speed a larger resistance must be seen between circuits V-14 (signal) and V-60 (reference ground). See Figure 5-84.

NOTE:

A Volt/Ohm meter must be used to measure resistance to ensure correct installation.

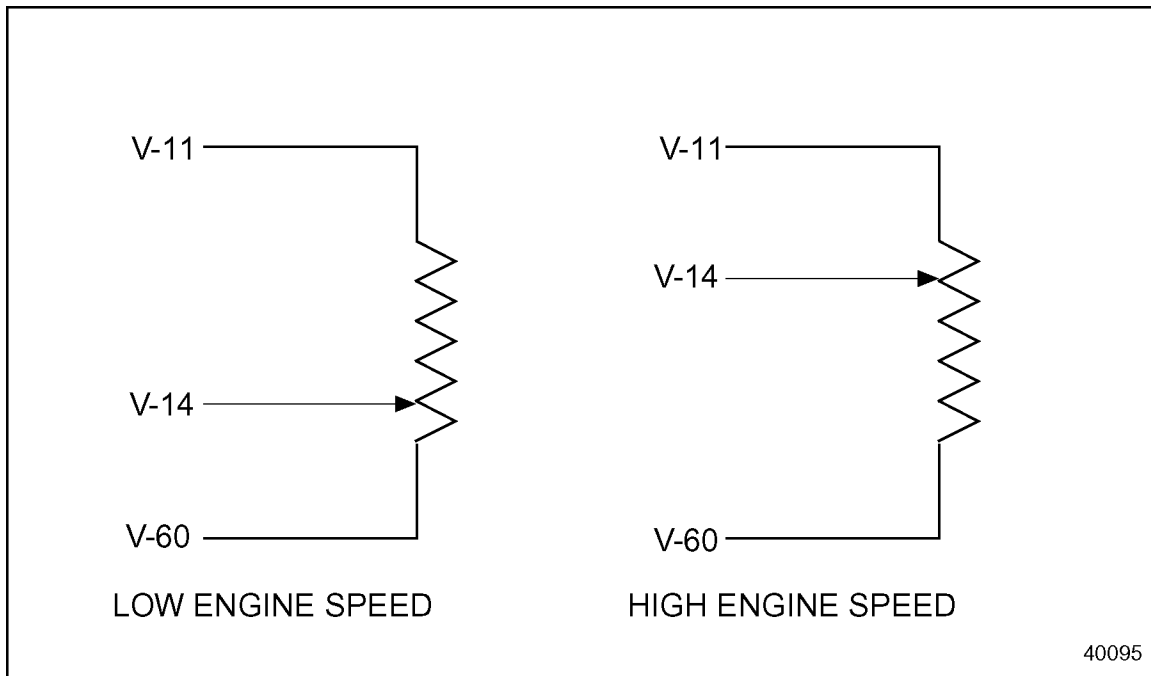


Figure 5-84 Hand Throttle Installation

VSG Hand Throttle Calibration

The hand throttle is calibrated with DDDL as follows:

1. Display the VSG counts. The VSG counts can range from 0 to 1023.
2. In the low speed position, set the hand throttle between 100 and 130 counts.
3. In the high speed position, set the hand throttle between 920 and 950 counts.

The hand throttle is an OEM supplied part. Vendor sources that may be contacted for additional design and installation details are:

Teleflex Morse

Phone: (610) 495-7011

VSG Accelerator Pedal

The AP can be used as an alternative to a hand throttle.

The AP provides an input signal to the ECU to control engine speed on the VSG, proportional to the foot pedal position. The idle validation switch is not applicable to the AP when used as an input to the VSG.

The Alternate Minimum VSG/Fast Idle input may also be used with the AP to provide an alternate engine operating speed range.

AP VSG requires a different application code.

Alternate Minimum VSG (Fast Idle)

The Alternate Minimum VSG option allows a customer to switch to an alternate VSG operating range when its input is switched to sensor return and VSG is the active governor.

Example:

VSG Minimum Speed - 500 RPM

VSG Alternate Minimum Speed - 1000 RPM

VSG Maximum Speed - 1500 RPM

When the Alternate Minimum VSG/Fast Idle input is inactive, the engine speed will be controlled between 500 and 1500 RPM. When the Alternate Minimum VSG option is initiated, the engine speed will increase and be controlled between 1000 and 1500 RPM depending on the hand throttle position.

The Alternate Minimum VSG/Fast Idle input may be used to operate the engine at a higher engine idle speed.

If the Alternate Minimum VSG becomes disabled when ALSG is the primary governor or for any other reason, the operator must toggle the switch to re-enable fast idle unless the primary speed controller is VSG.

Alternate Minimum VSG Programming Flexibility

The input "Alternate Minimum VSG" (Config ID 4112) can be set by order entry, VEPS or DRS.

Refer to section 4.1, "Digital and Analog Inputs," for additional information.

The parameters listed in Table 5-105 can be set with DDDL, VEPS or DRS if an input is configured for Alt Min VSG.

Parameter	Description	Choice / Display
ALT RPM	Sets the Alternate Minimum VSG RPM.	VSG MIN RPM to VSG MAX RPM

Table 5-105 Alternate Minimum VSG Programming

VSG Voltage Dividers

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

VSG Voltage Dividers Installation

The voltage divider consists of two precision resistors (+/- 1% tolerance, 1/4 watt minimum) in series between circuits V-11 and V-60 with a center tap. The values of the resistors determine engine speed. See Figure 5-85.

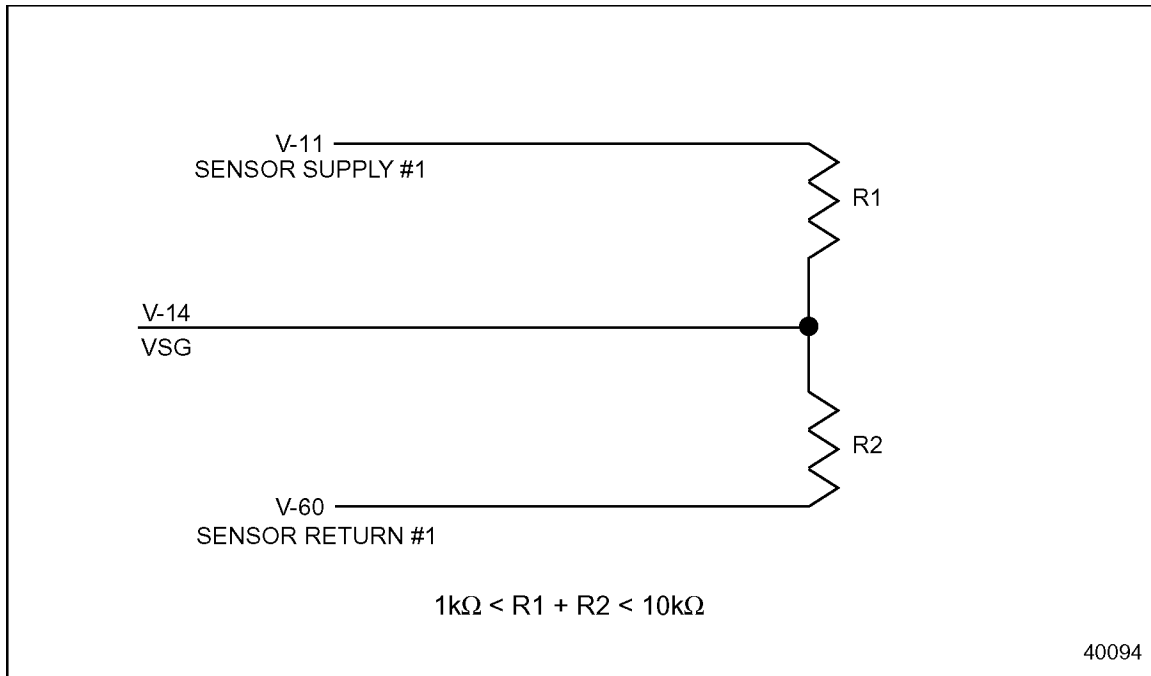


Figure 5-85 Voltage Divider

NOTE:

The voltage divider circuit must be placed inside a weatherproof container.

VSG Resistor Selection for Voltage Dividers

The selection of the resistors is accomplished by using the following calculations. These calculations determine the RPM/count, which is then used to determine the counts needed to reach the desired engine speed. The counts are a direct representation of voltage. See Figure 5-86.

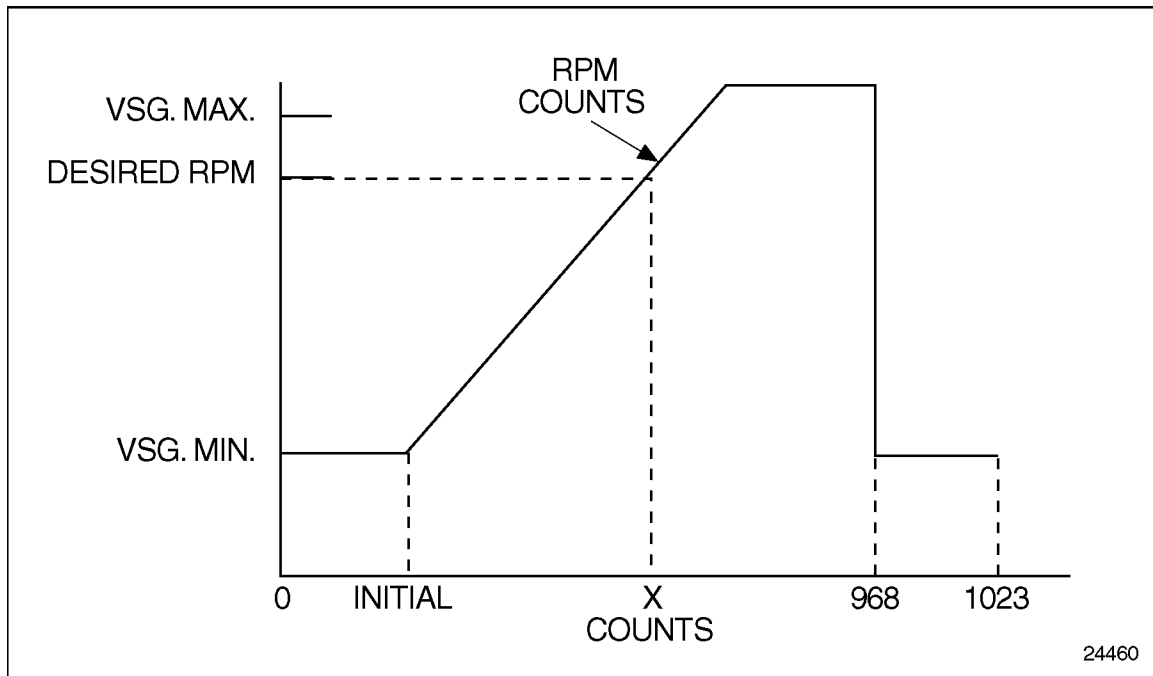


Figure 5-86 Throttle Count Profile

Use the following steps to calculate resistor values:

1. Determine a value for RPM/Count as follows:

$$\text{RPM / Count} = \frac{(\text{VSG Max. Speed} - \text{VSG Min. Speed})}{\text{Divisors}^*}$$

* Divisor = 775 (all applications not using VSG foot pedal)
 Divisor = 512 (all applications using VSG foot pedals)

2. Solve for the counts at the desired engine speed, X:

$$X = \frac{\text{Desired Speed} - \text{VSG Min. Speed}}{\text{RPM / Count}} + \text{PTO Offset}^\dagger$$

† PTO Offset = 140 (all applications not using VSG foot pedal)
 PTO Offset = 205 (all applications using VSG foot pedals)

3. Solve for the voltage divider resistance ratio, R:

$$R = \frac{X}{1024}$$

4. Choose a value for R1 and solve for a value of R2 as follows:

$$R = \frac{R2}{R1 + R2} \rightarrow R2 = \frac{R1 \times R}{1 - R} \quad 1 \text{ k}\Omega \leq R1 + R2 \leq 10 \text{ k}\Omega$$

The standard precision resistor values are listed in Table 5-106.

Standard Precision Resistor Values, Ω					
10.0	14.7	21.5	31.0	46.4	68.1
10.2	15.0	22.1	32.4	47.5	69.8
10.5	15.4	22.6	33.2	48.7	71.5
10.7	15.8	23.2	34.0	49.9	73.2
11.0	16.2	23.7	34.8	51.1	75.0
11.3	16.5	24.3	35.7	52.3	76.8
11.5	16.9	24.9	36.5	53.6	78.7
11.8	17.4	25.5	37.4	54.9	80.6
12.1	17.8	26.1	38.3	56.2	82.5
12.4	18.2	26.7	39.2	57.6	84.5
12.7	18.7	27.4	40.2	59.0	86.6
13.0	19.1	28.0	41.2	60.4	88.7
13.3	19.6	28.7	42.2	61.9	90.9
13.7	20.0	29.4	43.2	63.4	93.1
14.0	20.5	30.1	44.2	64.9	95.3
14.3	21.0	30.9	45.3	66.5	97.6

Standard precision resistors are available in the values listed and all multiples of 10 (i.e., 10.7 Ω , 107 Ω , 1.07k Ω , etc.)

Table 5-106 Precision Resistor Values (+/-1%; 1/4 Watt Minimum)

VSG Dual Throttle Controls

Some applications require VSG controls at multiple control stations. These include fire trucks, cranes, etc. Special circuits can be designed to handle these unique requirements.

A dual hand throttle implementation allows a hand throttle to be installed at two locations with one hand throttle active at any one time. Two inputs, Dual VSG and Dual VSG Complement, are used to transfer operation from one hand throttle to the other once station qualification is achieved.

DDEC monitors the switch inputs and maintains the engine speed when a station switch occurs until the newly selected station is qualified by reducing the station position to idle and then increasing it to the current engine speed position. After qualification, the engine speed is controlled by the new station. If qualification does not occur within 30 seconds, the engine speed will be ramped down from its current value to VSG minimum speed. If the new station becomes qualified, the rampdown process will be stopped and the new station will have control.

VSG Dual Throttle Controls Installation

See Figure 5-87 for a schematic of a dual hand throttle implementation. This allows a hand throttle to be installed at two locations with one hand throttle active at any one time.

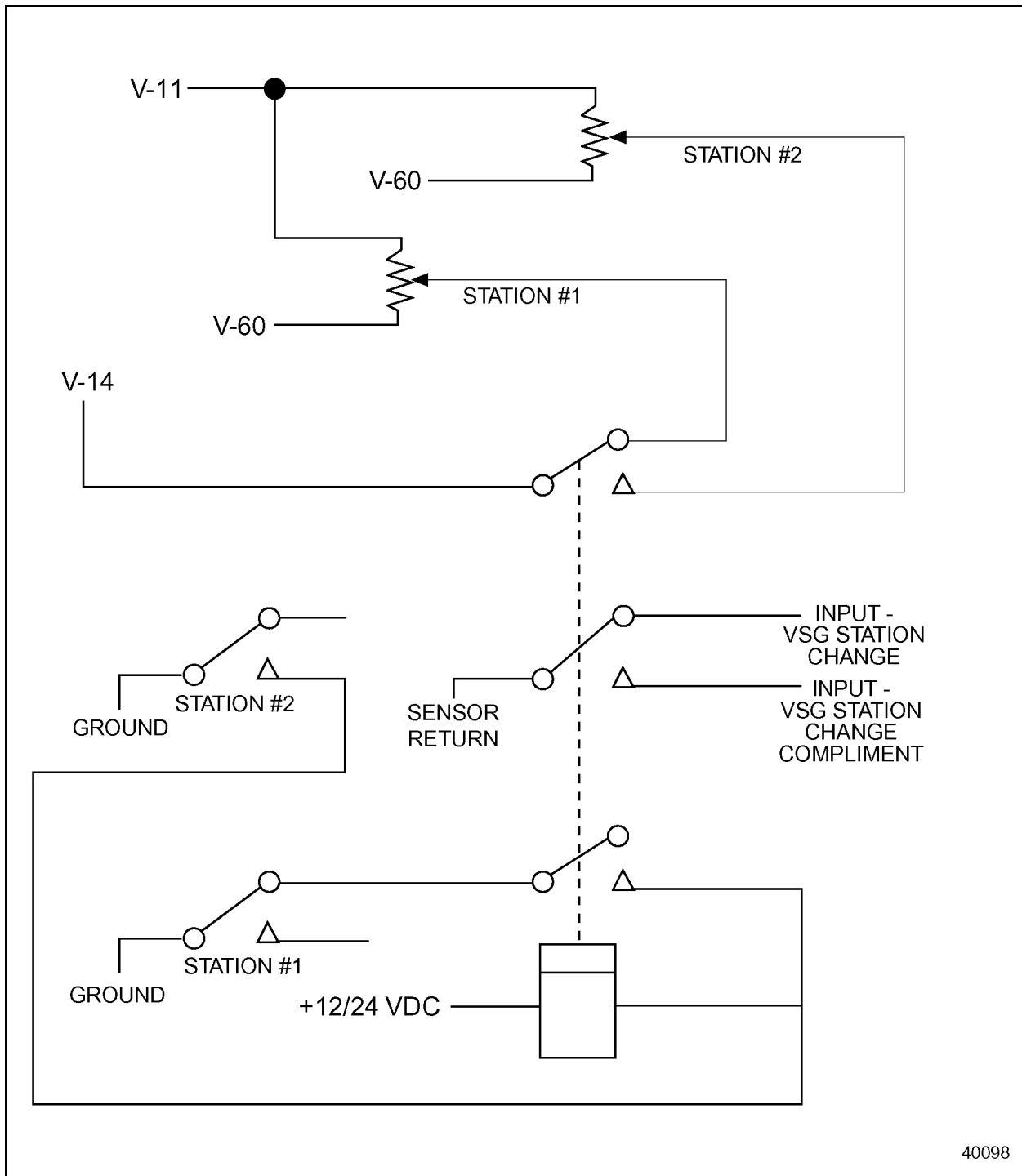


Figure 5-87 Dual Hand Throttle

Dual Throttle Controls Programming Requirements and Flexibility

The inputs listed in Table 5-107 can be set by order entry, VEPS or DRS.

Description	Config ID
VSG Station Change	4129
VSG Station Change Complement	4130

Table 5-107 Dual VSG, Throttle Control Inputs

Refer to section 4.1, Digital and Analog Inputs, for additional information.

VSG Dual Throttle Controls Diagnostics

If the two inputs (VSG Station Change and VSG Station Change Complement) are in the same state for two seconds, a fault (Flash code 11, PID 187 FMI 7) is logged. The engine will ramp to idle and neither station can control engine speed until the fault is inactive.

VSG Frequency Input

A frequency input can be used to control the VSG. This frequency is connected to the Vehicle Speed Input or the Frequency Input. The Frequency Input must be used for frequency control when vehicle speed is required in the application.

VSG Frequency Input Installation

The input, External Engine Synchronization (Config ID 4106), must be grounded for frequency control. See Figure 5-88.

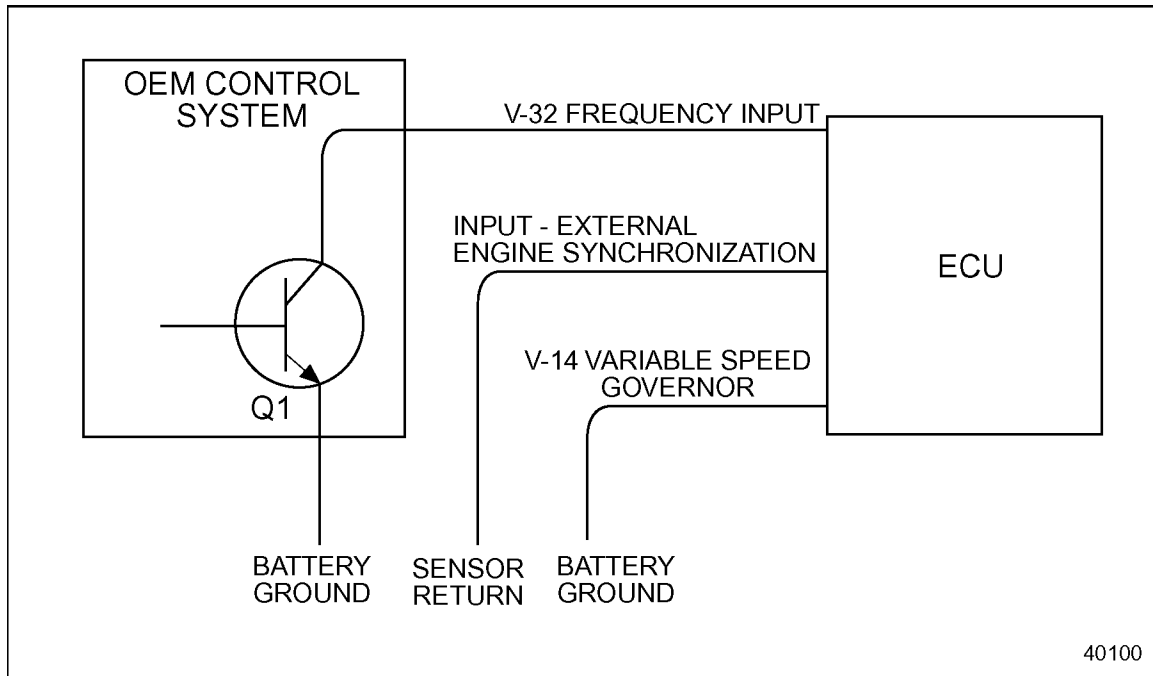


Figure 5-88 Frequency Input Diagram

VSG Frequency Input Programming Flexibility

The input "External Engine Synchronization" (config ID 4106) must be configured by engine order entry, VEPS or the DRS.

This feature must be enabled by the appropriate application code.

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5.26 TRANSMISSION INTERFACE

DDEC V communicates to transmissions using the following:

- ☐ Pulse Width Modulated Signal (PWM output)
- ☐ SAE J1587 Data Link
- ☐ SAE J1939 Powertrain Control Data Link
- ☐ Inputs/Digital Outputs

5.26.1 PWM OPERATION

The PWM port's output can be a 100 Hz modulated signal or a discrete on/off signal representing the powertrain demand with the corresponding duty cycle.

Powertrain demand is the ratio of operating torque over available torque at the current speed where operating torque:

- ☐ Includes torque generated by the driver (accelerator pedal)
- ☐ Includes torque generated by the Cruise Control Governor
- ☐ Includes torque reduction by the Vehicle Speed Governor
- ☐ Does not include torque generated by the Variable Speed Governor
- ☐ Does not include torque reduction due to emission control or engine protection
- ☐ Does not include torque generated by the Idle Governor
- ☐ Does not include torque reduction by the Rated Speed Governor

NOTE:

Percent load on the SAE J1587 Data Link (PID 92) is current torque over the maximum torque at current engine speed; includes all internal torque reductions and governors.

Modulated Signal

The PWM signal duty cycle range can cover 0-100% or be limited to 5-95% (representing full range). PWM sample duty cycles can be seen in the next three illustrations. See Figure 5-89 for a 10% duty cycle.

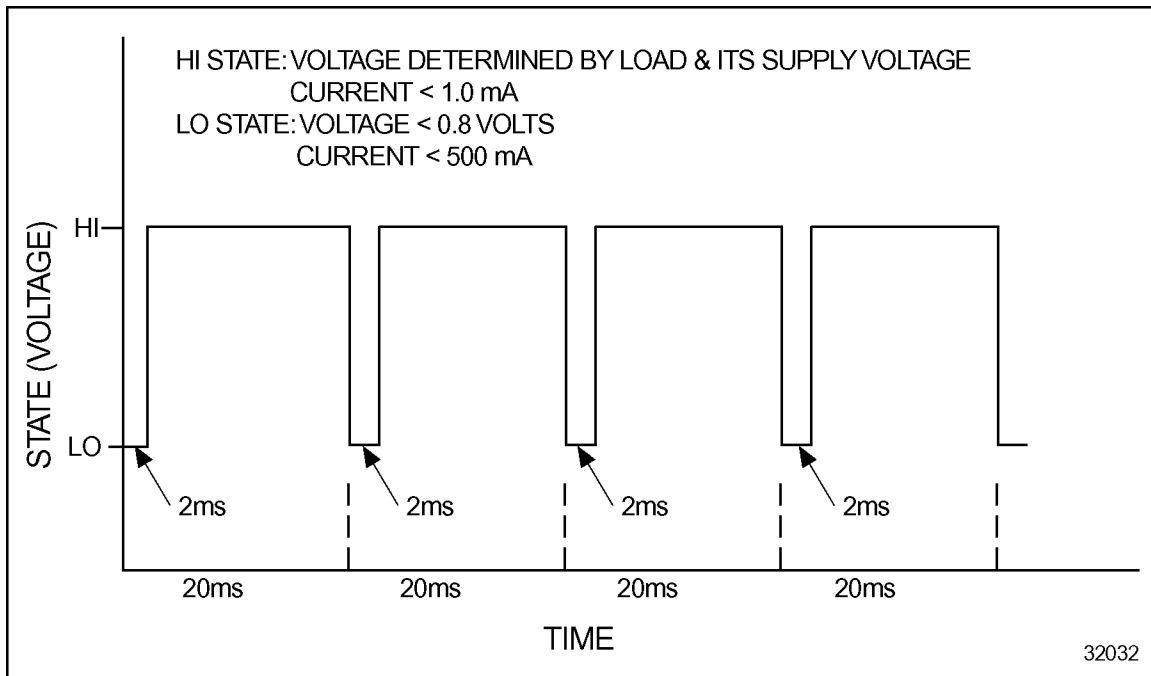


Figure 5-89 PWM Output - 10% Duty Cycle

See Figure 5-90 for a 50% duty cycle.

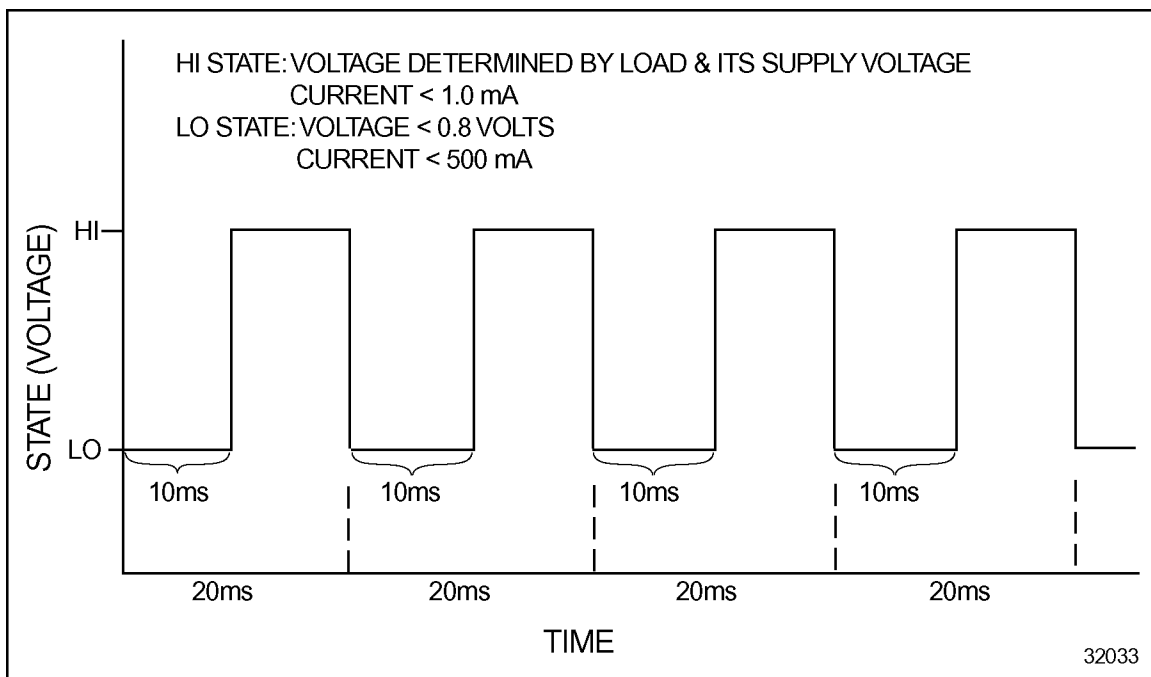


Figure 5-90 PWM Output - 50% Duty Cycle

See Figure 5-91 for a 90% duty cycle.

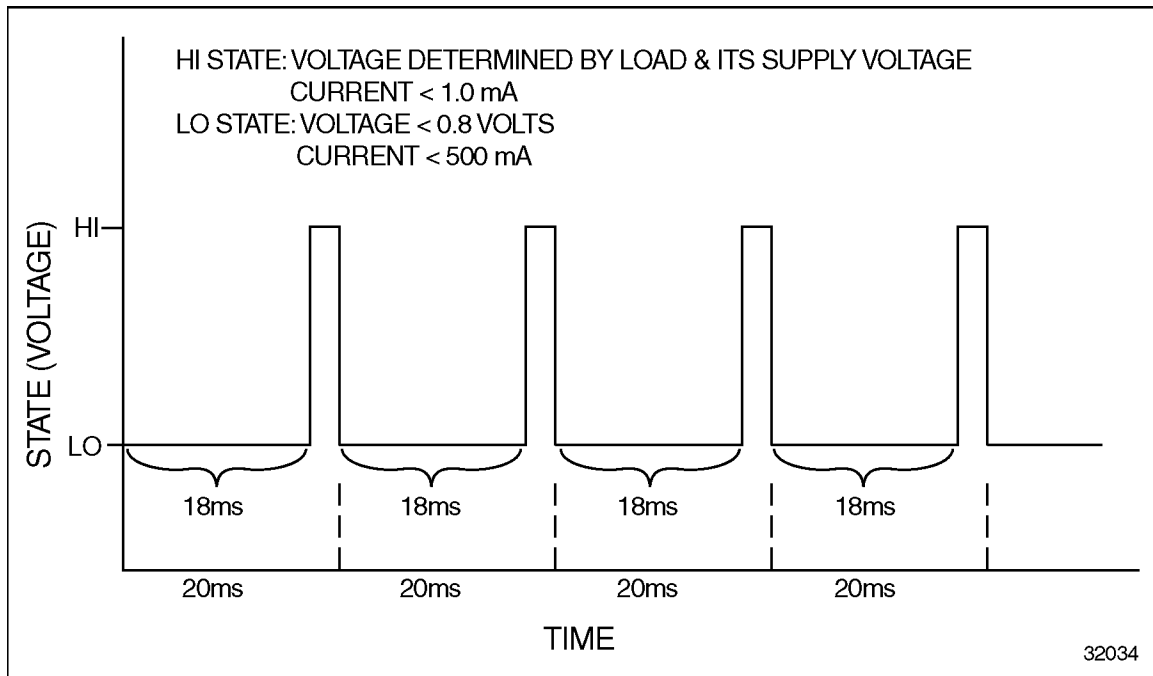


Figure 5-91 PWM Output - 90% Duty Cycle

Discrete On/Off signal

The PWM output can be used as a discrete on/off signal. The on trigger point and hysteresis are DDC calibrated parameters. The signal turns on (ground) once the powertrain demand reaches 80% and turns off (opens) once powertrain demand falls below 60%.

5.26.2 PWM INSTALLATION

The transmissions listed in Table 5-108 communicate with the ECU using a PWM output.

Transmission	ECU Communication	Information Sent	Duty Cycle	PWM Signal Description
Allison Hydraulic (refer to section 5.26.5)	PWM	Powertrain Demand	0-100%	Discrete
Allison Transmission Electronic Controls (ATEC) (refer to section 5.26.3)	PWM or J1939	Powertrain Demand	0-100%	Modulated
VOITH (refer to section 5.26.4)	PWM or SAE J1939 Data Link	Powertrain Demand	5-95%	Modulated
ZF Transmissions AVS™ or Ecomat™ (refer to section 5.26.4)	PWM or J1939	Powertrain Demand	5-95%	Modulated

Table 5-108 Transmissions Communicating with PWM

5.26.3 ALLISON INTERFACE MODULES

The Allison Throttle Interface Module (see Figure 5-92) translates the powertrain demand signal broadcast by the DDEC V ECU into a signal which is recognized by the transmission.

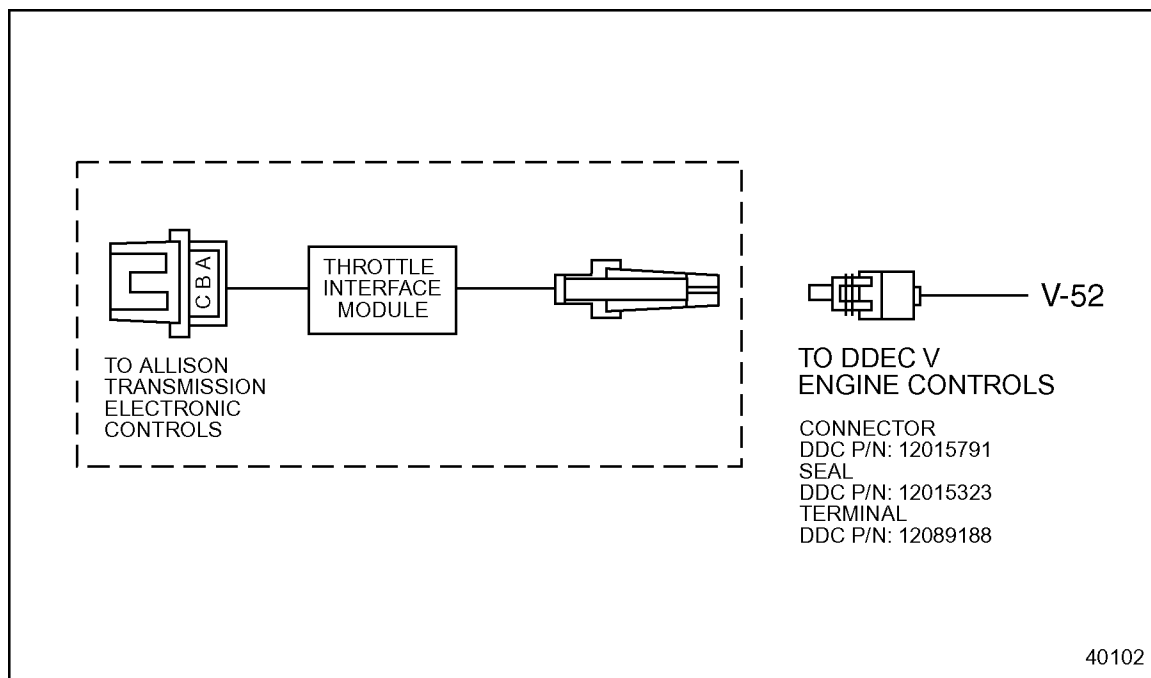


Figure 5-92 Throttle Interface Module, Allison Transmission®

The Allison Maximum Feature Interface Module translates the powertrain demand signal broadcast by the DDEC V ECU into a signal which is recognized by the transmission (see Figure 5-93).

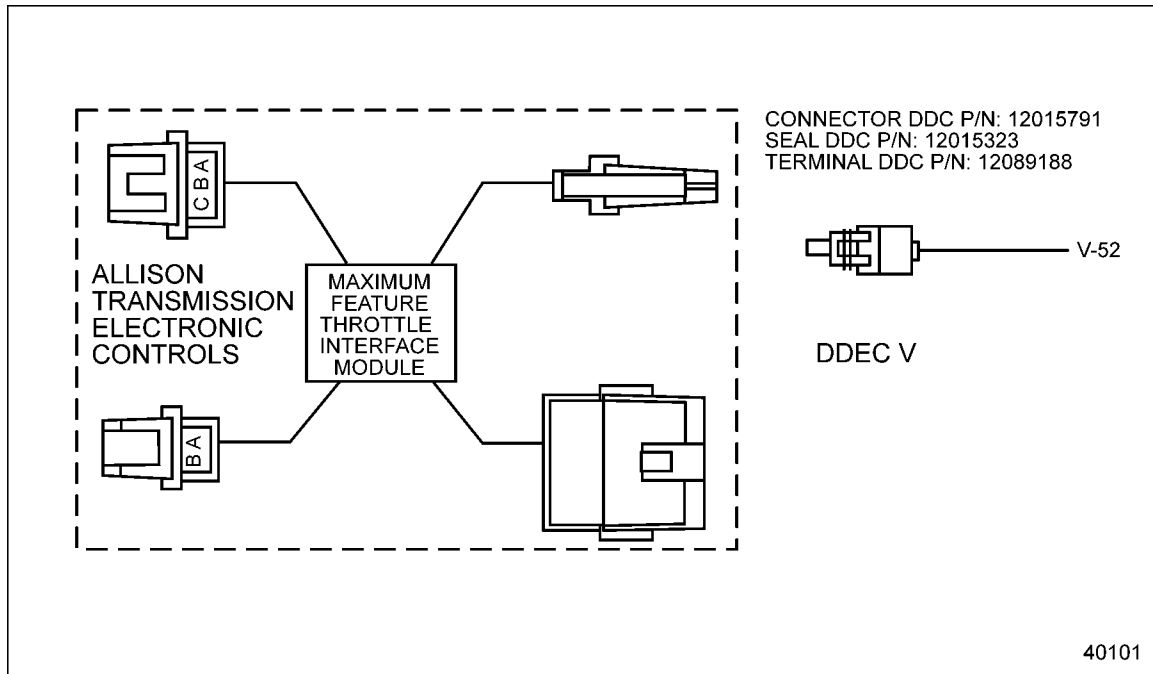


Figure 5-93 Maximum Feature Throttle Interface Module, Allison Transmission®

The module communicates the transmission output speed signal back to DDEC for use in Cruise Control/vehicle speed limiting. It also incorporates an integral engine speed switch which is sent to Allison Electronic Control as an input signal for the logic preventing shifting into a range above preset engine speeds. All Allison Electronic Control transmissions require this module or the throttle interface module when connected to DDEC V.

NOTE:

For Allison Transmission Electronic Controls refer to *Allison Automatic Transmissions General Book #1*, Page AS00-138, for World Transmission refer to *Allison Automatic Transmissions World Transmission WT Controls And General Information*, Page Sa07-040.

5.26.4 ZF ECOMAT AND VOITH TRANSMISSIONS

See Figure 5-94 for installation of the ZF Ecomat transmission interface.

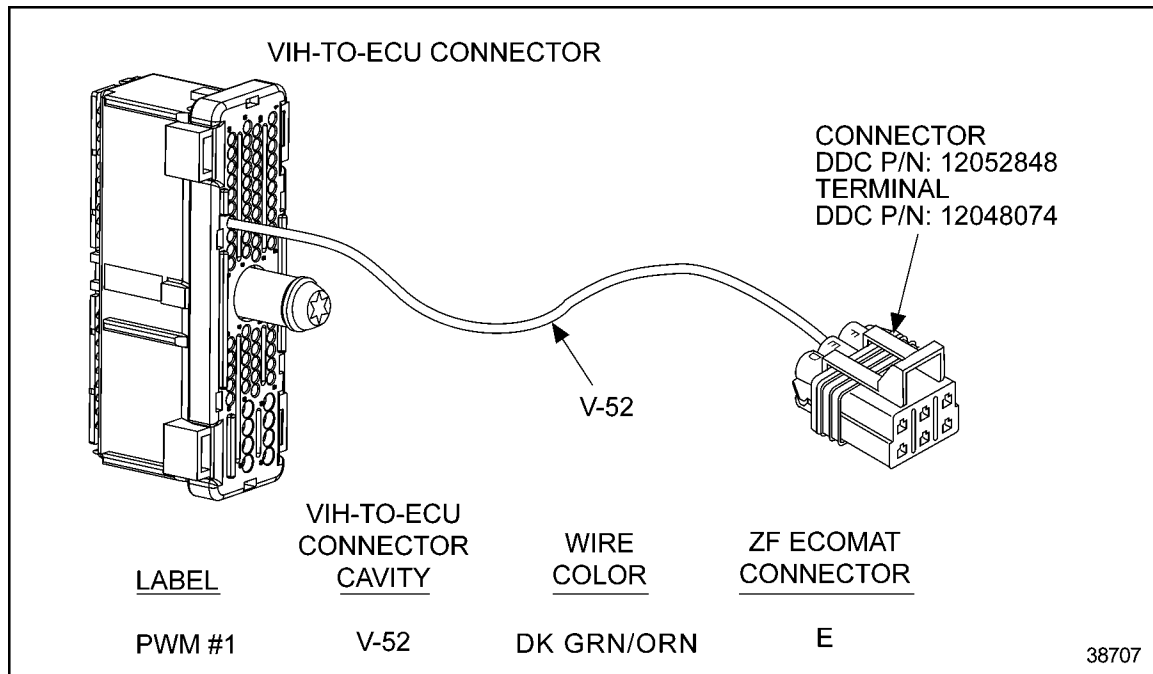


Figure 5-94 DDEC V to ZF Ecomat Transmission

See Figure 5-95 for installation of the Voith® transmission interface.

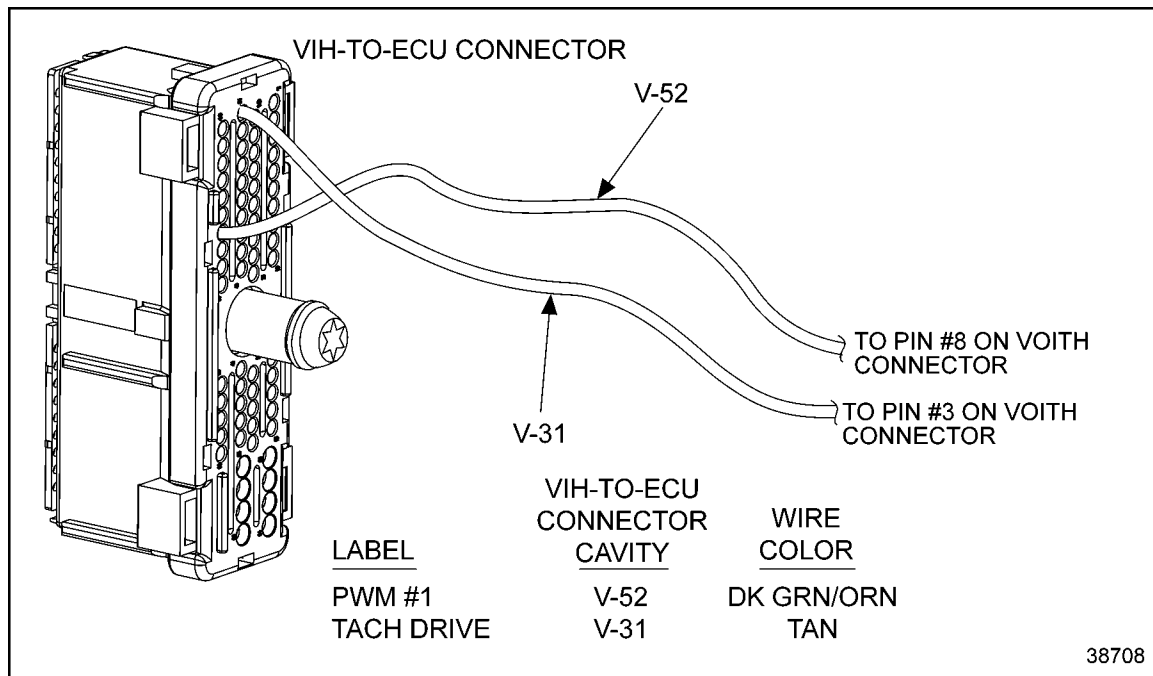


Figure 5-95 DDEC V to Voith® Transmission

5.26.5 ALLISON HYDRAULIC TRANSMISSION

See Figure 5-96 for a schematic of the Allison Hydraulic Transmission and DDEC V.

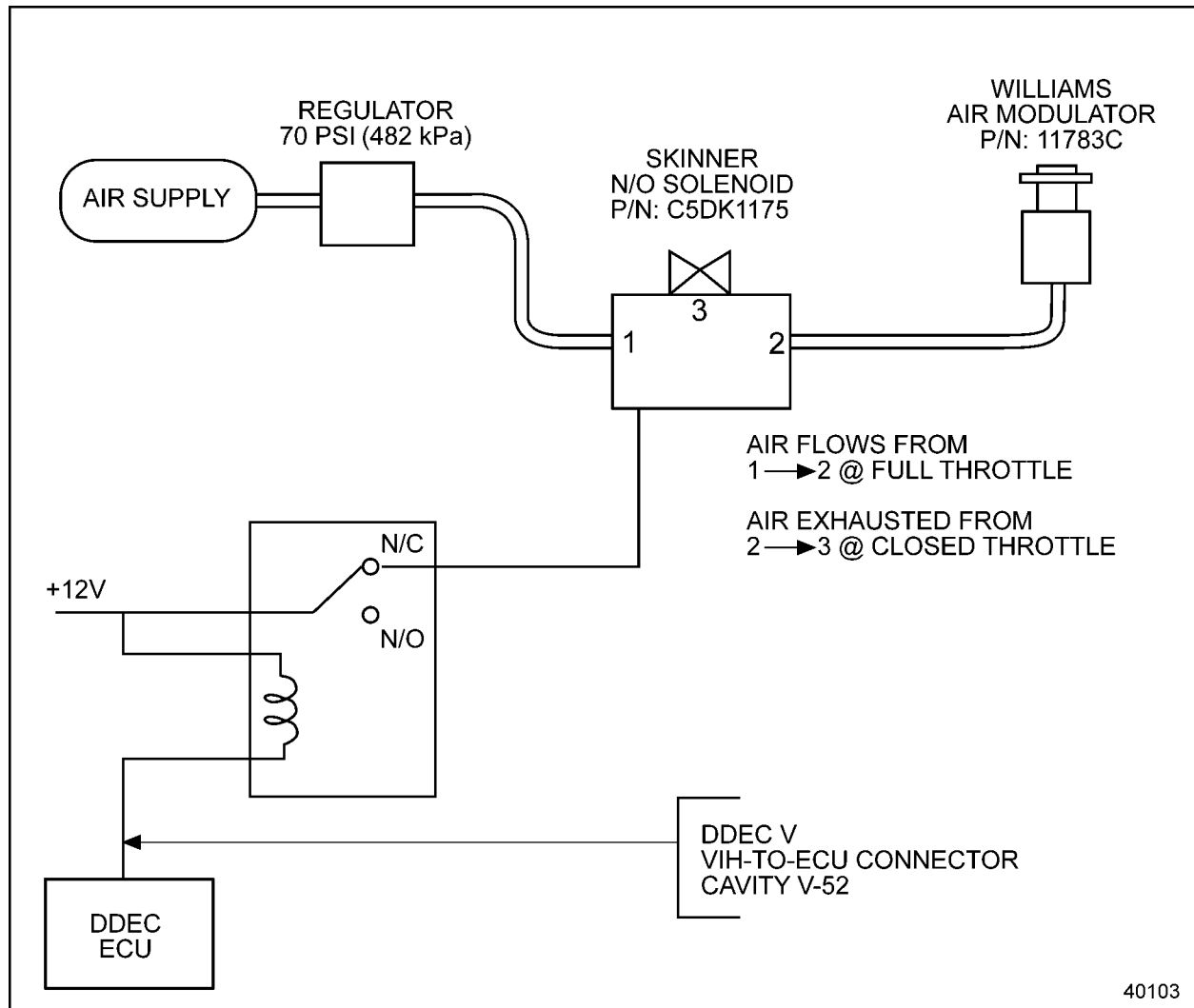


Figure 5-96 DDEC V to Allison Hydraulic Transmission

5.26.6 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The correct transmission type, listed in Table 5-109, must be programmed at engine order entry, by the Vehicle Electronic Programming System (VEPS), or the DDEC Reprogramming System (DRS).

Transmission	Transmission Type
Allison Hydraulic	1
Allison Transmission Electronic Controls (ATEC)	9
Voith	3
ZF Transmissions	4
% TPS Hydraulic	26

Table 5-109 Transmission Types

Transmission Type 1 – Allison Hydraulic– This selection identifies the transmission as a hydraulic Allison transmission. The PWM signal will be driven to 100% duty cycle above a predetermined throttle position (full power shifts) and will return to a 0% duty cycle below a predetermined throttle position. The maximum warm-up idle speed will be set to 800 rpm.

Transmission Type 3 – Voith– This selection identifies the transmission as a Voith electronic transmission. The PWM signal will be driven based on powertrain demand as a percentage of the maximum available torque at the current operating speed. The maximum warm-up idle speed will be set to 800 rpm.

Transmission Type 4 – Z-F Ecomat – This selection identifies the transmission as a Z-F electronic transmission. The PWM signal will be driven based on powertrain demand as a percentage of the maximum available torque at the current operating speed. The maximum warm-up idle speed will be set to 800 rpm.

Transmission Type 9 – Allison Electronic (ATEC)– This selection identifies the transmission as an Allison electronic first generation transmission. The PWM signal will be driven based on powertrain demand as a percentage of the maximum available torque at the current operating speed. This selection will also configure the Vehicle Speed Sensor input type the open-collector output that is generated internally by the Allison electronic module. The maximum warm-up idle speed will be set to 800 rpm.

Transmission Type 26 – %TPS Hydraulic – This selection is typically used to identify mechanical transmission such as the Allison Hydraulic that require a discrete signal. The PWM signal will be driven to 100% duty cycle above a predetermined throttle position (full power shifts) and will return to a 0% duty cycle below a predetermined throttle position. The maximum warm-up idle speed will be set to 700 rpm.

Transmission Type 32 – Optimum Load Curve– This selection is used with a GE AC power train system on electric mine haul trucks. PWM #1 will be configured to provide a signal that reflects if the engine is under loaded, overloaded or at optimum load throughout the engine RPM range. 5% duty cycle represents maximum overload, 50% is optimum load, and 95% is maximum under load.

There are two available PWM outputs (V-52 and V-46) on the VIH. One must be programmed for "PWM Transmission" as listed in Table 5-110.

Description	Type	Function Number
PWM Transmission	PWM Output	1

Table 5-110 PWM Transmission

DDEC uses the transmission output shaft speed to determine vehicle speed. Programming information is listed in Table 5-111.

Transmission	Sensor Type	DDEC V Cavity	Transmission Wire	DDEC V Calibration
Allison Transmission Electronic Controls	Open Collector	V-17	205	Open Collector
Allison Hydraulic	External Magnetic	V-17 V-18	--	--
ZF Ecomat™	Open Collector	V-17	714	Open Collector or Magnetic
Voith	Magnetic	V-17 V-18	pin 5 Blue wire pin 6 Brown wire	Magnetic

Table 5-111 VSS Information for Various Transmissions

For additional information on Vehicle Speed Sensors, refer to section 3.11.24.

5.26.7 COMMUNICATION LINKS OPERATION

The serial communication links SAE J1587 Data Link and SAE J1939 Data Link communicate control information from the engine to various vehicle systems such as transmissions. SAE J1587 Data Link defines the recommended format of messages and data being communicated between microprocessors used in heavy-duty vehicle applications. SAE J1939 Data Link transmits to the powertrain the messages assigned to both the engine and the transmission retarder.

5.26.8 COMMUNICATION LINKS INSTALLATION

The transmissions listed in Table 5-112 communicate with the ECU using the data links.

Transmission	ECU Communication
Allison World Transmission (refer to section 5.26.9)	SAE J1587 Data Link
Allison WTEC III	SAE J1939 Data Link & SAE J1587 Data Link
VOITH (refer to section 5.26.4)	PWM or SAE J1939 Data Link
SAE J1939 Data Link Transmissions (refer to section 5.26.10)	SAE J1939 Data Link
ZF Transmissions, AVS or Ecomat (refer to section 5.26.4)	SAE J1939 Data Link or PWM

Table 5-112 Transmissions Communicating with the Data Links

5.26.9 ALLISON WORLD TRANSMISSION

The Allison World Transmission Series utilizes the SAE J1587 Data Link to obtain transmission control information. See Figure 5-97 for installation instructions.

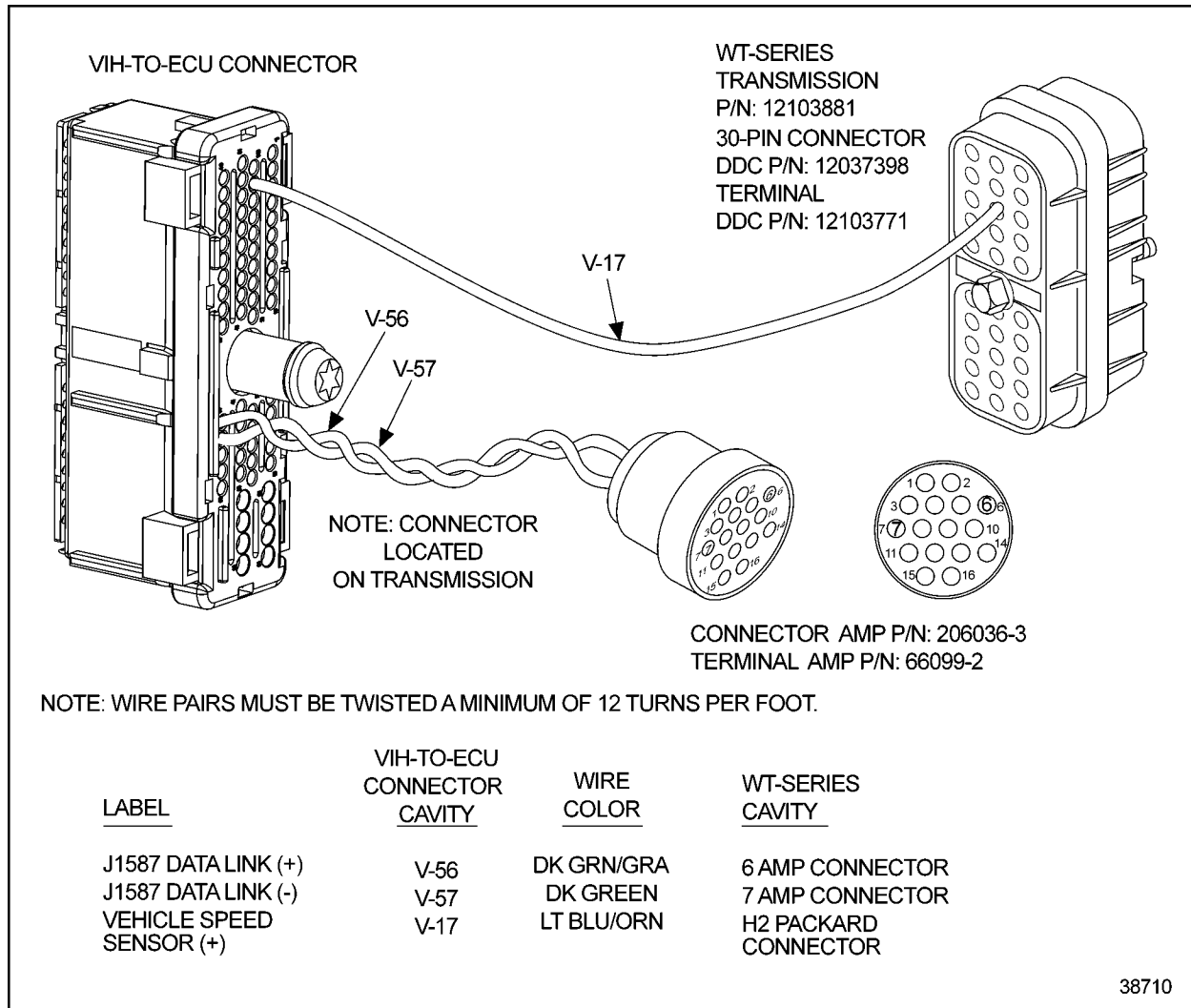


Figure 5-97 DDEC V to Allison WT-Series Transmission

DDEC V uses the open collector sensor type to integrate with the Allison Automatic Transmission to calculate vehicle speed (see Figure 5-98).

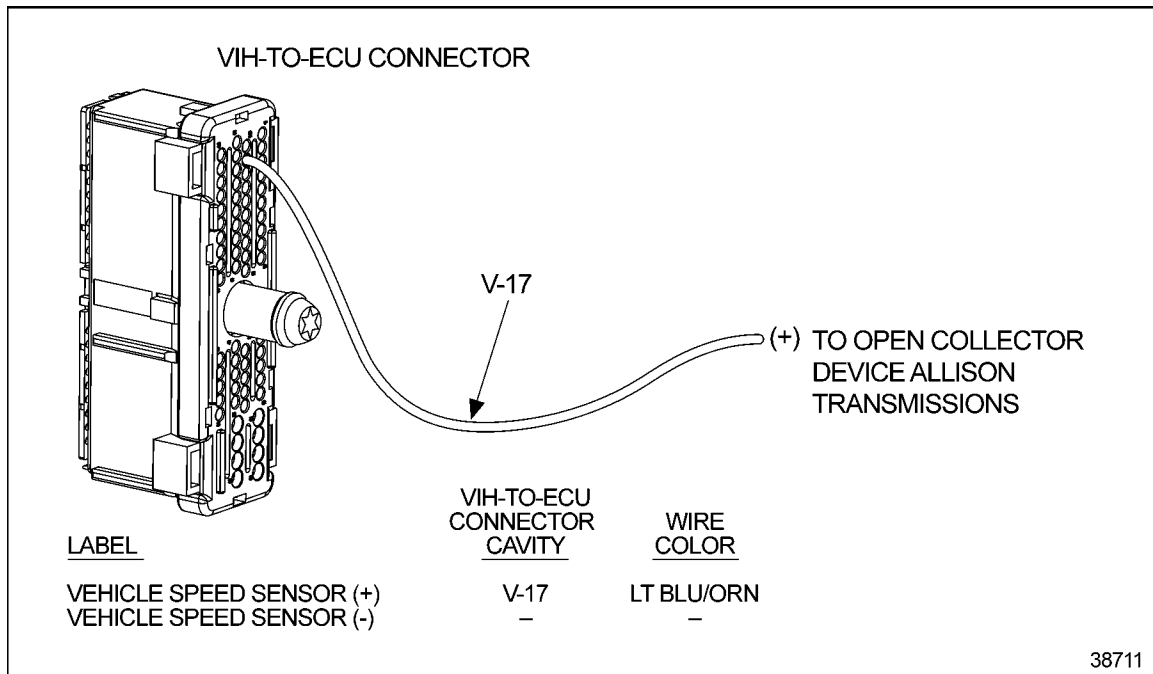


Figure 5-98 Allison Automatic Transmission Open Collector Speed Sensor

NOTE:

For Allison Transmission Electronic Controls refer to *Allison Automatic Transmissions General Book #1*, Page AS00-138, for world transmission refer to *Allison Automatic Transmissions World Transmission WT Controls And General Information*, Page Sa07-040.

5.26.10 SAE J1939 DATA LINK TRANSMISSIONS

The SAE J1939 Data Link powertrain control link is designed to communicate control information between the engine and the transmission.

5.26.11 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The correct transmission type, listed in Table 5-113, must be programmed at engine order entry, by the Vehicle Electronic Programming System (VEPS), or the DDEC Reprogramming System (DRS).

Transmission	Transmission Type
Allison World Transmission	12
Allison WTEC III	12 or 16
Voith	16 (for J1939 transmission)
SAE J1939 Data Link Transmissions	16
Eaton fuller Automatic	33

Table 5-113 Transmission Types

Transmission Type 12 – Allison WT – The Allison WT transmission uses the J1587 data link to determine current operating conditions. This selection is required to configure the Vehicle Speed Sensor input type to open-collector output that is generated internally by the Allison electronic module. The maximum warm-up idle speed will be set to 800 rpm.

Transmission Type 14 – Automatic – This selection identifies the transmission as an automatic transmission, other than those identified as Transmission Types 1, 4, 9, or 12. The maximum warm-up idle speed will be set to 700 rpm.

Transmission Type 16 – J1939 Transmission – This selection requires that the transmission provide output shaft speed via J1939 so a hard-wired Vehicle Speed Sensor is not required. However, the vehicle parameters (axle ratio, transmission ratio, and tire revs/mile) must be configured. The maximum warm-up idle speed will be set to 800 rpm.

Transmission Type 33– Eaton Fuller Automatic – This selection requires that the transmission provide output shaft speed via J1939 so a hard-wired Vehicle Speed Sensor is not required. However, the vehicle parameters (axle ratio, transmission ratio, and tire revs/mile) must be configured. The maximum warm-up idle speed will be set to 700 rpm.

5.26.12 DIGITAL INPUT AND DIGITAL OUTPUT TRANSMISSIONS

The transmissions supported by DDEC V that communicate using inputs and outputs are listed in Table 5-114.

Transmission	Transmission Models	ECU Communication
Eaton® Top2	RTLO-xx610B-T2 RTL-xx710B-T2 RTLO-xx713A-T2 RTLO-xx718B-T2	2 Digital Outputs

Table 5-114 Transmissions Communicating with Digital Inputs and Digital Outputs

5.26.13 EATON TOP2 OPERATION

The Top2 system automatically shifts between the top two gears of the Eaton Top2 Transmission to optimize drivetrain for best fuel economy or performance. Shifting between the two highest gears in the transmission is done by the ECU and requires no driver interaction. The system works with engine brakes and cruise control during automatic shifts. The torque demand from throttle or cruise control is smoothly ramped down before the shift and ramped up after the shift allowing the driver to maintain throttle position during shifts. Cruise Control is automatically resumed after the shift. When the transmission is shifted out of the two top gears, the driver has full manual control over the transmission. The engine will also detect skip shifts into the auto mode and still take control of the transmission's top two gears.

Installation

See Figure 5-99 to install Top2.

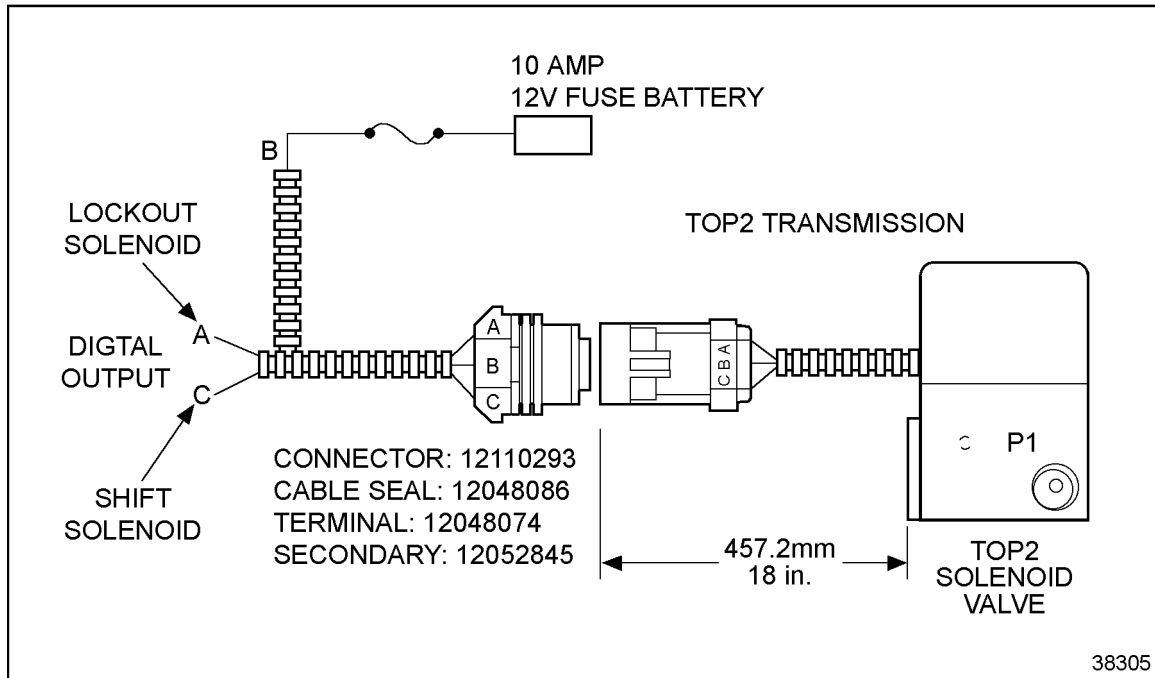


Figure 5-99 Top2 Transmission

Programming Requirements and Flexibility

The Top2 feature is enabled when the Top2 Shift Solenoid (function number 30) and the Top2 Lockout Solenoid (function number 31) digital outputs, listed in Table 5-115 are configured. The digital outputs must be configured at engine order entry, by the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS).

Description	Function Number
Top2 Shift Solenoid	30
Top2 Lockout Solenoid	31

Table 5-115 Digital Outputs Used by Top2

The two digital output functions, listed in Table 5-218, can be programmed on PWM outputs, if desired. They can be configured by order entry, VEPS, or DRS.

NOTE:

Program the outputs as either Digital Outputs or PWM Outputs, not both.

Description	Type	Function Number
Top2 Shift - Digital Output	PWM Output	7
Top2 Lockout - Digital Output	PWM Output	8

Table 5-116 Top2 Digital Outputs as PWM Outputs

Once Top2 is enabled, the logic will default to support the Super 10 Overdrive Transmission RTLO-xx610B-T2 unless one of the transmissions listed in Table 5-117 is selected.

Transmission Model	Transmission Type
RTLO-XX610B-T2	27
RTL-XX710B-T2	28
RTLO-XX713A-T2	29
RTLO-XX718B-T2	30

Table 5-117 Top2 Transmission Types

DRS, or VEPS allow you to enable/disable Top2 functionality as listed in Table 5-118. This allows the operator to disable Top2 by setting the Cruise Switch to OFF.

Parameter	Description	Choice
TOP2 CRUISE SW	If this option is set to ON, Top2 will be disabled when the Cruise Switch is in the OFF position. Top2 will be enabled when the Cruise Switch is in the ON position. If this option is set to OFF, Top2 will function normally and cannot be disabled by the Cruise Switch.	ON, OFF

Table 5-118 Top2 Reprogramming Choices

Diagnostics

If a fault is detected on either the shift solenoid or shift lockout digital output, the ECU will leave the transmission in manual mode until the fault is repaired. When there is a fault in any of the following sensors, the driver will be left with manual control of the transmission and the ECU will turn ON the AWL.

- ☐ Vehicle Speed Sensor (VSS)
- ☐ TRS/SRS (CKP/CMP) failure
- ☐ Lockout and shift solenoid failures

When there is a fault in any of the following features, the driver will be left with manual control of the transmission. The AWL will be turned ON for these conditions.

- ☐ Failed splitter engagements
- ☐ Failed splitter disengagements
- ☐ Failed synchronizing attempts (possible in-gear)

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5.27 TRANSMISSION RETARDER

A hydraulic transmission retarder is a device used to slow an engine by applying a torsional resistance to the engine output shaft. This resistance is achieved by the flow of hydraulic fluid against a rotating wheel, within an enclosed cavity. Energy is absorbed by the fluid, and is transferred as heat to an auxiliary cooler.

5.27.1 OPERATION

A digital output is switched to battery ground whenever the throttle is in the 0% position and Cruise Control is inactive. This signal, in conjunction with a relay, may be used to control a transmission retarder.

5.27.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The transmission retarder digital output listed in Table 5-119 may be configured by the Vehicle Electronic Programming System (VEPS), the DDEC Reprogramming System (DRS), or at engine order entry.

Description	Function Number
Transmission Retarder	9

Table 5-119 Transmission Retarder Digital Outputs

5.27.3 INTERACTION WITH OTHER FEATURES

A deceleration lamp can be used to warn that the vehicle is slowing down. A digital output (function number 15) is activated whenever the percent throttle is zero and Cruise Control is inactive. This output is typically used to drive a relay, which drives the deceleration lamps. Refer to section 4.2, "Digital Outputs" for additional information.

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5.28 TWO-SPEED AXLE

The Two-Speed Axle feature allows a digital input to be configured to switch between two axle ratios for calculation of vehicle speed.

5.28.1 OPERATION

When the digital input is open the first axle ratio will be used. When the switch is grounded, the second axle ratio will be used. The vehicle must be stopped before switching the axle ratios.

5.28.2 PROGRAMMING FLEXIBILITY & REQUIREMENTS

The digital input listed in Table 5-120 can be programmed at order entry, VEPS, or DRS.

Description	Config ID
Second Axle Ratio	4139

Table 5-120 Two-Speed Axle Digital Input

Both axle ratios listed in Table 5-121 must also be programmed with VEPS, DRS, DDR, or DDDL.

Parameter	Description	Choice/Display
Axle Ratio	Indicates the first axle ratio of the vehicle.	2.0 to 19.99
Second Axle Ratio	Indicates the second axle ratio of the vehicle.	2.0 to 19.99

Table 5-121 Programming the Axle Ratios

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5.29 VEHICLE SPEED LIMITING

The Vehicle Speed Limiting feature is available on all DDEC engines equipped with a Vehicle Speed Sensor.

5.29.1 OPERATION

Vehicle Speed Limiting discontinues engine fueling at any vehicle speed above the programmed limit.

5.29.2 INSTALLATION

An OEM supplied Vehicle Speed Sensor or output shaft speed over the SAE J1939 Data Link is required. Refer to section 3.11.24 for additional information.

5.29.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The Vehicle Limit Speed (VLS) is programmable at engine order entry or with Detroit Diesel Diagnostic Link, the Vehicle Electronic Programming System (VEPS) or the DDEC Reprogramming System (DRS) as listed in Table 5-122.

Parameter	Description	Choice / Display
VEHICLE LIMIT SPEED	Enables or disables Vehicle Speed Limiting feature.	YES, NO
SPEED LIMIT (MPH)	Sets the maximum vehicle speed in MPH.	20 MPH to (rated speed/VSS ratio)

Table 5-122 Vehicle Speed Limiting Parameters

5.29.4 INTERACTION WITH OTHER FEATURES

The Cruise Control maximum set speed cannot exceed the Vehicle Limit Speed. Fuel Economy Incentive or PasSmart will increase the Vehicle Limit Speed. When Vehicle Speed Limiting is enabled and a VSS code is logged, the engine speed in all gears will be limited for the duration of the ignition cycle to engine speed at the Vehicle Limit speed in top gear.

A vehicle can be set up with both PasSmart and Fuel Economy Incentive, but the extra speed increments provided by the two features do not add together. For example, if Fuel Economy Incentive is set up to give 7 MPH of extra speed when the driver hits the maximum fuel economy target and the PasSmart increase is 5 MPH the resulting speed increase is 7 MPH, not 12 MPH.

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5.30 VEHICLE SPEED SENSOR ANTI-TAMPERING

VSS Anti-tampering can be used to detect fixed frequency oscillators or devices which track engine RPM and produce fewer pulses per revolution than a VSS wheel. These devices are used to trick the ECU into believing that vehicle speed is low.

A VSS fault will be logged if the sensor appears to be working improperly but the vehicle speed is not zero. The engine speed in all gears will be limited for the duration of the ignition cycle to the engine speed at the Vehicle Speed Limit in top gear.

This feature should only be enabled on installations with manual transmissions where a Vehicle Speed Sensor is wired directly to DDEC.

NOTE:

Enabling VSS anti-tampering for use with SAE J1939, automatic, semi-automatic, or torque converter transmissions such as Eaton Top2 may cause false codes.

5.30.1 PROGRAMMING FLEXIBILITY

The DDR, DDDL, or the DRS can enable VSS anti-tampering. Vehicle Speed Limiting must also be enabled. The parameters are listed in Table 5-123.

Parameter	Description	Choice/Display
VSS Anti-tamper	Enables or Disables VSS Anti-tamper Feature	YES/NO
Vehicle Speed Limit Enable	Enables or Disables Vehicle Speed Limiting	YES/NO
Max Vehicle Speed	Sets the Max Vehicle Speed in MPH	20 MPH to (rated speed/VSS ratio)

Table 5-123 VSS Anti-tampering Parameters

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6 COMMUNICATION PROTOCOLS

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6.1 OVERVIEW

Key components of the DDEC V system are the serial communication links SAE J1587 and SAE J1939. Using these communication links allows DDEC V to offer the following functionality:

- Transmitting sensor information from the ECU via the data link at regular intervals and/or upon request to obtain data and to monitor for failures
- Sharing information between stand-alone modules used in the system via the data link
- Sharing engine data with electronic dashboard displays and vehicle management information systems via the data link
- Transmitting and performing diagnostic procedures from external instrumentation such as the hand-held diagnostic data readers or DDDL via the data link
- Transmitting customer requested changes to the ECU from external instrumentation via the data link
- Transmitting to the powertrain the messages assigned to both the engine and the transmission retarder.

The following industry standard Society of Automotive Engineers (SAE) documents can be used as a reference:

- SAE J1587, *Electronic Data Interchange Between Microcomputer Systems In Heavy Duty Vehicle Applications*
- SAE J1708, *Serial Data Communications Between Microcomputer Systems In Heavy Duty Vehicle Applications*
- SAE J1939/71, *Vehicle Application Layer*
- SAE J1939, *Top Layer (Overview)*
- SAE J1939/01, *Truck and Bus Applications*
- SAE J1939/11, *Physical Layer*
- SAE J1939/21, *Data Link Layer*
- SAE J1939/73, *Application Layer Diagnostics*

To obtain a copy of the above documents contact the Society of Automotive Engineers (SAE).

SAE International

400 Commonwealth Drive
Warrendale, PA 15096
Attention: Publications
Phone: (412) 776-4970
www.sae.org

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6.2 SAE J1587 DATA LINK

SAE RP J1587 defines the recommended format of messages and data being communicated between microprocessors used in heavy-duty vehicle applications. SAE J1587 Data Link + and SAE J1587 Data Link - as shown on the Vehicle Interface Harness schematic are used as the J1587 communication link. These circuits also exist in the DDEC nine-pin Diagnostic Connector, Cab for use with the diagnostic tools.

NOTE:

The maximum length for the SAE J1587 Data Link is 40 m (130 ft).

6.2.1 MESSAGE FORMAT

A complete description of the DDEC V parameters is provided within this section of the manual. DDEC V transmits parametric data at SAE J1587 recommended rates in packed message form. The first byte or character of each message is the Message Identification character (MID). The MID identifies which microcomputer on the serial communication link originated the information. Each device in the system originating messages must have a unique MID. The assignment of MIDs should be based on those listed in SAE RP J1587. The primary MID for DDEC V is 128.

The ProDriver display uses MID 171. Off-board diagnostic tools like hand-held readers should be identified by MID 172. Off-board programming stations like Vehicle Engine Programming Station (VEPS) should be identified by MID 182. Messages using MIDs as recommended by SAE RP J1587 will be responded to by the ECU.

Subsystems also require identifiers. The subsystem identifier character (SID) is a single byte character used to identify field-repairable or replaceable subsystems for which failures can be detected or isolated. SIDs are used in conjunction with SAE standard Diagnostic Trouble Codes defined in J1587 within PID 194.

The identifiers used by DDEC are defined and listed in Table 6-1.

Identifier	Description
Failure Mode Identifier (FMI)	The FMI describes the type of failure detected in the subsystem and identified by the PID or SID.
Message Identification Character (MID)	The MID is the first byte or character of each message that identifies which microcomputer on DDEC SAE J1587 DL serial communication link originated the information.
Parameter Identification Character (PID)	A PID is a single byte character used in DDEC SAE J1587 DL messages to identify the data byte(s) that follow. PIDs identify the parameters transmitted.
Subsystem Identification Character (SID)	A SID is a single byte character used to identify field-repairable or replaceable subsystems for which failures can be detected or isolated.

Table 6-1 Identifiers Used by DDEC

6.2.2 SAE J1708/J1587 MESSAGE PRIORITY

Each message sent by DDEC is assigned a priority on a scale of 1 to 8, in compliance with the message priority assignment specified in SAE RP J1708. The most critical message has a priority of one. The message assignments are listed in Table 6-2. All devices transmitting messages across DDEC's SAE J1708/J1587 Data Link must be prioritized and transmitted in this manner.

Priority	Description
1 and 2	Reserved for messages that require immediate access to the bus.
3 and 4	Reserved for messages that require prompt access to the bus in order to prevent severe mechanical damage.
5 and 6	Reserved for messages that directly affect the economical or efficient operation of the vehicle.
7 and 8	All other messages not fitting into the previous priority categories.

Table 6-2 Message Priority Assignments

SAE J1587 Parameters Available with DDEC V

DDEC V supports the J1587 parameter identifiers (PIDs) listed in Table 6-3.

NOTE:

Data is transmitted only if the source has been configured for the engine.

PID	Description	PID	Description
147	Average Fuel Economy — Natural Gas	249	Total Engine Revolution
148	Instantaneous Fuel Economy — Natural Gas	250	Total Fuel Used
149	Mass Flow Rate — Natural Gas	251	Clock
229	Total Fuel Used — Natural Gas	252	Date
230	Total Idle Fuel Used — Natural Gas	351	Turbo Compressor Inlet Temperature
231	Trip Fuel — Natural Gas	354	Relative Humidity
243	Device Identification	404	Turbo Compressor Out Temperature
244	Trip Miles	411	EGR Differential Pressure
245	Total Miles	412	EGR Temperature
247	Total Engine Hours	439	Extended Range Boost Pressure
248	Total VSG Hours		

Table 6-3 SAE J1587 PIDs Provided by DDEC V

PID	Description	PID	Description
18	Extended Range Fuel Pressure	109	Coolant Pressure
19	Extended Range Oil Pressure	110	Coolant Temperature
20	Extended Range Coolant Pressure	111	Coolant Level
21	Engine ECU Temperature	113	Engine Governor Droop
44	Attention/Warning Indicator Lamps Status	121	Engine Retarder Status
48	Extended Range Barometric Pressure	122	Engine Retarder Percent
51	Throttle Position	153	High Range Crankcase Pressure
52	Engine Intercooler Temperature	154	Auxiliary Input & Output Status #2
62	Retarder Inhibit Status	155	Auxiliary Input & Output Status #1
65	Service Brake Switch Status	—	—
68	Torque Limiting Factor	—	—
69	Two-speed Axle Switch Status	—	—
70	Parking Brake Switch Status	164	Injection Control Pressure
71	Idle Shutdown Timer Status	166	Rated Engine Power
72	Blower Bypass Valve Position/Blower Bypass Door Position	168	Battery Potential (Voltage)
73	Auxiliary Water Pump Pressure	171	Ambient Air Temperature
74	Vehicle Speed Set Limit	172	Air Inlet Temperature
81	Exhaust Back Pressure	173	Exhaust Temperature
83	Vehicle Speed Limit Status	174	Fuel Temperature
84	Vehicle Speed	175	Engine Oil Temperature
85	Cruise Control Switch Status	182	Trip Fuel
86	Cruise Control Set Speed	183	Fuel Rate
87	Cruise Control High Limit	184	Instantaneous Fuel Economy, (mile/gal)
88	Cruise Control Low Limit	185	Average Fuel Economy, (mile/gal)
89	VSG Switch Status	187	PTO Set Speed
91	Percent Throttle	188	Idle Engine Speed
92	Percent Engine Load	189	Rated Engine Speed
93	Output Torque	190	Engine Speed
94	Fuel Delivery Pressure	—	—
95	Fuel Filter Differential Pressure	192	Multi-sectioned Parameter
98	Engine Oil Level	194	Transmitter System Diagnostic Code and Occurrence Count Table
99	Oil Filter Differential Pressure	196	Diagnostic Data/Count Clear Response
100	Engine Oil Pressure	222	Anti-Theft
101	Crankcase Pressure	228	Speed Sensor Calibration
102	Turbo Boost Pressure	233	Unit Number
103	Turbo Speed	234	Software Identification
105	Intake Manifold Temperature	235	Total Idle Hours
106	Air Inlet Pressure	236	Total Idle Fuel Used
107	Air Filter Differential Pressure	237	Vehicle Identification Number (VIN)
108	Barometric Pressure	240	Last Customer Calibration Change Hours

Table 6-4 SAE J1587 PIDs Provided by DDEC V (continued)

6.2.3 SAE J1587 PIDS REQUIRING DDEC ACTION

DDEC will respond to data requests per the J1587 PID requests shown in the next sections.

Data Request

The format for a data request is shown below.

PID	Data
0	a
	a - Parameter number of the requested parameter

Component Specific Request

The format for a component specific request is shown below.

PID	Data
128	a b
	a - Parameter number of the requested parameter
	b - MID of the component from which the parameter data is requested

NOTE:

DDEC responds with the appropriate data provided the MID in byte (b) matches the MID stored in calibration. The primary MID for DDEC V is 128. Engines with 12 and 16 cylinders use MID 128 and MID 175. Engines with 20 or 24 cylinders use MID 128, MID 175 and MID 183.

Retarder Status Request

Electronic transmissions may indicate the status of the transmission output retarder to DDEC by using the following message:

PID	Data
47	a
	a - Transmission output retarder status
	Bits 1-2 Output retarder status
00 = off	10 = error
01 = on	10 = error
	Bits 3-8 Reserved, Bits set to 1

Transmitter Data Request / Clear Count

The format for a transmitter data request is shown below.

PID	Data
195	n a b c n - Number of parameter data characters = 3 a - MID of the device to which the request is directed b - SID or PID of a standard diagnostic code c - Diagnostic code number
Bits:1 - 4	Failure mode identifier (FMI) of a standard diagnostic code
Bit:5	Byte (b) identifier 1 - Byte (b) is a Subsystem Identifier (SID) 0 - Byte (b) is a Parameter Identifier (PID)
Bit:6	Type of diagnostic code 1 - Standard diagnostic code 0 - Reserved for expansion diagnostic codes
Bit:7, 8	00-- Request an ASCII descriptive message for the given diagnostic code. 01 - Request count be cleared for the given diagnostic code on the device with the given MID. 10 - Request counts be cleared for all diagnostic codes on the device with the given MID. The diagnostic code given in this transmission is ignored. 11 - Request additional diagnostic information for the given diagnostic code, the content of which is defined under PID 196.

NOTE:

DDEC responds with the appropriate data using PID 196.

source: ECU calculated; outputs represent intended state

PID 256 (255 0) Page 2 Data Request

The format for Page 2 data requests is shown below.

PID	Data
0	a a - Parameter number of the requested parameter from Page 2

J1587 Outputs - Single Byte Parameters

PID 18 - Extended Range Fuel Pressure

update rate: 1 time/s
resolution: 4 kPa/Bit (Uns/SI)
source: Fuel Pressure Sensor
comments: This PID is used to provide a wider range of pressure values than that provided with PID 94.

PID 19 - Extended Range Engine Oil Pressure

update rate: 1 time/s
resolution: 4 kPa/Bit (Uns/SI)
source: Engine Oil Pressure Sensor
sensor range: 0 to 145 psi
comments: This PID is used to provide a wider range of pressure values than that provided with PID 100.

PID 20 - Extended Range Coolant Pressure

update rate: 1 time/s
resolution: 2 kPa/Bit (Uns/SI)
source: Coolant Pressure Sensor
comments: This PID is used to provide a wider range of pressure values than that provided with PID 109.

PID 21 - Engine ECU Temperature

update rate: 1 time/s
resolution: 2.5°F/Bit (S/SI)

PID 44 - Attention/Warning Indicator Lamps Status

update rate: 1 time/s or 10
time/s when
changing

format:

Bit: 1,2	Red Stop Lamp Status
	00 - off
	01 - on
	10 - error
	11 - Not Available
Bit: 3,4	Amber Warning Lamp Status
	00 - off
	01 - on
	10 - error
	11 - Not Available
Bit: 5-8	Reserved, All Bits set to 1

PID 48 - Extended Range Barometric Pressure

update rate: 1 time/s

resolution: 0.6 kPa/Bit (Uns/SI)

source: Barometric Pressure Sensor or Turbo Boost Pressure Sensor

PID 51 - Throttle Position

update rate: 5 time/s

resolution: 0.4%/Bit (Uns/SI)

source: Throttle Position Sensor

comments: This parameter identifies the position of the value used to regulate the supply of a fluid, usually air or fuel/air mixture, to an engine - 0% represents no supply.

PID 52 - Engine Intercooler Temperature

update rate: 1 time/s

resolution: 1°F/Bit (Uns/SI)

source: Engine Intercooler Temperature Sensor

PID 62 - Retarder Inhibit Status

update rate: On request
 format:
 Bits: 1, 2 Retarder Inhibit Status
 00 - Off (not Inhibited)
 01 - On (Inhibited)
 Bits: 3-8 Uncommitted, all Bits set to 1
 source: Digital output for Engine Brake Enable
 comments: Used with the Engine Brake outputs.

PID 65 - Service Brake Status

update rate: 1 time/s
 format:
 Bits: 1, 2 Service Brake Status
 00 - off
 01 - on
 Bits: 3-8 Uncommitted, all Bits set to 1
 Bits 3-8 = 1
 source: Service Brake Switch

PID 68 - Torque Limiting Factor

update rate: 1 time/s
 resolution: 0.5%/Bit (Uns/SI)
 source: ECU calculated.
 comments: This parameter indicates the amount of engine protection torque reduction that is in effect.

PID 69- Two-Speed Axle Switch Status

update rate: 1 time/s
 format:
 Bits: 8 Two-Speed Axle Switch
 0 - off
 1 - on
 Bits: 1-7 All Bits set to 0

PID 70 - Parking Brake Switch Status

update rate: 1 time/s
 format:
 Bits: 8 Parking Brake Switch Status
 0 - off
 1 - on
 Bits: 1-7 Uncommitted, all Bits set to 0
 source: Parking Brake Switch

PID 71 - Idle Shutdown Timer Status

update rate: 1 time/s

format:

Bit: 1	Idle Shutdown Override ("Driver Alert") 1 - Active
Bit: 2	Engine Has Shutdown by Idle Timer to 1 - Yes
Bit: 3	Idle Timer Shutdown Override 1 - Active (Idle Shutdown has been overridden)
Bit: 4	Idle shutdown timer function 1 - Enabled in calibration 0 - Disabled in calibration
Bit: 8	Idle Shutdown Timer Status 1 - Active
Bits: 5-7	All Bits set to 0

source: ECU calculated

PID 72 - Blower Bypass Valve Position

update rate: 2 times/s

resolution: 0.4%/Bit (Uns/SI)

source: Blower Bypass Valve Position sensor

comments: Electronically controlled blower bypass valves are used on Methanol engines.

PID 73 - Auxiliary Water Pump Pressure

update rate: 1 time/s

resolution: 2 psi/Bit (Uns/SI)

source: Water Pump Pressure Sensor

comments: The auxiliary Water Pump Pressure system is used on fire trucks with DDEC pressure control. The transmitted value is gage pressure.

PID 74 - Vehicle Speed Set Limit (Road Speed Limiting)

update rate: On request only

resolution: 0.5 mph/Bit (Uns/SI)

source: Calibration value (customer defined)

comments: Vehicle Speed Limiting is a customer option.

PID 81 — Exhaust Back Pressure

update rate: 1 time/sec.

resolution: 0.169 kPa/Bit (Uns/SI)

comments: Update rate is different than that specified by SAE (every 10 sec)

PID 83 - Vehicle Speed Limit Status

update rate: 1 time/s

format:

Bit: 8	Vehicle Speed Status
	1 - Active
Bits: 1-7	All Bits set to 0

source: ECU calculated

comments: Vehicle Speed Limiting is a customer option.

PID 84 - Speed

update rate: 10 times/s

resolution: 0.5 mph/Bit (Uns/SI)

source: Vehicle Speed Sensor input

comments: Transmitted only if the Vehicle Speed Sensor is configured.

PID 85 - Cruise Control Switch Status

update rate: 10 times/s

format:

	On/Off Switch
Bit: 1	1-On 0-Off
	Set Switch
Bit: 2	1-Off 0-On
	Coast Switch
Bit: 3	1-Off 0-On
	Resume Switch
Bit: 4	1-Off 0-On
	Accel Switch
Bit: 5	1-Off 0-On
	Brake Switch
Bit: 6	1-Off 0-On
	Clutch Switch
Bit: 7	1-Off 0-On
	Cruise Active
Bit: 8	1-On 0-Off

source: Cruise Control switch inputs

comments: Cruise Control status (Bit 8) is not cleared if Cruise Control is active but being overridden by the throttle.

PID 86 - Cruise Control Set Speed

update rate: 0.1 times/s, 5 times/s when the set speed is changing

resolution: 0.5 mph/Bit (Uns/SI)

source: Cruise Control switch inputs

comments: Transmitted if Vehicle Speed Cruise control is enabled.

PID 87 - Cruise Control High Set Limit

update rate: On request only

resolution: 0.5 mph/Bit (Uns/SI)

source: Calibration value (customer define)

comments: Transmitted if Vehicle Speed Cruise control is enabled.

PID 88 - Cruise Control Low Set Limit

update rate: On request only
resolution: 0.5 mph/Bit (Uns/SI)
source: Calibration value
comments: Transmitted if Vehicle Speed Cruise control is enabled.

PID 89 - VSG Switch Status

update rate: 1 time/s
format:

Bit: 1	On/off switch 0-Off 1-On
Bit: 2	Set switch 0-Off 1-On
Bit: 3	Coast switch 0-Off 1-On
Bit: 4	Resume switch 0-Off 1-On
Bit: 5	Accel switch 0-Off 1-On
Bit: 6	Brake 0-Off 1-On
Bit: 7	Clutch 0-Off 1-On
Bit: 8	VSG 0-Off 1-On

source: VSG switch inputs/ECU calculated

comments: Transmitted when either the Pressure Sensor Governor, Cruise-Switch VSG or analog VSG is configured.

PID 91 - Percent Throttle

update rate: 10 times/s
resolution: 0.4%/Bit (Uns/SI)
source: Throttle Sensor input

PID 92 - Percent Engine Load

update rate: 10 times/s
resolution: 0.5%/Bit (Uns/SI)
source: ECU calculated
comments: Percent engine load is the ratio of actual torque and the minimum of the requested torque and digital torque limit.

PID 93 - Output Torque

update rate: 1 time/s
resolution: 20 ft-lb/Bit (S/SI)
source: ECU calculated

PID 94 - Fuel Delivery Pressure

update rate: 1 time/s
resolution: 0.5 psi/Bit (Uns/SI)
source: Fuel Pressure Sensor

PID 95 - Fuel Filter Differential Pressure

update rate: 0.1 time/s
resolution: 0.25 psi/Bit (Uns/SI)
source: Fuel Filter Differential Pressure Sensor

PID 98 - Engine Oil Level

update rate: 0.1 time/s
resolution: 0.5%/Bit (Uns/SI)
source: Oil Level Sensor

PID 99 - Oil Filter Differential Pressure

update rate: 0.1 time/s
resolution: 0.0625 psi/Bit (Uns/SI)
source: Oil Filter Differential Pressure Sensor

PID 100 - Engine Oil Pressure

update rate: 1 time/s
resolution: 0.5 psi/Bit (Uns/SI)
source: Oil pressure sensor
sensor range: 0 to 65 psi

PID 101 - Crankcase Pressure

update rate: 1 time/s
 resolution: 0.125 psi/Bit (S/SI)
 source: Crankcase pressure sensor
 comments: Some engine applications use a discrete switch in place of a full range sensor. In these applications, the crankcase pressure data transmitted on the J1587 data link is not a true representation of crankcase pressure.

PID 102 - Turbo Boost Pressure (Gage)

update rate: 2 times/s
 resolution: 0.125 psi/Bit (Uns/SI)
 source: Turbo Boost Pressure Sensor
 comments: Update rate is different that that specified by SAE (1 time/sec)

PID 103 - Turbo Speed

update rate: 1 time/s
 resolution: 500 rpm/Bit (Uns/SI)
 source: Turbo Speed Sensor

PID 105 - Intake Manifold Temperature

update rate: 1 time/s
 resolution: 1°F/Bit (Uns/SI)
 source: Intake Manifold Temperature Sensor

PID 106 - Air Inlet Pressure

update rate: 1 time/s
 resolution: 0.25 psi/bit (Uns/SI)

PID 107 - Air Filter Differential Pressure

update rate: 0.1 time/s
 resolution: 0.2 in.H₂O/Bit (Uns/SI)
 source: Air Filter Differential Pressure Sensor

PID 108 - Barometric Pressure

update rate: 1 time/s
 resolution: 0.0625 psi/Bit (Uns/SI)
 source: Barometric Pressure Sensor or ECU calculated

PID 109 - Coolant Pressure

update rate: 1 time/s
 resolution: 0.125 psi/Bit (Uns/SI)
 source: Coolant Pressure Sensor

PID 110 - Coolant Temperature

update rate: 1 time/s
 resolution: 1°F/Bit (Uns/SI)
 source: Coolant Temperature Sensor
 sensor range: 0 to 300 F

PID 111 - Coolant Level

update rate: 10 times/s
 resolution: 0.5%/Bit (Uns/SI) (or full = 100%, low = 0%)
 source: Coolant Level Sensor
 comments: If the Add Coolant Level Sensor (ACLS) is installed with the Engine Protection Coolant Level Sensor (CLS), the coolant level will be:
 100% When both sensors are in coolant
 50% When the ACLS is out of the coolant
 0% When both sensors are out of the coolant
 If only the CLS is configured:
 100% Full
 0% Low

PID 113 - Engine Governor Droop

update rate: On request only
 resolution: 2 rpm/Bit (Uns/SI)
 source: Calibration value

PID 121 - Engine Retarder Status

update rate: 1 time/s (5 times/s when changing)
 format:
 Bit: 1 1 - 2 cylinders active
 Bit: 2 1 - 3 cylinders active
 Bit: 3 1 - 4 cylinders active
 Bit: 4 1 - 6 cylinders active
 Bit: 5 1 - 8 cylinders active
 Bit: 8 1 - Retarder active
 comments: Transmitted only if engine brakes are configured.

PID 122 - Engine Retarder Percent

update rate: 1 time/s
 resolution: 0.5%Bit (Uns/SI)
 source: ECU calculated

PID 351 (255 95) - Turbo Compressor Inlet Temperature

update rate: 1 time/s

resolution: 1°F/Bit (Uns/SI)

PID 354 (255 98) - Relative Humidity

update rate: 10 time/s

resolution: 0.4%Bit (Uns/SI)

PID 355 (255 99) - Engine Oil Life

update rate: On Request

resolution: 0.4%Bit (Uns/SI)

Double Byte Parameters

PID 147 - Average Fuel Economy — Natural Gas

update rate: every 10 seconds
resolution: 1/512 km/kg per bit (Uns/I)

PID 148 - Instantaneous Fuel Economy — Natural Gas

update rate: 5 times/s
resolution: 1/512 km/kg per bit (Uns/I)

PID 149 - Fuel Mass Flow Rate — Natural Gas

update rate: 5 times/s
resolution: 0.125 kg/hr per bit (Uns/I)

PID 153 - Crankcase Pressure

update rate: 1 time/s
resolution: 0.0078125 kPa/Bit (S/I)
comments: Some engine applications use a discrete switch in place of a full range sensor. In these applications, the crankcase pressure data transmitted on the J1587 data link is not a true representation of crankcase pressure. This PID is used to provide crankcase pressure with better resolution than that provided with PID 101.

PID 154 - Auxiliary Input and Output status #2

update rate: On request

format:

PID Data

154 a b

- a - Auxiliary Input Status
 - Bit: 1, 2 Torque/RPM Limiting Switch
 - 00 - Off
 - 01 - On
 - 10 - Error Condition
 - 11 - Not Available
 - Bit: 4-3 Stop Engine Override Switch
 - 00 - Off
 - 01 - On
 - 10 - Error Condition
 - 11 - Not Available
 - Bit: 5, 6 A/C Disengaged
 - 00 - Off
 - 01 - On
 - 10 - Error Condition
 - 11 - Not Available
 - Bit: 8-7 Reserved
- b - Auxiliary Output Status
 - Bit: 1, 2 Fan Control #2
 - 00 - Off
 - 01 - On
 - 10 - Error Condition
 - 11 - Not Available
 - Bit: 3, 4 Reserved
 - Bit: 5, 6 Reserved
 - Bit: 7, 8 Reserved

source: ECU calculated; outputs represent intended state

PID 155 - Auxiliary Input and Output status #1

update rate: On request

format:

PID Data

154 a b

a -

Auxiliary Input Status

Bit:1, 2 Jake Brake Low Switch

00 - Off

01 - On

10 - Error Condition

11 - Not Available

Bit: 3, 4 Jake Brake Medium Switch

00 - Off

01 - On

10 - Error Condition

11 - Not Available

Bit: 5, 6 Idle Validation Switch

00 - Off

01 - On

10 - Error Condition

11 - Not Available

Bit: 7, 8 Throttle Inhibit Switch

00 - Off

01 - On

10 - Error Condition

11 - Not Available

b -

Auxiliary Output Status

Bit: 1, 2 Vehicle Power Shutdown

00 - Off

01 - On

10 - Error Condition

11 - Not Available

Bit: 3, 4 Starter Lockout

00 - Off

01 - On

10 - Error Condition

11 - Not Available

Bit: 5, 6 Coolant Level Low Light

00 - Off

01 - On

10 - Error Condition

11 - Not Available

Bit: 7, 8 Fan Control #1

00 - Off
 01 - On
 10 - Error Condition
 11 - Not Available

source: ECU calculated; outputs represent intended state

PID 164 - Injection Control Pressure

update rate: 1 time/s
 resolution: 1/256 MPa (Uns/I)
 source: Injection Pressure Sensor

PID 166 - Engine Horsepower Rating

update rate: On request only
 resolution: 1 bhp/Bit (Uns/I)
 source: Calibration value

PID 168 - Battery Voltage

update rate: 1 time/s
 resolution: 0.05 volts/Bit (Uns/I)
 source: Battery voltage measured at input to ECU
 comments: The ECU input battery voltage does fluctuate as injectors fire and will require filtering if used for display purposes.

PID 171 - Ambient Air Temperature

update rate: 1 time/s
 resolution: 0.25°F/Bit (S/I)
 source: ECU estimated

PID 172 - Air Inlet Temperature

update rate: 1 time/s
 resolution: 0.25°F/Bit (S/I)
 source: Air Temperature Sensor
 sensor range: -40 to 175°F

PID 173 — Exhaust Temperature

update rate: 1 time/sec
 resolution: 0.25°F/Bit (S/I)

PID 174 - Fuel Temperature

update rate: 1 time/s
resolution: 0.25°F/Bit (S/I)
source: Fuel Temperature Sensor
sensor range: -40 to 175°F

PID 175 - Engine Oil Temperature

update rate: 1 time/s
resolution: 0.25°F/Bit (S/I)
source: Oil temperature sensor
sensor range: -40 to 300°F

PID 182 - Trip Fuel

update rate: 0.1 times/s
resolution: 0.125 gal/Bit (Uns/I)
source: ECU calculated

PID 183 - Fuel Rate

update rate: 5 times/s
resolution: 1/64 gal/hour/Bit (Uns/I)
source: ECU calculated

PID 184 - Instantaneous Fuel Economy (MPG)

update rate: 5 times/s
resolution: 1/256 mpg/Bit (Uns/I)
source: ECU calculated
comments: Transmitted only if the Vehicle Speed Sensor is configured.

PID 185 - Average Fuel Economy (MPG)

update rate: 0.1 times/s
resolution: 1/256 mpg/Bit (Uns/I)
source: ECU calculated
comments: Trip information from DDEC requires that the Vehicle Speed Sensor is enabled.

PID 187 - VSG Set Speed

update rate: 0.1 times/s, 5 times per s when the set speed is changing
resolution: 0.25 rpm/Bit (Uns/I)
source: VSG switch input
comments: Used to indicate the current set speed from:

- ☐ Analog VSG
- ☐ Cruise Switch VSG
- ☐ Engine Speed Cruise Control
- ☐ Pressure Governor Mode - RPM or pressure
- ☐ Engine Sync. Mode (marine applications)

PID 188 - Idle Set Speed

update rate: On request only
resolution: 0.25 rpm/Bit (Uns/I)
source: Calibration value

PID 189 - Rated Engine Speed

update rate: On request only
resolution: 0.25 rpm/Bit (Uns/I)
source: Calibration value

PID 190 - Engine Speed

update rate: 10 times/s
resolution: 0.25 rpm/Bit (Uns/I)
source: ECU calculated

PID 404 (255 148) - Turbo Compressor Out Temperature

update rate: 1 times/s
resolution: 0.25°F/Bit (S/I)

PID 411 (255 155) - EGR Delta Pressure

update rate: 1 time/s
resolution: 0.0078125 kPa/Bit (S/I)

PID 412 (255 156) - EGR Temperature

update rate: 1 time/s
resolution: 0.25°F/Bit (S/I)

PID 439 (255 183) - Extended Range Boost Pressure

update rate: 1 time/s
resolution: 0.125 kPa/bit (Uns/I)

Variable Length Parameters

PID 192 - Multi-Section Parameter

update rate: Used to transmit messages that are greater than 21 bytes in length.

format:

PID	Data
192	n a b c/d c c c c c
	Byte count of data that follows this character. This excludes
n -	characters MID, PID 192 and n but it includes a, b, c, or d type character.
a -	PID specifying the parameter that has been sectioned.
	The last section number (total number of sections minus ONE) and the current section number. The upper nibble contains the
b -	current section number (1 to 15). The lower nibble contains the current section number and is limited to the range 0 to 15. Section numbers are assigned in ascending order.
	Data portion of the sectioned parameter. May be 1 to 14
c -	characters in the first packet. May be 1 to 15 characters in the middle and ending packets.
	Byte count of the total data portion. This character is sent only
d -	in the first packet. The values are limited to 239 or less but must be greater than 17.

comment: PID 192 is used to section any DDEC message that exceeds 21 bytes while the engine is running, in particular PID 194, PID 196, and PID 243. If the engine is stopped, DDEC may transmit messages up to 40 bytes in length.

PID 194 - Transmitter System Diagnostic Code / Occurrence Count Table

update rate: On Request only

format:

PID Data

194 n a b c a b c a b c a b c...

n - Byte count of data that follows this character. This excludes characters MID, PID 194 and n but includes a, b, c type characters.

a - SID or PID of a standard diagnostic code.

b - Diagnostic code character

Bits: 1-4 FMI of a standard diagnostic code

Bit: 5 Byte (a) Identifier

1 - Byte (a) is a SID

0 - Byte (a) is a PID

Bit: 6 Type of Diagnostic Code

1 - standard diagnostic code

0 - expansion diagnostic codes (PID/SID from page 2)

Bit: 7 Current Status of Fault

1 - fault is inactive

0 - fault is active

Bit: 8 Occurrence count

1 - count is included

0 - count is not included

c - Occurrence count for the diagnostic code defined by the preceding 2 characters. The maximum occurrence count is 255. Bit 8 of byte (b) of the diagnostic code is used to determine if it is included.

source: ECU calculated

comment: comments: Diagnostic codes are transmitted periodically while active. When the active code becomes inactive, the code is transmitted once to indicate that the fault became inactive. Inactive diagnostic codes are available by request of PID 194. If more than 6 codes are active at any point, PID 194 is sectioned as described in PID 192.

PID 196 - Diagnostic Data/count clear response

update rate: On Request only

format:

PID	Data
196	n a b c c c c c

Byte count of data that follows this character. This excludes characters MID, PID 194 and n but includes a, b, and c type characters.

a - SID or PID of a standard diagnostic code

b - Diagnostic Code Character

Bits 1-4 - FMI of a standard diagnostic code

Bit 5 - Byte (a) identifier

1 - Byte (a) is a SID

0 - Byte (a) is a PID

Bit 6 - Type of diagnostic code

1 - standard diagnostic code

0 - expansion diagnostic codes (PID/SID from page 2)

Bit 7-8 - Action

- Message is an ASCII descriptive message for the given diagnostic code.

01 - The count has been cleared for the given diagnostic code.

10 - All clearable diagnostic counts have been cleared for this device.

- Message is additional diagnostic information for the given diagnostic code, as defined below.

c = Additional information (if applicable)

c1-c5 - ATA/VMRS (DTDSC)

c6, c7 - Engine hours the code was first logged (LSB first)
format: 1 h/Bit.

range - 0-65535 hours.

c8, c9 - Calendar date (Month, Day) the code was first logged, if available.

c10, c11 - Clock time the code was first logged (hours, minutes), if available.

c12, c13 - Engine hours the code last became active (LSB first).

c14, c15 - Calendar date (Month, Day) the code last became active, if available.

c16, c17 - Clock time the code last became active (hours, minutes), if available.

PID 196 - Diagnostic Data/count clear response

update rate: On Request only

format:

PID Data

- c18, c19 - Number of ss the code has been active (LSB first).
format: ss = 1 s/Bit
range = 0-65535 (18.2 hours)
Value remains at 65535 ss once it has been reached.
- c20 - Number of Stop Engine Override Switch restarts while the code was active. The value remains at 255 once it has been reached.
- c21+ = Optional associated parameter value (scaled as defined in J1587)
For temperatures, pressures, and voltages with FMI 0 - Highest value achieved
For temperatures, pressures, and voltages with FMI 1 - Lowest value achieved
For engine speed with FMI 0 - Highest speed achieved
For vehicle speed with FMI 0 or 11 - Highest speed achieved

Last byte = checksum

source: ECU calculated

comment: The date and time that the code last became inactive (bytes c14-c17) will be transmitted as zero if the code is currently active. This data may be sectioned using PID 192.

PID 228- Speed Sensor Calibration

update rate: On Request only

format:

PID Data

228 n a a a a

n = number of bytes: 4

a = Speed Sensor Calibration 1 pulse/mi (Uns/LI)

source: Calculated from calibration values

PID 229- Total Fuel — Natural Gas

update rate: On Request

format:

PID Data

229 n a a a a

n = number of bytes: 4

a = total fuel used

resolution: 0.5 kg per bit (Uns/LI)

PID 230- Total Idle Fuel Used — Natural Gas

update rate: On Request

format:

PID Data

230 n a a a a

n = number of bytes: 4

a = total fuel used

resolution: 0.5 kg per bit (Uns/LI)

PID 231- Trip Fuel — Natural Gas

update rate: Every 10 seconds

format:

PID Data

231 n a a a a

n = number of bytes: 4

a = trip fuel

resolution: 0.5 kg per bit (Uns/LI)

PID 233- Unit Number (Power Unit)

update rate: On Request only

format:

PID Data

231 n a a a . . .

n = number of bytes: 10

a = unit number in alphanumeric ASCII characters

PID 234- Software Identification

update rate: On Request only

format:

PID Data

234 n a a b c c

n = number of bytes: 5

a = Major software release level in ASCII

b = ASCII "."

b = Minor software release level in ASCII

Example: "01.05" is interpreted as Major release 1, Minor release 5

source: ECU calculated

PID 235- Total Idle Hours

update rate: On Request only

format:

PID Data

235 n a a a a

n = number of bytes: 4

a = Total idle hours; scaled 0.05 hours/Bit (Uns/LI)

source: ECU calculated

comment: Accumulates time while the engine is operating at idle.

PID 236- Total Idle Fuel Used

update rate: On Request only

format:

PID Data

236 n a a a a

n = number of bytes: 4

a = Idle fuel used; scaled 1/8 gallons/Bit (Uns/LI)

source: ECU calculated

comment: Accumulates while the engine is operating at idle.

PID 237- Vehicle Identification Number (VIN)

update rate: On Request only

format:

PID Data

237 n a a a ...

n = number of bytes: up to 17

a = VIN in ASCII characters

source: Calibration value

PID 240- Last Customer Calibration Change Hours

update rate: On Request only

format:

PID Data

240 n a a a a

n = number of bytes: 4

a = Last customer calibration change hours; scaled 0.05 h/Bit (Uns/LI)

source: ECU calculated

comment: Used to identify the last customer reprogramming occurrence, stored in engine hours.

PID 243- Device Identification

update rate: On Request only

format:

PID	Data
243	n a b b b b c d d d d d d d e f f f f f f f f f f
	n = number of bytes: 26
	a = component ID = MID
	b = ATA/VMRS manufacturer ID (5 bytes)
	c = delimiter: ASCII '*'
	d = engine model number (8 bytes)
	e = delimiter: ASCII '*'
	f = engine serial number (10 bytes)

source: Calibration value

comment: This parameter may be sectioned using PID 192.

PID 244- Trip Miles

update rate: 0.1 times/s

format:

PID	Data
244	n a a a a
	n = number of bytes: 4
	a = trip miles 0.1 mile/Bit (Uns/LI)

source: ECU calculated

comment: Transmitted only if the vehicle speed sensor is configured.

PID 245- Total Miles

update rate: 0.1 times/s

format:

PID	Data
245	n a a a a
	n = number of bytes: 4
	a = total miles, 0.1 mile/Bit (Uns/LI)

source: ECU calculated

comment: Transmitted only if the vehicle speed sensor is configured.

PID 247- Total Engine Hours

update rate: On request only

format:

PID Data

247 n a a a a

n = number of bytes: 4

a = total engine hours 0.05 hour/Bit (Uns/LI)

source: ECU calculated

comment: Used to identify the total hours that the engine is operating. Time accumulated while the engine speed is above 60 rpm.

PID 248- Total VSG Hours

update rate: On request only

format:

PID Data

248 n a a a a

n = number of bytes: 4

b = total VSG hours 0.05 hour/Bit (Uns/LI)

source: ECU calculated

comment: Used to identify total engine hours the engine is operating in the following modes:

-Hand throttle VSG

-High idle using cruise switches

-Pressure governor mode: either RPM or pressure

PID 249- Total Engine Revolutions

update rate: On request only

format:

PID Data

249 n a a a a

n = number of bytes: 4

a = total engine revolutions 1000 revolutions/Bit (Uns/SI)

PID 250- Total Fuel Used

update rate: On request only

format:

PID Data

250 n a a a a

n = number of bytes: 4

a = total fuel used 0.125 gal/Bit (Uns/LI)

source: ECU calculated

PID 251- Clock

update rate: On request only

format:

PID Data

251 n a b c

n = number of bytes: 3

a = Seconds 0.25 sec/Bit, range 0 to 59.75 seconds

b = Minutes 1.0 min/Bit, range 0 to 59 minutes

c = Hours 1.00 hour/Bit, range 0 to 23 hours

comment: Transmitted if clock data is considered valid. The time is broadcast in Greenwich Mean Time.

PID 252- Date

update rate: On request only

format:

PID Data

252 n a b c

n = number of bytes: 3

a = Day 0.25 day/Bit, range 1 to 31.75 days

b = Month 1.0 month/Bit, range 1 to 12 months

c = Year - 1985 1.00 year/Bit, range 0 to 99

comment: Day of the month is scaled such that 0 is a null value, values 1, 2, 3, and 4 are the first day of the month, 5, 6, 7, 8, are the second day of the month, etc. Transmitted if clock data is considered valid.

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6.3 SAE J1939 DATA LINK

SAE J1939 DL +, SAE J1939 DL -, and SAE J1939 DL SHLD as shown on the VIH schematic are used as the J1939 communication link. See Figure 6-1. The SAE J1939 wiring must follow the SAE J1939 wiring guidelines including termination resistors. The maximum length of this data link is 130 feet (40 m).

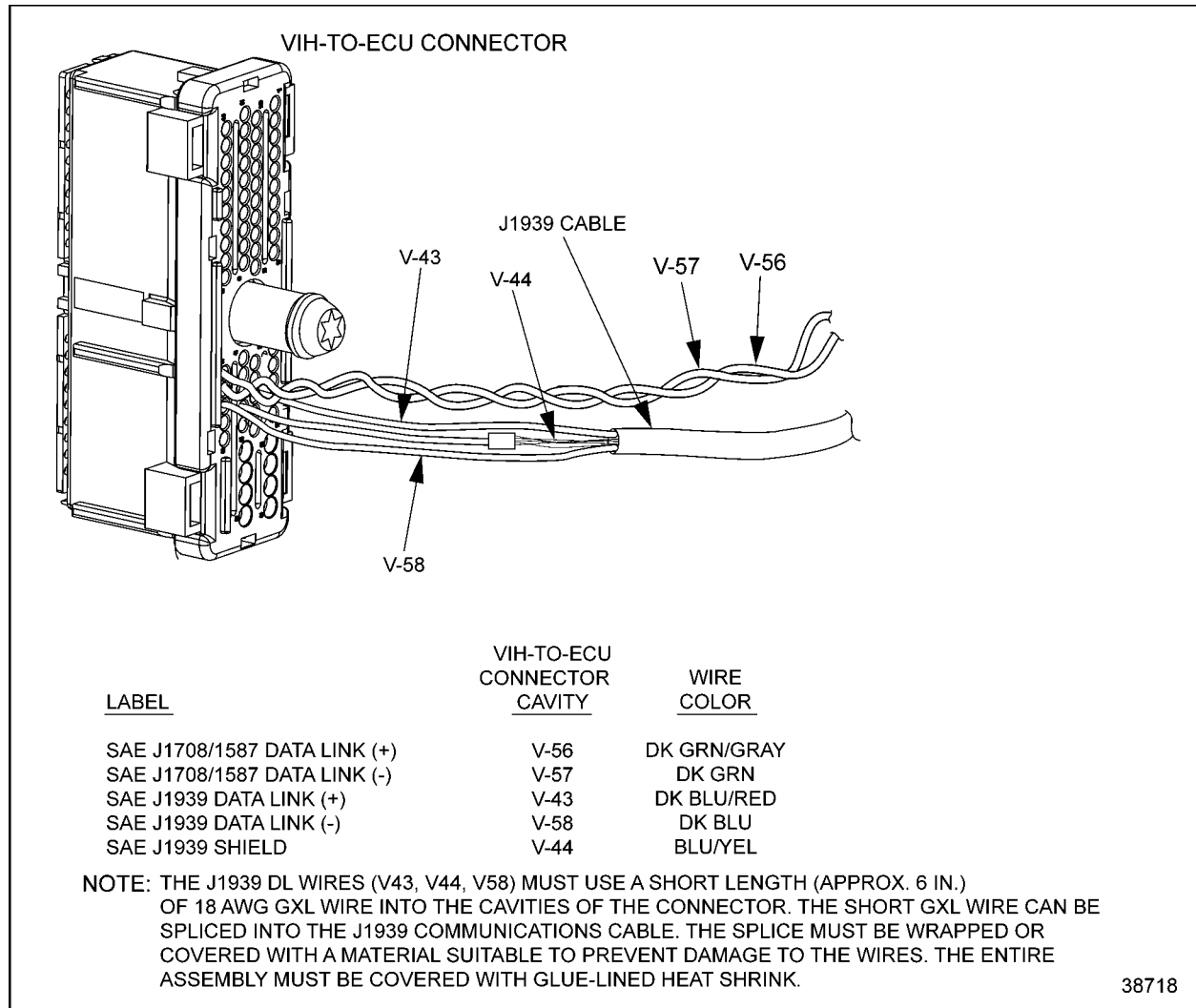


Figure 6-1 Communication Wiring

6.3.1 MESSAGE FORMAT

The message format uses the parameter group number as the label for a group of parameters. Each of the parameters within the group can be expressed in ASCII, as scaled data, or as function states consisting of one or more Bits. Alphanumeric data will be transmitted with the most significant byte first. Other parameters consisting of two or more data bytes shall be transmitted least significant byte first. The type of data is also identified for each parameter.

The following sections identify the parameters that are supported by DDEC, parameter group number response definitions (refer to section 6.3.2) and parameter group number command definitions (refer to section 6.3.3).

6.3.2 SAE J1939/71 APPLICATION LAYER

The Application Layer Parameter Group Number (PGN) response definitions are described in the following sections.

Electronic Engine Controller #1 – EEC1

Transmission Rate:	Engine Speed Dependent
Data Length:	8 bytes
Data Page:	0
PDU format:	240
PDU specific:	4
Default priority:	3
PGN:	61,444 (0x00F004)
Byte : 1	Status_EEC1
Bits: 8-5	Not Defined
Bits: 4-1	Engine / Retarder Torque Mode (SPN 899)
	0000: Low Idle Governor/No Request (Default Mode)
	0001: Accelerator Pedal/Operator Selection
	0010: Cruise Control
	0011: PTO Governor
	0100: Road Speed Governor
	0101: ASR Control
	0110: Transmission Control
	0111: ABS Control
	1000: Torque Limiting
	1001: High Speed Governor
	1010: Braking System
	1011: Remote Accelerator - N/A
	1100: Not Defined
	1101: Not Defined
	1110: Other
	1111: Not Available
Byte: 2	Drivers Demand Engine - Pct Torque (SPN 512)
	Resolution: 1% / Bit, -125% offset
Byte: 3	Actual Engine - Percent Torque (SPN 513)
	Resolution: 1% / Bit, -125% offset
Bytes: 4,5	Engine Speed (SPN 190)
	Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte: 6	Source address of controlling device for engine control (SPN 1483)
Byte: 7	Bits: 8–5 Not Defined
	Bits: 1–4 Engine Starter Mode – N/A
Byte: 8	Engine Demand–Percent Torque – N/A

Electronic Engine Controller #2 – EEC2

Transmission Rate :	50 ms
Data Length:	8 bytes
Data Page:	0
PDU format:	240
PDU specific:	3
Default priority:	3
PGN:	61,443 (0x00F003)
Byte: 1	Status_EEC2
	Bits: 8-7 Not Defined (Transmitted as 1111)
	Bits: 6–5 Road Speed Limit Status
	Note: Rel 2.02 or later
	00: Active
	01: Not Active
	Bits: 4-3 AP Kickdown Switch (SPN 559)
	00: Kickdown Passive
	01: Kickdown Active
	11: Not Configured
	Bits: 2,1 AP Low Idle Switch (SPN 558)
	00: Not In Low Idle Condition
	01: In Low Idle Condition
	10: Error Detected
	11: Not Configured
Byte: 2	Accelerator Pedal Position (TPS) (SPN 91)
	Resolution: 0.4% / Bit, 0% offset
Byte: 3	Percent Load At Current Speed (SPN 92)
	Resolution: 1% / Bit, 0% offset
Byte: 4	Remote Accelerator–N/A
Byte: 5	Accelerator Pedal Position #2 (SPN 29)
	Note: Rel 2.02 or later
	Resolution: 0.4%/ Bit, 0% offset

IO — Idle Operation

Transmission Rate : On Request
 Data Length: 8 bytes
 Data Page: 0
 PDU format: 254
 PDU specific: 220
 Default priority: 6
 PGN: 65,244 (0x00FEDC)
 Bytes: 1-4 Total Idle Fuel Used (SPN 236)
 Resolution: 0.5 L / Bit, 0 L offset
 Bytes: 5-8 Total Idle Hours (SPN 235)
 Resolution: 0.05 hr / Bit, 0 hr offset

TC — Turbocharger

Transmission Rate : 1 sec
 Data Length: 8 bytes
 Data Page: 0
 PDU format: 254
 PDU specific: 221
 Default priority: 6
 PGN: 65, 245 (0x00FEDD)
 Byte: 1 Turbo Oil Pressure - N/A
 Bytes: 2,3 Turbocharger 1 Speed (SPN 103)
 Resolution: 4 rpm / Bit, 0 rpm offset
 Byte: 4 Bits: 8–7 Turbo Oil Level Switch–N/A
 Bits: 6–1 Not Defined
 Bytes: 5-8 Not Defined

Electronic Engine Controller #3 – EEC3

Transmission Rate :	250 ms
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	223
Default priority:	6
PGN:	65,247 (0x00FEDF)
Byte: 1	Nominal Friction - Percent Torque (SPN 514) Resolution: 1% / Bit, -125% offset
Bytes: 2,3	Engine's Desired Operating Speed (SPN 515) Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte 4:	Engine's Desired Operating Speed Asymmetry Adjustment (SPN 519) ratio 0 to 250
Byte 5:	Engine Controlled Cooling Fan Losses — Percent torque Resolution: 1%/bit, —125% offset (SPN 2978)
Bytes: 6-8	Not Defined

VD — Vehicle Distance

Transmission Rate :	On Request
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	224
Default priority:	6
PGN:	65,248 (0x00FEE0)
Bytes: 1-4	Trip Distance (SPN 244) Resolution: 0.125 km / Bit, 0 km offset
Bytes: 5-8	Total Vehicle Distance (SPN 245) Resolution: 0.125 km / Bit, 0 km offset

Shutdown — Idle Shutdown

Transmission Rate :	1 sec
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	228
Default priority:	6
PGN:	65,252 (0x00FEE4)
Byte: 1	Idle shutdown_1
	Bits: 8,7 Idle Shutdown Timer State (SPN 590)
	00: Inactive
	01: Active
	Bits: 6,5 Idle Shutdown Timer Override (SPN 592)
	00: Inactive
	01: Active
	Bits: 4,3 Driver Alert Mode (SPN 594)
	00: Inactive
	01: Active
	Bits: 2,1 Engine Has Shutdown by Idle Shutdown (SPN 593)
	00: Engine has not shutdown by idle shutdown
	01: Engine has shutdown by idle shutdown
Byte: 2	Idle shutdown_2
	Bits: 8,7 Idle Shutdown Timer Function (SPN 591)
	00: Disabled in Calibration
	01: Enabled in Calibration
	Bits: 6-1 Not Defined
Byte: 3	Bits: 8,7 Not Defined
	Bits: 6,5 Refrigerant High Pressure Switch- N/A
	Bits: 4,3 Refrigerant Low Pressure Switch- N/A
	Bits: 2,1 A/C High Pressure Fan Switch-N/A
Byte: 4	Lamp_commands - N/A
Byte: 5	Engine Shutdown_1
	Bits: 8,7 Engine Protection System Timer State (SPN 1107)
	00:Timer not Active
	01:Timer Active
	Bits: 6,5 Engine Protection System Timer Override (SPN 1108)
	00:Override Off
	01:Override On
	Bits: 4,3 Engine Shutdown Approaching - N/A
	Bits: 2,1 Engine Has Shutdown By Engine Protection System (SPN 1110)

		00:Not Shutdown
		01:Has Shutdown
Byte: 6	Engine Shutdown_2	
	Bits: 8,7	Engine Protection System Configuration (SPN 1111)
		00:Not Enabled In Calibration
		01:Enabled In Calibration
	Bits: 6-1	Not Defined
Bytes: 7-8	Not Defined	

Engine Hours, Revolutions — Hours

Transmission Rate :	On Request
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	229
Default priority:	6
PGN:	65,253 (0x00FEE5)
Bytes: 1-4	Total Engine Hours (SPN 247)
	Resolution: 0.05 h / Bit, 0 h offset
Bytes: 5-8	Total Engine Revolutions (SPN 249)
	Resolution: 1000 revs / Bit, 0 revs offset

TD — Time/Date

Transmission Rate :	On Request
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	230
Default priority:	6
PGN:	65,254 (0x00FEE6)
Byte: 1	Seconds (SPN 959)
	Resolution: 0.25 sec / Bit, 0 sec offset
Byte: 2	Minutes (SPN 960)
	Resolution: 1 min / Bit, 0 min offset
Byte: 3	Hours (SPN 961)
	Resolution: 1 hour / Bit, 0 h offset
Byte: 4	Month (SPN 963)
	Resolution: 1 month / Bit, 0 month offset
Byte: 5	Day (see Note) (SPN 962)
	Resolution: 0.25 day / Bit, 0 day offset
Byte: 6	Year (SPN 964)
	Resolution: 1 year / Bit, 1985 year offset
Byte: 7	Local Minute Offset – N/A
Byte: 8	Local Hour Offset – N/A
Note:	The Day field represents days elapsed (e.g. 1/1/98 at 12:00 am would be 0 for byte 5 (Day) and 1/1/98 at 1:00 pm would be 2 for byte 5 and 1/15/98 at 1:00 pm would be 62 for byte 5).

VH — Vehicle Hours

Transmission Rate :	On Request
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	231
Default priority:	6
PGN:	65,255 (0x00FEE7)
Bytes: 1-4	Total Vehicle Hours -N/A
Bytes: 5-8	Total Power Takeoff Hours (SPN 248)
	Resolution: 0.05 h / Bit, 0 h offset

Fuel Consumption (Liquid) – LFC

Transmission Rate : On Request
Data Length: 8 bytes
Data Page: 0
PDU format: 254
PDU specific: 233
Default priority: 6
PGN: 65,257 (0x00FEE9)
Byte: 1-4 Trip Fuel (SPN 182)
Resolution: 0.5 L / Bit, 0 L offset
Bytes: 5-8 Total Fuel Used (SPN 250)
Resolution: 0.5 L / Bit, 0 L offset

CCSS – Cruise Control / Vehicle Speed Setup

Transmission Rate : On Request
Data Length: 8 bytes
Data Page: 0
PDU format: 254
PDU specific: 237
Default priority: 6
PGN: 65,261 (0x00FEED)
Byte: 1 Maximum Vehicle Speed Limit (SPN 74)
Resolution: 1 km/h / Bit, 0 km/h offset
Byte: 2 Cruise Control High Set Limit Speed. (SPN 87)
Resolution: 1 km/h / Bit, 0 km/h offset
Byte: 3 Cruise Control Low Set Limit Speed (SPN 88)
Resolution: 1 km/h / Bit, 0 km/h offset
Bytes: 4-8 Not Defined

Engine Temperature #1 – ET1

Transmission Rate :	1 sec
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	238
Default priority:	6
PGN:	65,262 (0x00FEEE)
Byte: 1	Engine Coolant Temperature (SPN 110)
	Resolution: 1°C / Bit, -40°C offset
Byte: 2	Fuel Temperature (SPN 174)
	Resolution: 1°C / Bit, -40°C offset
Bytes: 3,4	Engine Oil Temperature (SPN 175)
	Resolution: 0.03125°C / Bit, -273°C offset
Bytes: 5,6	Turbo Oil Temperature -N/A
Byte: 7	Engine Intercooler Temperature (SPN 52)
	Resolution: 1°C / Bit, -40°C offset
Byte 8:	Engine Intercooler Thermostat Opening–N/A

Engine Fluid Level/Pressure #1 – EFL/P1

Transmission Rate :	0.5 sec
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	239
Default priority:	6
PGN:	65,263 (0x00FEEF)
Byte: 1	Fuel Delivery Pressure (SPN 94)
	Resolution: 4 kPa / Bit, 0 kPa offset
Byte: 2	Extended Crankcase Blowby Pressure–N/A
Byte: 3	Engine Oil Level (SPN 98)
	Resolution: 0.4% / Bit, 0% offset
Byte: 4	Engine Oil Pressure (SPN 100)
	Resolution: 4 kPa / Bit, 0 kPa offset
Byte: 5,6	Crankcase Pressure (SPN 101)
	Resolution: 0.0078125 kPa / Bit (1/128 kPa / Bit), -250 kPa offset
Byte: 7	Coolant Pressure (SPN 109)
	Resolution: 2 kPa / Bit, 0 kPa offset
Byte: 8	Coolant Level (SPN 111)
	Resolution: 0.4% / Bit, 0% offset

PTO – Power Takeoff Information

Transmission Rate :	100 ms
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	240
Default priority:	6
PGN:	65,264 (0x00FEF0)
Byte: 1	Power Takeoff Oil Temperature - N/A
Byte: 2,3	Power Takeoff Speed - N/A
Byte: 4,5	Power Takeoff Set Speed (SPN 187)
	Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte: 6	Measured_PTO_1
	Bits: 8,7 Not Defined
	Bits: 6,5 Remote PTO Variable Speed Control Switch - N/A
	Bits: 4,3 Remote PTO Preprogrammed Speed Control Switch (SPN 979)
	00: Switch Off
	01: Switch On
	11: Not Configured
	Bits: 2,1 PTO Enable Switch (SPN 980)
	00: Switch Off
	01: Switch On
	11: Not Configured
Byte: 7	Measured_PTO_2
	Bits: 8,7 PTO Accelerate Switch (SPN 981)
	00: Switch Off
	01: Switch On
	11: Not Configured
	Bits: 6,5 PTO Resume Switch (SPN 982)
	00: Switch Off
	01: Switch On
	11: Not Configured
	Bits: 4,3 PTO Coast/Decelerate Switch (SPN 983)
	00: Switch Off
	01: Switch On
	11: Not Configured
	Bits: 2,1 PTO Set Switch (SPN 984)
	00: Switch Off
	01: Switch On
	11: Not Configured
Byte: 8	Not Defined

Cruise Control / Vehicle Speed – CCVS

Transmission/Reception Rate:	100 ms
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	241
Default priority:	6
PGN:	65,265 (0x00FEF1)
Byte: 1	Measured_SW1
	Bits: 8,7 Not Defined
	Bits: 6,5 Cruise Control Pause Switch–N/A
	Bits: 4,3 Parking Brake Switch (SPN 70)
	00: Park Brake Not Set
	01: Park Brake Set
	10: Error
	11: Not Configured
	Bits: 2,1 Two Speed Axle Switch (SPN 69)
	00: Low Speed Range
	01: High Speed Range
	10: Error
	11: Not Configured
Byte: 2,3	Wheel Based Vehicle Speed (SPN 84)
	Resolution: 1/256 km/h / Bit, 0 km/h offset (1/412 mph / Bit, 0 mph offset)
Byte: 4	Measured_CC_SW1
	Bits: 8,7 Clutch Switch (SPN 598)
	00: Clutch Pedal Released
	01: Clutch Pedal Depressed
	10: Error
	11: Not Configured
	Bits: 6,5 Service Brake Switch (SPN 597)
	00: Brake Pedal Released
	01: Brake Pedal Depressed
	10: Error
	11: Not Configured
	Bits: 4,3 Cruise Control Enable Switch (SPN 596)
	00: Cruise Control Disabled
	01: Cruise Control Enabled
	10: Error
	11: Not Configured
	Bits: 2,1 Cruise Control Active (SPN 595)
	00: Cruise Control Off
	01: Cruise Control On

		10: Error
		11: Not Configured
Byte: 5	Measured _CC_SW2	
	Bits: 8,7	Cruise Control Accelerate Switch (SPN 602)
		00: Accelerate Switch Off
		01: Accelerate Switch On
		10: Error
		11: Not Configured
	Bits: 6,5	Cruise Control Resume Switch (SPN 601)
		00: Resume Switch Off
		01: Resume Switch On
		10: Error
		11: Not Configured
	Bits: 4,3	Cruise Control Coast Switch (SPN 600)
		00: Coast Switch Off
		01: Coast Switch On
		10: Error
		11: Not Configured
	Bits: 2,1	Cruise Control Set Switch (SPN 599)
		00: Set Switch Off
		01: Set Switch On
		10: Error
		11: Not Configured
Byte: 6	Cruise Control Set Speed (SPN 86)	
	Resolution:	1 km/h / Bit, 0 km/h offset
Byte: 7	State_CC	
	Bits: 8–6	Cruise Control State (SPN 527)
		000: Off/Disabled
		001: Hold
		010: Accelerate
		011: Decelerate/Coast
		100: Resume
		101: Set
		110: Accelerator Override
		111: Not Available
	Bits: 5-1	PTO State (SPN 976)
		00000: Off/Disabled
		00001: Hold (PTO Mode is Active)
		Note: Rel 2.0 or later
Byte: 8	Measured_idle_SW1	

	Engine Shutdown Override Switch (SPN 1237)
Bits: 8,7	00: Off
	01: On
	011: Not Configured
Bits: 6,5	Engine Test Mode Switch - N/A
Bits: 4,3	Idle Decrement Switch - N/A
Bits: 2,1	Idle Increment Switch - N/A

Fuel Economy (Liquid) – LFE

Transmission Rate :	100 ms
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	242
Default priority:	6
PGN:	65,266 (0x00FEF2)
Bytes: 1,2	Fuel Rate (SPN 183)
	Resolution: 0.05 L/h / Bit, 0 L/h offset
Bytes: 3,4	Instantaneous Fuel Economy (SPN 184)
	Resolution: 1/512 km/L / Bit, 0 km/L offset
Bytes: 5,6	Average Fuel Economy (SPN 185)
	Resolution: 1/512 km/L / Bit, 0 km/L offset
Byte: 7	Throttle Position (SPN 51)
	Resolution: 0.4%/bit, 0% offset
Byte: 8	Not Defined

AMB – Ambient Conditions

Transmission Rate : 1 sec
 Data Length: 8 bytes
 Data Page: 0
 PDU format: 254
 PDU specific: 245
 Default priority: 6
 PGN: 65,269 (0x00FEF5)
 Byte: 1 Barometric Pressure (SPN 108)
 Resolution: 0.5 kPa / Bit, 0 kPa offset
 Byte: 2 Cab Interior Temperature - N/A
 Bytes: 4,5 Ambient Air Temperature (SPN 171)
 Resolution: 0.03125°C / Bit, -273°C offset
 Byte: 6 Air Inlet Temperature (SPN 172)
 Resolution: 1°C / Bit, -40°C offset
 Bytes: 7,8 Road Surface Temperature - N/A

Inlet / Exhaust Conditions – IC

Transmission Rate : 0.5 sec
 Data Length: 8 bytes
 Data Page: 0
 PDU format: 254
 PDU specific: 246
 Default priority: 6
 PGN: 65,270 (0x00FEF6)
 Byte: 1 Particulate Trap Inlet Pressure - N/A
 Byte 2: Boost Pressure (SPN 102)
 Resolution: 2 kPa / Bit, 0 kPa offset
 Byte 3: Intake Manifold Temperature (SPN 105)
 Resolution: 1°C / Bit, -40°C offset
 Byte 4: Air Inlet Pressure (SPN 106)
 Resolution: 2 kPa / Bit, 0 kPa offset
 Byte 5: Air Filter Differential Pressure (SPN 107)
 Resolution: 0.05 kPa / Bit, 0 kPa offset
 Bytes: 6,7 Exhaust Gas Temperature (SPN 173)
 Resolution: 0.03125°C / Bit, -273°C offset
 Byte: 8 Coolant Filter Differential Pressure - N/A

Turbocharger Information #6 – TCI6

Transmission rate:	1 sec
Data Length:	8 bytes
Data Page:	0
PDU Format:	253
PDU Specific	211
Default Priority:	6
PGN:	64,979 (0x00FDD3)
Byte: 1, 2	Turbocharger Compressor Outlet #1 Temperature (SPN 2629) Resolution: 0.03125°C/bit, -273°C offset
Byte: 3, 4	Turbocharger Compressor Outlet #2 Temperature — N/A
Byte: 5, 6	Turbocharger Compressor Outlet #3 Temperature — N/A
Byte: 7, 8	Turbocharger Compressor Outlet #4 Temperature — N/A

Exhaust Port Temperature #1 – EPT1

Transmission rate:	1 sec
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific	163
Default Priority:	7
PGN:	65,187 (0x00FEA3)
Byte: 1, 2	Exhaust Gas Port 1 Temperature (SPN 1137) Resolution: 0.03125°C/bit, -273°C offset
Byte: 3, 4	Exhaust Gas Port 2 Temperature (SPN 1138) Resolution: 0.03125°C/bit, -273°C offset
Byte: 5, 6	Exhaust Gas Port 3 Temperature (SPN 1139) Resolution: 0.03125°C/bit, -273°C offset
Byte: 7, 8	Exhaust Gas Port 4 Temperature (SPN 1140) Resolution: 0.03125°C/bit, -273°C offset

Exhaust Port Temperature #2 – EPT2

Transmission Rate:	1 sec
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	162
Default Priority:	7
PGN:	65,186 (Ox00FEA2)
Bytes: 1, 2	Exhaust Gas Port 5 Temperature (SPN 1141) Resolution: 0.03125°C/bit, –273°C offset
Byte: 3, 4	Exhaust Gas Port 6 Temperature (SPN 1142) Resolution: 0.03125°C/bit, –273°C offset
Byte: 5, 6	Exhaust Gas Port 7 Temperature (SPN 1143) Resolution: 0.03125°C/bit, –273°C offset
Byte: 7, 8	Exhaust Gas Port 8 Temperature (SPN 1144) Resolution: 0.03125°C/bit, –273°C offset

Exhaust Port Temperature #3 – EPT3

Transmission Rate:	1 sec
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	161
Default Priority:	7
PGN:	65,185 (Ox00FEA1)
Byte: 1, 2	Exhaust Gas Port 9 Temperature (SPN 1145) Resolution: 0.03125°C/bit, –273°C offset
Byte: 3, 4	Exhaust Gas Port 10 Temperature (SPN 1146) Resolution: 0.03125°C/bit, –273°C offset
Byte: 5, 6	Exhaust Gas Port 11 Temperature (SPN 1147) Resolution: 0.03125°C/bit, –273°C offset
Byte: 7, 8	Exhaust Gas Port 12 Temperature (SPN 1148) Resolution: 0.03125°C/bit, –273°C offset

Exhaust Port Temperature #4 – EPT4

Transmission Rate:	1 sec
Data Length:	8 bytes
Data Page:	0
PDU Format:	254
PDU Specific:	160
Default Priority:	7
PGN:	65, 184 (0x00FEA0)
Byte: 1, 2	Exhaust Gas Port 13 Temperature (SPN 1149) Resolution: 0.03125°C/bit, -273°C offset
Byte: 3, 4	Exhaust Gas Port 14 Temperature (SPN 1150) Resolution: 0.03125°C/bit, -273°C offset
Byte: 5, 6	Exhaust Gas Port 15 Temperature (SPN 1151) Resolution: 0.03125°C/bit, -273°C offset
Byte: 7, 8	Exhaust Gas Port 16 Temperature (SPN 1152) Resolution: 0.03125°C/bit, -273°C offset

VEP – Vehicle Electrical Power

Transmission Rate :	1 sec
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	247
Default priority:	6
PGN:	65,271 (0x00FEF7)
Byte: 1	Net Battery Current - N/A
Byte: 2	Alternator Current - N/A
Bytes: 3,4	Alternator Potential (voltage) - N/A
Bytes: 5,6	Electrical Potential (voltage) (SPN 168) Resolution: 0.05 V / Bit, 0 V offset
Bytes: 7,8	Battery Potential (Voltage), Switched (SPN 158) Resolution: 0.05 V / Bit, 0 V offset

Alternate Fuel #1 – A1

Transmission Rate : 500 ms
 Data Length: 8 bytes
 Data Page: 0
 PDU format: 254
 PDU specific: 253
 Default priority: 6
 PGN: 65,277 (0x00FEFD)
 Byte: 1 Blower Bypass Valve Position (SPN 72)
 Resolution: 0.4% / Bit, 0% offset
 Bytes: 2,3 Gas Supply Pressure (SPN 159)
 Resolution: 0.5 kPa/bit, 0 kPa offset
 Bytes: 4-8 Not Defined

Auxiliary Water Pump Pressure – AWPP

Transmission Rate : 1 sec
 Data Length: 8 bytes
 Data Page: 0
 PDU format: 254
 PDU specific: 254
 Default priority: 6
 PGN: 65,278 (0x00FEFE)
 Byte: 1 Auxiliary Pump Pressure (SPN 73)
 Resolution: 16 kPa / Bit, 0 kPa offset
 Byte: 2-8 Not Defined

EFL/P2 – Engine Fluid Level/Pressure #2

Transmission Rate : 500 ms
 Data Length: 8 bytes
 Data Page: 0
 PDU format: 254
 PDU specific: 219
 Default priority: 6
 PGN: 65,243 (0x00FEDB)
 Bytes: 1,2 Injection Control Pressure - N/A
 Bytes: 3,4 Injector Metering Rail Pressure (SPN 157)
 Resolution: 1/256 MPa / Bit, 0 MPa offset
 Bytes: 5,6 Injector Timing Rail 1 Pressure–N/A
 Bytes: 7,8 Injector Metering Rail 2 Pressure–N/A

VDHR – High Resolution Vehicle Distance

Transmission Rate : 1 sec
 Data Length: 8 bytes
 Data Page: 0
 PDU format: 254
 PDU specific: 193
 Default priority: 6
 PGN: 65,217 (0x00FEC1)
 Bytes: 1-4 High Resolution Total Vehicle Distance (SPN 917)
 Resolution: 5 m / Bit, 0 m offset (16.4 ft/Bit, 0 ft offset)
 Bytes: 5-8 High Resolution Trip Distance (SPN 918)
 Resolution: 5 m / Bit, 0 m offset (16.4 ft/Bit, 0 ft offset)

EEC4 – Electronic Engine Controller #4

Transmission Rate : On Request
 Data Length: 8 bytes
 Data Page: 0
 PDU format: 254
 PDU specific: 190
 Default priority: 6
 PGN: 65,214 (0x00FEBE)
 Bytes: 1,2 Rated Engine Power (SPN 166)
 Resolution: 0.5 kW / Bit, 0 kW offset (0.67 hp / Bit, 0 hp offset)
 Bytes: 3,4 Rated Engine Speed (SPN 189)
 Resolution: 0.125 rpm / Bit, 0 rpm offset
 Bytes: 5-8 Not Defined

Fan Drive – FD

Transmission Rate :	1 sec
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	189
Default priority:	6
PGN:	65,213 (0x00FEBD)
Byte: 1	Estimated Percent Fan Speed (SPN 975)
	Resolution: 0.4% / Bit, 0% offset
Byte: 2	State_Fan_Drive
	Bits: 8-5 Not Defined
	Bits: 4-1 Fan Drive State (SPN 977)
	0000: Fan Off
	0001: Engine System - General
	0010: Excessive Engine Air Temperature
	0011: Excessive Engine Oil Temperature
	0100: Excessive Engine Coolant Temperature
	0101-1000: Not Defined
	1001: Manual Control
	1010: Transmission Retarder
	1011: A/C System
	1100: Timer
	1101: Engine Brake
	1110: Other
	1111: Not Available
Bytes: 3,4	Fan Speed N/A
Bytes: 5-8	Not Defined

Electronic Retarder Controller #1 - ERC1

Transmission Rate :	100 ms
Data Length:	8 bytes
Data Page:	0
PDU format:	240
PDU specific:	0
Default priority:	6
PGN:	61,440 (0x00F000)
Byte : 1	Status_ERC1
	Bits: 8,7 Retarder Enable - Shift Assist Switch - N/A
	Bits: 6,5 Retarder Enable - Brake Assist Switch - N/A
	Bits: 4-1 Engine/Retarder Torque Mode (SPN 900)
	0000: No Request (Default Mode)
	0001: Accelerator Pedal/Operator Selection
	0010: Cruise Control
	0011: PTO Governor
	0100: Road Speed Governor - N/A
	0101: ASR Control
	0110: Transmission Control
	0111: ABS Control
	1000: Torque Limiting - N/A
	1001: High Speed Governor - N/A
	1010: Braking System
	1011: Remote Accelerator - N/A
	1100: Not Defined
	1101: Not Defined
	1110: Other
	1111: Not Available
Byte: 2	Actual Retarder - Percent Torque (SPN 520)
	Resolution: 1% / Bit, -125% offset
Byte: 3	Intended Retarder Percent Torque - N/A
Byte: 4	Coolant Load Increase
	Bits: 8-5 Not Defined
	Bits: 3,4 Retarder Requesting Brake Light-N/A
	Bits: 1,2 Engine Coolant Load Increase-N/A
Byte: 5	Source address of controlling device for retarder control (SPN 1480)
Byte: 6	Drivers Demand Retarder-Percent Torque-N/A
Byte: 7	Retarder Selection, non-engine-N/A
Byte: 8	Actual Maximum Available Retarder-Percent Torque-N/A

SOFT – Software Identification

Transmission Rate :	On Request
Data Length:	30 bytes
Data Page:	0
PDU format:	254
PDU specific:	218
Default priority:	6
PGN:	65,242 (0x00FEDA)
Byte: 1	Number of Software Identification Fields - 7
Byte: 2	1st digit of Major Version Level - ASCII
Byte: 3	2nd digit of Major Version Level - ASCII
Byte: 4	3rd digit of Major Version Level - ASCII
Byte: 5	* - Delimiter
Byte: 6	1st digit of Minor Version Level - ASCII
Byte: 7	2nd digit of Minor Version Level - ASCII
Byte: 8	3rd digit of Minor Version Level - ASCII
Byte: 9	* - Delimiter
Byte: 10	1st Digit of Cal Edit Version - ASCII
Byte: 11	2nd Digit of Cal Edit Version - ASCII
Byte: 12	3rd Digit of Cal Edit Version - ASCII
Byte: 13	* - Delimiter
Byte: 14	1st Digit of Edit Build Version - ASCII
Byte: 15	2nd Digit of Edit Build Version - ASCII
Byte: 16	3rd Digit of Edit Build Version - ASCII
Byte: 17	* - Delimiter
Byte: 18	Software Release Type - ASCII
	X - Experimental
	T - Pre-production
	R - Production
Byte: 19	* - Delimiter
Byte: 20	DDEC Hardware Version - ASCII
	3 – DDEC III, 4 – DDEC IV, 5 – DDEC V
Byte 21:	* - Delimiter
Bytes: 22-29	ECU Serial Number - ASCII
Byte: 30	* - Delimiter

Component Identification – CI

Transmission Rate : On Request
Data Length: 37 bytes
Data Page: 0
PDU format: 254
PDU specific: 235
Default priority: 6
PGN: 65,259 (0x00FEEB)
Bytes: 1-5 DTDSC - ASCII
Byte: 6 * - Delimiter
Byte: 7-14 Engine Model Number - ASCII
Byte: 15 * - Delimiter
Byte: 16-25 Engine Serial Number - ASCII
Byte: 26 * - Delimiter
Byte: 27-36 Unit Number (VIN) - ASCII
Byte: 37 * - Delimiter

Retarder Configuration – RC

Transmission Rate :	5 sec or On Request of Destination Specific Request
Data Length:	19 bytes
Data Page:	0
PDU format:	254
PDU specific:	225
Default priority:	6
PGN:	65,249 (0x00FEE1)
Byte: 1	Type And Location
Bits: 8-5	Retarder Location (SPN 902)
	0000: Primary Engine Retarder For Compression Brakes
	0001: Primary Engine Retarder For Exhaust Brakes
Bits: 4-1	Retarder Type (SPN 901)
	0011: Compression Release (Engine Retarder)
	0100: Exhaust
Byte: 2	Retarder Control Method (SPN 557)
	255 - when not configured
	0 - DVB
	1 - Konstantdrossel
	2 - Low/High Compression
	3 - Low/Med/High Compression
Bytes: 3, 4	Retarder Speed At Idle, Point 1- N/A
Byte: 5	Percent Torque At Idle, Point 1 - N/A
Bytes: 6, 7	Maximum Retarder Speed, Point 2 - N/A
Byte: 8	Percent Torque At Maximum Speed, Point 2 - N/A
Bytes: 9, 10	Retarder Speed At Point 3 - N/A
Byte: 11	Percent Torque At Point 3 - N/A
Bytes: 12, 13	Retarder Speed At Point 4 - N/A
Byte: 14	Percent Torque At Point 4 - N/A
Bytes: 15,16	Retarder Speed At Peak Torque, Point 5 - N/A
Bytes: 17,18	Reference Retarder Torque - N/A
Bytes: 19	Percent Torque At Peak Torque, Point 5 - N/A

Engine Configuration – EC

Transmission Rate :	5 sec, on change of torque/speed points of more than 10% since last transmission, or upon receipt of a destination specific request.
Data Length:	34 bytes
Data Page:	0
PDU format:	254
PDU specific:	227
Default priority:	6
PGN:	65,251 (0x00FEE3)
Bytes: 1,2	Engine Speed At Idle, Point 1 (SPN 188) Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte: 3	Percent Torque At Idle, Point 1 (SPN 539) Resolution: 1% / Bit, -125% offset
Bytes: 4, 5	Engine Speed At Point 2 (SPN 528) Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte: 6	Percent Torque At Point 2 (SPN 540) Resolution: 1% / Bit, -125% offset
Bytes: 7,8	Engine Speed At Point 3 (SPN 529) Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte: 9	Percent Torque At Point 3 (SPN 541) Resolution: 1% / Bit, -125% offset
Bytes: 10, 11	Engine Speed At Point 4 (SPN 530) Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte: 12	Percent Torque At Point 4 (SPN 542) Resolution: 1% / Bit, -125% offset
Bytes: 13, 14	Engine Speed At Point 5 (SPN 531) Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte: 15	Percent Torque At Point 5 (SPN 543) Resolution: 1% / Bit, -125% offset
Bytes: 16, 17	Engine Speed At High Idle, Point 6 (SPN 532) Resolution: 0.125 rpm / Bit, 0 rpm offset
Bytes: 18, 19	(KP) Of Endspped Governor - N/A
Bytes: 20, 21	Reference Engine Torque (SPN 544) Resolution: 1 Nm / Bit, 0 Nm offset
Byte: 22, 23	Maximum Momentary Engine Override Speed, Point 7 (SPN 533) Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte: 24	Maximum Momentary Engine Override Time Limit (SPN 534) Resolution: 0.1 s / Bit, 0 s offset
Byte: 25	Requested Speed Control Range Lower Limit (SPN 535) Resolution: 10 rpm / Bit, 0 rpm offset
Byte: 26	Requested Speed Control Range Upper Limit (SPN 536) Resolution: 10 rpm / Bit, 0 rpm offset

Byte: 27	Requested Torque Control Range Lower Limit (SPN 537) Resolution: 1% / Bit, -125% offset
Byte: 28	Requested Torque Control Range Upper Limit (SPN 538) Resolution: 1 % / Bit, -125% offset
Bytes: 29, 30	Extended Range Requested Speed Control Range Upper Limit (SPN 1712) Resolution: 0.125 rpm/bit, 0rpm offset
Bytes: 31, 32	Engine Moment of Inertia (SPN 1794) Resolution: 0.004 kgm ² /bit, 0 kgm ² /bit offset
Bytes: 33, 34	Default Engine Torque Limit — N/A

ACC1 – Adaptive Cruise Control

Reception rate :	100 ms
Data length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	111
PGN:	65135 (0x00FE6F)
Byte : 1	Speed of Forward Vehicle - N/A
Byte : 2	Distance to Forward Vehicle - N/A
Byte : 3	Adaptive Cruise Control Set Speed - N/A
Byte : 4	ACC Status 1 Bits: 8,7 Not Defined Bits: 6-4 Adaptive Cruise Control Set Distance Mode - N/A Bits: 3-1 Adaptive Cruise Control State (SPN 1590) 110: Error 111: Not Available
Byte : 5	Road Curvature - N/A
Byte : 6	Not Defined
Byte : 7	Bits: 8,7 Not Defined Bits: 5,6 ACC Distance Alert Signal–N/A Bits: 3,4 ACC System Shutoff Warning–N/A Bits: 1,2 ACC Target Detected–N/A
Byte : 8	Not Defined
Note:	This message is received only from an ACC device. It is not transmitted by the ECU.

Electronic Brake Controller #1 – EBC1

Reception Rate :	100 ms
Data Length:	8 bytes
Data Page:	0
PDU format:	240
PDU specific:	1
Default priority:	6
PGN:	61,441 (00F001)
Byte : 1	Status EBC1 – N/A
Byte: 2	Brake Pedal Position – N/A
Byte: 3	Status EBC2 – N/A
Byte: 4	Measured Aux.1 – N/A
Byte: 5	Engine Retarder Selection (SPN973)
	Resolution 0.4%/Bit, 0% Offset
	Definition: 0–24.8% = Engine Brake Off
	25.2–50% = Low
	50.4–74.8% = Medium
	75.2–100% = High
	Bits: 8–7 00: Off
	01: On
	Bits: 6,5 00: Off
	01: On
	Bits: 4,3 00: Off
	01: On
	Bits: 2,1 00: Off
	01: On
Byte: 6	Status Bits – N/A
Byte: 7	Source Add Control – N/A
Byte: 8	Not Defined

Torque Speed Control — TSC1

Reception Rate :	10 ms
Data Length:	8 bytes
Data Page:	0
PDU format:	0
PDU specific:	Destination Address
Default priority:	3
PGN:	0 (0x000000)
Byte : 1	Control Bits
	Bits: 8,7 Not Defined
	Bits: 6,5 Override Control Mode Priority (SPN 897)
	00: Highest
	01: High
	10: Medium
	11: Low
	Bits: 4,3 Requested Speed Control Conditions - N/A
	Bits: 2,1 Override Control Modes (SPN 695)
	00: Override Disabled
	01: Speed Control
	10: Torque Control
	11: Speed/Torque Limit
Byte: 2,3	Requested Speed / Speed Limit (SPN 898)
	Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte: 4	Requested Torque / Torque Limit (SPN 518)
	Resolution: 1% / Bit, -125% offset
	0-125% for engine torque requests
	-125-0% for retarder torque requests
Bytes: 5-8	Not Defined

Electronic Transmission Controller #1 – ETC1

Reception Rate :	10 ms
Data Length:	8 bytes
Data Page:	0
PDU format:	240
PDU specific:	2
Default priority:	3
PGN:	61,442 (0x00F002)
Byte : 1	Status_ETC1
	Bits: 8,7 Not Defined
	Bits: 6,5 Shift in Progress (SPN 574)
	00: Shift is not in process
	01: Shift in process
	11: N/A
	Bits: 4,3 Torque Converter Lockup Engaged (SPN573)
	Note: Rel 2.0 or later
	Note: If SPN 573 = 00 then engine brakes will be disabled.
	Rel 2.02 or later.
	00: Torque Converter Lockup Disengaged
	01: Torque Converter Lockup Engaged
	11: N/A
	Bits: 2,1 Driveline Engaged (SPN 560)
	00: Driveline Disengaged
	01: Driveline Engaged
	11: N/A
Byte: 2,3	Output Shaft Speed (SPN 191)
	Resolution: 0.125 rpm / Bit, 0 rpm offset
Byte: 4	Percent Clutch Slip - N/A
Byte: 5	Command_ETC1
	Bits: 8-5 Not Defined
	Bits: 4-3 Progressive Shift Disabled (SPN 607)
	00: Progressive Shift Is Not Disabled
	01: Progressive Shift Is Disabled
	11: N/A
	Bits: 2,1 Momentary Engine Overspeed Enable (SPN606)
	00: Momentary Engine Overspeed Is Disabled
	01: Momentary Engine Overspeed Is Enabled
	11: N/A
Bytes: 6,7	Input Shaft Speed - N/A
Byte: 8	Source Address of Controlling Device for Transmission Control–N/A

6.3.3 SAE J1939/21 DATA LINK LAYER

The Data Link Layer Parameter Group number (PGN) response definitions are described in the following sections.

Acknowledge / Negative Acknowledge

Transmission Rate	As Needed
:	
Data Length:	8 bytes
Data Page:	0
PDU format:	232
PDU specific:	Destination Address
Default priority:	6
PGN:	59, 392 (0x00E800)
Byte : 1	Control Byte
	0: Positive Acknowledgment (ACK)
	1: Negative Acknowledgment (NACK)
	2: Access Denied (PGN supported but access denied)
Byte: 2	Group Function Value (if applicable)- N/A
Bytes: 3-5	Not Defined
Bytes: 6	Least Significant Byte of PGN of Requested Information
Byte: 7	Middle Byte of PGN of Requested Information
Byte: 8	Most Significant Byte of PGN of Requested Information

Requests

Transmission Rate :	As Needed
Data Length:	3 bytes
Data Page:	0
PDU format:	234
PDU specific:	Destination Address
Default priority:	6
PGN:	59,904 (0x00EA00)
Byte : 1	Least Significant Byte of PGN
Byte: 2	Byte 2 of PGN
Byte: 3	Most Significant Byte of PGN

NOTE:

It is recommended that requests occur no more than 2 or 3 times per second.

NOTE:

For any unsupported PGN that is destination specific DDEC will transmit a NACK. DDEC will not transmit a NACK to a global request.

Transport Protocol Broadcast Announce (TP.CM_BAM)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format:	236
PDU Specific:	255
Default Priority:	7

Byte: 1	Control Byte — set to 32 for CM_BAM
Byte: 2, 3	Total Message Size, number of bytes
Byte: 4	Total number of packets
Byte: 5	Not Defined
Byte: 6–8	PGN of packeted message

Transport Protocol Data (TP.DT)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format	235
PDU Specific:	255
Default Priority:	7

Byte: 1	Sequence Number
Byte 2–8	Packetized Data (7 bytes)

NOTE:

The last packet of a multi-packet parameter group may require less than eight data bytes. The extra bytes will be filled with 255.

NOTE:

The data packets are spaced between 50 and 200 ms.

Transport Protocol Request to Send (TP.CM_RTS)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format:	236
PDU Specific:	Destination Address
Default Priority:	7

Byte: 1	Control Byte 16 — Designation Specific Request_To_Send (RTS)
Bytes: 2, 3	Total Message Size, number of bytes
Byte: 4	Total Number of Packets, zero not allowed
Byte: 5	Maximum number of packets that can be sent in response to one CTS.
Bytes: 6–8	Parameter Group Number (PGN) 255—indicates that no limit exists for the originator.

NOTE:

The ECU does not support incoming multi-placket messages and will ignore TP.CM_RTS messages.

Transport Protocol Connection Abort (TP.ConnAbort)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format:	236
PDU Specific:	Destination Address
Default Priority:	7

Byte: 1	Control Byte 255 — Connection Abort
Byte: 2–5	Not Defined
Bytes: 6–8	Parameter Group Number (PGN)

NOTE:

This message is sent if any of the time outs occurs or an invalid packet request occurs.

Transport Protocol End of Message (TP.EndofMsgACK)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format:	236
PDU Specific:	Destination Address
Default Priority:	7
Byte: 1	Control Byte 19—End_of_Message Acknowledge
Bytes: 2, 3	Total Message Size, number of bytes
Byte: 4	Total Number of Packets, zero not allowed
Byte 5:	Not Defined
Bytes: 6–8	Parameter Group Number (PGN)

Transport Protocol Clear to Send (TP.CM_CTS)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format:	236
PDU Specific:	Destination Address
Default Priority:	7
Byte: 1	Control Byte 17 — Destination Specific Clear_to_Send (CTS)
Byte: 2	Number of packets that can be sent
Byte: 3	Next packet number to be sent
Bytes: 4-5	Not Defined
Bytes: 6-8	Parameter Group Number (PGN)

Transport Protocol Data (TP.DT)

Transmission Rate:	As Required
Data Length:	8 bytes
Data Page:	0
PDU Format	235
PDU Specific:	Destination Address
Default Priority:	7

Byte: 1	Sequence Number
Bytes: 2–8	Packetized Data (7 Bytes)

NOTE:

The last packet of a multi-packet parameter group may require less than eighty data bytes. The extra bytes will be filled with 255.

The data packets will be spaced no more than 200 ms.

6.3.4 SAE J1939/73 DIAGNOSTIC LAYER

The Diagnostic Layer Parameter Group Number (PGN) response definitions are described in the following sections:

DM1 – Active Diagnostic Trouble Codes

Transmission Rate:	Whenever a DTC becomes an active fault and at a normal update rate of one second or longer, and then becomes inactive, a DM1 message will be transmitted to reflect this state change. If a different DTC changes state within one second update period, a new DM1 message is transmitted to reflect this new DTC.	
Data Length:	Variable	
Data Page:	0	
PDU Format:	254	
PDU Specific:	202	
Default Priority:	6	
PGN:	65226 (0x00FECA)	
Byte: 1	Bits: 8–7	Malfunction Indicator lamp Status–N/A
	Bits: 6–5	Red Stop Lamp Status (SPN 623)
		00 – Lamp Off
		01 – Lamp On
	Bits: 4–3	Amber Warning Lamp Status (SPN 624)
		00 – Lamp Off
		01 – Lamp On
	Bits: 2–1	Protect lamp Status–N/A
Byte: 2	Bits: 8–1	Reserved for SAE assignment Lamp Status (set to 0xFF)
Byte: 3	Bits: 8–1	SPN, 8 least significant bits of SPN (most significant at bit 8)
Byte: 4	Bits: 8–1	SPN, 8 second byte of SPN (most significant at bit 8)
Byte: 5	Bits: 8–6	SPN, 3 most significant bits (most significant at bit 8)
	Bits: 5–1	FMI (most significant at bit 5)
Byte: 6	Bit: 8	SPN Conversion Method (SPN 1706)
	Bits: 7–1	Occurrence Count (SPN 1216)
Byte: 7	Bits: 8–1	Not Defined (Set to 0xFF)
Byte: 8	Bits: 8–1	Not Defined (Set to 0xFF)

Previously Active Diagnostic Trouble Codes – DM2

Transmission Rate:	On Request	
Data Length:	Variable	
Data Page:	0	
PDU Format:	254	
PDU Specific:	203	
Default Priority:	6	
PGN:	65227 (0x00FECB)	
Byte: 1	Bits: 8–7	Malfunction Indicator lamp Status–N/A
	Bits: 6–5	Red Stop Lamp Status (SPN 623) 00 – Lamp Off 01 – Lamp On
	Bits: 4–3	Amber Warning Lamp Status (SPN 624) 00 – Lamp Off 01 – Lamp On
	Bits: 2–1	Protect lamp Status–N/A
Byte: 2	Bits:8–1	Reserved for SAE assignment Lamp Status (set to 0xFF)
Byte: 3	Bits:8–1	SPN, 8 least significant bits of SPN (most significant at bit 8)
Byte: 4	Bits:8–1	SPN, 8 second byte of SPN (most significant at bit 8)
Byte: 5	Bits:8–6	SPN, 3 most significant bits (most significant at bit 8)
	Bits:5–1	FMI (most significant at bit 5)
Byte: 6	Bit: 8	SPN Conversion Method (SPN 1706)
	Bits:7–1	Occurrence Count (SPN 1216)
Byte: 7	Bits:8–1	Not Defined (Set to 0xFF)
Byte: 8	Bits:8–1	Not Defined (Set to 0xFF)

Diagnostic Data Clear/Reset of Previously Active DTCs — DM3

Receptionion Rate: On Request using PGN 59904
Data Length: 0
Data Page: 0
PDU Format: 254
PDU Specific: 204
Default Priority: 6
PGN: 65,228 (0x00FECC)

Note: All of the non-permanent diagnostic information pertaining to previously active (inactive) visable diagnostic trouble codes will be erased when this PG is requested. The diagnostic data associated with active trouble codes will not be affected.

Upon reception of this PG request, DDEC will respond with a Positive Acknowledgement (ACK).

Diagnostic Data Clear/Reset for Active DTCs — DM11

Receptionion Rate: On Request using PGN 59904
Data Length: 0
Data Page: 0
PDU Format: 254
PDU Specific: 211
Default Priority: 6
PGN: 65,235 (0x00FED3)

Note: All of the non-permanent diagnostic information pertaining to active visable diagnostic trouble codes will be erased when this PG is requested. The diagnostic data associated with previously active (inactive) trouble codes will not be affected.

Upon reception of this PG request, DDEC will respond with a Positive Acknowledgement (ACK).

Stop Start Broadcast — DM13

Reception Rate :	As Received
Data Length:	8 bytes
Data Page:	0
PDU format:	223
PDU specific:	Destination Address
Default priority:	3
PGN:	57,008 (0x00DF00)
Byte : 1	SAE Primary Links
	Bits: 8,7 Current Data Link (SPN 1230)
	00: Stop Broadcast
	01: Start Broadcast
	11: Don't Care
	Bits: 6,5 J1587 * (SPN 608)
	00: Stop Broadcast
	01: Start Broadcast
	11: Don't Care
	Bits: 4,3 J1922 † (SPN 622)
	00: Stop Broadcast
	01: Start Broadcast
	11: Don't Care
	Bits: 2,1 J1939 Network #1, Primary Vehicle Network ‡ (SPN 639)
	00: Stop Broadcast
	01: Start Broadcast
	11: Don't Care
Byte: 2	Other Networks #1
	Bits: 8,7 J1939 Network #2 - N/A
	Bits: 6,5 ISO 9141 - N/A
	Bits: 4,3 J1850 - N/A
	Bits: 2,1 Other, Manufacture Specified Port - N/A
Byte: 3	Other Networks #2
	Bits: 8,7 J1939 Network #3 - N/A
	Bits: 6-1 Not Defined
Bytes: 4	Control Flags
	Bits: 8-5 Hold Signal (SPN 1236)
	0000: All Devices
	0001: Devices whose broadcast state has been modified
	0010-1110: Not Defined
	1111: N/A

Bits: 4–1 Not Defined

Bytes: 5-8 Not Defined

- * Only the broadcast data for the J1587 data link will be shutdown. The ECU will still respond to requests for data.
- † Only the broadcast data for the J1922 data link will be shutdown. The ECU will still respond to commands from other devices.
- ‡ Only the broadcast data for the J1939 data link will be shutdown. The ECU will still respond to requests for data.

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7 TOOLS

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7.1 VEHICLE ELECTRONIC PROGRAMMING SYSTEM

The purpose of the DDEC Vehicle Electronics Programming System (VEPS) is to give OEMs the ability to configure many ECU parameters. This allows DDEC features to be tailored to the specific customer requirements when the vehicle is assembled. Some of the features which may be configured by VEPS are the transmission type, cruise control, vehicle speed limit, idle shutdown, rating switches, digital inputs, and digital outputs.

7.1.1 SOFTWARE

The VEPS PC software package consists of the several files which are extracted when the software installation program is executed. A System Users Manual which defines the available parameters is included with the software package at the time of purchase.

The PC interface utilizes a communications driver which is defined in the TMC Recommended Practice RP1210A. The RP1210A software is used to translate the datalink signal of the ECU to the format required by Windows programs. The RP1210A communications driver is included as part of the VEPS software package.

7.1.2 HARDWARE

The hardware portion of the VEPS programming package includes the interface module and cables. The components that are included in the package are listed in Table 7-1.

Part Description	Part Number
100 Foot Cable	23512893
SAE J1708 6-Pin Dash Connector	23515957
J1708/RS-232 Translator Box	23512415
6 foot Cable	23515869

Table 7-1 VEPS Hardware

A cable kit, listed in Table 7-2, is also available.

Part Description	Part Number
Cable Kit (includes the 100 foot cable and the 6-pin dash connector)	23512980

Table 7-2 VEPS Cable Kit

A translator and cable kit, listed in Table 7-3, is also available.

Part Description	Part Number
Translator Kit (includes the J1708/RS-232 translator box, 100 foot cable and the 6-pin dash connector)	23512895

Table 7-3 VEPS Translator and Cable Kit

The VEPS software kit, listed in Table 7-4, is available.

Part Description	Part Number
Software Kit (includes the RP1202 Software and the VEPS Software)	Contact DDC Application Engineering

Table 7-4 VEPS Software Kit

7.2 DETROIT DIESEL DIAGNOSTIC LINK

The Detroit Diesel Diagnostic Link® (DDDL) is a sophisticated PC software package supporting the setting up, maintenance and repair of engines using the DDEC V ECU. DDDL software contains a powerful trip-reporting program assisting fleet managers to effectively and efficiently run their operations. Additionally, time and money saving diagnostic and troubleshooting tools offered by DDDL allow mechanics and technicians to pinpoint opportunities to improve operations and identify problems quickly. The latest version of DDDL (4.2) has full diagnostic support for Series 60 EGR engines. For additional information, refer to the on-line Help within the program.

7.2.1 CALIBRATION

You can use the DDDL to:

- ☐ Read and display the current calibration from an ECU.
- ☐ Create a calibration for the ECU on an individual engine.
- ☐ Save a single calibration with an ECU password so that the same calibration can be used conveniently for a fleet of vehicles with the same password, or can be used by a technician who does not have access to the password.
- ☐ Change the engine rating of a vehicle.
- ☐ Set the injector calibration when you replace the injectors.
- ☐ View an audit trail of ECU and injector calibration changes.

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7.3 DIAGNOSTIC DATA READER

The hand-held DDR plugs into the Data Link Connector located in the Vehicle Interface Harness (refer to section 3.7.3). This connection allows the DDR to receive data from the ECU. The DDR is used to display:

- Engine Description via the ENGINE DATA LIST menu
- Codes via the DIAGNOSTIC CODES menu
- View/reprogram certain operating parameters

A printout of the information displayed on the DDR can be obtained by attaching a printer.

NOTE:

Suite 9 is required for DDEC V.

7.3.1 REQUIREMENTS

The components and part numbers are listed in Table 7-5. Also see Figure 7-1.

Component	Part Number
Pro-Link® Plus with Case	108004
Multi Protocol Cartridge (MPC)	208040
Detroit Diesel Application Suite 9 PC Card, DDEC V	804218
Detroit Diesel MPC PCMCIA Manual	901012
Power and Data Cable (2 pc)	501002
Data Cable Only	501003
Power Cable Only	501004
PC Terminal Cable 8 ft	501005
6-pin Deutsch Adapter w/Atari End	408024
9-pin Deutsch Adapter w/Atari End	408028
6-pin and 9-pin Deutsch Adapter w/Atari End	408048
Storage Case	217003

Table 7-5 Diagnostic Data Reader/Pro-Link® Components and Part Numbers

Pro-Link® is a registered trademark of Micro Processor Systems, Inc.

NOTE:

Printers used in Europe must use a European power supply as listed in Table 7-6. Do not substitute an AC adapter for the European power supply.

Component	Part Number
Pro-Link Printer with Serial Adapter & AC Adapter	178001
Pro-Link Printer with 220–240 V Euro Adapter	171007
Printer AC Adapter	178003
Thermal Paper — 5 rolls	171002
Printer Battery Pack	178004
Euro Power Supply Only	400058

Table 7-6 DDR/Pro-Link® Printers and Power Supply

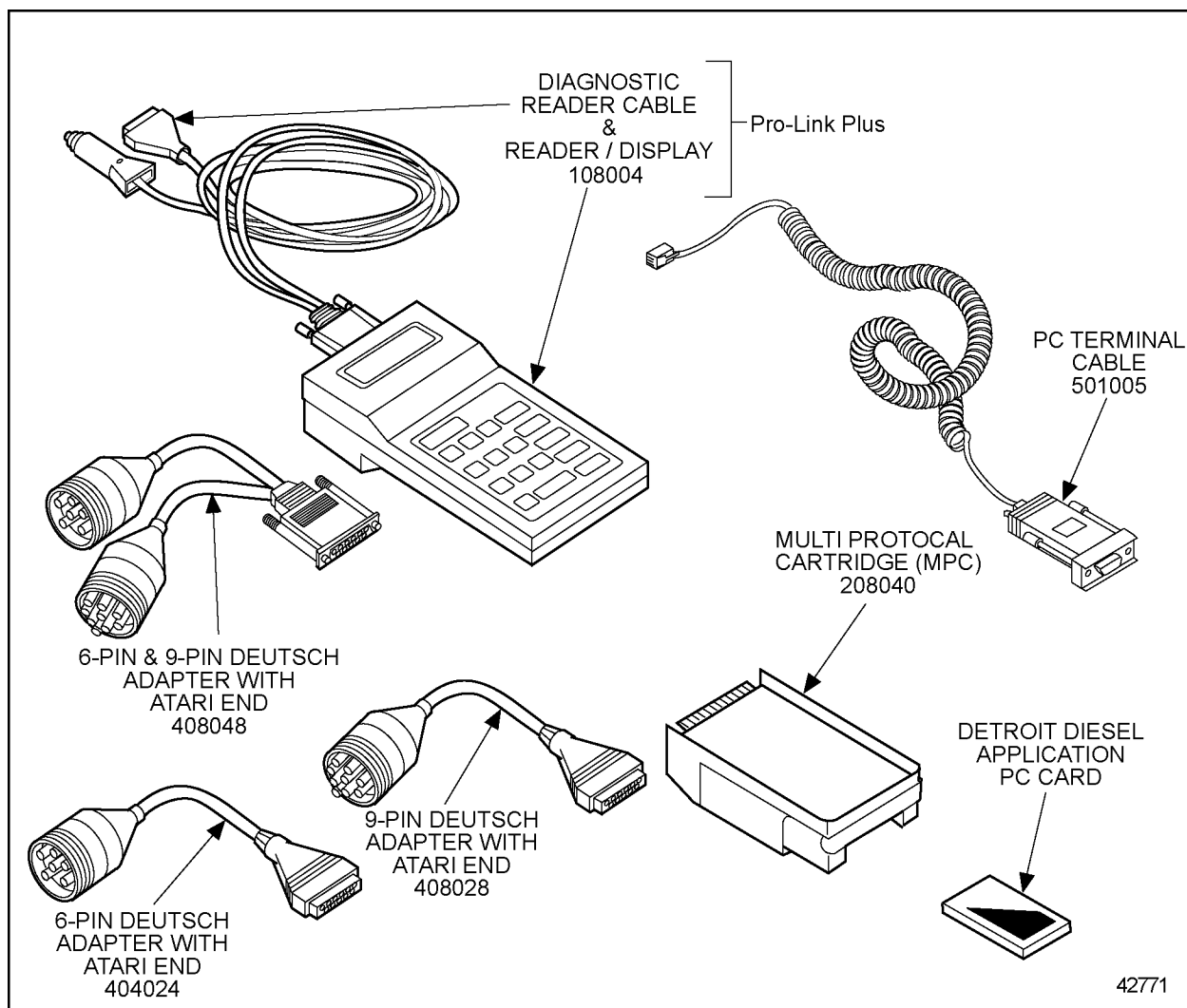


Figure 7-1 Pro-Link Plus/Diagnostic Data Reader Components



WARNING:

PERSONAL INJURY

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

The DDR can be purchased from:

Nexiq Technologies

Phone: 1-800-639-6774

www.nexiq.com

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7.4 DDEC REPROGRAMMING SYSTEM

The DDEC Reprogramming System (DRS) is composed of Programming Software, DDECcomm Mainframe Communications software, all the hardware required to connect a Personal Computer to the ECM, and a user manual explaining the use of the software. The DRS software is used to reprogram calibrations, modify customer calibration values, upgrade ECM software versions, update injector calibration codes, and program blank ECMs. The DDECcomm software is used to communicate via modem to the DDC Mainframe computer which stores all the DDEC Calibrations.

7.4.1 REQUIREMENTS

The DRS and DDECcomm software require a Personal Computer which meets certain minimum requirements. These minimum requirements include a pentium microprocessor with 16 MB of RAM, a modem, and the Windows 95 Operating System. DDC also sells kits which include a Laptop PC, please contact your Detroit Diesel representative for current Laptop specifications.

7.4.2 DRS WELCOME SCREEN

There are several choices on the Welcome Screen. The following sections describe these menu options.

Program ECM

Reprogram ECMs with a customer calibration that has previously been downloaded from the DDC mainframe computer. The customer configurable parameters are retained through this type of a reprogramming.

Program Fleet ECM

Reprogram fleet units from a single customer calibration that has previously been downloaded from the DDC mainframe computer. The customer configurable parameters are retained through this type of a reprogramming.

Program ECM With Mainframe Data

Reprogram ECMs with a customer calibration that has previously been downloaded from the DDC mainframe computer. Unlike the standard Program ECM option, this option will overwrite the customer configurable parameters, resulting in a calibration exactly like the one created by the factory.

Update Calibration at DDC

This function is used to store the ECM's electronic parameters on the PC. After performing this option, the Upload History function in the DDEC Mainframe Communications Program (DDECcomm) can be used to send the ECM data to the DDC mainframe computer.

Engine Configuration Data

Displays engine and ECM data information.

Update Customer Calibration

This option allows the electronic parameters to be updated. A customer password is required to perform this function. The following groups of information, listed in Table 7-7, can be modified.

Parameters That Can Be Updated		
Air Compressor	Output Config	VSG Configuration
Auto Cruise Resume	Idle Adjustment	Vehicle Number
CLS Polarity	Idle Shutdown	Function Lockout
Cruise Control	Rating	Lockout Password
Cruise Switch VSG	Rating Password	Fan Timer
Customer Password	Progressive Shift	Engine Brakes
Droop	Transmission	Half Engine Idle
Dynamic Braking	Vehicle Spd Limiting	TOP 2 Switch
Engine Protection	Vehicle Spd Sensor	Low Gear Torque Limiting
Pressure Sensor Governor	Vehicle ID Number	Engine Overspeed
Fuel Econ Incentive	Maintenance Alert System	Cruise Speeds
Input Config	Data Pages / DDEC Data	Adaptive Cruise
PasSmart	—	—

Table 7-7 Parameters that can be Updated with the Update Customer Calibration Option

Update Injector Calibration

This option displays a graphical representation of the engine allowing the injector calibration code to be updated. An injector password is required.

Update ECM Accumulators

Update ECM with engine data such as idle hours, engine hours, cruise hours, miles, etc.

DDC Mainframe Communications

This option is used to select DDECcomm to communicate with the server.

7.4.3 DRS MENU OPTIONS

Other functions available from the pull-down menu at the top of the screen are listed below.

Upgrade ECM Software

New versions of DDEC ECM software may be programmed into customer's ECMs with this option. There is a nominal charge each time this function is performed.

Change Passwords

Allows changes to the customer, group lockout, or rating password.

Random Customer Password

This option creates a random customer calibration password.

Random Rating Password

This option creates a random rating password.

Random Lockout Password

This option creates a random lockout password.

ECM S/W Versions

Displays ECM software versions that are available on the PC. These versions are used to electronically upgrade ECM software for DDEC III, IV, and V.

Display Station Log File

Displays a file containing system usage information.

Display Downloaded Units

This menu item displays the Unit Numbers of the engines which have been downloaded from the mainframe and are available for programming.

Comms Setting

This option allows changes to the comms protocol, interface hardware being used, and the baud rate.

Options

This option allows entry of the application ID for connecting to the DDC server.

7.4.4 DDECCOMM

DDECcomm is a Win95 program which can be invoked by selecting DDC Mainframe Communications. The following menu options are available in this program.

Download Engine Serial Calibration(s)

This option is used to download any changed or desired unit calibrations from the DDC mainframe computer. These calibrations are stored on the PC for a maximum of 14 days, after that period they are automatically deleted.

Download Fleet Calibration(s)

This option allows the download of a single "fleet" unit from the mainframe to the PC. This "fleet" unit calibration may be used to program multiple units in a fleet via the Program Fleet ECM option discussed above.

Upload History

This option takes the programming history on the PC and uploads it to the DDC mainframe. This allows DDC to maintain a current image of the calibration status should further service be required. The history file must first be created by running the Update Calibration at DDC menu option in the DRS Programming Software.

Display Available ECM S/W Versions

Displays ECM software versions that are available on the PC. These versions are used to electronically upgrade ECM software for DDEC III, IV, and V.

Display Station Log File

Displays a file containing system usage information.

Display Downloaded Units

This menu item displays the Unit Numbers of the engines which have been downloaded from the mainframe and are available for programming.

Update Logon Parameters

This option is used to configure mainframe logon and network settings. All user information may be updated when this option is selected.

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7.5 DDEC MANUALS

The following DDC manuals provide more information about specific DDEC features:

- *Construction & Industrial EDM and AIM Installation and Troubleshooting (7SA801)*
- *Construction & Industrial EDM and AIM User Manual (6SE710)*
- *ProDriver DC User Manual (6SE703)*
- *Electronic Fire Commander Installation and Troubleshooting (6SE476)*
- *Engine Synchro Shift™ Troubleshooting (6SE498)*
- *Optimized Idle - DDEC V - Installation and Troubleshooting (in process)*
- *IRIS User and Installation Guide (7SA804)*

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APPENDIX A: CODES

The codelisted may not be used in all applications. A default value in the normal operating range is used by the ECU to provide for engine operation if a sensor failure is present.

DDC Code # (Flashed)	J1939	J1587		FMI	Description
	SPN	PID	SID		
—	—	—	240	2	FRAM Checksum Incorrect
—	—	—	240	13	TPU Checksum Incorrect
—	—	—	253	9	Calibration Checks Invalid
—	—	—	254	0	External RAM Failed
—	—	—	254	1	Internal RAM Failed
—	—	—	254	6	Module Forced to Boot Mode
—	—	—	254	12	Boot Mode Checksum Incorrect
11	187	187	--	4	Variable Speed Governor Sensor Voltage Low
11	187	187	--	7	Variable Speed Governor Switch System Not Responding
12	187	187	--	3	Variable Speed Governor Sensor Voltage High
13	111	111	--	4	Coolant Level Sensor Input Voltage Low
13	111	111	--	6	Add Coolant Level Sensor Input Voltage Low
13	2791		146	6	EGR Valve Current too High
14	110	110	--	3	Coolant Temperature Sensor Input Voltage High
14	175	175	--	3	Oil Temperature Sensor Input Voltage High
15	110	110	--	4	Coolant Temperature Sensor Input Voltage Low
15	175	175	--	4	Oil Temperature Sensor Input Voltage Low
16	111	111	--	3	Coolant Level Sensor Input Voltage High
16	111	111	--	5	Add Coolant Level Sensor Input Voltage High
16	2791		146	5	EGR Valve Current too Low
21	91	91	--	3	Throttle Position Sensor Input Voltage High
22	91	91	--	4	Throttle Position Sensor Input Voltage Low
23	174	174	--	3	Fuel Temperature Sensor Input Voltage High
24	174	174	--	4	Fuel Temperature Sensor Input Voltage Low
25	—	--	--	--	Reserved for "No Codes"
26	640	--	25	11	Aux. Shutdown #1 Active
26	640	--	61	11	Aux. Shutdown #2 Active (Rel 1.0 only)
26	—	--	315	11	Aux. Shutdown #2 Active (Rel. 2.00 or later)
27	105	105	--	3	Intake Manifold Temperature Sensor Input Voltage High
27	171	171	--	3	Ambient Air Temperature Sensor Input Voltage High
27	172	172	--	3	Air Temperature Sensor Input Voltage High
28	105	105	--	4	Intake Manifold Temperature Sensor Input Voltage Low
28	171	171	--	4	Ambient Air Temperature Sensor Input Voltage Low
28	172	172	--	4	Air Temperature Sensor Input Voltage Low

DDC Code # (Flashed)	J1939	J1587		FMI	Description
	SPN	PID	SID		
29	351	351	–	4	TCI Temperature Circuit Failed Low
29	404	404	—	4	Turbo Compressor Temperature Out Sensor Input Voltage Low
31	703	--	51	3	Aux. Output #3 Open Circuit (High Side), Pin E-49
31	703	--	51	4	Aux. Output #3 Short To Ground (High Side), Pin E-49
31	703	--	51	7	Aux. Output #3 Mechanical System Fail, Pin E-49
31	704	--	52	3	Aux. Output #4 Open Circuit (High Side), Pin E-48
31	704	--	52	4	Aux. Output #4 Short to Ground (High Side), Pin E-48
31	704	--	52	7	Aux. Output #4 Mechanical System Failure, Pin E-48
31		—	260	3	Aux Output #12 Open Circuit (High Side) – Pin E-46
31		—	260	4	Aux Output #12 Short to Gnd (High Side) – Pin E-46
31		—	260	7	Aux Output #12 Mechanical System Failure – Pin E-46
31		—	261	3	Aux Output #13 Open Circuit (High Side) – Pin E-47
31		—	261	4	Aux Output #13 Short to Gnd (High Side) – Pin E-47
31		—	261	7	Aux Output #13 Mechanical System Failure – Pin E-47
31		—	262	3	Aux Output #14 Open Circuit (High Side) – Pin E-50
31		—	262	4	Aux Output #14 Short to Gnd (High Side) – Pin E-50
31		—	262	7	Aux Output #14 Mechanical System Failure – Pin E-50
31		—	263	3	Aux Output #15 Open Circuit (High Side) – Pin E-51
31		—	263	4	Aux Output #15 Short to Gnd (High Side) – Pin E-51
31		—	263	7	Aux Output #15 Mechanical System Failure – Pin E-51
31		—	264	3	Aux Output #16 Open Circuit (High Side) – Pin E-52
31		—	264	4	Aux Output #16 Short to Gnd (High Side) – Pin E-52
31		—	264	7	Aux Output #16 Mechanical System Failure – Pin E-52
31		—	265	3	Aux Output #17 Open Circuit (High Side) – Pin E-53
31		—	265	4	Aux Output #17 Short to Gnd (High Side) – Pin E-53
31		—	265	7	Aux Output #17 Mechanical System Failure – Pin E-53
32	623	--	238	3	RSL Short to Battery (+)
32	623	--	238	4	RSL Open Circuit
32	624	--	239	3	AWL Short to Battery (+)
32	624	--	239	4	AWL Open Circuit
33	102	102	--	3	Turbo Boost Pressure Sensor Input Voltage High
34	102	102	--	4	Turbo Boost Pressure Sensor Input Voltage Low
35	19	19	--	3	High Range Oil Pressure Sensor Input Voltage High
35	100	100	--	3	Oil Pressure Sensor Input Voltage High
36	19	19	--	4	High Range Oil Pressure Sensor Input Voltage Low
36	100	100	--	4	Oil Pressure Sensor Input Voltage Low

DDC Code # (Flashed)	J1939	J1587		FMI	Description
	SPN	PID	SID		
37	18	18	--	3	High Range Fuel Pressure Sensor Input Voltage High
37	94	94	--	3	Fuel Pressure Sensor Input Voltage High
37	95	95	--	3	Fuel Restriction Sensor Input Voltage High
38	18	18	--	4	High Range Fuel Pressure Sensor Input Voltage Low
38	94	94	--	4	Fuel Pressure Sensor Input Voltage Low
38	95	95		4	Fuel Restriction Sensor Input Voltage Low
39	2791	—	146	2	EGR Leak — Boost Power
39	2791	—	146	7	EGR Valve Not Responding
39	2791	—	146	12	EGR Leak — Boost Jake
39	641	—	147	2	VNT Vanes Not Responding — Boost Power
39	641	—	147	12	VNT Vanes Not Responding — Boost Jake
39	641	—	147	14	EGR Flow too Low
39	641	—	147	7	VNT Vanes Not Responding — EGR
41	636	--	21	0	Too Many SRS/CMP Sensor (missing TRS/CKP Sensor)
42	636	--	21	1	Too few SRS/CMP Sensor (missing SRS/CMP Sensor)
43	111	111	--	1	Coolant Level Low
44	105	105	--	0	Intake Manifold Temperature High
44	105	105	--	14	Engine Power Derate Due to Intake Manifold Temperature
44	110	110	--	0	Coolant Temperature High
44	110	110	--	14	Engine Power Derate Due to Coolant Temperature
44	172	172	--	0	Air Inlet Temperature High
44	175	175	--	0	Oil Temperature High
44	175	175	--	14	Engine Power Derate Due to Oil Temperature
45	19	19	--	1	High Range Oil Pressure Low
45	100	100	--	1	Oil Pressure Low
46	168	168	--	1	ECU Battery Voltage Low
46	168	168	--	14	OI Excessive Battery Time (Rel. 2.0 or later)
46	—	—	155	4	Injector V (reg) Voltage Failed Low
46	—	—	211	1	Sensor Supply Pins V-11/V-12 Low
46	—	—	212	4	Injector V (slope) Voltage Failed Low
46	1376	--	214	1	RTC Backup Battery Voltage Low, Pin V-61
46		—	221	4	Injector I (pull-in) Voltage Failed Low
46	620	--	232	1	Sensor Supply Voltage Low, Pin E-12/E-26
46	—	—	317	4	Injector V (reg) Voltage Failed Low (Rel. 2.0 or later)
47	18	18	--	0	High Range Fuel Pressure High
47	94	94	--	0	Fuel Pressure High
47	102	102	--	0	Turbo Boost Pressure High
47	102	102	--	14	Engine Power Derate Due to Turbo Boost Pressure

DDC Code # (Flashed)	J1939	J1587		FMI	Description
	SPN	PID	SID		
47	106	106	--	0	Air Inlet Pressure High
48	18	18	--	1	High Range Fuel Pressure Low
48	94	94	--	1	Fuel Pressure Low
48	106	106	--	1	Air Inlet Pressure Low
48	351	351	—	1	TCI Temperature Low
48	404	404	—	1	Turbo Compressor Temperature Out Low
48	411	411	—	1	EGR Delta Pressure Low
48	412	412	—	1	EGR Temperature Low
49	351	351	—	0	TCI Temperature High
49	404	404	—	0	Turbo Compressor Out Temperature High
49	404	404	—	14	Engine Power Derate Due to Turbo Compressor Out Temperature
51	351	351	—	3	TCI Temperature Circuit Failed High
51	404	404	—	3	Turbo Compressor Out Temperature Sensor Input Voltage High
52	—	—	254	3	ADC Reference Voltage High
52	—	—	254	4	ADC Reference Voltage Low
52	—	—	254	12	A/D Conversion Failed
53	—	—	253	2	Memory Check Failed on Startup
53	—	—	253	12	Memory Write Error — Single Location
53	—	—	253	13	Calibration Versions Invalid
53	—	—	253	14	Memory Write Error — All Locations
54	84	84	--	12	Vehicle Speed Sensor Fault
55	1484	--	216	14	Other ECU Fault (This fault is logged in conjunction with another fault to indicate missing information from another ECU.)
55	639	--	231	12	J1939 Data Link Fault
56	608	--	250	12	J1587 Data Link Fault
58	69	69	—	9	Two-speed Axle Switch Status not Responding
58	69	69	—	12	Two-speed Axle Switch Status Failed
58	92	92	--	0	Torque Overload
58	40	40	—	9	Engine Retarder Switch Status Not Responding
58	40	40	—	12	Engine Retarder Switch Status Failed
58	70	70	—	9	Park Brake/OI Switch Status Loop Not Responding
58	70	70	—	12	Park Brake/OI Switch Status Loop Failed
58	--	--	216	7	ECU Information not Responding — Mux'd IO
58	--	--	242	9	Cruise Control Resume/Accel Switch Status Not Responding
58	--	--	242	12	Cruise Control Resume/Accel Switch Status Failed
58	--	--	243	9	Cruise Control Set/Coast Switch Status Not Responding
58	--	--	243	12	Cruise Control Set/Coast Switch Status Failed
58	--	--	244	9	Cruise Control Enable Switch Status Not Responding

DDC Code # (Flashed)	J1939	J1587		FMI	Description
	SPN	PID	SID		
58	--	--	244	12	Cruise Control Enable Switch Status Failed
58	--	--	245	9	Clutch Pedal Switch Status Not Responding
58	--	--	245	9	Clutch Pedal Switch Status Failed
58	--	--	246	9	Service Brake Pedal Switch Status not Responding
58	--	--	246	12	Service Brake Pedal Switch Status Failed
61	--	--	xxx	0	Injector xxx Response Time Long
61	--	--	xxx	6	Injector xx Circuit Short to Ground
62	701	--	26	3	Aux. Output #1 Short to Battery (+), Pin V-4
62	701	--	26	4	Aux. Output #1 Open Circuit, Pin V-4
62	701	—	26	7	Aux. Output #1 Mechanical System Not Responding Properly - Pin V-4
62	702	--	40	3	Aux. Output #2 Short to Battery (+), Pin V-5
62	702	--	40	4	Aux. Output #2 Open Circuit, Pin V-5
62	702	—	40	7	Aux. Output #2 Mechanical System Not Responding Properly - Pin V-5
62	705	--	53	3	Aux. Output #5 Short to Battery (+), Pin V-6
62	705	--	53	4	Aux. Output #5 Open Circuit - Pin V-6
62	705	—	53	7	Aux. Output #5 Mechanical System Not Responding Properly - Pin V-6
62	706	--	54	3	Aux. Output #6 Short to Battery (+), Pin V-7
62	706	--	54	4	Aux. Output #6 Open Circuit - Pin V-7
62	706	--	54	7	Aux. Output #6 Mechanical System Not Responding Properly - Pin V-7
62	707	--	55	3	Aux. Output #7 Short to Battery (+), Pin V-40
62	707	--	55	4	Aux. Output #7 Open Circuit - Pin V-40
62	707	—	55	7	Aux. Output #7 Mechanical System Not Responding Properly - Pin V-40
62	708	--	56	3	Aux. Output #8 Short to Battery (+), Pin V-53
62	708	--	56	4	Aux. Output #8 Open Circuit - Pin V-53
62	708	--	56	7	Aux. Output #8 Mechanical System Not Responding Properly, Pin V-53
62	709	—	257	3	Aux Output #9 Short to Gnd — Pin V-54
62	709	—	257	4	Aux Output #9 Open Circuit — Pin V-54
62	709	—	257	7	Aux Output #9 Mechanical System Failure — V-54
62	710	—	258	3	Aux Output #10 Short to Gnd — Pin V-55
62	710	—	258	4	Aux Output #10 Open Circuit — Pin V-55
62	710	—	258	7	Aux Output #10 Mechanical System Failure — V-55
62	711	—	259	3	Aux Output #11 Short to Gnd — Pin E-13
62	711	—	259	4	Aux Output #11 Open Circuit — Pin E-13
62	711	—	259	7	Aux Output #11 Mechanical System Failure — Pin E-13
63	697	--	57	0	PWM #1 Above Normal Range, Pin V-52
63	697	--	57	1	PWM #1 Below Normal Range, Pin V-52
63	697	--	57	3	PWM #1 Short to Battery (+), Pin V-52

DDC Code # (Flashed)	J1939	J1587		FMI	Description
	SPN	PID	SID		
63	697	--	57	4	PWM #1 Open Circuit, Pin V-52
63	697	--	57	7	PWM #1 Mechanical Failure, Pin V-52
63	698	--	58	0	PWM #2 Above Normal Range, Pin V-46
63	698	--	58	1	PWM #2 Below Normal Range, Pin V-46
63	698	--	58	3	PWM #2 Short to Battery (+), Pin V-46
63	698	--	58	4	PWM #2 Open Circuit, Pin V-46
63	698	--	58	7	PWM #2 Mechanical Failure, Pin V-46
63	699	--	59	0	PWM #3 Above Normal Range, Pin E-1
63	699	--	59	1	PWM #3 Below Normal Range, Pin E-1
63	699	--	59	3	PWM #3 Short to Battery (+), Pin E-1
63	699	--	59	4	PWM #3 Open Circuit, Pin E-1
63	699	--	59	7	PWM #3 Mechanical Failure, Pin E-1
63	700	--	60	0	PWM #4 Above Normal Range, Pin E-4
63	700	--	60	1	PWM #4 Below Normal Range, Pin E-4
63	700	--	60	3	PWM #4 Short to Battery (+), Pin E-4
63	700	--	60	4	PWM #4 Open Circuit, Pin E-4
63	700	--	60	7	PWM #4 Mechanical Failure, Pin E-4
63	701	—	267	0	PWM # 5 Above Normal Range — Pin E-8
63	701	—	267	1	PWM # 5 Below Normal Range — Pin E-8
63	701	—	267	3	PWM # 5 Short to Battery — E-8
63	701	—	267	4	PWM # 5 Open Circuit — Pin E-8
63	701	—	267	7	PWM # 5 Mechanical System Failed — Pin E-8
63	702	—	268	0	PWM # 6 Above Normal Range — Pin E-11
63	702	—	268	1	PWM # 6 Below Normal Range — Pin E-11
63	702	—	268	3	PWM # 6 Short to Battery — E-11
63	702	—	268	4	PWM # 6 Open Circuit — Pin E-11
63	702	—	268	7	PWM # 6 Mechanical System Failed — Pin E-11
64	103	103	--	0	Turbo Overspeed
64	103	103	--	1	Turbo Speed Low (Rel. 2.0 or later)
64	103	103	--	8	Turbo Speed Sensor Input Failure — Abnormal Period
65	107	107	--	3	Air Filter Restriction Sensor Voltage High
65	107	107	--	4	Air Filter Restriction Sensor Voltage Low
66	99	99	--	3	Oil Filter Restriction Sensor Voltage High
66	99	99	--	4	Oil Filter Restriction Sensor Voltage Low
67	106	106	--	3	Air Inlet Pressure Sensor Input Voltage High
67	106	106	--	4	Air Inlet Pressure Sensor Input Voltage Low
67	109	109	--	3	Coolant Pressure Sensor Input Voltage High
67	109	109	--	4	Coolant Pressure Sensor Input Voltage Low
68	558	--	230	5	TPS Idle Validation Circuit Fault (open circuit)
68	558	--	230	6	TPS Idle Validation Circuit Fault (short to ground)

DDC Code # (Flashed)	J1939	J1587		FMI	Description
	SPN	PID	SID		
71	—	--	xxx	1	Injector xxx Response Time Short
72	84	84	--	0	Vehicle Overspeed
72	84	84	--	11	Vehicle Overspeed (Absolute)
73	107	107	—	0	Air Filter Restriction High
74	70	70	--	4	Optimized Idle Safety Loop Short to Ground
74	99	99	--	0	Oil Filter Restriction High
75	168	168	--	0	ECU Battery Voltage High
75	21	—	155	3	Injector V (reg) Voltage Failed High
75	21	—	211	0	Sensor Supply Pins V-11/V-12 Voltage High
75	21	—	212	3	Injector V (slope) Voltage Failed High
75	21	—	221	3	Injector V (pull-in) Voltage Failed High
75	21	—	317	3	Injector V (reg) Voltage Failed High (Rel. 2.0 or later)
75	1376	--	214	0	RTC Backup Battery Voltage High
75	620	--	232	0	Sensor Supply Voltage High. Pin E-26
76	121	121	--	0	Engine Overspeed With Engine Brake
77	19	19	—	0	High Range Oil Pressure High
77	20	20	—	0	High Range Coolant Pressure High
77	21	21	—	0	ECU Temperature Above Range
77	21	21	—	1	ECU Temperature Below Range
77	21	21	—	3	ECU Temperature Above Failed High
77	21	21	—	4	ECU Temperature Above Failed Low
77	73	73	—	1	Fire Pump Pressure Low
77	81	81	—	0	Exhaust Back Pressure High
77	81	81	—	1	Exhaust Back Pressure Low
77	81	81	—	3	Exhaust Back Pressure Sensor Voltage High
77	81	81	—	4	Exhaust Back Pressure Sensor Voltage Low
77	81	81	—	12	Exhaust Back Pressure at Rampdown Threshold
77	95	95	—	1	Fuel Filter Differential Pressure Low
77	99	99	—	1	Oil Filter Differential Pressure Low
77	100	100	—	0	Engine Oil Pressure High
77	102	102	—	1	Turbo Boost Pressure Low
77	105	105	—	1	Inlet Manifold Temperature Low
77	107	107	—	1	Air filter Restriction Pressure Low
77	108	108	—	0	Barometric Pressure High
77	108	108	—	1	Barometric Pressure Low
77	110	110	—	1	Coolant Temperature Low
77	111	111	—	0	Coolant Level High
77	171	171	—	0	Ambient Air Temperature High
77	171	171	—	1	Ambient Air Temperature Low
77	172	172	—	1	Air Inlet Temperature Low
77	174	174	—	0	Fuel Temperature High

DDC Code # (Flashed)	J1939	J1587		FMI	Description
	SPN	PID	SID		
77	174	174	—	1	Fuel Temperature Low
77	175	175	—	1	Engine Oil Temperature Low
77	222	222	—	14	Anti-Theft Fault Present
77	251	251	—	10	Clock Module Abnormal Rate of Change
77	251	251	—	13	Clock Module Failure
77	252	252	—	10	Clock Module Abnormal Rate of Change
77	252	252	—	13	Clock Module Failure
77	611	—	151	11	Service Now Lamp Fault Expiration
77	611	—	316	11	Service Now Lamp Fault Expiration (Rel 2.0 or later)
78	86	86	--	14	Cruise Control/Adaptive Cruise Control Fault
81	98	98	--	3	Oil Level Sensor Input Voltage High
81	153	153	--	3	Extended Crankcase Pressure Input Voltage High
81	173	173	--	3	Exhaust Temperature Sensor Input Voltage High
81	355	355	--	3	Engine Oil Life Circuit Failed High
81	411	411	—	3	EGR Delta Pressure Sensor Circuit Failed High
81	412	412	—	3	EGR Temperature Sensor Input Failed High
82	98	98	--	4	Oil Level Sensor Input Voltage Low
82	101	101	--	4	Crankcase Pressure Sensor Input Voltage Low
82	153	153	--	4	Extended Crankcase Pressure Input Voltage Low
82	173	173	—	4	Exhaust Temperature Sensor Input Voltage Low
82	355	355	—	4	Engine Oil Life Circuit Failed Low
82	411	411	—	4	EGR Delta Pressure Sensor Circuit Failed Low
82	412	412	—	4	EGR Temperature Circuit Failed Low
83	73	73	—	0	Pump Pressure High
83	98	98	--	0	Oil Level High
83	101	101	--	0	Crankcase Pressure High
83	153	153	--	0	Extended Crankcase Pressure High
83	173	173	—	0	Exhaust Temperature High
83	355	355	—	9	Coolant Ingress Fault Detected
83	355	355	—	14	Change Oil Now
83	411	411	—	0	EGR Delta Pressure High
83	412	412	—	0	EGR Temperature High
84	98	98	--	1	Oil Level Low
84	355	355	—	1	Change Oil Soon
85	190	190	--	0	Engine Overspeed
85	190	190	--	14	Engine Overspeed Signal
86	73	73	--	3	Pump Pressure Sensor Input Voltage High
86	108	108	--	3	Barometric Pressure Sensor Input Voltage High
87	73	73	--	4	Pump Pressure Sensor Input Voltage Low
87	108	108	--	4	Barometric Pressure Sensor Input Voltage Low

DDC Code # (Flashed)	J1939	J1587		FMI	Description
	SPN	PID	SID		
89	95	95	--	0	Fuel Restriction High
89	111	111	--	12	Maintenance Alert Coolant Level Fault

APPENDIX B: HARNESS WIRING DIAGRAMS

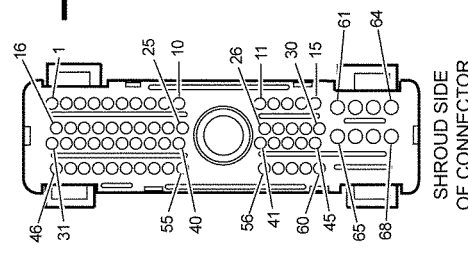
The following wiring diagrams are available on the next four pages.

- ☐ Vehicle Interface Harness — On-highway
- ☐ Series 60 Engine Harness — On-highway
- ☐ Vehicle Interface Harness — Off-highway
- ☐ Series 60 Engine Harness — Off-highway

A larger version of the wiring diagrams is available on the DDC extranet.

LABEL

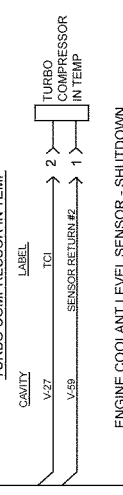
AMBER WARNING LAMP	V-1
RED STOP LAMP	V-2
SERVICE BRAKE RELEASED	V-3
FAN CONTROL #1	V-4
DIGITAL OUTPUT	V-5
VEHICLE PWR SHUTDOWN	V-6
CRUISE ENABLE	V-7
CRUISE RELEASED	V-8
CLUTCH RELEASED	V-9
SENSOR SUPPLY #1	V-10
SENSOR SUPPLY #2	V-11
THROTTLE POSITION	V-12
VSG	V-13
IGNITION	V-14
IDLE VALIDATION	V-15
VEHICLE SPEED SENSOR (+)	V-16
VEHICLE SPEED SENSOR (-)	V-17
NO CONNECTION	V-18
NO CONNECTION	V-19
NO CONNECTION	V-20
AIR FILTER RESTRICTION	V-21
EXHAUST TEMPERATURE	V-22
SEODIAG REQUEST	V-23
A/C STATUS	V-24
ANALOG INPUT - 1.5kΩ PULLUP	V-25
TURBO COMPRESSOR IN TEMP	V-26
NO CONNECTION	V-27
EXHAUST BACK PRESSURE OR	V-28
FIRE TRUCK PUMP PRESSURE	V-29
NO CONNECTION	V-30
TACHOMETER	V-31
FREQUENCY - SPARE	V-32
FREQUENCY - SPARE	V-33
NO CONNECTION	V-34
NO CONNECTION	V-35
NO CONNECTION	V-36
ADD COOLANT LEVEL	V-37
COOLANT LEVEL - SHUTDOWN	V-38
ENGINE BRAKE LOW	V-39
OIL ALARM	V-40
AUX SHUTDOWN #1	V-41
OIL THERMOSTAT	V-42
J 1939 DL (+)	V-43
J 1939 DL SHIELD	V-44
NO CONNECTION	V-45
PWM OUTPUT	V-46
SET/COAST	V-47
ANALOG INPUT - 1.5kΩ PULLUP	V-48
FAN CONTROL OVERRIDE	V-49
PARK BRAKE	V-50
ENG BRAKE MED	V-51
PWM OUTPUT	V-52
ETHER START	V-53
OIL STARTER	V-54
OIL ACTIVE LAMP	V-55
J 1587 +	V-56
J 1587 -	V-57
J 1939 DL (-)	V-58
SENSOR RETURN #2	V-59
SENSOR RETURN #1	V-60
+12V / +24V	V-61
+12V / +24V	V-62
BATTERY GROUND	V-63
BATTERY GROUND	V-64
+12V / +24V	V-65
+12V / +24V	V-66
BATTERY GROUND	V-67
BATTERY GROUND	V-68



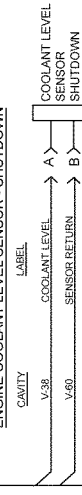
SHROUD SIDE OF CONNECTOR

68-WAY CONNECTOR 18 AWG TERMINAL
DDC PIN: 23528252 DDC PIN: 23528271
14 AWG TERMINAL
DDC PIN: 23528272

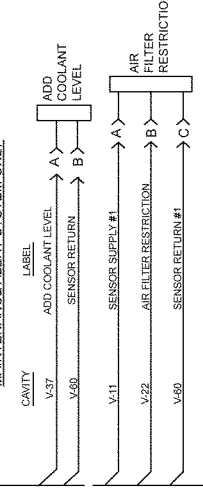
TURBO COMPRESSOR IN TEMP



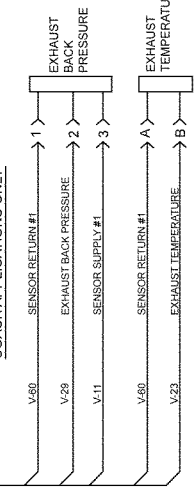
ENGINE COOLANT LEVEL SENSOR - SHUTDOWN



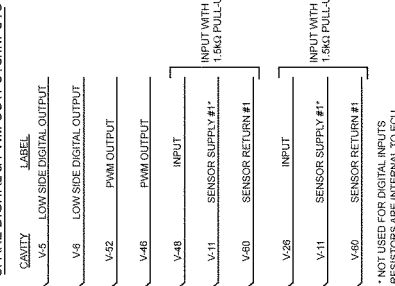
MAINTENANCE ALERT SYSTEM ONLY



COACH APPLICATIONS ONLY

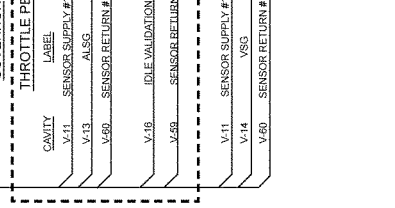


SPARE DIGITAL & PWM OUTPUTS/INPUTS

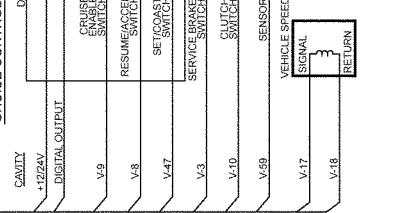


* NOT USED FOR DIGITAL INPUTS
RESISTORS ARE INTERNAL TO ECU

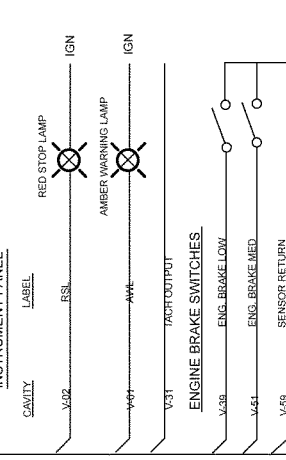
GOVERNOR THROTTLE PEDAL



CRUISE CONTROL



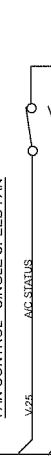
INSTRUMENT PANEL



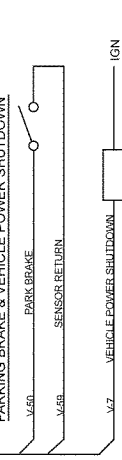
DIAGNOSTIC REQUEST / STOP ENGINE OVERRIDE



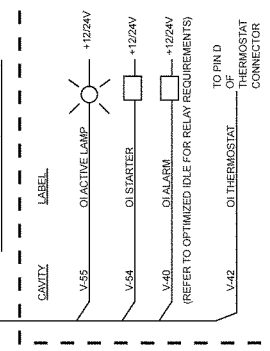
FAN CONTROL - SINGLE SPEED FAN



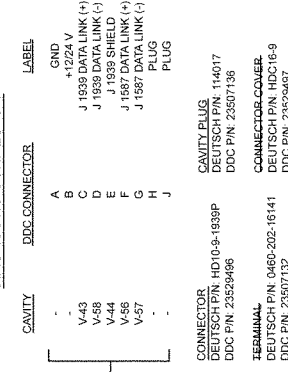
PARKING BRAKE & VEHICLE POWER SHUTDOWN



OPTIMIZED IDLE (OPTIONAL)



DIAGNOSTIC CONNECTOR



DDEC V

VEHICLE INTERFACE HARNESS



DDEC V WIRING DIAGRAM

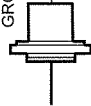
PIN NO.

WIRE COLOR

DESCRIPTION

E-1	BLK	EGR HYDRAULIC VALVE CONTROL
E-2	WHT	AIR TEMP
E-3	WHT	SPARE
E-4	BLK	VNT VPOD CONTROL
E-5	YEL	ENGINE COOLANT TEMP
E-6	YEL	SPARE
E-7	TAN	ENGINE OIL TEMP
E-8	WHT	SPARE
E-9	ORN	SUPPLY FUEL TEMP
E-10	DK GRN	EGR TEMP
E-11	DK GRN	SPARE
E-12	GRA	SENSOR SUPPLY
E-13	WHT	SPARE
E-14	BLK	SENSOR RETURN
E-15	BLK	SENSOR RETURN
E-16	YEL	FUEL RESTRICTION - MAS
E-17	PURPLE	TRS-
E-18	DK GRN	TRS+
E-19	LT BLU	SRS+
E-20	WHT	SRS-
E-21	DK GRN	OIL LEVEL - MAS
E-22	DK BLU	TURBO COMPRESSOR TEMP OUT
E-23	DK BLU	SPARE
E-24	WHT	SPARE
E-25	WHT	SPARE
E-26	WHT	SPARE
E-27	WHT	SPARE
E-28	WHT	SPARE
E-29	WHT	GROUND - SPARE
E-30	WHT	GROUND - SPARE
E-31	BRN	ENGINE OIL PRESSURE
E-32	WHT	SPARE
E-33	WHT	SPARE
E-34	BRN	TURBO SPEED SENSOR+
E-35	BLK	TURBO SPEED SENSOR-
E-36	BLK	SPARE
E-37	WHT	BAROMETRIC PRESSURE
E-38	DK BLU	EGR DELTA PRESSURE
E-39	LT GRN	INTAKE MANIFOLD PRESSURE SENSOR
E-40	WHT	CAN2+
E-41	WHT	SPARE
E-42	BLK	GROUND - VNT VPOD
E-43	WHT	GROUND - SPARE
E-44	WHT	GROUND - SPARE
E-45	WHT	GROUND - SPARE
E-46	WHT	SWITCHED BATTERY+ - VNT
E-47	LT GRN	SPARE
E-48	RED	JAKE MED/HI
E-49	ORN	JAKE LOW/HI
E-50	WHT	SPARE
E-51	YEL	SWITCHED BATTERY+ - EGR VALVE
E-52	WHT	SWITCHED BATTERY (+) - SPARE
E-53	WHT	SPARE
E-54	WHT	CAN2-
E-55	BLK	CAN2 SHIELD
E-56	WHT	SPARE
E-57	WHT	SPARE
E-58	WHT	SPARE
E-59	WHT	EXTERNAL RTC BATTERY+
E-60	WHT	GROUND PIN - SPARE
E-61	WHT	S60 COMMON CYL #1,2,3
E-62	WHT	S60 COMMON CYL #4,5,6
E-63	WHT	S60 CYL #1
E-64	WHT	S60 CYL #3
E-65	WHT	S60 CYL #2
E-66	WHT	S60 CYL #5
E-67	WHT	S60 CYL #6
E-68	WHT	S60 CYL #4

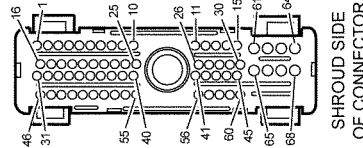
GROMMET ASSEMBLY



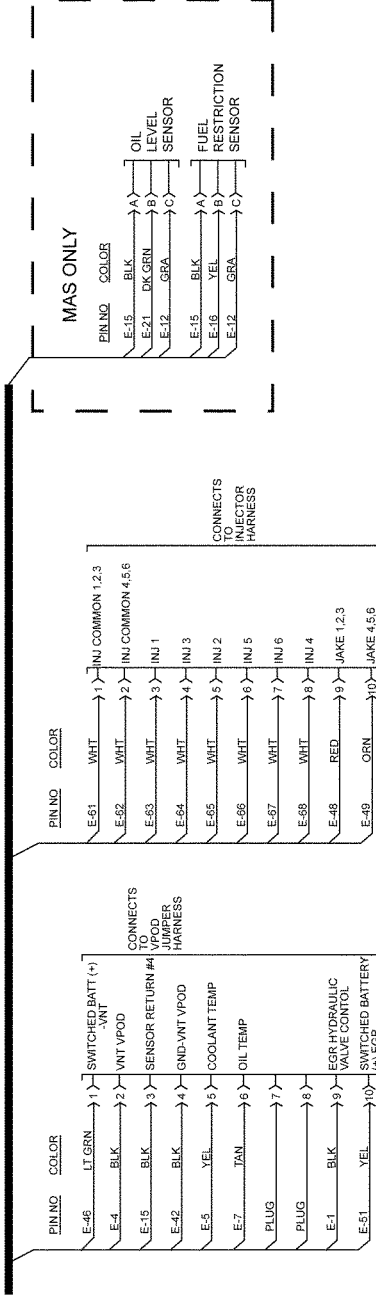
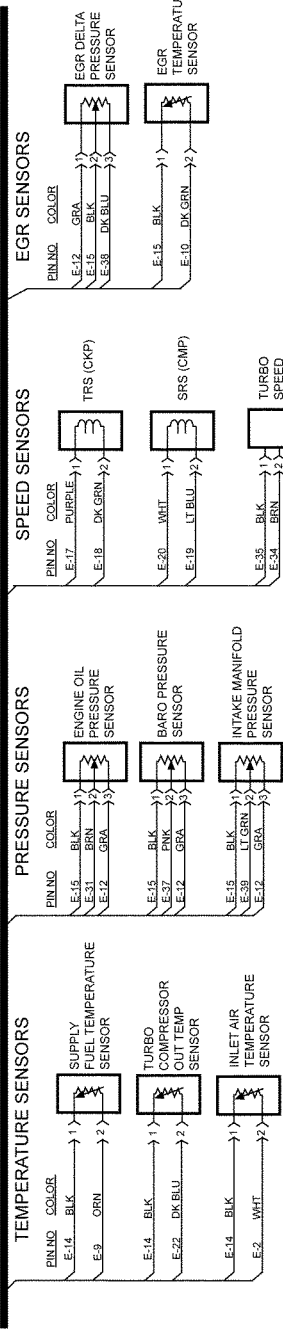
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6	WHT	INJ 5
7	WHT	INJ 6
8	WHT	INJ 4
9	WHT	JAKE 1,2,3
10	WHT	JAKE 4,5,6

SHROUD SIDE OF CONNECTOR



INJECTOR HARNESS (WITH JAKE BRAKE)

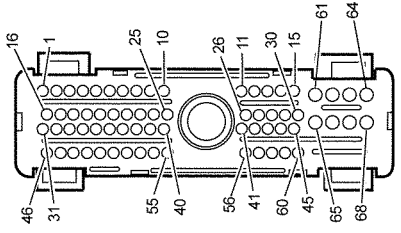


VPOD JUMPER HARNESS

PIN NO.	COLOR	DESCRIPTION
1	LT GRN	SWITCHED BATT (+) - VNT
2	BLK	VNT VPOD CTRL
3	BLK	SENSOR RETURN #4
4	BLK	GND-VNT VPOD
5	YEL	COOLANT TEMP
6	TAN	OIL TEMP
7	PLUG	
8	PLUG	
9	BLK	EGR HYDRAULIC VALVE CTRL
10	YEL	SWITCHED BATT (+) - EGR

SERIES 60 DDEC V EGR ENGINE HARNESS

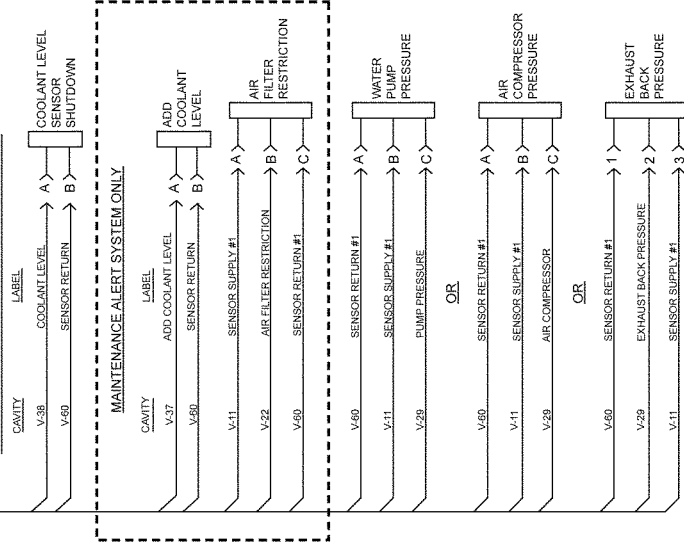
LABEL	CAVITY
AMBER WARNING LAMP	V-1
RED STOP LAMP	V-2
SERVICE BRAKE RELEASED	V-3
FAN CONTROL #1	V-4
FAN CONTROL #2	V-5
DIGITAL OUTPUT	V-6
STARTER LOCKOUT	V-7
RESUME/ACCEL	V-8
CRUISE ENABLE	V-9
SPARE	V-10
SENSOR SUPPLY #1	V-11
SENSOR SUPPLY #2	V-12
THROTTLE POSITION	V-13
VSG	V-14
IGNITION	V-15
IDLE VALIDATION	V-16
VEHICLE SPEED SENSOR (+)	V-17
VEHICLE SPEED SENSOR (-)	V-18
NO CONNECTION	V-19
NO CONNECTION	V-20
NO CONNECTION	V-21
AIR FILTER RESTRICTION	V-22
EXHAUST TEMPERATURE	V-23
SEO/DIAG REQUEST	V-24
A/C STATUS	V-25
ENGINE BRAKE DISABLE	V-26
SPARE	V-27
NO CONNECTION	V-28
EXHAUST BACK PRESSURE OR	V-29
WATER PUMP PRESSURE OR	V-30
AIR COMPRESSOR PRESSURE	V-31
NO CONNECTION	V-32
TACHOMETER	V-33
FREQUENCY - SPARE	V-34
NO CONNECTION	V-35
NO CONNECTION	V-36
NO CONNECTION	V-37
ADD COOLANT LEVEL	V-38
COOLANT LEVEL - SHUTDOWN	V-39
ENGINE BRAKE LOW	V-40
DIGITAL OUTPUT	V-41
AUX SHUTDOWN #1	V-42
SPARE	V-43
J 1939 DL (+)	V-44
J 1939 DL SHIELD	V-45
NO CONNECTION	V-46
VARIABLE SPEED FAN	V-47
SET/COAST	V-48
THROTTLE INHIBIT	V-49
FAN CONTROL OVERRIDE	V-50
PARK BRAKE	V-51
ENG BRAKE MED	V-52
PWM OUTPUT	V-53
COOLANT LEVEL LOW LAMP	V-54
NOT USED	V-55
SPARE	V-56
J 1587 +	V-57
J 1587 -	V-58
J 1939 DL (-)	V-59
SENSOR RETURN #2	V-60
SENSOR RETURN #1	V-61
+12V / +24V	V-62
+12V / +24V	V-63
BATTERY GROUND	V-64
+12V / +24V	V-65
+12V / +24V	V-66
BATTERY GROUND	V-67
BATTERY GROUND	V-68



SHROUD SIDE
OF CONNECTOR

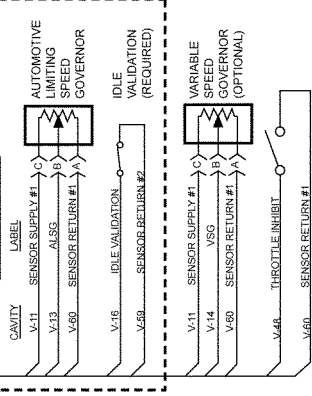
68-WAY CONNECTOR 18 AWG TERMINAL
DDC P/N: 23528252
14 AWG TERMINAL
DDC P/N: 23528272

ENGINE COOLANT LEVEL SENSOR - SHUTDOWN

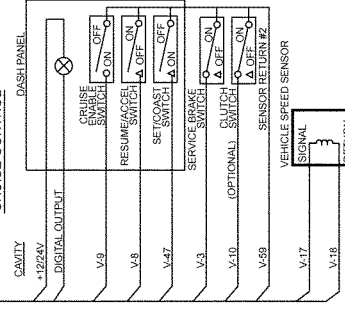


MUST PROVIDE IGNITION POWER
TO ALL IGNITION CIRCUITS.
DO NOT SHORTEN WIRE DEC
ACCESSORY FROM IGN CIRCUIT (V-15)

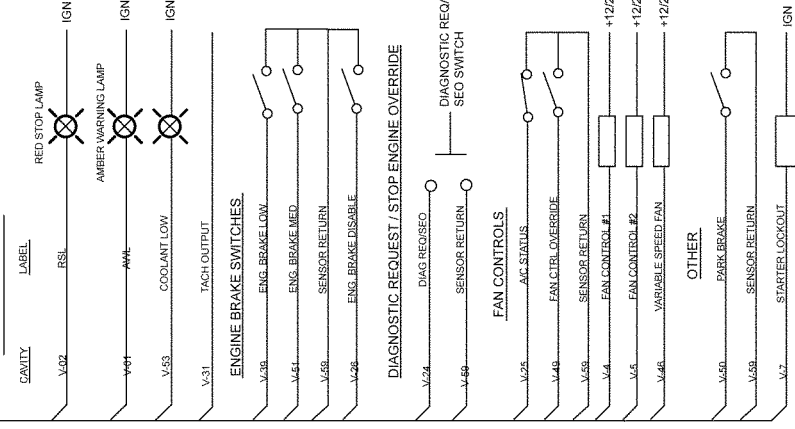
GOVERNOR THROTTLE PEDAL



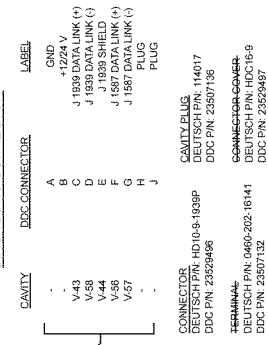
CRUISE CONTROL



INSTRUMENT PANEL



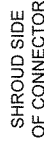
DIAGNOSTIC CONNECTOR



DDEC V VEHICLE INTERFACE HARNESS (NON-ROAD EQUIPMENT)

DDC RESPONSIBILITY

PIN NO	COLOR	DESCRIPTION
1	WHT	INJ COMMON 1,2,3
2	WHT	INJ COMMON 4,5,6
3	WHT	INJ 1
4	WHT	INJ 3
5	WHT	INJ 2
6	WHT	INJ 5
7	WHT	INJ 6
8	WHT	INJ 4
9	WHT	JAKE 1,2,3
10	WHT	JAKE 4,5,6



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APPENDIX C: CUSTOMER PROGRAMMABLE PARAMETERS

The following features have customer programmable parameters.

C.1 AIR COMPRESSOR

The air compressor parameters listed in Table C-1 can be set by customers.

Parameter	Description	Range	Access
LOAD PSI	Indicates the delta value above the current air pressure set point that will initiate the air compressor governor to reload the system.	0 to Unload PSI	DDDL, DRS, VEPS
UNLOAD PSI	Indicates the delta value above the current air pressure set point that will initiate the air compressor governor to unload the system.	Load PSI to 31 PSI	DDDL, DRS, VEPS
MIN RAT #1 PSI	Indicates the minimum allowable air pressure set point for engine rating #1.	0 to Rating 1 Max	DDDL, DRS, VEPS
MIAX RAT #1 PSI	Indicates the maximum allowable air pressure set point for engine rating #1.	Rating 1 Min to 999 PSI	DDDL, DRS, VEPS
MIN RAT #2 PSI	Indicates the minimum allowable air pressure set point for engine rating #2.	0 to Rating 2 Max	DDDL, DRS, VEPS
MAX RAT# 2 PSI	Indicates the maximum allowable air pressure set point for engine rating #2.	Rating 2 Min to 999 PSI	DDDL, DRS, VEPS
MIN RAT #3 PSI	Indicates the minimum allowable air pressure set point for engine rating #3.	0 to Rating 3 Max	DDDL, DRS, VEPS
MAX RAT #3 PSI	Indicates the maximum allowable air pressure set point for engine rating #3.	Rating 3 Min to 999 PSI	DDDL, DRS, VEPS
Air Compressor Integral Gain	Integral Gain	0 – 128 RPM/PSI x SEC	DRS, VEPS
Air Compressor Proportional Gain	Proportional Gain	0 – 128 RPM/PSI	DRS, VEPS
Air Compressor Pressure Increment	Percent Pressure Increment	0 – 50%	DRS, VEPS

Table C-1 Air Compressor Parameters

C.2 CRUISE CONTROL

The Cruise Control parameters listed in Table C-2 can be set by customers.

Parameter	Description	Range	Access
ENABLE CRUISE	Enables or disables Cruise Control operation.	YES, NO	DDDL, VEPS, or DRS
MIN CRUISE SPEED	Sets the minimum vehicle Cruise Control speed.	20 MPH to Max Cruise Speed	DDDL, VEPS, or DRS
MAXIMUM CRUISE SPEED	Sets the maximum cruise speed in MPH or KPH.	Min. Cruise Speed to Vehicle Speed Limit or 127 mph if Vehicle Speed Limiting is not enabled.	DDDL, VEPS, or DRS
AUTO RESUME	The Auto Resume feature provides automatic cruise control resumption upon completion of a manual gear shift change.	YES, NO	DDDL, VEPS, or DRS
CRUISE SWITCH VSG	Allows the cruise switches to select a desired VSG set point.	YES, NO	DDDL, VEPS, or DRS
INITIAL VSG SET SPEED	Sets the cruise switch VSG initial set speed.	VSG MIN RPM to VSG MAX RPM	DDDL, VEPS, or DRS
RPM INCREMENT	Defines the size of increase or decrease in RPM to the existing set speed for every switch toggle.	1 to 255 RPM	DDDL, VEPS, or DRS
CRUISE ENGINE BRAKE	Provides for automatic operation of the engine brake if the cruise set speed has been exceeded by the value of "Cruise Engine Brake Activation Speed." The engine brake is activated at the low level unless the operator has turned off the engine brakes with the dash mounted switches.	YES, NO	DDDL, VEPS, or DRS
CRUISE/ENGINE BRAKE ACTIVATION SPEED	Delta speed at which the engine brakes will be activated during cruise control operations. Entering a 0 will disable this option.	1 to 7 MPH	DDDL, VEPS, or DRS
ENG BRAKE INCREMENT MPH	Sets the additional incremental speed that must be reached before the engine brake will activate the medium and/or high level of retardation.	1 to 4 MPH	DDDL, VEPS, or DRS
ADAPTIVE CRUISE	Enables/Disables the Smart Cruise feature.	YES, NO	VEPS, DRS

Table C-2 Cruise Control Parameters

C.3 ENGINE BRAKE

The Engine Brake parameters listed in Table C-3 can be set by customers.

Parameter	Description	Choice / Display	Access
CRUISE CONTROL ENGINE BRAKE	Enables or disables the feature that allows the engine brake to be used while on cruise control if the vehicle exceeds the cruise set speed.	YES, NO	VEPS, DDDL, or DRS
CRUISE/ENGINE BRAKE ACTIVATION SPEED	Sets the delta speed that the engine brake should be applied to slow the vehicle while in cruise control.	1 to 7 MPH	VEPS, DDDL, or DRS
ENGINE BRAKE INCREMENT	Sets the additional incremental speed that must be reached before the engine brake will activate the medium and/or high level of retardation.	1 to 4 MPH	VEPS, DDDL, or DRS
DYNAMIC BRAKING	Provides additional engine braking by activating the DDEC controlled fan whenever the engine brakes are active in high. This function requires both DDEC engine brake controls and DDEC fan controls.	YES, NO	VEPS, DDDL, or DRS
SERVICE BRAKE ENABLE	When this function is enabled, an input from the service brake is required in order to activate the engine brake.	YES, NO	VEPS, DDDL, or DRS
ENGINE BRAKE MINIMUM MPH	The minimum vehicle speed required before engine braking will occur.	0 – 40 MPH	VEPS, DDDL, or DRS

Table C-3 Engine Brake Programmable Parameters

C.4 ENGINE OVERSPEED

The Engine Overspeed parameters listed in Table C-4 can be set by customers.

Parameter	Definition	Range/Choice	Access
Signal Enable	Engine Speed to enable the Engine Overspeed signal.	600-2500 rpm	VEPS, DRS
Signal Disable	Engine speed to disable the engine overspeed signal	600-2500 rpm	VEPS, DRS
Signal Fault Enable	Allows a diagnostic fault to be logged for engine overspeed conditions	YES, NO	DRS

Table C-4 Engine Overspeed Parameters

C.5 ENGINE PROTECTION

The Engine Protection parameters listed in Table C-5 can be set by customers.

Parameter	Definition	Choice	Access
OIL PRESSURE	Determines the type of engine protection with low oil pressure.	WARNING, RAMPDOWN, SHUTDOWN	VEPS, DDDL, or DRS
OIL LEVEL	Determines the type of engine protection with low oil level.	WARNING, RAMPDOWN, SHUTDOWN	DDDL, or DRS
COOLANT LEVEL	Determines the type of engine protection with low coolant level.	WARNING, RAMPDOWN, SHUTDOWN	VEPS, DDDL, or DRS
COOLANT TEMP	Determines the type of engine protection with high coolant temperature.	WARNING, RAMPDOWN, SHUTDOWN	VEPS, DDDL, or DRS
OIL TEMP	Determines the type of engine protection with high oil temperature.	WARNING, RAMPDOWN, SHUTDOWN	VEPS, DDDL, or DRS
AUXILIARY SHUTDOWN 1	Determines the type of engine protection with an active auxiliary switch #1 input.	WARNING, RAMPDOWN, SHUTDOWN	VEPS, DDDL, or DRS
AUXILIARY SHUTDOWN 2	Determines the type of engine protection with an active auxiliary switch #2 input.	WARNING, RAMPDOWN, SHUTDOWN	VEPS, DDDL, or DRS

Table C-5 Engine Protection

C.6 FAN CONTROL

The Fan Control parameter to set the minimum A/C Fan time is listed in Table C-6 can be set by customers.

Parameter	Description	Choices	Access
AC Fan Timer	The minimum duration of time the fan will remain ON after the AC status input has indicated that the AC unit has turned OFF. The timer starts when the input is grounded after being open.	0-255 seconds	VEPS or DRS

Table C-6 Fan Timer Parameter

C.7 FUEL ECONOMY INCENTIVE

The Fuel Economy Incentive parameters listed in Table C-7 can be set by customers.

Parameter	Definition	Limits	Access
MINIMUM ECONOMY	Indicates the minimum economy fuel economy goal.	5 to 10 MPG	DDDL, VEPS, or DRS
MAXIMUM MPH	Indicates customer set maximum vehicle speed.	0 to 10 MPH	DDDL, VEPS, or DRS
CONVERT FACTOR	The miles per hour desired for each full mile per gallon above the minimum MPG.	0.1 to 20 MPH/MPG	DDDL, VEPS, or DRS
CALC TYPE	FILTERED bases the calculations on the fuel information, by periodic sampling of fuel consumption, recorded in the ECU. TRIP bases the calculation on the trip portion of the fuel usage information.	FILTERED, TRIP	DDDL, VEPS, or DRS

Table C-7 Fuel Economy Incentive Parameters

C.8 IDLE SHUTDOWN

The Idle Shutdown parameters listed in Table C-8 can be set by customers.

Parameter	Description	Choice / Display	Access
ENABLE IDLE SHUTDOWN	Enables or Disables the Idle Shutdown feature. N/A will be displayed if the parking brake has not been configured as an input.	YES, NO	DDDL, VEPS, or DRS
TIME (MIN)	The amount of engine idle time that is allowed before the idle shutdown feature stops fueling the engine.	1 to 100 minutes	DDDL, VEPS, or DRS
OVERRIDE	The override will flash the AWL 90 seconds before shutdown to allow the driver to cancel the shutdown by pressing the accelerator pedal.	YES, NO	DDDL, VEPS, or DRS
ENABLED ON VSG	Enables or disables the idle timer shutdown feature when operating on the Variable Speed Governor.	YES, NO	DDDL, VEPS, or DRS
OVERRIDE TEMPERATURE DISABLE LOWER LIMIT	The lower limit of the ambient air temperature range that will disable the idle shutdown override feature based on ambient air temperature. 167°F will disable this feature.	-40 to "UPPER LIMIT" °F	DDDL, VEPS, or DRS
OVERRIDE TEMPERATURE DISABLE UPPER LIMIT	The upper limit of the ambient air temperature range that will disable the idle shutdown override feature. 167°F will disable this feature.	"LOWER LIMIT" to 167°F	DDDL, VEPS, or DRS
AMBIENT AIR TEMP AUTO OVERRIDE	Enables an automatic override if the ambient air temperature is out of a specified range.	YES, NO	DDDL, VEPS, or DRS

Table C-8 Idle Shutdown Timer Programming Options

C.9 LOW GEAR TORQUE LIMITING

The Low Gear Torque Limiting parameters listed in Table C-9 can be set by customers.

Parameter	Description	Choice / Display	Access
LOW GEAR TORQUE LIMITING	Provides a limit on the available torque if the ratio of vehicle speed to engine speed is below a set point.	0 to 65535 ft lb 65535 ft lb disables this feature.	VEPS or DRS
LOW GEAR THRESHOLD	The gear ratio below which torque is limited.	0.47 to 300	VEPS or DRS

Table C-9 Low Gear Torque Limiting Parameters

C.10 MAINTENANCE ALERT SYSTEM

The MAS parameters listed in Table C-10 can be set by customers.

Parameter	Description	Range	Access
Levels	Sets the function of the AWL and RSL when MAS is enabled for Level sensors	Flash at Ignition On, Continuous when Active, Both Flash and Continuous	DRS, VEPS
Filters	Sets the function of the AWL and RSL when MAS is enabled for filter sensors	Flash at Ignition On, Continuous when Active, Both Flash and Continuous	DRS, VEPS

Table C-10 MAS Parameters

C.11 MANAGEMENT INFORMATION PRODUCTS

The Data Pages/DDEC Data parameters can be set by customers.

Parameter	Description	Choice	Access
Diagnostic Record	Enables/disables the activity report	YES, NO	DRS, VEPS
Maintenance	Enables/disables the diagnostic record report	YES, NO	DRS, VEPS
Engine Usage	Enables/disables the maintenance report	YES, NO	DRS, VEPS
Engine Usage	Enables/disables the engine usage report	YES, NO	DRS, VEPS
Hard Brake/Last Stop Incidents	Enables/disables the hard brake and last stop record report	YES, NO	DRS, VEPS

Table C-11 Data Pages/DDEC Data Parameters

C.12 OPTIMIZED IDLE

The Optimized Idle parameters listed in Table C-12 can be set by customers.

Parameter	Description	Range	Default	Access
Battery Charging - Continuous Run	When enabled and OI has started the engine for battery three consecutive times, the engine will run continuously in OI Mode	YES/NO	NO	DDDL
Battery Charging - Threshold on Ambient Air	When enabled, the battery voltage threshold will be based on ambient air temperature.	YES/NO	NO	DDDL
Battery Charging - Enable Alternate Battery Run Time	Enables an alternate run time for battery starts.	YES/NO	NO	DDDL
Battery Charging - Alternate Battery Run Time	Sets the alternate run time for battery starts.	20 min to 2 hrs	0 min	DDDL
Continuous Run Upper Limit Temp	Set the continuous run upper limit. When the ambient air temperature is above this limit, the engine will run continuously.	70°F-120°F	90°F	DDDL
Continuous Run Lower Limit Temp	Sets the continuous run lower limit. When the ambient air temperature is below this limit, the engine will run continuously.	0°F-50°F	25°F	DDDL
Thermostat Max Time	Maximum amount of time the engine can run in Thermostat Mode.	0-64 hrs	0 hr	DDDL
Target RPM	Sets the speed the engine will operate at in OI Mode.	1000-1800 rpm	1100 rpm	DDDL

Table C-12 Optimized Idle Parameters

C.13 PASSSMART

The PasSmart parameters listed in Table C-13 can be set by customers.

Parameter	Description	Choice / Display	Access
Passing Speed Duration	The duration of time per interval that is permitted at the higher speed. A value of zero will disable the feature.	0 to 255 minutes	DDDL, VEPS, or DRS
Passing Speed Interval	The period of time when the ECU resets to begin a new period.	1 to 24 hours*	DDDL, VEPS, or DRS
Passing Speed Increment	The additional vehicle speed permitted above the programmed vehicle limit speed. A value of zero will disable the feature.	0 to 20 MPH	DDDL, VEPS, or DRS

* A value of 8, 12, or 24 will always reset the interval at midnight otherwise it resets every reset interval after the reprogramming was done.

Table C-13 PasSmart Parameters

C.14 PASSWORD/GROUP LOCKOUT

The Password parameters listed in Table C-14 can be set by customers.

Parameter	Description	Choice	Access
ENGINE/VEHICLE OPTIONS	Enables/Disables lockout for Engine/Vehicle parameters.	YES, NO	DDDL, VEPS, or DRS
DROOP	Enables/Disables lockout for Droop parameters.	YES, NO	DDDL, VEPS, or DRS
VSG	Enables/Disables lockout for VSG parameters.	YES, NO	DDDL, VEPS, or DRS
CRUISE CONTROL	Enables/Disables lockout for Cruise Control parameters.	YES, NO	DDDL, VEPS, or DRS
IDLE SHUTDOWN TIMER	Enables/Disables lockout for Idle Shutdown parameters.	YES, NO	DDDL, VEPS, or DRS
ENGINE PROTECTION	Enables/Disables lockout for Engine Protection parameters.	YES, NO	DDDL, VEPS, or DRS
AIR COMPRESSOR	Enables/Disables lockout for Air Compressor parameters.	YES, NO	DDDL, VEPS, or DRS
PROGRESSIVE SHIFT	Enables/Disables lockout for Progressive Shift parameters.	YES, NO	DDDL, VEPS, or DRS
TOP2	Enables/Disables lockout for Top2 parameters.	YES, NO	DDDL, VEPS, or DRS
MAINTENANCE ALERT SYSTEM	Enables/Disables lockout for Maintenance Alert System parameters.	YES, NO	DDDL or DRS
DISABLE DDEC DATA PAGE	Enables/Disables lockout for DDEC Data Pages.	YES, NO	DDDL or DRS
NATURAL GAS	Enables/Disables lockout for Natural Gas	YES, NO	DDDL or DRS

Table C-14 Group Lockout Parameters

C.15 PRESSURE SENSOR GOVERNOR

The Pressure Sensor Governor parameters listed in Table C-15 can be set by customers.

Parameter	Description	Range	Access
Integral Gain	Sets the Integral gain	0-39	DRS, VEPS
Proportional Gain	Sets the proportional gain	0-511	DRS, VEPS
Pressure Increment	Sets the pressure increment	0-99	DRS, VEPS
RPM Increment	Sets the RPM increment	0-250	DRS, VEPS
Pump Cavitation Timeout	Sets the timeout period while operating in PSG mode.	YES, NO	DRS, VEPS

Table C-15 Pressure Sensor Governor Parameters

C.16 PROGRESSIVE SHIFT

The Progressive Shift parameters listed in Table C-16 can be set by customers.

Parameter	Description	Choice	Access
ENABLED	Indicates the enabled/disabled status of the progressive shift feature.	YES, NO	DDDL, VEPS, or DRS
LOW GEAR #1 OFF SPEED (MPH)	Sets the low gear #1 turn off speed.	12 to 27 mph	DDDL, VEPS, or DRS
LOW GEAR #1 RPM LIMIT	Sets the low gear #1 RPM limit.	1000 to Low Gear #1 Max RPM	DDDL, VEPS, or DRS
LOW GEAR #1 MAXIMUM LIMIT (RPM)	Sets the low gear #1 maximum RPM limit.	1400 to Rated Speed RPM	DDDL, VEPS, or DRS
LOW GEAR #2 OFF SPEED (MPH)	Sets the low gear #2 turn off speed.	Low Gear #1 Off Speed to High Gear On Speed MPH	DDDL, VEPS, or DRS
LOW GEAR #2 RPM LIMIT	Sets the low gear #2 RPM limit.	1000 to Low Gear #2 Max RPM	DDDL, VEPS, or DRS
LOW GEAR #2 MAXIMUM LIMIT (RPM)	Sets the low gear #2 maximum RPM limit.	Low Gear #1 Max Limit to High Gear RPM Limit	DDDL, VEPS, or DRS
HIGH GEAR ON SPEED (MPH)	Sets the high gear turn on speed.	Low Gear #2 Off Speed to 127 MPH	DDDL, VEPS, or DRS
HIGH GEAR RPM LIMIT	Sets the high gear RPM limit.	1400 to Rated Speed RPM	DDDL, VEPS, or DRS

Table C-16 Progressive Shift Programming

C.17 THROTTLE CONTROLS

The Throttle Control parameters listed in Table C-17 and Table C-18 can be set by customers.

Parameter	Description	Range	Access
VSG MIN RPM	The VSG minimum speed can be set between the hot idle speed and the rated engine speed (or VSG MAX SPD when selected). This causes the engine speed to jump from the hot idle speed to VSG idle speed when the VSG throttle position is first moved (above 140 counts).	Idle — VSG Max RPM	DDDL, VEPS, or DRS
VSG MAX RPM	The VSG maximum speed can be set between the hot idle (or VSG MIN SPD when selected) and the engine rated speed.	VSG Min RPM — Rated Speed and Droop	DDDL, VEPS, or DRS
VSG ALT MIN RPM	The alternate minimum VSG (VSG ALT MIN SPD) option allows the customer to switch to a VSG idle speed greater than the VSG minimum speed (VSG MIN SPD).	VSG Min – VSG Max RPM	DDDL, VEPS, or DRS
VSG DROOP RPM	The VSG droop can be programmed between 0 and ALSG droop but not greater than 300 RPM, depending on engine rating.	0 – 300 RPM	DDDL, VEPS, or DRS
ENABLE CRUISE SWITCH VSG	Enables or disables the cruise switch VSG set speed feature.	YES, NO	DDDL, VEPS, or DRS
INITIAL RPM	Sets the cruise switch VSG initial set speed.	VSG MIN RPM to VSG MAX RPM	DDDL, VEPS, or DRS
VSG RPM INCREMENT	Sets the cruise switched VSG RPM increment.	1 to 255 RPM	DDDL, VEPS, or DRS

Table C-17 VSG Options

Parameter	Description	Range	Access
Idle Adjust RPM	Adjusts the idle RPM	-25 — 100 RPM	DDDL, DRS
ALSG Droop RPM	Sets the ALSG droop	0 – RPM	DDDL, DRS, VEPS

Table C-18 Idle Adjust and Droop

C.18 TWO-SPEED AXLE

The Two Speed Axle parameters listed in Table C-19 can be set by customers.

Parameter	Description	Choice/Display	Access
Axle Ratio	Indicates the first axle ratio of the vehicle.	2.0 to 19.99	DDDL, VEPS, or DRS
Second Axle Ratio	Indicates the second axle ratio of the vehicle.	2.0 to 19.99	DDDL, VEPS, or DRS

Table C-19 Programming the Axle Ratios

C.19 VEHICLE SPEED LIMITING

The Vehicle Speed Limiting parameters listed in Table C-20 can be set by customers.

Parameter	Description	Choice / Display	Access
VEHICLE LIMIT SPEED	Enables or disables Vehicle Speed Limiting feature.	YES, NO	DDDL, VEPS, or DRS
SPEED LIMIT (MPH)	Sets the maximum vehicle speed in MPH.	20 MPH to (rated speed/VSS ratio)	DDDL, VEPS, or DRS
OVERSPEED LIMIT FUELING	When this speed is exceeded and the engine is being fueled by the operator for at least 2 seconds, a diagnostic fault is generated.	0 – 127 MPH	DDDL, VEPS, or DRS
OVERSPEED LIMIT NO FUEL	When this speed is exceeded and the engine is not being fueled by the operator for at least 2 seconds, a diagnostic fault is logged.	0 – 127 MPH	DDDL, VEPS, or DRS

Table C-20 Vehicle Speed Limiting Parameters

C.20 VEHICLE SPEED SENSOR

The Vehicle Speed Sensor listed in Table C-21 parameters can be set by customers.

Parameter	Description	Choice / Display	Access
Enable Vehicle Speed Sensor	Enables or disables the vehicle speed sensor input.	YES, NO	DDDL, VEPS, or DRS
VSS Type	Type of vehicle speed sensor used	TAIL, WHEEL	DDDL, VEPS, or DRS
VSS Teeth	Number of teeth on the vehicle speed sensor wheel.	0 to 250	DDDL, VEPS, or DRS
VSS Signal	Type of vehicle speed sensor signal.	SWITCHED, MAGNETIC	DDDL, VEPS, or DRS
Tire Size	Vehicle tire revolutions per mile.	100 to 999	DDDL, VEPS, or DRS
Axle Ratio	Indicates the rear axle ratio of the vehicle.	2.00 to 19.99	DDDL, VEPS, or DRS
Top Gear Ratio	Indicates the vehicle transmission final drive ratio.	0.5 to 2.55	DDDL, VEPS, or DRS
VSS Anti-tamper	Enables or Disables VSS Anti-tamper Feature	YES/NO	DDDL, VEPS, or DRS

Table C-21 Vehicle Speed Sensor Parameters

C.21 OTHER PARAMETERS

Other parameters that can be set by customers are listed in Table C-22.

Parameter	Description	Entry	Access
Transmission Type	Sets the transmission type	Various	DRS, VEPS
Low Coolant Light Polarity	Sets the polarity for the low coolant digital output	Standard, Reverse	DRS
Vehicle ID Number	Sets the VIN	Alphanumeric entry	DRS, VEPS, DDDL
Vehicle Unit Number	Sets the vehicle unit number	Alphanumeric entry	DRS, DDDL

Table C-22 Various Parametes

APPENDIX D: ACRONYMS

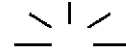
AAT Sensor	Ambient Air Temperature Sensor
ABS	Anti-lock Braking System
AECL Sensor	Add Engine Coolant Level Sensor
ACP Sensor	Air Compressor Pressure Sensor
ACS	Application Code System
AFR Sensor	Air Filter Restriction Sensor
AIM	Auxiliary Interface Module
ALSG	Automotive Limiting Speed Governor
AP	Accelerator Pedal
AP Sensor	Accelerator Pedal Sensor
ATI	Aux Timed Input
A/T	Automatic Transmission
AWL	Amber Warning Lamp
BPP	Brake Pedal Position
CKP	Crankshaft Position Sensor
CMP	Camshaft Position Sensor
CPP Switch	Clutch Pedal Position Switch
DCC	Diagnostic Connector, Cab
DDC	Detroit Diesel Corporation
DDEC	Detroit Diesel Electronic Controls
DDDL	Detroit Diesel Diagnostic Link
DLC	Data Link Connector

DRS	DDEC Reprogramming System
DTC	Diagnostic Trouble Code
ECL Sensor	Engine Coolant Level Sensor
ECT Sensor	Engine Coolant Temperature Sensor
ECU	Engine Control Unit
EDM	Electronic Display Module
EEPROM	Electrically Erasable Programmable Read Only Memory
EFC	Electronic Fire Commander
EH	Engine Harness
EOL Sensor	Engine Oil Level Sensor
EOP	Engine Over Temperature Protection
EOP Sensor	Engine Oil Pressure Sensor
EOT Sensor	Engine Oil Temperature Sensor
ESS	Engine Synchro Shift
ET Sensor	Exhaust Temperature Sensor
FEI	Fuel Economy Incentive
FMI	Failure Mode Identifier
FRS	Fuel Restriction Sensor
HEI	Half Engine Idle
IAT Sensor	Intake Air Temperature Sensor
IMP Sensor	Intake Manifold Pressure Sensor
ISD	Idle Shutdown
MAS	Maintenance Alert System

MPG	Miles Per Gallon
MPH	Miles Per Hour
MID	Message IDentification Character
OECL Sensor	Optical Engine Coolant Level Sensor
OEM	Original Equipment Manufacturer
OI	Optimized Idle
PGN	Parameter Group Number
PID	Parameter IDentification Character
PSG	Pressure Sensor Governor
PTO	Power Take-off
PVM	Pulse to Voltage Module
PW	Pulse Width
PWM	Pulse Width Modulated
RSL	Red Stop Lamp
SEO	Stop Engine Override
SID	Subsystem IDentification Character
SFT Sensor	Supply Fuel Temperature Sensor
TDC	Top Dead Center
VEPS	Vehicle Electronic Programming System
VIH	Vehicle Interface Harness
VIN	Vehicle Identification Number
VLS	Vehicle Limiting Speed
VSG	Variable Speed Governor
VSS	Vehicle Speed Sensor

APPENDIX E: SYMBOLS

ALARM

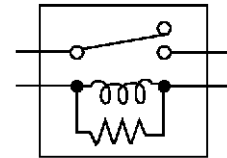


COIL

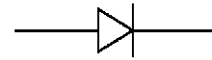


COIL, RELAY

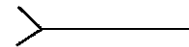
Normally open single pole double throw relay



DIODE



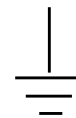
FEMALE TERMINAL



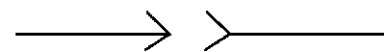
FUSE



GROUND, BATTERY



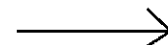
INLINE CONNECTION



LIGHT



MALE TERMINAL

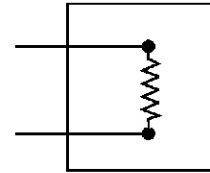


40396

PICKUP, MAGNETIC



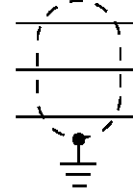
POTENTIOMETER



RESISTOR



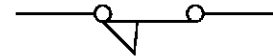
SHIELDED CABLE



SPLICE



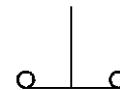
SWITCH, LIGHT
(Normally Closed)



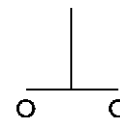
SWITCH, LIGHT
(Normally Open)



SWITCH, MOMENTARY
(Closed)



SWITCH, MOMENTARY
(Open)

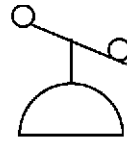


SWITCH, MUSHROOM-HEAD SAFETY
(Normally Closed)



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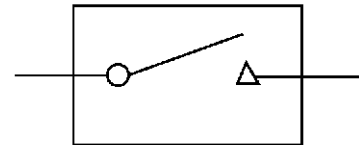
SWITCH, PRESSURE
(Closes on Rising Pressure)



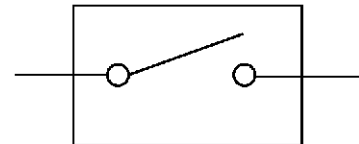
SWITCH, SAFETY INTERLOCKS
(Circuit Closing)



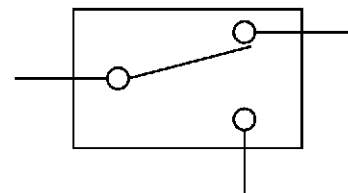
SWITCH, SINGLE POLE, SINGLE THROW
(With Spring Return)



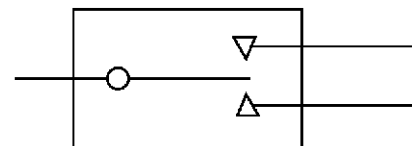
SWITCH, SINGLE POLE, SINGLE THROW
(Without Spring Return)



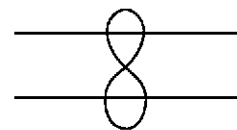
SWITCH, SINGLE POLE, DOUBLE THROW
(Without Spring Return)



SWITCH, SINGLE POLE, DOUBLE THROW
(With Double Spring Action)



TWISTED PAIR



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APPENDIX F: VENDORS

Compatible engine accessories may be obtained from several vendors. This section provides vendors name, address.

FANS

Single-speed fans are available from:

Linnig Corp

5131 Royal Atlantic Drive
Tucker, GA 30054
Phone: (770) 414-9499
www.linnig.com

Index Sensors & Controls, Inc.

7112 265th ST NW
Stanwood, WA 98292
Phone: 1-800-726-1737
www.indexsensors.com

Bendix Commercial Vehicle Systems

901 Cleveland St.
Elyria, OH 44035
Phone: 1-800-AIR-BRAKE
www.bendix.com

Borg Warner

Phone: 1-800-828-8127
www.bwinstruments.com

Two-speed fans are available from:

Linnig U.S.A.

5131 Royal Atlantic Drive
Tucker, GA 30054
Phone: (770) 414-9499
www.linnig.com

A variable speed fan is available from:

Rockford Powertrain, Inc.

1200 Windsor Road
Rockford, IL 61111
Phone: (815) 633-7460
www.rockfordpowertrain.com

VEHICLE SPEED SENSORS

Wabash Technologies

1375 Swan Streets
Huntington, Indiana 46750-0829
Phone: 260-356-8300
www.wabashtech.com

Airpax Instruments

Phillips Technologies
150 Knotter Drive
Cheshire, Connecticut 06410
Phone: 1- 800-643-0643

Invensys Electro Corporation

1845 57th Street
Sarasota, Florida 34243
Phone: 1-800-446-5762
Fax: 941-355-3120
www.electrocorp.com

ACCELERATOR PEDAL ASSEMBLY

Williams Controls

14100 S.W. 72nd Avenue
Portland, Oregon 97223
Phone: (503) 684-8600
www.williamscontrols.com

Bendix Commercial Vehicles

901 Cleveland
Elyria, Ohio 44035
Phone: 1-800-AIR-BRAKE
www.bendix.com

HAND THROTTLE

Telflex Morse

Phone: 610-495-7011

DOCUMENTATION

SAE International

400 Commonwealth Drive
Warrendale, PA 15096
Attention: Publications
Phone: (412) 776-4970
www.sae.org

SHRINK WRAP

Alpha Wire Corporation

711 Lidgerwood Ave
P.O. Box 711
Elizabeth, New Jersey 07207-0711
Phone: 1-800-52ALPHA

Tyco Electronics Corporation

Raychem Cable Identification and Protection

300 Constitution Drive
Menlo Park, CA 94025
Phone: 1-800-926-2425
www.raychem.com

GLOSSARY

Add Engine Coolant Level Sensor	Provides another coolant level sensor, higher in the top tank of the vehicle cooling system. Typically, this is used to recognize the coolant is low, but not low enough to activate the DDEC engine protection.
Amber Warning Lamp	A panel mounted yellow indicator light, provided by the vehicle OEM as standard.
Air Filter Restriction Sensor	Monitors the condition of the air filter for applications which have the Maintenance Alert System (MAS).
Automotive Limiting Speed Governor	Maintains vehicle speed based on driver throttle input. The engine changes RPM to maintain a vehicle speed with the accelerator pedal.
Camshaft Position Sensor	Indicates crank position of every cylinder; tells the ECU where the rotation of the engine is or when to fuel each cylinder. DDC standard.
Crankshaft Position Sensor	Indicates a specific cylinder in the firing order; tells the ECU when the #1 cylinder is at top dead center of its stroke. DDC standard.
Cruise Control	Operates in either Engine or Vehicle Speed Mode and maintain a targeted speed (MPH or RPM) by increasing or decreasing fueling to maximize fuel economy and driveability.
Customer Option Password	A 4 digit alpha-numeric password to protect and change customer parameters in DDDL. This password is set with DDDL. This password does <u>not</u> protect the horsepower rating.
DDEC V	Fifth generation of Detroit Diesel Electronic Controls.
Deceleration Light	Illuminates on the rear of the vehicle when you take your foot off the accelerator pedal to indicate that the vehicle is slowing down. Typically, this is used on the rear of a bus that operates in the city.
Diagnostic Request Switch	A switch that allows the yellow and red lights to flash two digit diagnostic codes when the engine is idling or off. The yellow light flashes inactive (or historic) codes. The red light flashes active codes. These two digit codes are

	defined on the DDEC DDR pocket card. This can be the same switch as the stop engine override.
Engine Control Unit	The ECU includes control logic to provide overall engine management. The ECU continuously performs self diagnostic checks and monitors other system components
Electronic Fire Commander	Designed for the fire fighting and emergency services market, EFC combines the DDEC Pressure Sensor Governor (PSG), a system monitor, and a pump panel display for vital engine operating parameters into one compact, durable package.
Engine Brakes Cruise Control	Provides cruise control compatibility with engine brakes. While in cruise control, the engine brakes will turn on and go off automatically in order to maintain the same cruise set speed.
Engine Brake LOW ON (Above Cruise Control)	The additional engine speed above the driver selected cruise speed that the low engine brakes (Jake Brakes) turn on.
Engine Brake Medium/High On (Increment)	Sets the engine brake medium and high limits to a vehicle speed above engine brake low.
Engine Coolant Level Sensor	Activates the engine protection if the coolant level is low.
Engine Coolant Temperature Sensor	Provides coolant level information to the ECU. Used for engine protection.
Engine Fan Braking	Automatically engages the cooling fan clutch when all the engine brakes are on, (HIGH).
Engine Fuel Restriction Sensor	Monitors the condition of the fuel filter for applications which have the Maintenance Alert System (MAS).
Engine Fuel Temperature Sensor	Provides fuel temperature information to the ECU. Used for determining hot fuel, and adjusting the calibration based on this temp.
Engine Harness	Connects the ECU to all engine sensors, facilitates the receipt of inputs and outputs signals, controlling the fuel injection process and engine speed.
Engine Oil Level Sensor	Monitors engine oil level for applications which have the Maintenance Alert System (MAS).

Engine Oil Pressure Sensor	Provides engine oil pressure to the ECU. Used for engine protection.
Engine Oil Temperature Sensor	Provides the engine oil temperature to the ECU. Used for engine protection and fan controls.
Engine Protection	Provides three levels of protection to the engine if it is operating out of the limits. These three levels are warning, rampdown, and shutdown. Coolant level, coolant temperature, oil temperature, oil pressure, and two additional sensors provide protection to the engine. Typically, the additional sensors are used for high oil temperature in the automatic transmission, low oil level in the engine, and other vehicle systems that require the engine to shutdown.
Engine Over Temperature Protection	The reduction in operating power from between the time the CEL and the SEL illuminates. For high coolant and/or oil temperature <u>only</u> .
Engine Overspeed	Logs diagnostic code at 2500 RPM, DDC standard.
Ether Start	A fully-automatic engine starting fluid system used to assist a DDEC equipped diesel engine in cold starting conditions.
Failure Mode Identifier	The FMI describes the type of failure detected in the subsystem and identified by the PID or SID.
Fan Clutch Override	Used to engage the cooling fan when desired. Fan Controls use the DDEC oil temperature, coolant temperature, or air temperature sensors to engage the cooling fan.
Half Engine Idle	The engine idles on three of the cylinders to reduce the amount of white smoke on cold engine startup.
High Range Max MPH	Defines the minimum vehicle speed required to activate the high range max RPM function. This is used to encourage the driver to use high gear, while in cruise control.
High Range Max RPM	Limits the maximum engine speed in the top range of gears, encouraging the driver to upshift to the next higher gear to increase vehicle speed. This function will determine the vehicle speed limit, unless a slower speed limit is selected for the vehicle speed limit parameter.

	During the shift sequence, the high range max MPH must be reached before the high range max RPM is achieved.
Horsepower Rating Password	A 4 digit alpha-numeric password to protect and activate the horsepower rating in the ECU. This password is set with DDDL.
Horsepower Rating Security	Protects the multiple horsepower ratings in the ECU. Only one rating will be available with this feature turned on. This lock is set at the time of engine order from DDC or the OEM.
Idle Timer Shutdown Override With Throttle	Allows the engine shutdown to be canceled by depressing the accelerator pedal while the Amber Warning Lamp is flashing 90 seconds before engine shutdown.
Idle Time	The amount of time spent idling before the engine will automatically shutdown; set with DDDL.
Idle Timer Shutdown	Allows the engine to shutdown after a customer set time expires on idling (low idle or high idle or PTO).
Intake Air Temperature Sensor	An intake mounted sensor which provides air temperature information to the ECU.
Intake Manifold Pressure Sensor	Provides air pressure (atmospheric and boost) information from turbocharger to the ECU. This sensor is located in the air intake manifold. Used for white smoke and emissions. DDC standard.
Maintenance Alert System	An optional feature that monitors engine fluid levels and filter restrictions and notifies the driver and/or technician when maintenance is required.
Management Information Products	A modular system that provides monitoring of any DDEC-equipped engine.
Maximum Security	Protects and locks out <u>all</u> of the programmed parameters in the ECU. This lock is set at the time of engine order from DDC or at the OEM. Feature settings cannot be changed with maximum security turned on.
Optimized Idle	An optional feature that automatically stops and restarts the engine to reduce engine idle time by running the engine only when required.

PasSmart	An optional feature that allows a fleet manager to enable a second Vehicle Limit Speed above the primary Vehicle Limit Speed so drivers may increase their vehicle speed above the primary Vehicle Limit Speed for the purpose of passing.
Parameter Identification Character	A PID is a single byte character used in J1587 messages to identify the data byte(s) that follow.
Power Take Off	A mechanical gear device used to divert engine horsepower to other machinery.
Progressive Shifting	Encourages the driver to shift in to a higher gear before the engine reaches governed speed. The Spec Manager program should be utilized to determine maximum vehicle speed. Typically, this is used on 2100 RPM rated engines.
Pressure Sensor Governor For Fire Trucks	Maintains a set water pressure on a fire truck water pump. The engine speed will vary to maintain a constant water pressure. This feature is in fire trucks.
Pressure Sensor Governor Light For Fire Trucks	Indicates that the Pressure Sensor Governor is active.
Pulse Width	The duration of time the injectors are fueling the engine, measured in degrees of rotation of the engine.
Pulse Width Modulated	A type of electrical signal output.
Rail Fuel Pressure Sensor	Produces a signal, indicating fuel pressure to warn the operator of impending power loss.
Red Stop Lamp	A panel mounted red indicator light provided by the OEM as standard.
SAE J1587	Communication link used for DDDL, Data Hub, ABS, etc.
SAE J1939	Communication link used for multiple block engines and other vehicle systems.
Starter Lockout	Prevents the starter from activating after the engine is already running. Typically, this is used in buses.
Stop Engine Override	This switch allows an override of the engine protection system when toggled in the rampdown or shutdown mode

every 30 seconds. This can be the same switch as the Diagnostic Request Switch.

Subsystem Identification Character	A SID is a single byte character used to identify field-repairable or replaceable subsystems for which failures can be detected or isolated.
Throttle Inhibit	Disables the accelerator pedal by making it unresponsive when a switch is toggled. Typically, this is used in buses for when the doors are open, or when the pressure governor system is active in a fire truck.
Throttle Position Sensor	Converts the operator's hand throttle and/or foot pedal input into a signal for the ECU, better known as the accelerator pedal. This pedal, located on the floor of the vehicle cab, tells the ECU how much fuel is needed based on the driver input. Provided by the OEM, standard.
Top Dead Center	When the piston is at the top of the stroke nearest the head of the engine. The point at which the piston stops going up and starts going down.
Variable Speed Governor	Maintains a constant engine speed with varying loads. A variable speed governor is referred to as: high idle, fast idle, hand throttle, Vernier, voltage divider, power take off (PTO), Cruise Control, or Cruise Switch VSG.
Vehicle Electronic Programming System	A PC software package used to to change the parameters to be programmed into the DDEC V ECU. OEM supplied.
Vehicle Interface Harness	Connects the ECU to other vehicle systems and batteries.
Vehicle Power Shutdown	Allows the chassis power and DDEC power to shutdown after idling on low idle or high idle for the set idle time. The idle shutdown override with throttle will override the vehicle power shutdown. In addition, the vehicle power will shutdown after an engine protection shutdown. This can be overridden by the stop engine override switch.
Vehicle Limiting Speed	The vehicle's fastest speed. limits the vehicle from going faster than a preset limit.
Vehicle Speed Maximum	The fastest vehicle speed (MPH/KPH) the driver is allowed to travel on flat ground.
Vehicle Speed Sensor	Tells the ECU how fast the vehicle is going. This magnetic pickup is located on the tail shaft of the

transmission or on the rear drive wheel of the vehicle. Provided by the OEM. Required for cruise control, vehicle speed limiting, vehicle overspeed with/without throttle, progressive shift, and engine brakes. Optional.

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